In Reply Refer to:
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March 21, 2024

Memorandum

To: Kate Norman, Assistant Regional Director
Pacific Regional Office; Portland, Oregon

From: Brad Thompson, State Supervisor
Washington Fish and Wildlife Office; Lacey, Washington

BRADLEY THOMPSON

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Date: 2024.03.21 10:27:55 -07'00'

Subject: Reinitiation of Consultation on Issuance of the Incidental Take Permit for the Washington State Trust Lands Habitat Conservation Plan (PRT-812521)

This memorandum transmits the U. S. Fish and Wildlife Service's (USFWS) Reinitiated Biological Opinion on the Incidental Take Permit (ITP) (PRT-812521) previously issued to the Washington State Department of Natural Resources (WDNR or DNR) for the Washington State Trust Lands Habitat Conservation Plan (HCP), and its effects on northern spotted owl (*Strix occidentalis caurina*) (spotted owl), and its designated critical habitat and bull trout (*Salvelinus confluentus*), and its designated critical habitat. The HCP and ITP cover WDNR-managed forested lands located within the range of the spotted owl in Washington. For some species, such as bull trout, the HCP and ITP only apply west of the Cascade Crest. Reinitiation of formal consultation was conducted in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (ESA). Your request for reinitiation of formal consultation was received on September 29, 2022.

On January 30, 1997, USFWS issued an ITP (PRT-812521) to the WDNR, pursuant to section 10(a)(1)(B) of the ESA. The ITP authorized the incidental take of several species listed under the ESA (including the threatened spotted owl) likely to be taken in the course of otherwise lawful forest management-activities associated with implementation of the HCP. This Federal action required intra-Service consultation.

On January 27, 1997, USFWS completed a Biological Opinion (the 1997 Opinion) (USFWS 1997a) under section 7(a)(2) of the ESA at the time of the issuance of the ITP. Because the National Marine Fisheries Service (NMFS) also approved the HCP, NMFS completed a separate analysis (NMFS 1997) of potential effects of the HCP on anadromous fish as required by the ESA. On January 29, 1997, a conference report (USFWS 1997b) was also prepared regarding the pending issuance of the permit. The conference report addressed a plant species proposed for Federal listing and, consistent with USFWS policy regarding intra-Service consultations to address candidate species as if they were proposed for Federal listing, the conference report also addressed three candidate species. One of these candidate species was bull trout. On December 18, 1998, a biological opinion and conference opinion (the 1998 Opinion) (USFWS 1998) was conducted for the addition of bull trout to the permit regarding HCP lands west of the Cascade Crest. Therefore, this request includes reinitiation with respect to two biological opinions: the 1997 Opinion and the 1998 Opinion. In conducting reinitiation of consultation, we are not making a determination regarding the extent of discretion, if any, that USFWS retains regarding the ITP, but will assume discretion for purposes of completing consultation under section 7 of the ESA.

The attached Reinitiated Biological Opinion (Reinitiation) of these two previous Opinions is based on information provided in the 1997 and 1998 Opinions, the Final HCP (WDNR 1997), subsequent approved HCP amendments, and other sources of information as cited in this Reinitiation. A complete record of this consultation is on file at USFWS's Washington Fish and Wildlife Office in Lacey, Washington.

If you have any questions regarding the attached Reinitiated Biological Opinion, please contact Sonja Kokos (sonja_kokos@fws.gov) or Vince Harke (vince_harke@fws.gov).

Attachment

cc:
WDNR, Olympia, WA, (A. Estep)
WDNR, Olympia, WA (C. Crump)
USFWS, Portland, OR (K. Freund)
USFWS, Portland, OR (C. Simes)
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Endangered Species Act - Section 7 Consultation

Intra-Service

BIOLOGICAL OPINION

U.S. Fish and Wildlife Service Reference:
2023-0004491

Effects of Continued Implementation of the Incidental Take Permit for the Washington State Trust Lands Habitat Conservation Plan (PRT-812521)

Multiple Counties, Washington

Federal Action Agency:

U.S. Fish and Wildlife Service
Pacific Regional Office
Portland, Oregon

Consultation Conducted By:

U.S. Fish and Wildlife Service
Washington Fish and Wildlife Office
Lacey, Washington

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Brad Thompson, State Supervisor
Washington Fish and Wildlife Office

March 21, 2024
Date

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ACRONYMS AND ABBREVIATIONS

ARU	autonomous recording units
CFR	Code of Federal Regulations
CRNMP	Comprehensive Road Network Management Plan
CH	Critical Habitat
CHU	Critical Habitat Unit
DBH	diameter-at-breast-height
DFC	Desired Future Condition
DPS	Distinct Population Segment
EIS	Environmental Impact Statement
ESA	Endangered Species Act of 1973, as amended (16 U.S.C. l531 *et seq.*)
FEIS	Final Environmental Impact Statement
FMO	Foraging, Migration and Overwintering
FPHCP	Forest Practices Habitat Conservation Plan
FR	Federal Register
GC	glucocorticoids
GIS	Geographic Information System
GM	general management
HCP	Habitat Conservation Plan
IA	Implementing Agreement
ITP	Incidental Take Permit
ITS	incidental take statement
LTFC	Long-term Forest Cover
mi^2	square mile
MoRF	movement, roosting, and foraging
NAP	Natural Area Preserve
NMFS	National Marine Fisheries Service
NRCA	Natural Resource Conservation Area
NRF	Nesting, Roosting, Foraging
NWFP	Northwest Forest Plan
OESF	Olympic Experimental State Forest
PPDFC	Ponderosa Pine Desired Future Condition
RD	Relative Density
RDFC	Riparian Desired Future Condition
RFRS	Riparian Forest Restoration Strategy
RMAPs	Road Management and Abandonment Plans
RMZ	Riparian Management Zone
SEPA	State Environmental Policy Act
Services	U.S. Fish and Wildlife Service and National Marine Fisheries Service
tpa	Trees per acre
USFWS	U.S. Fish and Wildlife Service
WDFW	Washington Department of Fish and Wildlife
WDNR	Washington State Department of Natural Resources
YFM	Young Forest Marginal Habitat

1 EXECUTIVE SUMMARY

This document is a reinitiated Biological Opinion based on a review of past and ongoing implementation of an Incidental Take Permit (ITP) issued by the U.S. Fish and Wildlife Service (USFWS) to the Washington State Department of Natural Resources (WDNR) in accordance with section 10(a)(1)(B) of the Endangered Species Act (ESA). The ITP applies to implementation of the 1997 Washington State Trust Lands Habitat Conservation Plan (HCP), as amended. The HCP covers timber harvest, road management, and various other forest management activities on over 1.91 million acres of state trust lands located within the range of the spotted owl in Washington. The initial term of the HCP is 70 years, ending January 30, 2067.

The Biological Opinion evaluates the effects of continued implementation of the existing HCP/ITP to the threatened northern spotted owl (spotted owl) and bull trout, and designated critical habitats for these species in accordance with section 7 of the ESA. Based on our review, it is the Opinion of the USFWS that continued implementation of the HCP/ITP is not likely to jeopardize the continued existence of the bull trout or the spotted owl and is not likely to destroy or adversely modify designated critical habitat for these species. Additionally, we determined that the amount of incidental take authorized by the ITP for spotted owl and bull trout has not been exceeded, and issuance of a modified ITP is not required.

Spotted owl populations have continued to decline since the species was listed as threatened in 1990. Competition from the barred owl is now the primary driver behind spotted owl population declines, greatly overwhelming the impacts of habitat loss or degradation over the past 25 years. Barred owl management will be essential to spotted owl recovery efforts in Washington. Habitat conservation also remains important for the recovery of the spotted owl. The spotted owl conservation strategies included in the HCP provide for maintaining or restoring spotted owl habitat in key geographic locations that compliment spotted owl conservation efforts on adjacent federal lands managed under the Northwest Forest Plan. The effects of continued forest management under the HCP to spotted owl numbers, reproduction, and distribution are not appreciable at scale of individual recovery units or across the species range. Therefore, continued implementation of the HCP/ITP is not likely to jeopardize the continued existence of the spotted owl. The long-term, landscape-scale habitat conservation provided by the HCP is essential for supporting ongoing spotted owl conservation and recovery efforts in Washington.

The riparian conservation strategies included in the HCP are designed to maintain and restore habitat for salmon, bull trout, and other aquatic species for all fish-bearing streams on the HCP-covered lands. Because these conservation strategies are effective at minimizing most land-management effects to aquatic habitat, we conclude that the ongoing effects of HCP implementation will not result in appreciable reductions in the bull trout numbers, distribution, or reproduction within the coastal recovery unit or across the species range. Therefore, continued implementation of the HCP/ITP is not likely to jeopardize the continued existence of the bull trout. Continued forest management under the HCP is also not likely to result in the destruction or adverse modification of designed bull trout habitat. The HCP riparian conservation strategies will lead to the long-term restoration and recovery of bull trout habitat that was degraded by the past effects of historical forest practices that did not provide for the protection of aquatic and riparian habitats. Therefore, continued implementation of the HCP/ITP is not expected to preclude recovery of bull trout.

Critical habitat for the bull trout and spotted owl has not been designated on the HCP-covered lands. Effects to designated critical habitat from ongoing HCP implementation is limited to indirect effects (e.g., downstream effects, or edge-effects on adjacent federal lands) in a few scattered locations. These effects do not reduce the function or value of designated critical habitats to support conservation and recovery for the bull trout or spotted owl.

2 INTRODUCTION

This document represents the USFWS Reinitiated Biological Opinion (Reinitiation) for bull trout (*Salvelinus confluentus*) and northern spotted owl (*Strix occidentalis caurina*) (spotted owl) and their respective critical habitats. This Biological Opinion is based on our review of the past and proposed continued implementation of the ITP (PRT-812521) issued to the WDNR authorizing the incidental take of several species listed under ESA which are likely to be taken during otherwise lawful forest management activities associated with the Washington State Trust Lands HCP. Reinitiation of formal consultation was conducted in accordance with section 7 of the ESA.

Incidental Take Permits

Section 9 of the ESA and federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. *Harm* is defined by the USFWS as an act which actually kills or injures wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering (50 CFR 17.3). *Harass* is defined by USFWS as an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering (50 CFR 17.3). *Incidental take* is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity.

To obtain an incidental take permit, an applicant must develop a conservation plan that meets specific requirements identified in section 10(a)(2)(A) of the ESA and its implementing regulations at 50 CFR 17.22 (endangered species) and 17.32 (threatened species), and 50 CFR 222.25, 222.27, and 222.31). Among other requirements, the plan must specify the impacts that are likely to result from the taking, the measures the permit applicant will undertake to minimize and mitigate such impacts, and the funding that will be available to implement such measures. Conservation plans developed under section 10(a)(1)(B) of the ESA are referred to as HCPs.

WDNR State Trust Lands HCP

On January 30, 1997, the USFWS issued an ITP predicated on the Washington State Trust Lands HCP approved and adopted by the Board of Natural Resources (Resolution 96-911, November 5,1996) and later reprinted in September 1997 as the Final HCP (WDNR 1997, entire). The

Final HCP reflects the changes made to the draft HCP following public comment and negotiations between the agencies: the USFWS, WDNR, and National Marine Fisheries Service (NMFS), and includes all the decision and execution documents completed and approved in the January 1997 issuance of the ITP. Among other species, the ITP included anticipated take of spotted owl associated with WDNR HCP activities.

Along with the issuance of the ITP and approved HCP, the Services (USFWS and NMFS together) and WDNR entered into an Implementation Agreement (IA). The IA provides the same assurances WDNR received for listed species and provides that the unlisted species are treated as though they are listed within a properly implemented HCP. The unlisted species provisions only apply to species west of the Cascades Crest due to a lack of riparian strategy east of the Cascades Crest, among other reasons. The IA also limits the ability of the Services to impose new requirements upon WDNR, so long as the HCP is functioning properly.

Under the IA, WDNR could request the addition of newly listed species to the ITP, and the USFWS would process such requests including the completion of a Biological Opinion (Opinion) addressing such newly listed species.

In 1998, the USFWS listed the Columbia River Distinct Population Segment (DPS) of bull trout as threatened (63 FR 31647 [June 10, 1998]) and proposed listing the Coastal Puget Sound DPS of bull trout as threatened (63 FR 31693). Following this listing and proposed listing, the USFWS completed an Opinion and conference opinion (USFWS 1998, entire) for the addition of bull trout to the ITP for HCP lands west of the Cascade Crest. Potential incidental take and effects to critical habitat of bull trout associated with WDNR actions east of the Cascade Crest were addressed through the Forest Practices HCP (WDNR 2005, entire) and associated ITP.

Between 1998 and the present, the HCP has undergone several publicly-noticed amendments and modifications, and the Board of Natural Resources established additional policies (e.g., *Policy for Sustainable Forests* – WDNR 2006a, entire) that affect HCP implementation. These changes are summarized below in the *Consultation History* and the *Description of the Proposed Action.*

In January 2018, the Olympic Forest Coalition (OFCO) and Conservation Northwest (collectively, the plaintiffs) filed a *60-day Notice of Intent to Sue* the USFWS in federal court for failure to reinitiate consultation under section 7 of the ESA (OFCO et al. 2018, entire). The notice of intent argued that the USFWS had violated the ESA for failing to reinitiate consultation under section 7 of the ESA on its authorization of incidental take of bull trout and spotted owls in the Olympic Experimental State Forest (OESF), and failure to consult on the USFWS's approval of WDNR's 2016 OESF Forest Land Plan (WDNR 2016a, entire). Following the *Notice of Intent*, the USFWS and WDNR met with the plaintiffs on several occasions to discuss the issues of concerns. On July 29, 2022, OFCO sued the USFWS for allegedly violating the ESA (OFCO et al. 2022, entire).

USFWS Review of the Reinitiation Criteria

As provided in 50 CFR 402.16, reinitiation of formal consultation is required where: 1) the amount or extent of incidental take is exceeded; 2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this Opinion; 3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this Opinion; or 4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

In our 2022 review of the reinitiation criteria with respect to the 1997 HCP and ITP, as amended, we determined that criteria 2) *new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this Opinion,* and 4) *a new species is listed or critical habitat designated that may be affected by the action*, had been met. The USFWS issued a final rule revising designated critical habitat for the spotted owl in 2012 (77 FR 71876:71879 [December 4, 2012]). The revised critical habitat designation increased the area of spotted owl critical habitat in Washington over prior designations in 1992 and 2008. Additionally, the USFWS designated critical habitat for the bull trout in 2004 and 2005 and issued a final rule for revised critical habitat for bull trout in 2010 (75 FR 60735 [October 18, 2010]. Accordingly, with respect to both bull trout and spotted owl designated critical habitats, we determined in 2022 that the 1997 HCP and ITP, as amended, may affect critical habitat in a manner or to an extent not was not previously considered in the 1997 and 1998 Opinions. Additionally, the 1997 Opinion did not address the invasion of the barred owl (*Strix varia*), climate change, or increased risk of high-severity wildfires, all of which are now regarded as significant threats to spotted owls (85 FR 81146 [December 15, 2020]). At the time the bull trout was listed as a threatened species in 1999, climate change effects were not considered as a factor affecting bull trout. However, the USFWS now recognizes that bull trout are vulnerable to the effects of climate change (USFWS 2015a, pp. 17-19).

Based on this review, and in consideration of other information provided in the OFCO et al. 2018 *Notice of Intent* and 2022 *Complaint* (e.g., reduced application of exterior wind buffers compared to what was anticipated in the 1997 Opinion), the USFWS determined reinitiation of ESA section 7 consultation was appropriate. The request for reinitiation of formal consultation was received on September 29, 2022. On November 7, 2022, the District Court for the Eastern District of Washington, where OFCO filed suit, granted a joint motion of the parties requesting an 18-month stay to allow the USFWS to voluntarily reinitiate and complete consultation on the HCP, as amended.

This Reinitiation considers information provided in the 1997 and 1998 Opinions, the Final HCP (WDNR 1997, entire) and associated Final Environmental Impact Statement (FEIS) of October 25, 1996 (USDI et al. 1996, entire), WDNR HCP annual reports, USFWS records of HCP amendments and modifications, and other sources of information as cited throughout the Biological Opinion.

In this Reinitiation, we summarize the HCP and associated documents and address broadly the covered actions and conservation program including summary of amendments, modifications, variances, and clarifications, where applicable. Where necessary, additional detail is incorporated by reference. The HCP summarized herein, and any document incorporated by reference, speak for themselves and are the best evidence of their content. In conducting this

Reinitiation of consultation, we are not making a determination regarding the extent of discretion, if any, that the USFWS retains regarding the ITP.

A complete record of this consultation is on file at the USFWS's Washington Fish and Wildlife Office in Lacey, Washington.

3 CONSULTATION HISTORY

The following is a summary of important events associated with this consultation:

- Beginning in 1993, the USFWS, NMFS, and WDNR began discussions regarding Phase 1 of a 3-phase HCP. Phases 2 and 3 were contemplated for agricultural and aquacultural activities. Phase 1 was designed to be an HCP for forest-management activities on WDNR-managed lands within the range of the spotted owl that would address spotted owls, marbled murrelets (*Brachyramphus marmoratus*), and salmonids. This effort merged with an effort by the U.S. Congress to conserve spotted owls in the OESF. The conservation effort was later expanded to cover additional listed and unlisted species.
- From 1994 through 1996, the Services worked closely together to help WDNR develop an HCP that would be acceptable to the Services, and all three agencies worked together to prepare the associated documents required by the National Environmental Policy Act of 1970, as amended (42 U.S.C. § 4321 *et seq*.), including a Draft and then Final Environmental Impact Statement (DEIS and FEIS, respectively) (USDI et al. 1995, entire; USDI et al. 1996, entire).
- In January 1997, the 1997 Opinion and a Conference Report were completed, the HCP was approved, the IA was signed, and the ITP was issued. A Record of Decision and a Statement of Findings were also completed.
- In September of 1997, the Final HCP (WDNR 1997, entire) was officially printed.
- In October of 1998, WDNR published the "merged" FEIS (WDNR 1998, entire) to provide additional clarity as the FEIS completed in 1997 used redline/strikeout (tracked changes) for changed sections and often omitted those sections that did not change.
- On December 18, 1998, the 1998 Opinion regarding bull trout (in part supplanting the 1997 Conference Report with respect to bull trout) was completed. The Conference Report addressed bull trout as a species across the entire HCP area; however, the 1998 Opinion was restricted to an assessment of effects to bull trout in the portion of the HCP area west of the Cascade Crest where bull trout were a covered species. Only west side planning units were considered in that 1998 effects analysis. Bull trout populations east of the Cascade Crest were addressed in that 1998 Opinion only "as part of the environmental baseline." That incidental take statement (ITS) applied only to the listed Columbia River and the proposed Coastal/Puget Sound DPS of the bull trout located west of the Cascade Crest. Subsequently, in 2006, the Opinion (USFWS 2006, entire) on the Forest Practices HCP (WDNR 2005, entire) assessed impacts to bull trout within the WDNR State Lands on the east side of the Cascade Crest.
- On April 30, 2004, the first amendment of the HCP was completed. The 2004 amendment addressed the spotted owl conservation strategy in the Klickitat Planning

Unit. The amendment afforded more short-term and long-term conservation than the original spotted owl strategy.

- In December 2006, the Board of Natural Resources adopted the *Policy for Sustainable Forests*. This document established several policies, including *the Policy on Old-growth Stands in Western Washington*. This policy defers from harvest old-growth stands 5 acres in size or larger that originated naturally prior to 1850 (WDNR 2006a, p. 34).
- In August 2016, WDNR completed a State Environmental Policy Act (SEPA) FEIS (WDNR 2016b, entire) for the Forest Land Plan regarding the OESF Planning Unit of the HCP. Following this, in September 2016, the WDNR completed the Forest Land Plan for the OESF (OESF Plan) (WDNR 2016a, entire). The goal of the OESF Plan is to guide the management of over 270,000 acres of forested state trust lands on the western Olympic Peninsula.
- In September of 2016, both Services wrote a joint letter (USFWS and NMFS 2016, entire) to WDNR confirming that aspects of the OESF Plan were “consistent with your State Trust Lands Habitat Conservation Plan, which we approved in 1997”. That letter identified the tactical model, pathways approach, and the combined planning for all 11 landscapes in the OESF as the items the Services considered.
- On December 19, 2019, the Board of Natural Resources approved an amendment to the 1997 HCP. The amendment replaced the 1997 HCP interim strategy for the marbled murrelet with a long-term conservation strategy. As part of this process the USFWS amended the ITP to authorize the long-term strategy. The effects of the long-term strategy were evaluated in a FEIS (USFWS and WDNR 2019, entire), and in the Opinion completed for the amendment (USFWS 2019, entire).
- On September 29, 2022, the Washington USFWS Office received a request to reinitiate consultation for spotted owls and bull trout and their respective critical habitats from the USFWS’s Pacific Regional Office.

In preparation for reinitiation, USFWS review of HCP-related documents revealed several issues. These issues included HCP-related actions that the WDNR and Services have not yet completed (e.g., completion of a headwater streams conservation strategy). See Appendix A for a summary of the issues and proposed resolutions.

4 CONCURRENCE AND EFFECT DETERMINATIONS

In this Reinitiation, we address effects to the spotted owl and bull trout and their respective critical habitats from HCP implementation. The 1997 Opinion addressed effects to designated spotted owl critical habitat in a concurrence section. As explained further below, we are not concurring with a "not likely to adversely affect" determination, and so we are taking a different approach with this Reinitiation.

In 1997, the USFWS determined that the issuance of the ITP and implementation of the HCP "may affect but is not likely to adversely affect" spotted owl critical habitat. The critical habitat designation in effect at that time did not include WDNR-managed lands and therefore the USFWS determined that effects to the critical habitat located on adjacent lands would be limited and insignificant in scope. The 1997 Opinion stated that "Removal of forest or suitable spotted owl habitats on WDNR-managed lands adjacent to spotted owl critical habitat could potentially indirectly affect critical habitat. However, the scope or extent of these potential effects is insignificant or discountable" (USFWS 1997a, p. 3). The USFWS revised the spotted owl critical habitat designation on December 4, 2012, (77 FR 71875) and November 10, 2021, (86 FR 62606).

The 2012 and 2021 critical habitat designations excluded all lands covered by the HCP but expanded the total area of designated critical habitat in Washington. The expansion in critical habitat increased the area of critical habitat located adjacent to HCP-covered lands. In considering the potential for effects to critical habitat from HCP-covered activities, we determined that edge effects, including increased risk of windthrow, has the potential to result in the loss or degradation of spotted owl habitat within designated critical habitat. Therefore, we determined that continued implementation of the HCP "may affect and is likely to adversely affect" spotted owl critical habitat.

Similarly, the USFWS issued a revised critical habitat designation for bull trout on October 18, 2018 (75 FR 63898). The bull trout critical habitat designation excluded all lands covered by the HCP. In considering the potential for effects to critical habitat from HCP-covered activities, we determined that WDNR forest management and the associated road network has the potential to result in the degradation of bull trout habitat elements in designated areas located downstream of WDNR lands. Therefore, we determined that continued implementation of the HCP "may affect and is likely to adversely affect" designated bull trout critical habitat.

This Reinitiation is limited to spotted owls and bull trout, and their respective critical habitats. Other federally listed species under the jurisdiction of the USFWS that are covered under the HCP include gray wolf (*Canis lupus*), and marbled murrelet. We are not addressing the effects of continued HCP implementation to the marbled murrelet because these effects were fully evaluated in a FEIS (USFWS and WDNR 2019, entire), and in the Opinion completed for the marbled murrelet long-term conservation strategy (USFWS 2019, entire). The gray wolf remains federally listed in much of Washington, but prior analyses and conservation measures for this species remain adequate and the USFWS determined in 2022 during its reinitiation criteria review that reinitiation criteria for this species have not been met.

Other federally listed species that occur in western Washington that are not covered by the HCP are not addressed in this reinitiation. This includes federally listed species with little or no potential for overlap with HCP-covered lands (e.g., streaked horned lark [*Eremophila alpestris strigata*]). The grizzly bear (*Ursus arcto horribilis*) was originally listed as a covered species under the HCP, but the term of ITP coverage for the grizzly was limited to 5 years and expired in 2002 (USFWS 1997c, p.8). Under the IA (Section 25b), WDNR has the option to request additional species be added to the ITP. Any such additions will be evaluated in accordance with section 7 of the ESA.

5 BIOLOGICAL OPINION

6 DESCRIPTION OF THE PROPOSED ACTION

A federal action means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies in the United States or upon the high seas (50 CFR 402.02).

The federal agency action is the continued implementation of the ITP (PRT-812521) issued to WDNR for the Washington State Trust Lands HCP (WDNR 1997, entire). In this case, the consultation is an internal consultation, where the USFWS is both the consulting agency as well as the action (permitting) agency.

6.1 Scope of State Lands HCP and Covered Activities

During the preparation of the HCP, the HCP area was defined by the range of the spotted owl within Washington from the Canadian border to the Columbia River Gorge, and from eastern Washington over the Cascade Crest to the Pacific Coast (Figure 1). It is further limited to forest lands that are managed by WDNR. The HCP uses the term "DNR-managed lands" instead of State trust lands because spotted owl habitat in Natural Resources Conservation Areas (NRCAs) and Natural Area Preserves (NAPs) contributes toward habitat thresholds under the HCP. WDNR is given credit for the habitat contributions provided by these lands in terms of meeting the conservation objectives of the HCP (WDNR 1997, p. I.5). Table 1 summarizes the changes to HCP lands from 1997 to 2023 by planning unit.

Table 1. Summary of changes in WDNR HCP lands by planning unit (1997-2023).

HCP Unit Name	WDNR HCP Lands - 1997 (acres)	WDNR HCP Lands - 2023 (acres)	Change (acres)
CHELAN	19,203	17,340	-1,863
COLUMBIA	301,705	288,442	-13,263
KLICKITAT	161,349	96,229	-65,119
N. PUGET	432,266	457,256	+24,990
OESF	271,518	273,053	+1,535
S. COAST	255,775	260,716	+4,941
S. PUGET	150,937	178,130	+27,194
STRAITS	118,341	127,919	+9,578
YAKIMA	133,886	212,419	+78,532
Totals	**1,844,979**	**1,911,504**	**+66,525**

Note: The boundaries for the Klickitat and Yakima planning units were modified in 2004 with the Klickitat amendment. This resulted in a reduction of lands within the Klickitat unit, and an increase in lands within the Yakima planning unit.

The HCP covers only forested Trust lands managed by WDNR, which come with a legal responsibility to generate revenue for their designated fiduciary beneficiaries, such as schools, counties, and critical local services. In addition to earning income, activities on Trust lands are managed to protect habitat for native plant and animal species, provide clean and abundant water, and offer diverse public recreation opportunities. These Trust lands include Federal Grant Lands, State Forest Trust Lands, NAPs, and NRCAs. Of these Trust lands, 92 are Natural Areas managed by WDNR on more than 152,000 acres statewide, including 56 NAPs and 36 NRCAs. These lands are managed for conservation, research, and education for the benefit of all people of Washington. Approximately 128,454 acres of NRCAs and NAPs on WDNR lands contribute to habitat commitments of the HCP (WDNR 2023, p. 40).

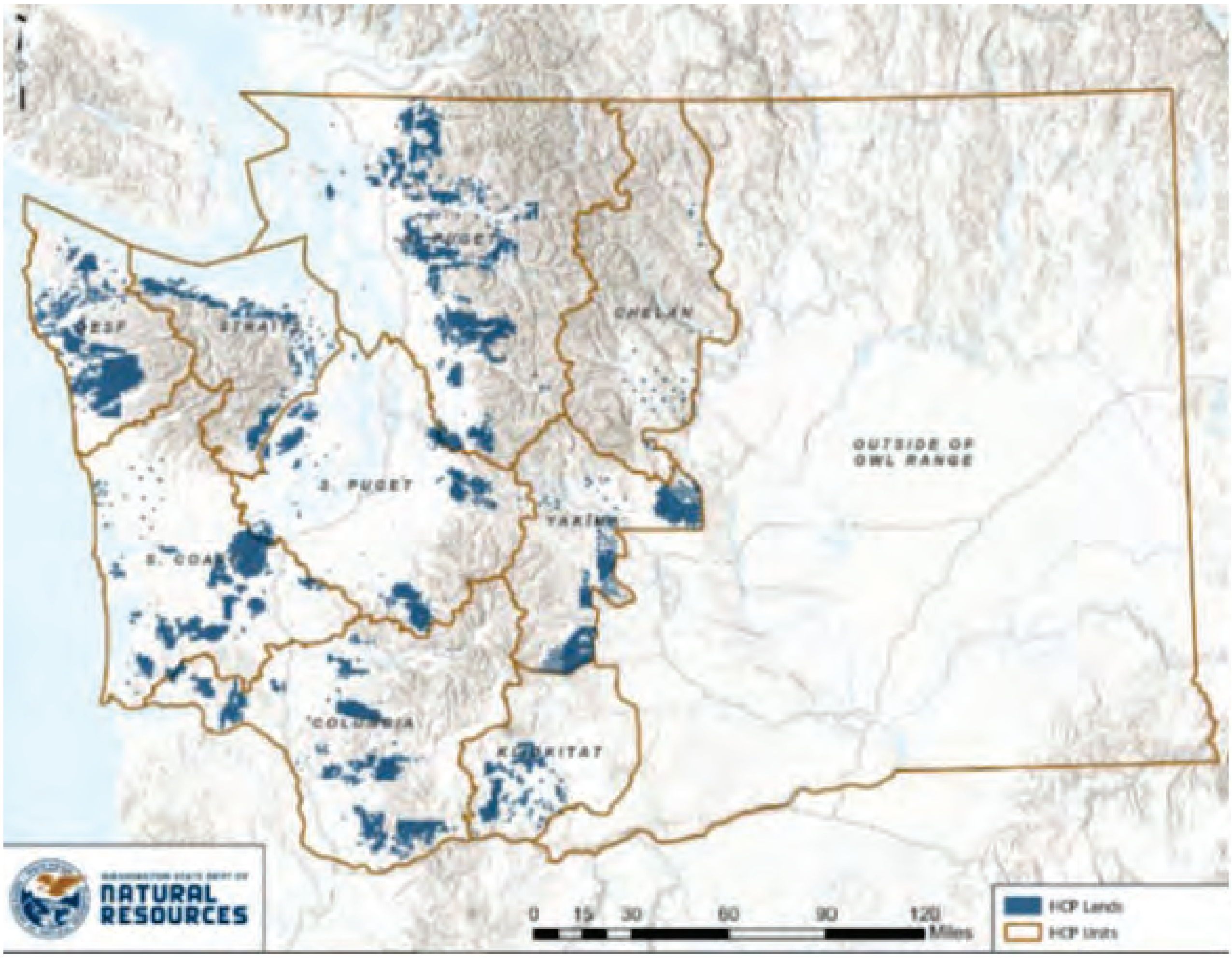

Figure 1. HCP lands and HCP units in Washington.

Covered Activities

The ITP does not authorize any activities but does authorize the incidental take of listed species that may be associated with the covered activities of the HCP. As such, this analysis will address the covered activities described in the HCP as they are limited, constrained, and modified by avoidance, minimization, and mitigation measures of the HCP.

Activities covered by the HCP include timber-management and forest-management activities (herein referred to generally as timber activities), as well as nontimber activities conducted in forests. Conservation Measures, including research and monitoring tasks and implementation requirements, are covered activities as well (See 5.2 Conservation Measures).

Covered activities are the same as those described in 1997 HCP (WDNR 1997, pp. IV.191 to IV.212). No activities have been added or deleted. These activities include:

1. Timber Activities:
    a. Variable retention timber harvest (felling, yarding, rigging, hauling etc.).
    b. Commercial thinning timber harvest (roads, yarding, rigging, etc.).
    c. Salvage harvest of trees damaged by wind, fire, insects (roads, yarding, etc.)
    d. Reforestation (tree planting, fertilization, weed control, spraying).
    e. Forest health treatments (harvest, thinning, aerial spraying, replanting, etc.).
    f. Pre-commercial thinning.
    g. Forest resource inventory and monitoring, experimental treatments, research activities.
    h. Fire suppression (including aerial operations).
    i. Transportation Network (existing and new facilities):
        i. New road construction.
        ii. Road reconstruction or maintenance.
        iii. Road decommissioning or abandonment.
        iv. Use and development of rock quarries (existing, new, blasting, crushing).
2. Nontimber Activities:
    a. Recreation Activities (existing and new facilities developments):
        i. Developed campgrounds.
        ii. Day-use areas, trailheads, parking lots, restroom facilities.
        iii. Recreation trails (motorized and non-motorized).
    b. Nontimber Resources:
        i. Rights-of-way (roads, transmission lines, etc.).
        ii. Special forest products (floral greens, mushrooms, firewood).
        iii. Communications leases.
        iv. Mineral/Prospecting leases.
        v. Oil/Gas leases.
3. Land Disposition and/or Acquisitions.

Timber Activities

WDNR implements a variety of timber harvest methods to achieve management objectives including generating revenue for various state trusts consistent with sustainable timber harvest policies. Other objectives include managing for ecological values such as wildlife and riparian habitat enhancement or managing for wildfire risk reduction and resilience. The most common timber harvest methods used include thinning treatments and regeneration harvest (WDNR 2023, pp. A-25 – A-26):

1. *Commercial thinning:* Commercial thinning generates revenue and is performed to meet a wide range of objectives, including improving the growth of the stand, enhancing stand health, reducing tree mortality, or accelerating the development of habitat. Regeneration of a stand is not an objective of thinning.

2. *Variable density thinning:* Variable density thinning is a type of commercial thinning that creates a mixture of small openings (gaps), un-thinned patches (skips), and varying stand densities to achieve specific objectives, such as accelerating development of a complex stand structure to meet spotted owl habitat objectives. Variable density thinning may also include treatments to create or encourage development of large down wood and snags.
3. *Uneven-aged management:* In uneven-aged management, trees are removed from a multi-aged forest stand while maintaining multiple age classes within that stand. Uneven-aged management is often used on sites with poor soils on which intensive management is not cost-effective. This type of management may also be used in fire-prone areas to mimic the effects of periodic, lower-intensity fires that do not remove all of the trees.
4. *Variable retention harvest:* Variable retention harvest is a type of regeneration or stand-replacement harvest. With this type of harvest, WDNR removes most of the existing forest stand to make room for regeneration of a new stand, while leaving elements of the existing stand, such as down wood, snags, and live leave trees (trees that are not harvested), for incorporation into the new stand. Variable retention harvest is different from a clear-cut, in which all or nearly all the existing stand is removed.

WDNR provides an annual summary of all silvicultural activities including timber harvesting in the HCP annual reports. For the 10-year period from 2013 through 2022, WDNR reported a cumulative total of over 159,600 acres of timber harvest across all HCP units, indicating an average annual harvest rate of 15,961 acres per year (Table 2). Average harvest rates vary by planning unit, with the highest rates of annual harvest in the Columbia and North Puget planning units. The average area harvested per year is generally 1 percent or less of total HCP lands in a unit.

Table 2. Summary of WDNR timber harvest by HCP planning unit 2013-2022.

HCP Unit Name	WDNR HCP lands (acres)	All timber harvest (2013-2022) (acres)	Average annual timber harvest (acres)	Average percent of HCP lands harvested per year
CHELAN	17,340	672	67	0.4%
COLUMBIA	288,442	35,849	3,585	1.2%
KLICKITAT	96,229	5,895	590	0.6%
N. PUGET	457,256	30,402	3,040	0.7%
OESF	273,053	22,686	2,269	0.8%
S. COAST	260,716	29,889	2,989	1.1%
S. PUGET	178,130	13,064	1,306	0.7%
STRAITS	127,919	13,371	1,337	1.0%
YAKIMA	212,419	7,780	778	0.4%
Totals	**1,911,504**	**159,608**	**15,961**	**0.8%**

Source: WDNR HCP annual reports for fiscal years 2013 through 2022. Values in this table represent all harvest types including thinning, regeneration, and salvage.

The type of timber harvest also varies by HCP units. In the Eastside HCP units, thinning and uneven-aged management harvest types were the most common harvest methods used (76 percent). In the Westside units, over 80 percent of the reported timber harvest was variable retention harvest (Table 3). In the OESF, the number of thinning treatments (55 percent) and variable retention harvest (45 percent) is nearly equal (Table 3).

The average rates of timber harvest derived from the past 10 years of reported harvest in the Westside planning units are similar to the projected values reported by WDNR in the 2019 FEIS for the sustainable harvest calculation, which estimates that harvest activities take place on an annual average of 11,447 acres and thinning on 1,592 acres, with most thinning projected to occur in landscapes with spotted owl management areas (WDNR 2019a, 2-15).

Table 3. Summary of average timber harvest rates and harvest types reported for 2013-2022.

HCP Area	Average annual timber harvest	Harvest type: variable retention harvest or even-age management (acres)	Percent of harvest type: - variable retention or even-age management	Harvest type: commercial thinning, variable density thinning, uneven-aged management (acres)	Percent of harvest type: - thinning treatments or uneven-aged management
Eastside Units	1,435	348	24%	1,087	76%
Westside Units	12,258	10,057	82%	2,200	18%
OESF	2,269	1,014	45%	1,254	55%
Totals	**15,961**	**11,419**	**72%**	**4,542**	**28%**

Source: WDNR HCP annual reports for fiscal years 2013 through 2022. As noted in annual reports, salvage harvest is included these totals.

Research and monitoring activities, including experimental timber harvest treatments, are also covered by the HCP, but require discussion with and approval from the Services when proposed treatments vary from the standard conservation measures provided by the HCP (e.g., experimental timber harvest treatments within riparian management zones or within marbled murrelet occupied site buffers (WDNR 2024, p. 54). These experimental research activities may be addressed through site-specific or situation-specific variances for these activities. The HCP includes protection measures to avoid, minimize, and mitigate potential impacts caused by these activities, and conduct of those protective measures are also covered.

Transportation Network

As of 2022, the WDNR transportation network included 10,683 miles of inventoried roads on HCP-covered lands (WDNR 2023, p. 33). WDNR manages the road network to be in compliance with the HCP standards (WDNR 1997, pp. IV.65 – IV.68), and the Washington Forest Practices rules for road maintenance and abandonment plans (WAC 222-24-051). The total amount of inventoried roads within the transportation network has varied over time with HCP land acquisitions and dispositions. Management of the transportation network includes road construction, road maintenance, public access management, road decommissioning, and culvert and /or bridge installations and removals. As a part of HCP annual reporting, WDNR tracks the number of road miles constructed (newly built roads), reconstructed (existing roads improved to a timber-haul standard), decommissioned (roads stabilized and made impassable to vehicular traffic), or abandoned (roads stabilized and abandoned to forest practices standards), as well as active forest road miles and the total number of fish barriers removed (Table 4).

Over the 10-year period from 2013 to 2022, WDNR reported construction of a cumulative total of 792 miles of new roads. During the same period, WDNR reported decommissioning (192 miles) and abandoning (525 miles) a cumulative total of 717 miles of roads closed or removed (Table 4). However, in 2022, WDNR reported a net decrease of total inventoried road miles on HCP-managed lands (from 10,723 to 10,683 miles) due to land transactions, abandonment, decommissioning, and updates to the road inventory (WDNR 2023, p. 33). On average, WDNR constructs (79 miles) or reconstructs (64 miles) about 143 miles of roads per year and decommissions (19 miles) or abandons (52 miles) about 71 miles or roads per year (Table 5).

Table 4. Summary of WDNR road management by HCP planning unit 2013-2022.

HCP Unit Name	New Road Miles Constructed (2013 – 2022)	Road Miles Reconstructed (2013 -2022)	Road Miles Abandoned (2013 – 2022)	Road Miles Decommissioned (2013-2022)	Current Road Miles (2022 inventory)	Fish Barriers Removed (2013 – 2022)
CHELAN	0	0	0	1	51	0
COLUMBIA	157	105	105	16	1,283	65
KLICKITAT	1	8	7	4	604	7
N. PUGET	276	362	287	33	1,485	74
OESF	35	39	4	38	1,837	205
S. COAST	166	54	38	10	1,765	46
S. PUGET	64	24	25	18	1,365	51
STRAITS	76	28	13	15	922	22
YAKIMA	18	22	46	57	1,370	11
Totals	**792**	**642**	**525**	**192**	**10,683**	**481**

Source: WDNR HCP annual reports for fiscal years 2014 through 2022 (WDNR 2015, p. 36; 2016c, p. 23; 2017, p. 42; 2018, p. 34; 2019b, p. 37; 2020, p. 35; 2021a, p. 33; 2022a, p. 34; 2023, p. 33). Inventoried roads include both forest roads and decommissioned roads.

Table 5. Summary of average annual road management activities reported from 2013-2022.

HCP Area	Road Miles Constructed	Road Miles Reconstructed	Road Miles Abandoned	Road Miles Decommissioned	Road Miles Inventoried	Fish Barriers Removed
Eastside Units	1.8	3.0	5.3	6.2	2,066.9	2
Westside Units	73.9	57.3	46.8	9.2	6,702.4	26
OESF	3.5	3.9	0.4	3.8	1,835.6	21
Totals	**79.2**	**64.2**	**52.5**	**19.2**	**10,604.9**	**48**

Source: WDNR HCP annual reports for fiscal years 2013 through 2022.

Nontimber Activities

WDNR implements a variety of nontimber activities associated with Trust land transportation networks, recreation sites (e.g., campgrounds, trails), and other nontimber special use permits such as leases, communications sites, and special forest products (WDNR 1997, pp. IV.196 – IV.199). The expectation stated in the HCP is that the impacts of the nontimber activities is *de minimis* relative to the impacts of timber management and road work activities covered under the HCP (WDNR 1997, p. IV.193, p. IV.199). For example, roads constructed to access a communication site, provide a right-of-way, or access to a special use permit lease area are considered to be part of the total WDNR transportation network that is available forest management. Proposed nontimber activities are reviewed by WDNR to ensure compliance with the commitments of the HCP. WDNR provides annual summaries of the nontimber activities in the HCP annual reports (e.g., WDNR 2023, pp. 43-45).

Land Disposition and/or Acquisition

WDNR implements an active land transaction program including the designation of urban lands and the leasing of permit lands for commercial, industrial, residential, or agricultural purposes. With any land repositioning activities, WDNR maintains the conservation objectives outlined in the HCP (WDNR 1997, entire). For example, lands within a specific HCP-designation, such as a spotted owl management area, or a designated marbled murrelet special habitat area, if disposed, would require replacement acres with commensurate habitat values (IA – 17.4). In the event that disposed land increases the level of take analyzed in the HCP or does not remain subject to the conservation objectives and the cumulative impact of the disposition would have a significant adverse effect on a particular species, WDNR would follow the process for making a major amendment to the HCP and ITP as outlined in the IA (WDNR 1997, pp. IV.193). The land transaction program does not alter WDNR's obligations for mitigation as set forth in the HCP. Over the past 27 years, WDNR has increased the total area of HCP-covered lands through acquisitions from 1.84 million acres to 1.91 million acres (Table 1).

6.1.1 Covered Species

The HCP-covered species include the federally listed species addressed in the 1997 HCP, and all species thereafter listed as threatened or endangered that may use the types of habitats found within the five westside planning units and the OESF that may now or in the future use the HCP lands (IA – Section 25b). Under the terms of the IA, WDNR has the option to request additional federally listed species be added to the ITP. Incidental take of new federally listed species is not covered until such time as the USFWS issues an amended ITP to cover the species requested. There are several exceptions to this:

1. Grizzly bears are no longer covered on any part of the HCP lands. ITP coverage for grizzly bears lasted for 5 years and expired, along with applicable species-specific conservation measures, in January 2002 (USFWS 1997c, p.8).
2. The list of covered species east of the Cascades crest is limited to those species listed at the time the permit was issued (i.e., spotted owl and gray wolf).
3. Plants are not covered species.

Peregrine falcons, Aleutian Canada geese, and bald eagles were delisted subsequent to completion of the HCP. When a species is delisted, the commitments of the HCP and the IA are terminated, and species-specific mitigation measures no longer apply (IA – Section 27.4). In the case of bald eagles, the WDNR continues to implement conservation measures at nest sites for that species consistent with USFWS recommendations (USFWS 2007, p.13). Gray wolf and spotted owl are currently the only covered listed species on the east side of the Cascade Crest, with other covered listed species (e.g., marbled murrelets and Columbian white-tailed deer) not likely to occur in the East Cascades. Additionally, bull trout is included in the covered species only on the west side of the Cascade crest and OESF. This reinitiation is limited to the two requested species, bull trout and spotted owl, and their respective critical habitats.

6.1.2 HCP Duration

The HCP was approved, the IA was signed, and the ITP was issued on January 30, 1997. The initial term of the HCP is 70 years, ending January 30, 2067. Pursuant to Sections 19.2 and 19.3 of the IA, "Permit Renewal" and "Permit Continuation," the 1997 HCP, ITP, and IA may be extended for up to 30 additional years, consisting of three 10-year extensions. This Reinitiation assesses the effects of HCP implementation through January 30, 2067, since renewal is not reasonably certain to occur, and additional information regarding the effects of HCP implementation will be available closer to the time any renewal is requested.

6.2 Conservation Measures

The conservation measures described and considered in this reinitiation are derived from implementation provisions of the HCP. To meet the ITP issuance criteria established by the ESA and its implementing regulations, this HCP is required to contain a conservation program such that the effects of the taking from covered activities are minimized and mitigated to the maximum extent practicable.

In this section, we will distinguish between the descriptions of the minimization and mitigation measures (conservation program) in the 1997 HCP, 1997 Opinion, 1997 Conference Report, Permit Amendments and Minor Modifications completed since permit issuance, and other site-specific or situation-specific variances agreed upon by WDNR and the Services).

Development of the HCP Conservation Strategies

Because the HCP covers a broad and diverse geographic range, the HCP is divided into HCP Planning Units and in some cases smaller units. WDNR-managed forests are distributed from the Canadian border to the Columbia River Gorge and from the eastern edge of spotted owl habitat in Eastern Washington over the Cascade crest to the Pacific Coast. The HCP lists eight vegetative zones including Sitka Spruce, Western Hemlock, Pacific silver fir, subalpine fir / mountain hemlock, alpine zone, grand fir, Douglas-fir, and Ponderosa pine (see WDNR 1997, Table I.3).

Primarily, the HCP may differ between those lands on the Eastside of the Cascade Crest and lands on the Westside of the Cascade Crest. Within the Westside of the Cascades, the OESF often has its own strategy and requirements for reasons discussed below. Strategies were developed for murrelets and for riparian areas west of the Cascades only. Spotted owl strategies were developed for the entire HCP area but vary depending on the importance of respective areas for the spotted owl. In addition, several then-listed species had their own protective measures and most other species were addressed under a multi-species strategy founded on the premise of addressing unique and valuable wildlife habitats.

Forest Practices Rules

In addition to statutes and regulations discussed elsewhere, as a forest land manager, WDNR must comply with the Forest Practices Act, Chapter 76.09 RCW, which regulates forest management activity in Washington. These rules constitute Chapter 222 WAC, which sets minimum standards for forest practices such as road construction, timber harvesting, precommercial thinning, reforestation, fertilization, and brush control. Also included are rules concerning forest practices and habitat for threatened and endangered species (See WAC 222-16-050(1)(b) and 222-16-080). Habitat conservation plans have a special relationship to the forest practices rule regarding state-designated critical habitats. When applications for proposed forest practices are submitted, they are assigned to one of four classes established by rule by the Forest Practices Board. Forest practices classified as Class IV-Special are subject to environmental review under SEPA Chapter 43.21 RCW. Certain practices on "critical wildlife habitats (state) and critical habitat (federal) of threatened and endangered species" require a Class IV-Special designation (WAC 222-16-050(l)(b), 080). However, such habitats are no longer considered critical if the forest practices are "consistent" with a "conservation plan and permit for a particular species [that has been] approved by the U.S. Fish and Wildlife Service" (WAC 222-16-080(7)(a)). Therefore, additional environmental review under SEPA would not be required.

When an HCP contains provisions that will replace or modify the application of State Forest Practices Rules, the WDNR Forest Practices Division works with the HCP Permittee to develop a "crosswalk" so that all parties understand the relationship between the HCP and the Rules during the processing of future Forest Practices Application. The WDNR State Lands Division has four sets of crosswalks with Forest Practices: 1) spotted owls; 2) marbled murrelets; 3) riparian for the OESF; and 4) riparian for the remainder of the westside of the Cascade Crest. Items not addressed in the crosswalk remain fully subject to Forest Practices Rules.

Northwest Forest Plan

The Northwest Forest Plan (NWFP) (USDA and USDI 1994a, b, entire) is a landscape approach to federal land management designed to protect threatened and endangered species while also contributing to social and economic sustainability in the region. The NWFP covers 24.5 million acres of federally managed lands in western Oregon, Washington, and northwestern California, including 17 National Forests, 7 Bureau of Land Management Districts, 6 National Parks, and some National Wildlife Refuges and Department of Defense lands. A central component of the NWFP was the creation of a regional set of land allocations, each with associated management standards and guidelines. The reserve network was primarily designed to meet the habitat requirements of the spotted owl, marbled murrelet, and salmon species. Primary land allocations in the original allocation under the NWFP included over 7.3 million acres of Congressionally

Reserved Areas (Lands reserved by the U.S. Congress such as wilderness areas, wild and scenic rivers, and national parks and monuments), over 7.4 million acres of Late-Successional Reserves (LSRs) (Lands reserved for the protection and restoration of late-successional and old growth forest ecosystems and habitat for associated species, including marbled murrelet reserves and spotted owl activity core reserves), and 102 thousand acres of Managed Late-Successional Areas (Areas for the restoration and maintenance of optimum levels of Late-Successional Old Growth stands on a landscape scale, where regular and frequent wildfires occur. Silvicultural and fire hazard reduction treatments are allowed to help prevent older forest losses from large wildfires or disease and insect epidemics.) Together this reserve network comprised over 60 percent of the NWFP lands, with additional contributions from the allocations discussed below.

Other land allocations included Administratively withdrawn areas (>1.4 million acres), Adaptive Management Areas (AMAs) (>1.5 million acres), and matrix lands which are federal lands outside of reserved allocations where most timber harvest and silvicultural activities were expected to occur (>3.9 million acres). Riparian reserves (>2.6 million acres) are protective buffers along streams, lakes, and wetlands designed to enhance habitat for riparian-dependent organisms, provide good water-quality dispersal corridors for terrestrial species, and provide connectivity within watersheds.

The locations of these NWFP reserve lands were intended to focus on areas with higher densities of spotted owls and where habitat conditions may be conducive to murrelets. The role of nonfederal lands was generally considered as either contributing to demographic support or providing dispersal or connectivity support between major portions of federal lands. In this way, the HCPs developed during the mid-1990s were intended to make the most effective and efficient contribution to spotted owl conservation by supporting the NWFP.

Science Team

In 1994, WDNR and the USFWS convened a “Science Team” to develop recommendations and the scientific basis for three components of the HCP: marbled murrelets, spotted owls, and salmonids (riparian). The science team included staff from the USFWS, WDNR, USFS, and Washington Department of Fish and Wildlife (WDFW). The Science Team provided the foundations of the spotted owl and salmonid strategies, while most of the marbled murrelet strategy was constructed by a subcomponent of the Science Team. That subcomponent consisted of a staff person from WDNR and a staff person from the USFWS, in consultation with a self-employed expert familiar with the development of similar strategies for murrelets.

With respect to the spotted owl, a substantial part of the HCP strategy was to support the conservation effort on federal lands. In general, the HCP provides demographic support to LSRs and some special areas and provides connectivity between blocks of federal lands. The Science Team considered the NWFP land allocations as well as densities of spotted owl site centers. With respect to marbled murrelets, the Science Team staff placed additional emphasis on Southwest Washington due to limited federal lands in that region and proximity to marine waters.

The Olympic Experimental State Forest

In 1992, Congress passed the Olympic Experimental Forest Act (Title II of P.L. 102-436(106 Stat. 2217)). That Act gave WDNR permission to prepare a plan that would "provide for the conservation of the northern spotted owl on the forest and reflect scientifically sound ecosystem management to aid conservation of fisheries, other sensitive species, and the ecology of the forest in general" through an experimental management program. Once this plan was approved by the USFWS, actions conducted under this Plan would not be considered prohibited take of the spotted owl under the ESA. The WDNR and the USFWS developed both spotted owl and salmonid proposed strategies for the OESF. Eventually, it became apparent that a separate plan for the OESF was not feasible, and the two efforts were combined by bringing the OESF into the larger HCP. The uniqueness of the OESF was retained in separate components for spotted owls and salmonids.

Multiple Species

Following the involvement of the Science Team, the multi-species components of the HCP were developed between the USFWS and WDNR. These were a combination of species-strategies for certain species and habitat-based prescriptions and assumptions for other species. These were presented to the Science Team, which declined to present findings or recommendations that went beyond the murrelet, owl, and salmonids. Consistent with the organization in the development of the HCP, the below description of the HCP begins with the three components of the Science Team recommendations (owls, murrelets, and salmonids) and then concludes with components developed for additional individual species and components developed for particular habitats and habitat features.

Description of management strategies for the HCP generally address the following elements:

1. Spotted Owls (spotted owl nesting, roosting, foraging (NRF) habitat; spotted owl dispersal habitat; provision of experimental areas);
2. Marbled Murrelets (now fully contained in the long-term strategy, but originally addressed through a series of steps);
3. Riparian Conservation Strategies (waterbody and stream typing);
4. Riparian Conservation Strategies in Westside Planning Units;
5. Riparian Conservation Strategies in the OESF;
6. Other Riparian Protections in Westside Planning Units (road network management; unstable hillslopes and mass wasting; hydrologic maturity; and wetlands protection);
7. Other Riparian Protections in the OESF (road network management; unstable hillslopes and mass wasting; hydrologic maturity; and wetlands protection);
8. Other Listed Species (a series of provisions for specific species);
9. Unlisted Species (a series of provisions for specific species, protections for uncommon habitats, and commitments to various forest stand-stages over time).

6.2.1 Spotted Owl Conservation Strategy

The HCP conservation strategy for spotted owls is described in detail in the HCP and is briefly summarized here. WDNR's conservation objective for the spotted owl is to provide habitat that makes a significant contribution to demographic support, maintenance of species distribution, and facilitation of dispersal (WDNR 1997, p. IV.1).

Demographic Support

Demographic support refers to the contribution of individual territorial spotted owls or clusters of spotted owl sites to the stability and viability of the entire population. The HCP conservation strategy provides demographic support through the designation of specific nesting, roosting, and foraging (NRF) management areas on WDNR lands. Because the majority of spotted owl habitat and known spotted owl sites are located on federal lands in Washington, NRF management areas are generally designated under the HCP in areas where WDNR lands are located within a 2-mile radius of federal reserves designated under the NWFP (USDA and USDI 1994a, b, entire). In addition, some WDNR managed lands farther than 2 miles from federal reserves in the Columbia Planning Unit were determined to be important for both maintaining species distribution and demographic support (WDNR 1997, p. IV.3). A similar process was used in the East Cascades planning units; the only difference is that WDNR lands on the eastside within 1.8 miles of federal reserves were considered important for demographic support instead of within 2 miles as in western Washington (WDNR 1997, p. IV.20).

In areas designated to provide NRF habitat, the HCP requires that WDNR provide a target condition of at least 50 percent of its managed lands measured within each Watershed Administrative Unit (WAU) as NRF habitat (WDNR 1997, p. IV.4). HCP-specific definitions of NRF habitat are provided in Appendix B – *Spotted Owl Habitat Definitions*. In 2006, WDNR adopted the use of Spotted Owl Management Units (SOMUs) to replace WAUs as landscape units for tracking and reporting spotted owl habitat in both NRF and Dispersal designated landscapes. WDNR currently has approximately 223,604 acres of lands designated as NRF management areas in westside and eastside planning units (Table 6). Refer to Appendix C for maps of HCP NRF management areas.

Dispersal Support

Dispersal is the movement of juvenile, subadult, and adult animals (in this case, spotted owls) from one sub-population to another. Similar to the strategy for demographic support, areas designated under the HCP for dispersal support are based on locations where WDNR-managed lands are located between federal reserves designated under the NWFP (WDNR 1997, p. IV.3). In one place, dispersal habitat is designated to provide connectivity between the Yakama Indian Reservation and a federal reserve (WDNR 1997, p. IV.29).

In areas designated to provide dispersal habitat, the HCP requires that WDNR provide a target condition of at least 50 percent of its managed lands measured within each designated area as dispersal habitat (WDNR 1997, p. IV.9). HCP-specific definitions of dispersal habitat are provided in Appendix B. WDNR currently has approximately 174,384 acres of lands designated as dispersal management across westside and eastside planning units (Table 6). Refer to Appendix C for maps of HCP dispersal management areas.

Management within NRF or Dispersal Management Areas

Active forest management within designated NRF or dispersal management areas is an integral part of the spotted owl conservation strategy. If the amount of existing NRF habitat in a SOMU is greater than 50 percent, WDNR may harvest NRF habitat, so long as the threshold of 50 percent NRF habitat within the SOMU is maintained. If the amount of NRF habitat in a SOMU is below 50 percent, WDNR can use active management (e.g., commercial thinning) in non-habitat stands within the SOMU to promote the future development of NRF habitat (WDNR 1997, pp. IV.4 – IV.5). Management within forest stands that provide functional NRF habitat is permitted, so long as the management maintains the habitat function (in SOMUs where habitat levels are below target thresholds). The same standard applies in designated dispersal management areas, where the directive of the HCP is to develop or maintain dispersal habitat on 50 percent of WDNR managed lands within each SOMU designated for dispersal (WDNR 1997, p. IV.9). In SOMUs that are currently below habitat thresholds, WDNR identifies forest stands that represent the "next best" habitat for future habitat recruitment or development. Next best stands are considered non-habitat but are tracked to ensure that habitat thresholds within each SOMU will be met either through active or passive management (WDNR 2022b, p. B-4).

Conservation Strategy for Spotted Owl on the OESF

Each of the 11 landscape planning units in the OESF are also designated as SOMUs (272,427 acres) (Table 6). In each SOMU, the HCP habitat goal is to maintain or restore a minimum of 40 percent spotted owl habitat. This objective has two components, including a target of 20 percent old-forest habitat for each SOMU, and at least 40 percent of the landscape that are potential old-forest, sub-mature, or young- forest marginal spotted owl habitat types, including any old-forest habitat (WDNR 1997, pp. IV.88 – IV.89). HCP-specific definitions for these habitat types are provided in Appendix B. In SOMUs that are below habitat thresholds, active forest management in non-habitat stands can be used to promote future habitat development. The HCP estimated that it would take 40 to 60 years for all landscape planning units in the OESF to meet the target habitat thresholds (WDNR 1997, p. IV.91).

Spotted Owl Activity Centers and Spotted Owl Management Circles

The HCP conservation strategy for spotted owls is based on managing specific landscape areas to provide spotted owl habitat for demographic or dispersal support, rather than site-specific management based on spotted owl management circles. In designated NRF management areas in the North Puget and Columbia planning units, the HCP provides for the protection of two nesting habitat patches per approximately 5,000 acres of WDNR designated NRF management area (WDNR 1997, pp. IV.6 – IV.8). These 500-acre patches are to be comprised of 300 acres of high-quality nesting habitat and 200 acres of at least sub-mature habitat within a 0.7-mile-radius circle. The HCP directs that these areas should be prioritized to include known spotted owl pair locations where available but recognized not all NRF management areas contained known pair locations. In such instances, the best available habitat for this designation is to be identified and protected (WDNR 1997, pp. IV.8). The HCP provides for the designation of two nesting habitat patches in the South Puget planning unit.

In NRF management areas in both the eastside and westside planning units, WDNR will avoid harvest of suitable spotted owl habitat within 0.7 miles of known nest sites during the breeding season (WDNR 1997, pp. IV.9, IV.21). Otherwise, the provisions of the spotted owl strategy do not place any special conditions upon forest stands that contain spotted owl activity centers, or occur within spotted owl management circles, except that timber harvest within a 70-acre core surrounding a nest site will be seasonally restricted to avoid the breeding season (WDNR 1997, pp. IV.10, IV.22).

Summary of Modifications to the Conservation Strategy for Spotted Owl

Following the adoption of the HCP in 1997, WDNR in consultation with the Services have completed several amendments or minor modifications to the spotted owl conservation strategy to address specific issues related to HCP implementation, as explained in the following sections.

Klickitat Planning Unit Administrative Amendment

Completed in 2004, WDNR amended the HCP conservation strategy in the Klickitat Planning Unit to address issues related to forest health, insects and disease, and fire risk, and to eliminate requirements to manage for spotted owl habitat in areas that are not habitat capable, or unlikely to sustain spotted owl habitat over time (WDNR 2004, entire). The amendment modified the Klickitat Planning Unit boundary to consolidate the Ahtanum State Forest within the Yakima Planning Unit. HCP-designated NRF management areas and dispersal management areas were modified: designated NRF management areas were increased by over 19,000 acres, and dispersal management areas decreased by over 36,000 acres. Dispersal management areas were reclassified as Desired Future Condition (DFC) areas based on natural vegetative series. Vegetative series capable of sustaining dispersal habitat are managed to meet sub-landscape goals for dispersal habitat, rather than by quarter-townships. Vegetative series that are not capable of sustaining dispersal habitat were removed from dispersal designation, including over 15,000 acres classified as ponderosa pine DFC areas.

South Puget Planning Unit Dispersal Management

Completed in 2009, WDNR modified the dispersal management strategy in the South Puget Planning Unit to aggregate groups of SOMU's into 4 larger landscape areas and modified the HCP definition for westside dispersal habitat to include two habitat definitions: movement habitat and movement, roosting, and foraging (MoRF) habitat (WDNR 2009, pp. 29-32). Movement habitat is similar to the HCP definition of westside dispersal habitat, and MoRF habitat is similar to the definition for westside submature habitat which includes criteria for snags, down wood, and canopy layers (see Appendix B for habitat definitions). Under the modified dispersal strategy, 50 percent of each aggregated SOMU landscape is to be managed to attain and maintain 35 percent in MoRF habitat and 15 percent in movement habitat.

Ahtanum State Forest Dispersal Management

Similar to modifications applied in the Klickitat Planning Unit, dispersal management areas in the Ahtanum State Forest were modified to account for the vegetative series that are capable of supporting and sustaining spotted owl dispersal habitat, while areas that were identified as non-habitat or not habitat capable were removed from designated dispersal management areas. Forest areas capable of sustaining dispersal habitat are managed to meet sub-landscape goals for dispersal habitat, rather than by quarter-townships. The Ahtanum includes two sub-landscapes for dispersal management, with an objective to maintain a minimum of 50 percent in dispersal habitat or better. The total area designated for dispersal management increased by 799 acres, and the amount of existing dispersal habitat within designated management areas increased by over 2,500 acres. This modification was completed in 2021 (WDNR 2021b, entire).

Table 6. Summary of HCP spotted owl management designations by planning unit.

HCP Planning Unit	HCP designated Dispersal / DFC areas (acres)	HCP designated NRF areas (acres)	OESF spotted owl strategy (acres)	No HCP spotted owl role	All WDNR HCP Lands - 2023 (acres)	HCP spotted owl management (acres)
CHELAN	0	5,551	0	11,789	17,340	5,551
COLUMBIA	31,584	53,440	0	203,418	288,442	85,024
KLICKITAT	15,989	39,351	0	40,889	96,229	55,340
NORTH PUGET	15,167	110,691	0	331,398	457,256	125,858
OESF	0	0	272,427	0	272,427	272,427
SOUTH COAST	0	0	0	260,716	260,716	0
SOUTH PUGET	78,088	2,554	0	97,488	178,130	80,642
STRAITS	0	0	0	127,919	127,919	0
YAKIMA	33,556	13,069	0	165,794	212,419	46,625
Totals	**174,384**	**224,656**	**272,427**	**1,239,411**	**1,910,879**	**671,467**
Percent of total HCP lands	9%	12%	14%	65%	100%	35%

Notes: In designated Dispersal or NRF management areas, the HCP objective is to provide 50 percent of designated acres within the appropriate habitat type. In the OESF, the HCP objective is to provide 40 percent of the landscape in appropriate habitat types (20 percent old forest, 20 percent structural habitat).

Summary of the HCP Spotted Owl Conservation Strategy

In summary, HCP management designations for the spotted owl are located in areas that were identified as important for supporting spotted owl conservation on adjacent federal lands, or important for providing connectivity between federal reserves. The various spotted owl designations comprise over 671,000 acres (35 percent) of HCP lands (Table 6). In NRF management areas, the HCP is expected to restore or maintain over 111,000 acres of habitat capable of supporting spotted owl nesting (50 percent of NRF management areas). In dispersal areas, the HCP is expected to restore or maintain over 87,000 acres capable of supporting spotted owl dispersal (50 percent of dispersal management areas). In the OESF, the HCP is expected to restore or maintain over 108,000 acres of structural habitat (40 percent of OESF acres) (foraging or nesting quality habitat). Because these areas are designated within close proximity to federal reserves, HCP designated habitat areas are expected to contribute to the maintenance and restoration of habitat capacity to support spotted owl populations and distribution on adjacent federal lands.

6.2.2 Marbled Murrelet Conservation Strategy

The 1997 HCP included an Interim Conservation Strategy (Interim Strategy) for the marbled murrelet (murrelet) because at the time the 1997 HCP was developed (mid 1990s), information about murrelet habitat use, both generally and specific to WDNR-managed HCP lands, was not sufficient to design and implement a long-term conservation strategy. From 1997 through 2019, WDNR implemented land management activities within western Washington in compliance with the Interim Strategy as described in the 1997 HCP, and consistent with concurrence letters issued by USFWS in 2007 and 2009 regarding modifications to the Interim Strategy (USFWS and WDNR 2019, Appendix I).

A summary of murrelet surveys, habitat relationship studies, and other efforts undertaken by WDNR to implement the interim murrelet strategy and develop a long-term conservation strategy for murrelets is described in the *Final HCP Amendment* (USFWS and WDNR 2019, Appendix Q), the *Occupied Sites Focus Paper* (USFWS and WDNR 2019, Appendix D), and in the *Recommendations and Supporting Analysis of Conservation Opportunities for the Marbled Murrelet Long-term Conservation Strategy* (Raphael et al. 2008, entire).

Public scoping to inform development of alternatives for a long-term strategy was completed in 2006, 2012, and in 2013 as described in the Scoping Report (USFWS and WDNR 2019, Appendix A). From 2013 through 2019, USFWS staff provided technical assistance to WDNR in the development of alternatives considered for a long-term strategy including the final proposed HCP Amendment.

The USFWS and WDNR jointly published a draft Environmental Impact Statement (EIS) in December 2016, and a revised draft EIS and draft HCP amendment in September 2018. Following a comment period ending December 8, 2018, the USFWS and WDNR published a final EIS and proposed final HCP amendment on September 20, 2019 (USFWS and WDNR 2019). On December 19, 2019, the Board of Natural Resources approved the long-term conservation strategy amendment. The amendment replaced the 1997 HCP interim strategy for the marbled murrelet. As part of this process, the USFWS amended the ITP to authorize the long-term strategy.

The 2019 Amendment summarized the current status of the species, the environmental baseline, the current murrelet strategy and other contributing aspects of the HCP, and the effects to murrelets, designated marbled murrelet critical habitat, and other listed species that would emanate from implementation of the long-term strategy (USFWS 2019, entire). The long-term strategy builds upon an existing network of long-term forest cover (LTFC) that is comprised of approximately 567,000 acres of WDNR-managed forest lands that are deferred from variable-retention timber harvest. The long-term strategy increased the area in LTFC from 567,000 acres to approximately 604,000 acres. Under the long-term strategy, marbled murrelet conservation is concentrated in 20 “special habitat areas” that encompass over 46,000 acres on WDNR-managed lands (WDNR 2019c). In addition, the long-term strategy includes conservation measures to protect all existing murrelet Occupied Sites, and most existing murrelet habitat on WDNR managed lands. The long-term strategy released approximately 38,000 acres of murrelet habitat for potential harvest over a minimum period of two decades. Under the long-term strategy, total murrelet habitat is projected to increase on WDNR-managed lands from approximately 207,000 acres (2019) to 272,000 acres (2067) over the term of the HCP (USFWS 2019, p. 66).

The long-term strategy focuses on areas of murrelet habitat and areas capable of developing suitable murrelet habitat in the future. The long-term strategy also influences both bull trout and spotted owl conservation by conserving additional areas that were not protected under the provisions of the 1997 HCP. The benefits of the long-term strategy are ancillary to the benefits of the spotted owl and riparian strategies and therefore are not discussed in additional detail in this document. For additional information on the marbled murrelet long-term strategy, consult the Amendment (WDNR 2019c, entire) or the section 7 consultation (USFWS 2019, entire).

6.2.3 Riparian Conservation Strategies

The riparian conservation strategy addresses forest management practices affecting certain ecological functions that are important for creating, restoring, and maintaining aquatic habitats. The strategy protects these functions along typed waters by restricting forest practices activities from the most sensitive parts of riparian areas and by limiting activities in other areas.

Under the HCP, differing riparian conservation strategies are implemented in both the Westside planning units and the OESF. The riparian conservation strategy for the OESF is different than the Westside planning units because 1) in the OESF, the emphasis on research and the systematic application of knowledge gained will likely lead to refinements and revisions in the riparian conservation strategy over time; and 2) the climatic, geological, and physiographic characteristics of the Olympic Peninsula present special problems for forest management around riparian areas (WDNR 1997, p. IV.56).

Stream Typing System

Riparian protection begins with the determination of stream type. On state trust lands in western Washington, the WDNR State Lands HCP uses a numerical system (Type 1 through Type 5) to categorize streams based on their physical characteristics such as stream width, steepness, and whether or not fish are present (WAC 222-16-031). Type 1 streams are the largest and Type 5 streams are the smallest. WDNR and the Services have agreed that these stream typing rules meet the intent of WDNR’s HCP:

1. **"Type 1 Water"** means all waters, within their ordinary high-water mark, as inventoried as "shorelines of the state" under chapter 90.58 RCW and the rules promulgated pursuant to chapter 90.58 RCW, but not including those waters' associated wetlands as defined in chapter 90.58 RCW.

2. **"Type 2 Water"** means segments of natural waters which are not classified as Type 1 Water and have a high fish, wildlife, or human use. These are segments of natural waters and periodically inundated areas of their associated wetlands, which:

   a. Are diverted for domestic use by more than 100 residential or camping units or by a public accommodation facility licensed to serve more than 10 persons, where such diversion is determined by the department to be a valid appropriation of water and only considered Type 2 Water upstream from the point of such diversion for 1,500 feet or until the drainage area is reduced by 50 percent, whichever is less;

   b. Are diverted for use by federal, state, tribal or private fish hatcheries. Such waters shall be considered Type 2 Water upstream from the point of diversion for 1,500 feet, including tributaries if highly significant for protection of downstream water quality. The department may allow additional harvest beyond the requirements of Type 2 Water designation provided by the department of fish and wildlife, department of ecology, the affected tribes and interested parties that:

      i. The management practices proposed by the landowner will adequately protect water quality for the fish hatchery; and
      ii. Such additional harvest meets the requirements of the water type designation that would apply in the absence of the hatchery;

   c. Are within a federal, state, local, or private campground having more than 30 camping units: Provided, that the water shall not be considered to enter a campground until it reaches the boundary of the park lands available for public use and comes within 100 feet of a camping unit.

   d. Are used by fish for spawning, rearing or migration. Waters having the following characteristics are presumed to have highly significant fish populations:

      i. Stream segments having a defined channel 20 feet or greater within the bankfull width and having a gradient of less than 4 percent.
      ii. Lakes, ponds, or impoundments having a surface area of 1 acre or greater at seasonal low water; or

   e. Are used by fish for off-channel habitat. These areas are critical to the maintenance of optimum survival of fish. This habitat shall be identified based on the following criteria:

      i. The site must be connected to a fish bearing stream and be accessible during some period of the year; and
      ii. The off-channel water must be accessible to fish through a drainage with less than a 5 percent gradient.

3. **"Type 3 Water"** means segments of natural waters which are not classified as Type 1 or 2 Waters and have a moderate to slight fish, wildlife, or human use. These are segments of natural waters and periodically inundated areas of their associated wetlands which:

   a. Are diverted for domestic use by more than 10 residential or camping units or by a public accommodation facility licensed to serve more than 10 persons, where such diversion is determined by the department to be a valid appropriation of water and the only practical water source for such users. Such waters shall be considered to be Type 3 Water upstream from the point of such diversion for 1,500 feet or until the drainage area is reduced by 50 percent, whichever is less;

b. Are used by significant numbers of anadromous or resident game fish for spawning, rearing, or migration. If fish use has not been determined:

   i. Waters having any of the following characteristics are presumed to have significant anadromous or resident game fish use:

      A. Stream segments having a defined channel of 2 feet or greater within the bankfull width in Western Washington; or 3 feet or greater in width in Eastern Washington; and having a gradient of 16 percent or less;

      B. Stream segments having a defined channel of 2 feet or greater within the bankfull width in Western Washington; or 3 feet or greater within the bankfull width in Eastern Washington, and having a gradient greater than 16 percent and less than or equal to 20 percent, and having greater than 50 acres in contributing basin size in Western Washington or greater than 175 acres contributing basin size in Eastern Washington, based on hydrographic boundaries;

      C. Ponds or impoundments having a surface area of less than 1 acre at seasonal low water and having an outlet to a fish stream;

      D. Ponds of impoundments having a surface area greater than 0.5 acre at seasonal low water.

   ii. The Department shall waive or modify the characteristics in (i) of this subsection where:

      A. Waters have confirmed, long term, naturally occurring water quality parameters incapable of supporting fish;

      B. Snowmelt streams have short flow cycles that do not support successful life history phases of fish. These streams typically have no flow in the winter months and discontinue flow by June 1; or

      C. Sufficient information about a geomorphic region is available to support a departure from the characteristics in (i) of this subsection, as determined in consultation with the department of fish and wildlife, department of ecology, affected tribes and interested parties.

4. **"Type 4 Water"** classification shall be applied to segments of natural waters which are not classified as Type 1, 2 or 3, and for the purpose of protecting water quality downstream are classified as Type 4 Water upstream until the channel width becomes less than 2 feet in width between the ordinary high water marks. Their significance lies in their influence on water quality downstream in Type 1, 2, and 3 Waters. These may be perennial or intermittent.

5. **“Type 5 Water”** classification shall be applied to all natural waters not classified as Type 1, 2, 3, or 4; including streams with or without well-defined channels, areas of perennial or intermittent seepage, ponds, natural sinks and drainage ways having short periods of spring or storm runoff.

Changes in Stream Typing Systems over the Span of the HCP

WDNR’s stream typing system has gone through changes since the HCP was signed in 1997. The stream typing system used by WDNR changed for a period of about 5 to 6 years without any modification of the HCP. The stream typing system used in drafting the HCP was the Forest Practices 1996 emergency rules, identifying Type 1 through Type 5 stream types. In 2000, the Forest Practices stream typing rules were changed from 1996 emergency rules to the Forest and Fish rules, identifying S, F, Np, and Ns stream types. This created an incongruity with the HCP that led to confusion and mistyping. In 2006, WDNR reverted back to the original HCP system and renamed them the “Water Typing System for Forested State Trust HCP Lands.” The HCP uses water types as defined in WAC 222-16-031 as of January 1997. In the field, the width of the riparian buffer is measured as the horizontal distance from, and perpendicular to, the outer margin of the 100-year floodplain. Table 7 compares the two stream typing systems.

Table 7. A comparison of stream typing rules implemented under the HCP.

1996 Types	1996 Definitions	2000 Types	2000 Definitions
1	Shorelines of the State	S	Shorelines of the State
2	>20’ OHWM <4% gradient Fish	F	>20’ OHWM <4% gradient Fish
3	≥ 2’ OHWM <16% gradient or >16% or <20% with >50 acres contributing basin size. Fish	F	≥ 2’ OHWM <16% gradient or >16% or <20% with >50 acres contributing basin size. Fish
4	≥ 2’ OHWM <16% gradient or >16% or <20% with >50 acres contributing basin size No Fish	Np	Stream segment contains water at all times during normal rainfall year Downstream from perennial source Basin size ≥ 52 acres (outside of Sitka spruce zone) Basin size ≥ 13 acres (in Sitka spruce zone) No Fish
5	< 2’ OHWM May not have a well-defined channel Water may be seasonal	Ns	Seasonal water Stream segment physically connected to a Type 1, 2, 3, or 4 water

The primary differences between the two stream-typing systems are found in how non-fish bearing streams are defined. The 1996 definitions consider whether the stream meets physical criteria (gradient and width), while the 2000 definitions consider whether the stream supports perennial flow. While there is likely considerable overlap between definitions, this is not always the case. A large difference between the systems is the ease and reliability of typing the streams; typing perennial and seasonal streams has a short window in a typical year and considerable between year variability, while typing stream width and gradient is simpler and can be applied at all times of the year.

Between 2000 and 2006, some Type 5 streams that are perennial may have received more protection than anticipated in the HCP, and some Type 4 streams that are seasonal may have received less protection. The difference between protection is substantial and it is more likely that Type 4 streams were under-protected in comparison to the HCP. For instance, a seasonal stream greater than 2 feet wide with no fish would not have received protection regardless of its width or how important its function may have been during the 2000 to 2006 period. Effects associated with stream protections are discussed further in the Effects Section.

6.2.4 Riparian Conservation Strategies in the Westside Planning Units

The riparian management strategy for the westside units defines the riparian management zone (RMZ) and describes future forest management with respect to unstable hillslopes, the road network, hydrologic maturity within the rain-on-snow zone, and wetlands. The WDNR State Lands HCP identifies two objectives for the riparian conservation strategy for the five Westside planning units (WDNR 1997, p. IV-60):

1. Maintain or restore salmonid freshwater habitat on DNR-managed forestlands, and,
2. Contribute to the conservation of other aquatic and riparian obligate species.

Interior and Exterior Riparian Buffers in Westside Planning Units

The RMZ in the westside units consists of both an inner riparian buffer and an outer (exterior) wind buffer when needed. The principal function of the riparian buffer is to protect salmonid habitat; the principal function of the exterior wind buffer is protection of the riparian buffer (WDNR 1997, p. IV.56).

The interior riparian buffer width for Type 1 through Type 3 streams is defined by the estimated 100-year site potential tree height, or 100 feet, whichever is greater (WDNR 1997, p. IV-56). The site-potential height is derived from standard site index tables (King 1966), using 100 years as the age of mature conifer stand. The site index table used will be that corresponding to the dominant conifer species occurring in the upland portion of riparian ecosystem. The average riparian buffer width is expected to be between 150 feet and 160 feet. An interior riparian buffer of 100 feet is applied to both sides of Type 4 waters. The width of riparian buffers is measured as the perpendicular horizontal distance from the outer margin of the 100-year floodplain (WDNR 1997, p. IV.56; WDNR 2006b, p. 17).

An exterior wind buffer is applied on the windward side of Types 1, 2, and 3 waters in areas that are prone to windthrow (WDNR 1997, p. IV-59) (Table 8). Physical evidence of windthrow, windthrow models, and the potential for windthrow will guide the placement of outer wind buffers along riparian buffers. Where forest stands are subject to strong winds from multiple directions, it may be necessary to put wind buffers along the riparian buffers on both sides of the stream as opposed to just the windward side. If no evidence of windthrow exists or models predict a low risk of windthrow, then wind buffers will not be applied. Management within the wind buffers will be largely experimental, and therefore, the forest conditions within the wind buffer cannot be accurately predicted.

Table 8. Riparian buffers applied in westside planning units (excluding the OESF).

Stream Type	Average Interior Core Riparian Buffer Width	Exterior Wind Buffer (where applied)
1	Site potential tree height (average 145 ft, minimum 100 ft, maximum 215 ft)	100 ft
2	Site potential tree height (average 145 ft, minimum 100 ft, maximum 215 ft)	100 ft
3	Site potential tree height (average 145 ft, minimum 100 ft, maximum 215 ft)	50 ft. Applied only to streams > 5 ft wide
4	100 ft	n/a
5	Variable application	n/a

Source: WDNR 2006b, p. 17.

Inner, Middle, and Outer Riparian Management Zones

The HCP allows forest management activities within RMZs that maintain or restore the quality of salmonid habitat. To ensure that this occurs, site-specific forest management activities along all Types 1, 2, 3, and 4 waters are required to conform to the following (WDNR 1997, pp. IV.59 – IV.60):

1. **No timber harvest shall occur within the first 25 feet** (horizontal distance) from the outer margin of the 100-year floodplain. Maintenance of stream bank integrity is the primary function of the no-harvest area, and therefore, a wider no-harvest area will be established where necessary. WDNR anticipates that only ecosystem restoration will occur in this area.
2. **The next 75 feet of the riparian buffer shall be a minimal-harvest area**. Activities occurring between 25 and 100 feet (horizontal distance) from the 100-year floodplain must not appreciably reduce stream shading, the ability of the buffer to intercept sediment, or the capacity of the buffer to contribute detrital nutrients and large woody debris. Maintaining natural levels of stream temperature, sediment load, detrital nutrient load, and instream large woody debris is the primary function of the minimal-harvest area, and therefore, a wider minimal harvest area will be established where necessary. WDNR anticipates that only two types of silvicultural activities will occur in this area: ecosystem restoration and the selective removal of single trees.
3. **The remaining portion of the riparian buffer (more than 100 feet from the active channel margin) shall be a low-harvest area**. WDNR anticipates that selective removal of single trees, selective removal of groups of trees, thinning operations, and salvage operations will occur in this area.

These three zones will be referred to as the inner (first 25 feet), middle (up to 100 feet), and outer zone on Type 1-3 Waters, and as the inner (first 25 feet) and outer zone (up to 100 feet) on Type

4 Waters. Exceptions to the specific measures listed above include road construction for necessary stream crossings (WDNR 1997, p. IV.132), and stand conversion of streamside hardwood stands to conifer stands (WDNR 1997, p. IV.208).

Type 5 Waters in Westside Units Outside of the OESF

The HCP does not define a specific RMZ for Type 5 waters. Type 5 waters that flow through an area with a high risk of mass wasting are protected to the same extent that unstable hillslope features are protected (WDNR 1997, p. IV.59; IV.62). The HCP specifies that Type 5 waters are protected when necessary for water quality, fisheries habitat, stream banks, wildlife, and other important elements of the aquatic system (WDNR 1997, p. IV.59). The original intent of the 1997 HCP is that WDNR would study the effects of forest management along Type 5 waters located on stable slopes during the first 10 years of HCP implementation. At the end of the 10-year period, a long-term conservation strategy for forest management along Type 5 waters was to be developed and incorporated into the HCP as an adaptive management component (WDNR 1997, p. IV.59). To date (2024), WDNR has not yet completed a long-term conservation strategy for Type 5 waters, and they continue to manage Type 5 waters under the interim guidance provided in the HCP.

According to the Riparian Forest Restoration Strategy (RFRS) (WDNR 2006b, p. 17), in the interim, Type 5 streams should be afforded the following protection:

1. No equipment should pass across, within, or through these stream segments, where possible.
2. Trees should be directionally felled away from these stream segments.
3. Where operationally feasible, leave trees should be retained adjacent to these stream segments to provide protection of water quality, stream bank integrity, and wildlife habitat.

Although not specified in the HCP or the RFRS, at a minimum, Type 5 streams are protected with a 30-feet wide equipment limitation zone regardless of whether the stream is on stable ground or potentially unstable slopes or landforms consistent with the Washington Forest Practices rules (WAC 222-30-021) (e.g., WDNR 2016, p. 3-29). For purposes of this Biological Opinion, the USFWS expects that at a minimum, the existing interim Type-5 protections provided by the interim strategy will be included in a final Headwaters Conservation Strategy (HCS) required by the HCP. See Appendix A for more about the final HCS.

Riparian Forest Restoration Strategy

On August 15, 2005, the Services approved the August 2005 version of RFRS and noted that the procedures fulfill the requirements outlined in the HCP (WDNR 1997, p. IV.61) and provide the promised guidance for site specific riparian management while not changing any existing HCP conservation strategies.

In April of 2006, the WDNR completed the Implementation Procedures for the Habitat Conservation Plan: RFRS for the westside planning units excluding the Olympic Experimental

State Forest (WDNR 2006b, entire). The RFRS describes wind buffers and methods for making site-specific, forest-management decisions in the RMZs to accommodate greater flexibility afforded by managing riparian areas on a site-specific basis and the uncertainties surrounding the results of these activities conducted over time. The objective of the RFRS is to use thinning activities to hasten the development of riparian forests toward long-term structurally complex, fully functional forests (i.e., old-forest characteristics). The strategy focuses on the growth of large, site-adapted conifer trees, downed woody debris, layering of the tree canopy, and important structural components such as large snags.

The main objective of all riparian silvicultural activities is to put the RMZ on an accelerated trajectory toward the riparian desired future condition (RDFC). The RDFC is divided into five categories representing the most important components for developing the Fully Functional stand development stage (WDNR 2006b, p. 53), and therefore the long-term restoration goal (WDNR 2006b, p. 9):

1. Large conifer trees
2. Complex stand structure
3. Site-adapted tree species composition
4. Down wood
5. Snags

The RFRS also establishes threshold targets of (WDNR 2006b, p.9):

1. Basal area (≥ 300 square feet per acre).
2. Quadratic mean diameter (Trees ≥ 21 inches diameter at breast height [DBH]).
3. Snags (retain existing snags ≥ 20" DBH through no-cut zones and maintain at least 3 snags per acre).
4. Large down wood (maintain ≥ 2,400 cubic feet/ac and actively create down wood (contribute 5 trees from the largest thinned DBH class) during each conifer management entry.
5. Vertical stand structure (maintain at least 2 canopy layers [bimodal or developing reverse J-shaped diameter distribution]).
6. Species diversity (maintain at least 2 main canopy tree species suited to the site).

The RFRS uses active forest management to achieve riparian objectives:

- *Type I Thinning*: Type I thinning includes non-commercial treatments such as pre-commercial thinning in young forest plantations to reduce tree density and promote stand development and diversity. Type I thinning activities may take place in the inner zone to the edge of the 100-year flood plain (WDNR 2006b, p. 22).

- *Type II Thinning*: Commercial thinning treatments to increase stand stability and promote forest growth. Type II thinning generally occurs in stands below 40 years in age and represent plantations established after regeneration harvest (WDNR 2006b, p. 22).
- *Type III Thinning*: Commercial thinning treatments in stands that are in more advanced stages of stand development. Type III thinning generally only occurs in stands less than 70 years of age. If appropriate, thinning activities may occur in stands greater than 70 years of age with written approval from the HCP Implementation Manager and in consultation with the Federal Services (WDNR 2006b, p. 23).

Riparian thinning (Type II or Type III) in conifer-dominated stands is designed to maintain a relative density (RD) of greater than 35, or at least 100 trees per acre of dominant and co-dominant trees, whichever is greater (WDNR 2006b, p. 25). A relative density of 30 may be used with HCP implementation manager approval. For operational efficiency, the RFRS combines the middle zone and outer zone of the RMZ for Type 1-3 waters. The intent is that the management prescriptions are designed to meet HCP objectives for the middle zone (WDNR 2006b, p. 18).

For hardwood-dominated stands, both conifer release and stand conversion are options depending on whether there are at least 25 viable conifers per acre that have a reasonable chance of release. Hardwood stands will not be converted if it is determined that the site is not conducive to conifer growth (i.e., based on physical criteria or the lack of conifer stumps) or if the upstream/downstream forest landscape assessment reveals that the forest stand should be retained in the present condition to provide a mixture of conifer/hardwood conditions across the landscape. Conversion would also not occur if restoration were deemed cost-prohibitive or impractical in light of the need for repeated brush control treatments.

Estimates of Riparian Thinning

In 2006, WDNR intended to apply commercial silvicultural treatments to a maximum of 1 percent of its riparian areas annually for the Westside planning units outside the OESF (WDNR 2006b, p. 20). At that time, WDNR estimated there were over 11,000 miles of streams in the westside planning units, with over 273,000 acres in RMZs (WDNR 2006b, p. 7). The 2007 sustainable harvest level calculations assumed that 10 percent of the total riparian area available for thinning would be thinned in the decade (1 percent per year). The resulting volume estimate was 394 million board feet (MMBF), including the OESF planning unit. However, only 39 MMBF was thinned from riparian areas during the fiscal year 2004–2015 period. About 1 percent of the total area thinned or harvested by WDNR in the fiscal year 2004–2015 period was in riparian areas (WDNR 2019, p. 2-4). WDNR noted that riparian thinning is more expensive to implement due to pre-sale costs and operability challenges. Due to these challenges, the 2019 sustainable harvest level preferred alternative allows for riparian thinning but does not include riparian timber volume when setting sustainable harvest levels (WDNR 2019, p. 2-15). WDNR estimated that for the period from 2012 to 2022, approximately 3,500 acres of RMZs had been treated to accelerate development of complex forest structure (WDNR 2023, p. 11). This equates to an average of about 318 acres of RMZ restoration thinning per year dispersed across the 5 Westside planning units and the OESF combined.

Table 9 shows the various inner, middle, and outer riparian management zone widths according to stream type, and the associated management activities that can occur adjacent to waters within the HCP planning area.

Table 9. Summary of Westside Unit Riparian Forest Management Guidelines under the Riparian Forest Restoration Strategy.

Stream Class	**RMZ Management Zone**	**Zone Width (measured from edge of 100-year flood plain)**	**Allowed Management Actions: Conifer Dominated Stands** (Conifer Basal Area >50%)	**Allowed Management Actions: Hardwood Dominated Stands** (Conifer Basal Area <50%)
Type 1-4 Waters	Inner Zone or "No-Harvest Area"	0-25 feet	Type I Thinning: No commercial timber removal. Restoration limited to wood placement, underplanting, release of suppressed conifers, LWD creation and noxious weed control. Disturbance will be restricted to road crossings and yarding access.	
Type 1-3 Waters	Middle Zone or "Minimal Harvest Area"	>25 – 100 feet	Type II Thinning (little existing structure): RMZ Thinning with Upland Thinning – retain RD >35 Type III Thinning (some existing structure): RMZ Thinning with Upland Thinning – retain RD >35 Type III RMZ Thinning with Upland Regeneration	≥25 conifer tpa: Conifer Release <25 Conifer tpa: Conversion
Type 1-3 Waters	Outer Zone or "Low Harvest Area"	≥100 feet	Same as Middle Zone	Same as Middle Zone
Type 4 Waters		>25 – 100 feet		
Type 1-3	Wind Buffer	100 feet past the Edge of Outer Zone	Same as Outer Zone	Same as Outer Zone

Source: WDNR 2006b, p. 25.

Other Riparian Protections in Westside Planning Units

Roads

WDNR's HCP contains a road-management strategy (see WDNR 1997, p. IV.62-68) that has specific commitments, as well as a commitment to complete a Comprehensive Road Network Management Plan (CRNMP) that, among other things, also addresses road densities. On a WAU basis, WDNR must minimize adverse impacts to salmonid habitat caused by the road network. With this conservation objective in mind, a comprehensive landscaped-based road network management process must be developed and instituted by WDNR (WDNR 1997, p. IV.62).

Major components of this process include:

1. The minimization of active road density.
2. A site-specific assessment of alternatives to new road construction (e.g., yarding systems) and the use of such alternatives where practicable and consistent with conservation objectives.
3. A base-line inventory of all roads and stream crossings.
4. Prioritization of roads for decommissioning, upgrading, and maintenance.
5. Identification of fish blockages caused by stream crossings and a prioritization of their retrofitting or removal.

As a baseline, the HCP describes the WDNR's current road-management strategy. Much of the requirements of this strategy have already been met through the preparation and completion of Road Management and Abandonment Plans (RMAPs) under the Washington Forest Practices Rules (222-24-WAC Road Construction and Maintenance) and through additional WDNR policies and directives. Changes in road systems are summarized in the description of the *Transportation Network*. Remaining concerns focus on road densities in some areas, specific hot spots that may not have been identified, orphaned roads, jointly managed road systems, and road systems on newly acquired State lands that have not yet been addressed.

Unstable Slopes

Under the 1997 HCP, unstable hillslopes are identified through field reconnaissance or with slope geomorphology models and verified through field reconnaissance with qualified staff (WDNR 1997, p. IV.62). Timber harvest and road construction may occur on unstable slopes if such can be accomplished without increasing the frequency or severity of slope failure. The intent of the HCP is that timber harvest in areas identified as having a high risk of mass wasting will be deferred until it can be demonstrated that such activity can be accomplished without increasing the frequency or severity of slope failure (WDNR 1997, p. 78).

Following the 1997 HCP, the Forest Practices Rules were amended to implement the Forest and Fish Report (USFWS et al. 1999, entire). Currently, WDNR relies on those Forest Practices Rules to meet the intent of the HCP. Timber harvest or construction of roads, landings, gravel pits, rock quarries, or spoil disposal areas are subject to a Class IV-special Forest Practices Application classification and SEPA analysis if proposed on specified potentially unstable slopes and landforms and if they have the potential to deliver sediment/debris to a public resource or to threaten public safety (WAC 222-16-050(1)(d)).

The Forest Practice Rules list potentially unstable slopes and landforms (rule-identified landforms) as:

1. Inner gorges, convergent headwalls, and bedrock hollows steeper than 35 degrees (75 percent).
2. Toes of deep-seated landslides steeper than 33 degrees (65 percent).
3. Groundwater recharge areas for glacial deep-seated landslides.

4. Outer edges of meander bends along valley walls or high terraces of an unconfined meandering stream.
5. Any areas containing features indicating the presence of potential slope instability which cumulatively indicate the presence of unstable slopes.

SEPA policies in the Forest Practices Rules are described in WAC 222-10-030 as well as Board Manual 16. WDNR follows the processes outlined in the Forest Practice Rules for forest management on unstable slopes. This includes the requirement for additional SEPA review in many cases. If roads are proposed for construction on unstable slopes, a geotechnical report is required. The Forest Practices Rules for protection of unstable slopes are more specific than the general language included in the 1997 HCP, and are intended to accomplish the same objectives described in the HCP for minimizing risk of slope failure.

Hydrologic Maturity in Rain-on-Snow Zones

The HCP specifies that WDNR must minimize the adverse impacts to salmonid habitat caused by rain-on-snow floods (WDNR 1997, p. IV.68). The expectation is that two-thirds of the WDNR-managed forest lands in drainage basins in the significant rain-on-snow zone will be maintained in forest that is hydrologically mature. This prescription is applied to drainage basins that are approximately 1,000 acres or larger in size. Exceptions are provided where:

1. The basin has less than one-third of its area in the significant rain-on-snow zone.
2. The basin has at least two-thirds of its area in the significant rain-on-snow zone covered by hydrologically mature forests, and there is a reasonable assurance that it will remain in that condition (e.g., forests in National Parks or National Forest Late Successional Reserves).
3. The basin has less than one-half of its area in the significant rain-on-snow zone under WDNR management, and there is no reasonable assurance that other landowners will contribute hydrologically mature forests (e.g., because land is in mines, farms, or housing developments). In such situations, an interdisciplinary team of scientists will be convened to develop a prescription for WDNR-managed land within the drainage basin. Economic considerations will be included in the deliberations.

On the west side of the Cascades, conifer forests reach hydrologic maturity with respect to rain-on-snow events at approximately 25 years. For the purposes of the HCP, hydrologically mature is defined as a well-stocked conifer stand 25 years or older (WDNR 1997, p. IV.68).

Since completion of the HCP, climate change has increasingly become a concern. Anticipated patterns generally indicate that the rain-on-snow zone will move higher in elevation, and in some watersheds the rain-on-snow zone may increase in size. Hydrological maturity may need to be reassessed on an ongoing basis to account for harvest and re-growth, but also for shifts in the rain-on-snow zone. See Environmental Baseline for a more detailed discussion of climate change’s effects on the Action Area.

Wetlands

Management activities in and around wetlands must be consistent with the Forest Resource Plan Policy No. 21 (WDNR 1992, p. 361), which states that WDNR “will allow no overall net loss of naturally occurring wetland acreage and function.” The primary conservation objective of the wetlands protection strategy is to maintain hydrologic function (WDNR 1997, p. IV.69). This will be achieved through:

1. Continuously maintaining a plant canopy that provides a sufficient transpiration surface and established rooting.
2. Maintaining natural water flow (e.g., no channelization of surface or subsurface water flow).
3. Ensuring stand regeneration.

The primary wetland functions that will be protected are the augmentation of stream flow during low-flow seasons and the attenuation of storm peak flows. Wetlands to receive protection are those that fit the definition used by the state Forest Practices Rules (WAC 222-16-010). All wetlands 0.25 acre or larger are protected by a wetland buffer. The minimum size of wetland to be protected was based on operational feasibility because wetlands smaller than this are difficult to locate.

Wetlands that are larger than 1 acre have a buffer width approximately equal to the site potential height of trees in a mature conifer stand or 100 feet, whichever is greater. For the purposes of this the HCP, the height shall be derived from standard site index tables (King 1966), using 100 years as the age at breast height of a mature conifer stand (WDNR 1997, p. IV.69). Wetlands from 0.25 acre to 1 acre will have a 100-foot-wide buffer. In the field, the width of the wetlands buffer is measured as the perpendicular horizontal distance from the edge of the wetland. Seeps and wetlands smaller than 0.25 acre are afforded the same protection as Type 5 waters and protected where part of an unstable hillslope.

Timber harvest within the forested portions of forested wetlands and wetland buffer areas will be designed to maintain and perpetuate a stand that:

1. Is as wind-firm as possible.
2. Has large root systems to maintain the uptake and transpiration of ground water.
3. Has a minimum basal area of 120 square feet per acre.

No road building is allowed in wetlands or wetland buffers without mitigation. Roads constructed within wetlands or wetland buffers require on-site and in-kind equal acreage mitigation in accordance with WDNR's wetland policy. The intent of the HCP is that the effects of roads on natural surface and subsurface drainage will be minimized.

6.3 Riparian Conservation Strategies in the OESF

The riparian conservation strategy for the OESF is distinct from that of the westside HCP planning units because of the unique physical and ecological features of the western Olympic

Peninsula (WDNR 1997, p. IV.106). The need for special protective measures stems from a high potential throughout the OESF for:

1. Mass wasting (i.e., landslides, debris torrents, channel-bank collapse), due to highly erosive, weathered bedrock and overlying glacial deposits, heavy annual precipitation, and steep terrain.
2. Tree blowdown, due to alignment of major river valleys with the prevailing wind directions, fully saturated soils during the winter months, and edge effects associated with clearcutting adjacent to mature timber stands.

Of the many factors affecting habitat for salmonids and riparian-dependent species, mass wasting and windthrow exert the greatest short- and long-term influences (WDNR 1997, p. IV.106). The conservation strategy addresses these two driving factors by creating riparian buffers designed to minimize mass wasting and windthrow. A principal working hypothesis of this approach is that buffers designed to minimize mass wasting and blowdown will be sufficient to protect other key physical and biological functions of riparian systems. The riparian conservation strategy for the OESF seeks to meet the stated objectives by establishing (WDNR 1997, p. IV.108):

1. Interior-core buffers on stream Types 1 through 4, and as needed on Type 5 streams to protect identifiable channels and unstable ground.
2. Exterior wind buffers on stream Types 1 through 4, and as needed on Type 5 streams.

Interior-Core Buffer Widths

Interior-core riparian buffers that are described in the HCP (WDNR 1997, pp. IV. 109 – IV.112) will be referred to in this document as "HCP functional interior buffers." The HCP functional interior buffers are intended to minimize disturbance of unstable channel banks and adjacent hillslopes (i.e., potential areas of mass wasting) to protect and aid natural restoration of riparian processes and functions. Harvesting in HCP functional interior buffers can occur, provided that management activities are consistent with the conservation objectives. The ability of management, conservation, and restoration activities to meet the conservation objectives are evaluated through landscape-level assessments of the physical and biological conditions of riparian forests.

The width of HCP functional interior buffers is determined on a site-specific basis, according to the assessment procedure. Although these buffers are established based on landscape-level field evaluations, WDNR expects that HCP functional interior buffer widths will be, on average, comparable to those in HCP Table IV.5 (WDNR 1997, p. IV.58). All Types 1 through 4 streams are protected with HCP functional interior-core buffers (Table 10).

Type 5 Streams

A separate protocol is warranted for Type 5 channels because of the abundance and variety of intermittent streams found on the western Olympic Peninsula. Management objectives in the OESF are to protect all Type 5 streams that cross unstable ground and occupy stable ground but have identifiable channels with evidence of water discharge or material transport WDNR 1997, p. IV.111). In the OESF, approximately 90 percent of Type 5 streams occupy unstable ground and directly contribute materials to the channel network. Of the remaining 10 percent, about 5 percent have identifiable channels on stable ground. The other 5 percent exert a negligible influence on aquatic or riparian habitat and thus require no special protection. Channels in this last group include those not connected to the watershed stream-network (e.g., sinks, seasonal wet areas excluding forested wetlands), slope depressions with no identifiable banks (e.g., swales with a continuous groundcover), and artificial channels that do not support aquatic habitat (e.g., ditches, yarding trails) (WDNR 1997, p. IV.111).

There are no available quantitative models or databases that specify which Type 5 channels require buffer protection. Type 5 channels that cross unstable ground with a potential for delivering water, wood, sediment, nutrients, and energy to the channel network will be protected from the active channel margin outward to the topographic break in slop on either side of the channel, as well as upstream to the channel initiation point and downstream to the channel confluence (WDNR 1997, p. IV.113). Type 5 streams that do not meet the criteria listed above, occur on stable ground, and lack a definable channel do not require an interior core buffer under the 1997 HCP.

In the 2016 OESF Forest Plan WDNR specifies in its procedures that Type 5 waters on stable ground will not receive interior core buffers, but all streams, including all Type 5 waters will receive a 30-foot-wide equipment limitation zones to project stream banks (WDNR 2016a, pp. 3-27; p. 3-29).

Management Activities within Interior-Core Buffers

Management activities that are most likely to occur in the HCP functional interior-core buffers in the OESF (WDNR 1997, pp. IV.131 – IV.132) are:

1. Selective harvest of hardwoods to encourage long-term sources of coniferous woody debris and channel-bank stabilization (harvest would occur on stable ground, where feasible and ecologically sound).
2. Thinning of young stands to promote wind-firm trees.
3. Restoration efforts, including habitat-enhancement projects.
4. Research projects, provided that they maintain or improve habitat for aquatic and riparian-dependent species.
5. Tree pruning to diversify forest structure.
6. Single-tree removals, if the number and size of trees removed do not reduce the long-term functions and processes of riparian ecosystems.

Management activities in the HCP functional interior-core buffers, or forested wetland and their buffers, exclude herbicide release and new road construction in riparian areas unless, in the case of riparian buffers, stream crossings are essential (WDNR 1997, p. IV.132). Roads in wetlands or their buffers will require on-site and in-kind wetland replacement, in accordance with the Forest Resource Plan (WDNR 1992, entire). Crossings will be designed to take the most-direct route possible across streams, to minimize obstructions to fish passage, peak flows, bank destabilization, and sediment delivery.

The 2016 OESF forest plan defines how limited areas of regeneration harvest can occur within "allotted acres" located within interior core buffers (WDNR 2016a, pp. 3-29 – 3-32). Allotted acre harvest is anticipated to occur in limited situations such as when a road is already present in the default buffer and implementation of the buffer would retain a narrow stand of trees on the upland side of the road. The amount of allowed allotted acres is determined based on an assessment of RMZ conditions within individual Type 3 watershed, using automated 12-step watershed assessment process. Allotted acre harvest must be placed at least 25 ft from the outer edge of the 100-year floodplain (measured horizontally) (WDNR 2016a, p. 3-31).

<u>Exterior Buffers</u>

Exterior buffers are intended to protect the integrity of interior core buffers from damaging winds. Exterior buffers will also help maintain channel-floodplain interactions, moderate riparian microclimate, shield the inner core from the physical and ecological disturbances of intensive management on upslope sites, and maintain diverse habitat for riparian dependent and upland biota (WDNR 1997, p. IV.112).

The OESF riparian strategy treats the design and the layout of the exterior buffer in two ways:

1. It intends light partial harvests, tailored to local landform and meteorological conditions, as an initial management approach.
2. It relies on experiments, from which WDNR can gain new knowledge to improve management techniques in riparian forests.

In 1997, tree blowdown was recognized as a significant problem for timber management on the western Olympic Peninsula. Hence, the HCP included provisions for experimental approaches to determine the optimum buffer width and long-term management strategies for maintaining wind-firm streamside forests (WDNR 1997, p. IV. 112). Harvest and other management activities in the experimental exterior buffers could follow any one of a series of experimental designs that will be replicated across the landscape to ensure statistical significance of experiment results. The HCP provides that "As a starting hypothesis, the average width of exterior buffers will be 150 feet for Type 1 through 3 streams and 50 feet for Type 4 and 5 streams ..., measured in horizontal distances laterally from the outer edge of the interior-core buffer on either side of the stream. These are average, rather than absolute, values because the size and configuration of wind buffers must vary locally to accommodate terrain and stand characteristics." (WDNR 1997, p. IV.112-117). "The wind buffer specifications of [the] HCP should be considered interim. The width of the wind buffer may change as research concerning wind throw in managed forests, especially that conducted in the Olympic Experimental Forest State, finds means of minimizing windthrow (WDNR 1997, p. IV.73). Management to achieve wind-firm riparian stands [is] adaptive, in order to test a variety of strategies and apply those strategies that are most effective in the long term" (WDNR 1997, p. IV.117). Consistent with the flexibility to modify exterior buffer widths provided by these HCP provisions, WDNR has modified the buffer widths from those originally contemplated in the HCP. Table 10 shows the interior and exterior riparian buffer widths on the OESF according to stream type.

Table 10. OESF riparian buffers as described in 2016 OESF Forest Land Plan.

Stream Type	Default minimum interior core riparian buffer width	Exterior Wind Buffer width (where applied)
1	150 ft	80 ft
2	150 ft	80 ft
3	100 ft	80 ft
4	100 ft	80 ft
5	width necessary to protect unstable ground	n/a

Source: WDNR 2016a, pp. 3-27, 3-35.

The values listed in Table 10 (above), are consistent with the expected average buffer widths listed in the HCP for the OESF (WDNR 1997, p. IV.58) except for the exterior wind buffer widths. Where exterior buffers are applied, exterior buffer widths in the OESF have been reduced from 150 feet wide to 80 feet wide on Type 1-3 streams and have been increased from 50 feet to 80 feet on Type 4 streams and Type 5 streams. The 80-foot exterior buffer width is based on the findings that more than 75 percent of windthrow occurs within approximately the first 80 feet of a forest stand, measured from an exposed edge (Lanquaye 2003, p. 68). Whether exterior buffers are applied is now partially based on a WDNR-developed windthrow-risk model that, in addition to predicting when exterior buffers are prudent, also guides the modification of harvest units to reduce the probability of windthrow (WDNR 2016a, pp. 3-33 – 3.36).

Management within Exterior Buffers

Management to achieve wind-firm riparian stands are adaptive, to test a variety of strategies and apply those strategies that are most effective in the long-term. Exterior buffer widths (Table 10) are applied to interior-core buffers through a standard procedure or an experimental approach.

To achieve the objective of wind-firm riparian forest using standard procedure, wind buffers are placed on all riparian segments for which stand wind-firmness cannot be documented by historical information, windthrow modeling (e.g., Tang 1995), or other scientific means. Thirty-three percent or less, by volume, of the riparian trees in the designated exterior buffer may be removed for commercial purposes (i.e., excluding pre-commercial thinning and restoration activities) per rotation, until research is available supporting more frequent entry.

WDNR anticipated that the standard practice for implementing exterior buffers, as described in the HCP, would be applied on approximately 75 to 85 percent of the riparian areas in the OESF (WDNR 1997, p. IV.118). Now, following the 2016 OESF Plan, WDNR anticipates that fewer than 1 percent of the Type 1 through 4 streams will receive exterior buffers (WDNR 2016b, p. 2-25).

Management activities most likely to occur in exterior buffers in the OESF (WDNR 1997, p. IV. 132) are:

1. Partial cuts of 33 percent or less by volume, per rotation, aggregated or dispersed, depending on the operational objectives for maintaining wind-firm stands.
2. Experiments designed to promote wind-firmness of the interior-core buffer.
3. Forest-structure modifications, including thinning, pruning, and tree-topping to improve stand wind-firmness.

6.3.1 Other Riparian Protections in the OESF

Roads

The OESF presents challenges in road planning due to its steep topography and large amounts of precipitation. The objectives of a comprehensive road-maintenance plan for the OESF (WDNR 1997, p.IV.118) are to:

1. Ensure annual inventories of road conditions.
2. Maintain existing roads to minimize drainage problems and stream sedimentation.
3. Stabilize and close access to roads that no longer serve a management function or that cause intractable management or environmental problems.
4. Assure sound construction of any new roads.
5. Guarantee that additional new roads are built only where no other operationally or economically viable option exists for accessing management areas by existing roads or alternative harvest methods (e.g., full-suspension yarding).
6. Minimize active road density.
7. Prioritize roads for decommissioning, upgrading, and maintaining.
8. Identify fish blockages caused by stream crossings and prioritize their retrofitting or removal.

As discussed for the westside planning units, many of these objectives have already been met through the completion of RMAPs under the Forest Practices Rules and are also addressed by WDNR policies and guidance. The remaining issues are anticipated to be addressed in the overall CRNMP within the next 2 years.

Unstable Slopes

The strategy for unstable slopes on the OESF is primarily contained within the strategies for riparian buffers and road management. Activities on the OESF follow the same procedures as described for the westside planning units regarding avoidance of activities on Washington Forest Practices rule-identified landforms.

Hydrological Maturity

The OESF riparian strategy does not specifically address hydrological maturity. In the HCP, WDNR recommends to itself that it should use forest practices methods for analyzing rain-on-snow zones and maintaining hydrologic maturity (WDNR 1997, p. 126). However, the HCP does not require any specific conservation measures to address maintaining hydrologic maturity in the OESF. The HCP concludes that the unzoned forest approach to conserving habitat for listed species likely will lead to forest conditions, within about 35 years [i.e., by 2032], that will assure hydrologic maturity in at least 70 percent of each Type 3 basin (WDNR 1997, p. IV.126).

Although the 1997 HCP lacks specificity regarding standards to maintain hydrologic maturity in the OESF, WDNR does take hydrologic maturity into consideration when planning timber sales in the OESF (WDNR 2016a, p. 3-26; p.3-29). The purpose of the evaluation is to prevent detectable increases in peak flows, which can be prevented by maintaining enough hydrologically mature forest in each watershed. This evaluation is done at the scale of Type 3 watersheds, which are small drainages on the order of 500 – 2,000 acres. Type 3 watersheds are defined as the drainages surrounding the smallest class of fish-bearing streams (Type 3 streams) (WDNR 2024, p.2).

Wetlands

The objective of forested-wetlands protection in the OESF is to maintain and aid natural restoration of wetland hydrologic processes and functions (WDNR 1997, p. IV.119). The wetland strategy for the OESF seeks to achieve this objective by:

1. Retaining plant canopies and root systems that maintain adequate water transpiration and uptake processes.
2. Minimizing disturbance to natural surface and subsurface flow regimes.
3. Ensuring stand regeneration.

In addition, wetlands in areas susceptible to blowdown are treated comparably to stream buffers, with maintenance of wind-firm stands as a primary conservation objective. Harvest-design experiments to achieve sturdy buffers should be considered in these instances.

Wetlands, as defined by the state Forest Practices Board Manual (WFPB 1993a, p. M-81), are protected in the OESF. Forested wetlands larger than 0.25 acre and bogs larger than 0.1 acre are protected with buffers and special management considerations.

HCP Table IV.9 describes the level of buffer protection proposed for forested and non-forested wetlands in the OESF. Average buffer widths are measured from the outer edge of the forested wetland, as defined by the USFWS (See Bigley and Hull 1993, pp. 26-32). The buffer width for wetlands greater than 5 acres is equal to the average site potential tree height for riparian forests in the OESF. For wetlands between 0.25 and 5 acres, the buffer width averages two-thirds of the site potential tree height. Site-potential tree heights are determined from Wiley (1978) for dominant conifer species. Average buffer widths are measured from the outer edge of the forested wetland. Average buffer widths for forested wetlands are 150 feet for wetlands greater than 5 acres and 100 feet for wetlands 0.25 to 5 acres.

Harvest within forested wetlands and their buffers is permitted but must retain at least 120 square feet basal area. For harvest within forested buffers of non-forested wetlands, there would be no harvest within 50 feet of wetland edge; harvest within buffers beyond 50 feet will be designed to maintain stand wind-firmness, as per recommendations for exterior riparian buffers; and leave trees should be representative of the dominant and co-dominant species in the intact forest edge of the wetland.

6.3.2 Other Listed Species Strategies

Additional species-specific measures are described in the HCP:

1. Oregon silverspot butterfly (*Speyeria zerene hippolyta*) (p. IV.47).
2. Bald eagles (*Haliaeetus leucocephalus*) (p. IV.48).
3. Peregrine falcon (*Falco peregrinus*) (p. IV.48).
4. Gray wolf (*Canis lupus*) (p. IV.49).
5. Grizzly bear (*Ursus arctos horribilis*) (p. IV.51-52), which are no longer in effect as of 2002 (USFWS 1997c, p.8).
6. Columbian white-tailed deer (*Odocoileus virginianus leucurus*) (p. IV.52).

No additional measures were provided for the then-listed Aleutian Canada goose (*Branta canadensis leucopareia*).

6.3.3 Multi-Species Strategies (Westside Only)

Strategies for spotted owls, murrelets, and riparian and aquatic species, as well as the stand-stage projections (WDNR 1997, p. IV-181) are the foundation of the multiple-species conservation strategies. The aggregate effect of this species-specific conservation is the creation of landscapes containing interconnected patches of late successional forest. In addition, the other managed forests will provide early and mid-sera1 stage forest habitat. Within the confines of a managed forest, the most effective means for the conservation of wildlife is to provide functional habitat. Under the HCP, WDNR will contribute to the survival of species of concern and other unlisted species through forest management that provides a variety of well-distributed, interconnected habitats.

In the HCP, there are a number of species-specific protections (e.g., nest and denning sites) as well as protections for special habitats (e.g., caves, cliffs, etc.). While these may have some small effects of reducing impacts for spotted owls or bull trout, these reductions in impacts are almost imperceptible in the larger scheme of the HCP. The exception is the requirements for snag and wildlife tree retention where the enhanced retention under the HCP, as well as WDNR policies, that can have meaningful conservation for snag and large-tree dependent species as future stands develop into habitat in the years to come.

Additional habitat types receiving conservation measures include Talus (WDNR 1997, p. IV.151-153), Caves (p. IV.153-154), Cliffs (p. IV.154-155), Oak Woodlands (p. IV. 155-156), Large Structurally Unique Trees (p. IV.156-157), Snags (p. IV.157-158), Balds (p. IV.158), and Mineral Springs (p. IV,158). In addition to providing conservation for various unlisted species, these strategies have ancillary benefits for spotted owls by providing for a greater diversity of prey species and habitat settings. They may also provide some benefit for bull trout by the measures provided to mineral springs.

6.4 Action Area

The action area is defined as all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action (50 CFR 402.02). In delineating the action area, we evaluated the farthest reaching physical, chemical, and biotic effects of the action on the environment.

ITP-covered activities occur on WDNR managed lands, although direct and indirect effects may occur in adjacent areas. For purposes of this consultation, the action area includes the entire geographic extent of the WDNR HCP covered lands. The action area encompasses over 1.91 million acres of lands that are currently managed under the HCP as of 2023, and other lands located adjacent to the HCP-covered lands for distances of up to one mile. The terrestrial limit of the action area is defined based on the extent of above-ambient sound levels associated with forest management actions, including timber harvesting, pile-burning, blasting, aircraft, and road construction activities. The aquatic action area includes all streams and waterbodies located on HCP-covered lands, as well as downstream waters extending to major lakes or the marine environment.

7 ANALYTICAL FRAMEWORK FOR THE JEOPARDY AND ADVERSE MODIFICATION DETERMINATIONS

7.1 Jeopardy Determination

In accordance with our regulations (see 50 CFR 402.02, 402.14(g)), the jeopardy determination in this Biological Opinion relies on the following four components:

1. The *Status of the Species* evaluates the species’ current range-wide condition relative to its reproduction, numbers, and distribution; the factors responsible for that condition; its survival and recovery needs; and explains if the species’ current range-wide population retains sufficient abundance, distribution, and diversity to persist and retains the potential for recovery (see USFWS and NMFS, 1998).

2. The *Environmental Baseline* section of this Biological Opinion evaluates the past and current condition of the species in the action area relative to its reproduction, numbers, and distribution absent the effects of the proposed action; including the anticipated condition of the species contemporaneous to the term of the proposed action; the factors responsible for that condition; and the relationship of the action area to the survival and recovery of the species.

3. The *Effects of the Action* section of this Biological Opinion evaluates all consequences to the species that are reasonably certain to be caused by the proposed action (i.e., the consequences would not occur but for the proposed action and are reasonably certain to occur) and how those consequences are likely to influence the survival and recovery of the species.

4. *Cumulative Effects* section of this Biological Opinion evaluates the effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation, on the species and its habitat, and how those effects are likely to influence the survival and recovery of the species.

In accordance with policy and regulation, the jeopardy determination is made by formulating the USFWS's opinion as to whether the proposed Federal action, including its consequences, taken together with the status of the species, environmental baseline, and cumulative effects, reasonably would be expected to reduce appreciably the likelihood of both the survival and recovery of the species in the wild by reducing the reproduction, numbers, or distribution of that species.

7.2 Destruction/Adverse Modification Determination

In accordance with regulations and regional implementing guidance, the destruction or adverse modification determination in this Biological Opinion relies on the following four components:

1. The *Status of Critical Habitat* section evaluates the range-wide condition of the critical habitat (CH) in terms of essential habitat features, primary constituent elements, or physical and biological features that provide for the conservation of the listed species; the factors responsible for that condition; and the intended value of the CH for the conservation of the listed species.

2. The *Environmental Baseline* section of this Biological Opinion evaluates the past and current condition of the CH in the action area absent the effects of the proposed action; including the anticipated condition of the species and its CH contemporaneous to the term of the proposed action; the factors responsible for that condition; and the conservation value of CH in the action area for the conservation of the listed species.

3. The *Effects of the Action* section of this Biological Opinion evaluates all consequences to CH that are reasonably certain to be caused by the proposed action (i.e., the consequences would not occur but for the proposed action and are reasonably certain to occur) and how those consequences are likely to influence the conservation value of the affected CH for the species in the action area.

4. *Cumulative Effects* section of this Biological Opinion evaluates the effects to CH of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation, and

how those effects are likely to influence the conservation value of the affected CH for the species in the action area.

In accordance with regulation, the DAM determination is made by formulating the USFWS's opinion as to whether the effects of the proposed Federal action, taken together with the status of the critical habitat, environmental baseline, and cumulative effects, reasonably would be expected to result in a direct or indirect alteration that appreciably diminishes the value of CH for the conservation of the species.

8 STATUS OF THE SPECIES: Spotted Owl and Designated Spotted Owl Critical Habitat

8.1 Summary of the Status of the Spotted Owl

The northern spotted owl (spotted owl) was listed as a threatened species in 1990 because of widespread loss of habitat across the species range and the inadequacy of existing regulatory mechanisms to conserve the species (55 FR 26114 [June 26, 1990]). Monitoring from 1995 through 2017 indicates the spotted owl population has declined at a rate of 5.3 percent per year across the species range (Franklin et al. 2021, p. 11). Spotted owl decline has been most severe in the northern parts of the species' range, where populations have declined by greater than 80 percent from 1995 to 2017 (Franklin et al. 2021, p. 12). Historic and ongoing loss of suitable forest habitat and increasing competition from the barred owl (*Strix varia*) are two major factors affecting the survival of the spotted owl. Monitoring indicates that this species is rapidly declining and that its extinction risk has increased since the time of listing, primarily due to competition with barred owls and loss of habitat from wildfires. In 2020, the USFWS determined that reclassification of the spotted owl from a threatened species to an endangered species is warranted, but reclassification is precluded due to other listing priorities (85 FR 81144 [Dec. 15, 2020]).

Forests suitable for spotted owl nesting and roosting are defined as areas with the full range of environmental conditions necessary to support occupancy, survival, and reproduction (Davis et al. 2022, abstract). The latest estimates indicate that range-wide nesting and roosting habitat have increased from 8.89 million acres in 1993 to 9.15 million acres in 2017 on the Northwest Forest Plan federal lands, which is an overall net gain of about 3 percent (Davis et al. 2022, abstract, p. 29). However, while some nesting and roosting habitat was gained due to succession, 1.05 million acres on federal land were also lost, and this is equal to an 11.8 percent loss since 1993 (Davis et al. 2022, p. 29). The largest sources of loss between 1993 and 2017 were mainly from wildfire (703,700 acres or 7.9 percent loss) and timber harvest (257,700 acres or 2.9 percent loss) (Davis et al. 2022, abstract).

Across all lands (federal and nonfederal), nesting and roosting habitat increased from approximately 12.37 million acres to 12.62 million acres, which is a net gain of about 2.1 percent from 1993 to 2017 (Davis et al. 2022, p. 32) (Table 11). This gain was due to succession; however, 2.93 million acres of nesting/roosting habitat were also lost, which is equal to a 23.7 percent loss since 1993. The largest sources of loss during this period were from wildfire (785,700 acres or 6.3 percent loss) and timber harvest (2.05 million acres or 16.6 percent loss)

(Davis et al. 2022, p. 32). While wildfires were the primary cause of habitat loss on federal lands, timber harvest was the primary cause of habitat loss on non-federal lands (Davis et al. 2022, pp. 29-32).

Table 11. Estimates of spotted owl nesting/roosting forests by state in 2017 from Northwest Forest Plan monitoring. Values are presented in thousands of acres.

State	Federal lands	Nonfederal lands	Totals	Percent of rangewide habitat
Washington	2,797.0	764.7	3,561.7	28%
Oregon	4,312.3	1,131.2	5,443.6	43%
California	2,046.4	1,575.8	3,622.2	29%
Totals	**9,155.7**	**3,471.8**	**12,627.5**	**100%**
Percent of rangewide habitat	73%	27%	100%	

Source: Davis et al. 2022, pp. 29-32.

Despite the net increase of about 3 percent in nesting and roosting habitat on federal lands, the estimated mean spotted owl occupancy rate declined steeply; it ranged from 46 to 91 percent in 1993 to 7 to 38 percent in 2017 (Franklin et al. 2021, Davis et al. 2022, p. 18). Overall, it is estimated that the spotted owl population decreased by 61.8 percent on federal lands from 1993 to 2018 (Davis et al. 2022, p. 18). A primary cause for this decline on federal lands is attributed to the displacement of spotted owls from habitat by the invasive barred owl.

Over the past two decades it has become apparent that competition from the barred owl poses a significant threat to the spotted owl (Franklin et al. 2021, pp. 15, 18). There is strong evidence that barred owls have negatively affected spotted owl populations by decreasing annual survival rates and increasing rates of local territory abandonment (Dugger et al. 2016, Franklin et al. 2021, pp. 15, 18). Range-wide, barred owls are driving the decline of spotted owl populations. Moreover, past habitat loss (range-wide and at smaller spatial scales) and current habitat loss (e.g. from wildfires, climate, timber harvest, and other disturbance) remain important factors that influence segments of spotted owl populations, and their territory occupancy at smaller scales (Davis et al. 2016, pp. 34-35; Yackulic et al. 2019; Franklin et al. 2021, pp. 15, 18). Franklin et al. (2021, p. 18) reinforced the importance of maintaining even currently unoccupied spotted owl habitat on the landscape as they can 1) provide areas for re-colonization by spotted owls should management actions allow for reduction of barred owl populations and 2) facilitate connectivity for dispersing spotted owls among occupied areas (Sovern et al. 2014). However, although abundant habitat can help to mitigate the negative effect of barred owls on spotted owl occupancy, it does not reverse the negative effect of barred owls (Yackulic et al. 2019, Franklin et al. 2021, Davis et al. 2022, p. 18).

Because spotted owl population monitoring has generally been limited to demography study areas, the total population of spotted owls across the species range is unknown. To estimate the current spotted owl population, we estimated habitat carrying capacity using methods developed by Glenn et al. (2017) to identify areas that could support territorial spotted owl pairs, based on the amount and arrangement of nesting and roosting forest cover, topographic position, and territory spacing (Table 12). Pair occupancy rates of potential pair sites is based on the occupancy levels from demographic studies (Davis et al. 2022, p. 37, USFWS 2023, p. 85). The analysis estimated habitat capacity for each physiographic province (recovery units) (USFWS 2011, p. III-1), with the exception of the Willamette and Western Washington Lowlands provinces.

Based on this analysis, the amount of habitat capacity across the species range has the potential to support over 16,000 pair sites. However, due to the prevalence of barred owls across the species range, only about 21 percent of the estimated pair sites are likely to be currently occupied, and most of the estimated population is in the California provinces, with only about 4 percent of the estimated population occurring in Washington (Table 12). It is important to note that these represent estimates of occupied pair sites and do not account for non-resident or single birds that may still be present in the landscape.

Table 12. Estimated number of spotted owl pairs by physiographic province in 2023.

<table>
<tr><th>Physiographic Province</th><th>Estimated habitat carrying capacity (spotted owl pairs)</th><th>Estimated percent of sites occupied by spotted owl pairs</th><th>Estimated number of spotted owl pairs</th><th>Percent of rangewide habitat capacity and pairs</th></tr>
<tr><td>Olympic Peninsula</td><td>554</td><td>7%</td><td>41</td><td rowspan="3">Washington:
12 % of capacity,
4 % of pairs.</td></tr>
<tr><td>Western Washington Cascades</td><td>1,073</td><td>6%</td><td>66</td></tr>
<tr><td>Eastern Washington Cascades</td><td>484</td><td>4%</td><td>19</td></tr>
<tr><td>Oregon Coast Range</td><td>1,777</td><td>9%</td><td>160</td><td rowspan="4">Oregon:
36 % of capacity,
24 % of pairs.</td></tr>
<tr><td>Western Oregon Cascades</td><td>1,897</td><td>19%</td><td>367</td></tr>
<tr><td>Eastern Oregon Cascades</td><td>415</td><td>17%</td><td>69</td></tr>
<tr><td>Oregon Klamath</td><td>1,989</td><td>13%</td><td>261</td></tr>
<tr><td>California Coast</td><td>5,469</td><td>29%</td><td>1,587</td><td rowspan="3">California:
52 % of capacity,
72 % of pairs.</td></tr>
<tr><td>California Klamath</td><td>2,931</td><td>32%</td><td>938</td></tr>
<tr><td>California Cascades</td><td>389</td><td>17%</td><td>65</td></tr>
<tr><td>Totals</td><td>16,978</td><td>n/a</td><td>3,573</td><td>21% of estimated pair sites currently occupied</td></tr>
</table>

Source: USFWS 2023, p.85. Note: Physiographic provinces are defined as recovery units for the spotted owl (USFWS 2011, p. III-1).

The *Revised Recovery Plan for the Northern Spotted Owl* (Recovery Plan) (USFWS 2011) identifies (a) habitat loss and (b) competition from barred owls as the primary threats to the survival and recovery of spotted owls. The Recovery Plan includes recovery actions specific to addressing barred owl competition, including implementation of a barred owl removal experiment, management to reduce the effect of barred owls on spotted owls, and the retention and restoration of high quality spotted owl habitat to buffer the effects of barred owl competition in the short term (USFWS 2011, pp. III-65, 67).

The USFWS initiated a barred owl removal experiment in 2013 to evaluate the effectiveness of removing barred owls as a strategy for conserving and recovering spotted owls (Wiens et al. 2017, p. 2). A pilot study in California indicated that removal of barred owls may be able to slow or even reverse population declines of spotted owls at local scales (Diller et al. 2016, p. 691). The barred owl experiment indicated that removal of invasive barred owls had a strong, positive effect on survival of native spotted owls, which in turn alleviated long-term population declines. Barred owl removal had a positive, but weaker, effect on recruitment of spotted owls (Wiens et al. 2021, pp. 1, 5). Wiens et al. (2021, p. 6) provided robust evidence that removals increased apparent survival of spotted owls by approximately 10 percent across all study areas. After removals, the estimated mean annual rate of population change for spotted owls stabilized in areas with removals (0.2 percent decline per year), but continued to decline sharply in areas without removals (12.1 percent decline per year). The results demonstrated that the most substantial changes in population dynamics of spotted owls over the past two decades were associated with the invasion, population expansion, and subsequent removal of barred owls.

As barred owls continue to displace spotted owls from existing and recruited forest habitat, the species will likely decline to extirpation in the northern portion of the species' range where barred owls have been present for the longest period and rate of spotted owl population decline is steepest. Spotted owl population simulations suggest that, without a reduction in barred owl impacts on spotted owls, spotted owl populations have a greater than 50 percent probability of extirpation within 50 years in Washington and the Oregon Coast Ranges (Yackulic et al. 2019). The long-term persistence of spotted owls will depend heavily on reducing the negative impacts of barred owls while simultaneously addressing other threats, such as habitat loss (Wiens et al. 2020, p. 1).

8.2 Summary of the Status of Designated Spotted Owl Critical Habitat

Critical habitat contains those areas that are essential to the conservation of the species, and which may require special management consideration. The expectation of critical habitat is to ameliorate habitat-based threats. The recovery of the spotted owl requires habitat conservation in concert with the implementation of recovery actions that address other, non-habitat-based threats to the species, including the barred owl (77 FR 71876:71879 [December 4, 2012]). The conservation role of spotted owl critical habitat is to "adequately support the life-history needs of the species to the extent that well-distributed and inter-connected spotted owl nesting populations are likely to persist within properly functioning ecosystems at the critical habitat unit and range-wide scales" (77 FR 71876:71938 [December 4, 2012]).

On November 10, 2021, the USFWS issued a final rule which revised the total area of designated critical habitat for the spotted owl. Approximately 204,294 acres of critical habitat located in Oregon were excluded, while the total area of designated critical habitat in Washington and California remained unchanged (86 FR 62606 [November 10, 2021]). Critical habitat for the spotted owl now includes approximately 9,373,676 acres in 11 units and 60 subunits in California, Oregon, and Washington (86 FR 62606:62641 [November 10, 2021]). Our GIS data on current total area of designated critical habitat vary slightly (9,372,892 acres) from the total number of acres published in the Federal Register (a difference of 784 acres).

Critical habitat for the spotted owl encompasses a broad range of forest types and seral conditions. The primary constituent elements identified in the spotted owl critical habitat rule include (1) forest types in early-, mid-, or late-seral stages that support the spotted owl across its geographic range; (2) nesting and roosting habitat; (3) foraging habitat; and (4) dispersal habitat (77 FR 72051-72052). Much of the suitable nesting and roosting habitat within the critical habitat exists in fragmented patches due to past timber harvest, wildfire, disease, and other disturbances. Based on the spotted owl habitat data developed for the Northwest Forest Plan 25-year monitoring report (Davis et al. 2022), we estimate that in 2023, approximately 47.6 percent of the lands within Critical Habitat Units (CHUs) contained suitable spotted owl nesting / roosting habitat (4.46 million acres), and 29.2 percent (2.80 million acres) of designated critical habitat acres are highly suitable/nesting-roosting habitat.

Due to land management actions and natural disturbance events such as fire, windstorms, and insect damage, not all habitat capable lands in a CHU are likely to be high quality habitat at any one time. However, these lands retain the physical and biological features necessary to allow for the regrowth of the habitat characteristics required by spotted owls and are essential to achieving the area, quality, and configuration of habitat required for recovery of the owl (77 FR 71876:71877 [December 4, 2012]).

Detailed information regarding the status, threats, life history and conservation needs of the spotted owl are presented in the USFWS's 2011 *Revised Recovery Plan for the Northern Spotted Owl* (USFWS 2011) and Appendix D: *Status of the Species: Northern Spotted Owl and Northern Spotted Owl Critical Habitat*.

9 ENVIRONMENTAL BASELINE: Spotted Owl and Designated Spotted Owl Critical Habitat

Regulations implementing the ESA (50 CFR 402.02) define the environmental baseline as the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline.

The Action Area for this analysis includes WDNR-managed lands within the range of the spotted owl in Washington (1.91 million acres) and other lands located adjacent to WDNR-managed lands. Generally, lands located within a 1-mile radius of WDNR lands may be exposed to distant noise. The analysis area for this consultation extends beyond the physical action area to account for spotted owl territories. Due to the complex nature of the ownership patterns within the action area, we use the best available information regarding spotted owl habitat conditions and trends across state, federal, and other ownerships in Washington to describe the environmental baseline, with an emphasis on current conditions on WDNR-managed lands. Because the action area overlaps multiple recovery units for the spotted owl, the environmental baseline analysis begins with a summary description of the recovery units in Washington.

9.1 Spotted Owl Recovery Units in Washington

The range of the spotted owl is divided into 12 physiographic provinces that reflect the physical, biological, and environmental factors that shape broad-scale landscape features and natural plant communities (USFWS 2011, p. III-1). In the revised recovery plan for the spotted owl, the physiographic provinces are identified as individual recovery units that represent the current and historic distribution of spotted owl habitat and populations (USFWS 2011, p. III-1). In Washington, there are four spotted owl recovery units, including the Olympic Peninsula, the Western Washington Lowlands, the Western Washington Cascades, and the Eastern Washington Cascades. Except for the Western Washington Lowlands, each recovery unit in Washington has significant areas of federal lands that contain most of the estimated spotted owl habitat in Washington. Because WDNR HCP lands are present in each of these provinces, we present information on spotted owl habitat trends and spotted owl populations in Washington.

9.2 Factors Responsible for the Current Condition of the Species

<u>Spotted Owl Habitat Trends in Washington</u>

Timber harvest prior to the listing of the spotted owl as a threatened species in 1990 removed most of the late-successional forest from within the historic range of the species in Washington. Based on spotted owl habitat monitoring data developed for the Northwest Forest Plan, there was approximately 3.32 million acres of spotted owl nesting/roosting habitat in Washington across all lands in 2023 (Table 13).

Monitoring data indicate a net loss of about 14 percent of nesting/roosting habitat acres in Washington across all ownerships over the past two decades (Table 13). At the scale of recovery units, habitat loss has been greatest in the Western Lowlands province, where there is limited federal ownership, and few historic spotted owl sites. Habitat loss on federal lands has been greatest in the Eastern Washington Cascades province (Davis et al. 2022, p. 15). Most habitat loss on non-federal lands was attributed due to timber harvest, while habitat loss on federal lands has largely been attributed to wildfires, insects, and other natural disturbances (Davis et al. 2022, pp. 29 – 32). Habitat gains through natural forest succession has also occurred (Davis et al. 2022, pp. 14). On the Olympic Peninsula, habitat gains have exceeded habitat losses on federal lands, resulting in a slight net increase in habitat on federal lands (Table 13). Currently, only about 20 percent of forest-capable lands in Washington contain potential nesting/roosting habitat, reflecting the high level of historic habitat loss that occurred prior to the listing of the spotted owl in 1990.

Table 13. Summary of changes in potential spotted owl nesting / roosting habitat by general landownership in Washington from 1997 to 2023.

Spotted Owl Physiographic Province	General land ownership	Forest-capable lands (acres)	1997 nesting / roosting habitat (acres)	2023 nesting / roosting habitat (acres)	Percent change in nesting / roosting habitat
Eastern WA Cascades	Federal lands:	2,671,640	731,368	552,580	-24%
	Nonfederal lands:	1,542,627	265,301	186,148	-30%
	Province totals:	**4,214,267**	**996,669**	**738,728**	**-26%**
Olympic Peninsula	Federal lands:	1,345,552	723,452	724,549	0%
	Nonfederal lands:	1,377,052	142,910	124,928	-13%
	Province totals:	**2,722,604**	**866,362**	**849,476**	**-2%**
Western WA Cascades	Federal lands:	3,060,841	1,394,233	1,353,092	-3%
	Nonfederal lands:	2,198,532	378,285	251,277	-34%
	Province totals:	**5,259,373**	**1,772,518**	**1,604,369**	**-9%**
Western Lowlands	Federal lands:	88,835	13,210	10,406	-21%
	Nonfederal lands:	4,439,890	202,431	120,739	-40%
	Province totals:	**4,528,726**	**215,642**	**131,144**	**-39%**
Washington totals	Federal lands	7,166,868	2,862,264	2,640,627	-8%
	Nonfederal lands	9,558,101	988,927	683,091	-31%
	State totals	**16,724,969**	**3,851,191**	**3,323,718**	**-14%**

Notes: Data presented in this table represent estimates of spotted owl nesting / roosting habitat, from habitat models developed for the Northwest Forest Plan monitoring program (Davis et al. 2022; USFS 2023). Forest-capable lands represent areas capable of growing trees. Non-forest capable areas (e.g., alpine areas, urban areas, lakes) are not included in these estimates.

The majority of existing nesting/roosting habitat in Washington occurs on federal lands (79 percent) while approximately 9 percent of the potential nesting/roosting habitat occurs on WDNR-managed lands (306,000 acres) (Table 14). It is important to note that habitat estimates developed for the Northwest Forest Plan monitoring program are not directly comparable to habitat estimates reported by WDNR due to differences in monitoring methods and data sources used. We report the Northwest Forest Plan habitat values here because the methods used to estimate habitat are consistently applied across all land ownerships.

Table 14. Summary of spotted owl nesting/roosting habitat by major landowner and physiographic province in Washington.

Spotted Owl Physiographic Province	Federal lands (acres)	WDNR HCP lands (acres)	Other nonfederal (acres)	Totals (All lands)
EASTERN CASCADES	552,580 (75%)	51,347 (7%)	134,801 (18%)	738,728 (100%)
OLYMPIC PENINSULA	724,549 85%	75,173 (9%)	49,755 (6%)	849,476 (100%)
WESTERN CASCADES	1,353,092 84%	142,088 (9%)	109,189 (7%)	1,604,369 (100%)
WESTERN LOWLANDS	10,406 (8%)	37,514 (29%)	83,225 (63%)	131,144 (100%)
WA Totals	2,640,627 (79%)	306,165 (9%)	376,970 (11%)	3,323,718 (100%)

Notes: Data presented in this table represent estimates of spotted owl nesting / roosting habitat (suitable and highly suitable), from habitat models developed for the Northwest Forest Plan monitoring program, representing 2023 conditions (Davis et al. 2022; USFS 2023).

Spotted Owl Population Trends in Washington

The total population of spotted owls in Washington is unknown. The WDFW maintains a database of spotted owl occurrences documented through surveys across various ownerships from the 1980s to present. The database includes 1,076 sites classified as known nest sites, documented pair locations, or resident single owls (also referred to as Status 1, 2, or 3 sites, respectively) including 86 sites located on WDNR HCP lands (Table 15). These sites represent known occurrences for resident spotted owl territories documented in Washington. However, monitoring data and demography analysis indicate that many of these sites are no longer likely to be occupied due to significant declines in the spotted owl population over the past 3 decades (Franklin et al. 2021, pp. 11-13).

Table 15. Summary of documented Status 1, 2, or 3 spotted owl sites in Washington by major landownership and the estimated number of currently occupied sites.

Physiographic Province	Federal lands	WDNR HCP lands	Other nonfederal lands	Total spotted owl sites	Estimated occupancy rate (2023)	Estimate of occupied sites (2023)
Olympic Peninsula	212	30	4	246	0.07	17
Eastern Cascades	257	20	70	347	0.04	14
Western Cascades	416	27	19	462	0.06	28
Western Lowlands	0	9	12	21	0	0
Totals	**885**	**86**	**105**	**1,076**	n/a	**59**
Percent	**82%**	**8%**	**10%**	**100%**	n/a	**5%**

Notes. Compilation of spotted owl sites documented in the WDFW species occurrence database from surveys conducted from the 1980s to present. Estimated occupancy rates are from Davis et al. 2022, p. 37), except for the Western Lowlands province, where we assume there is no current occupancy at historic sites based on past monitoring reports for that area (WDNR 2007b, NCASI 2010).

In Washington, territory occupancy rates for spotted owl territories have declined, from between 65 and 85 percent occupied in 1993 to between 7 and 12 percent occupied in 2018 (Franklin et al. 2021, pp. 11-13, Davis et al. 2022, p. 37). To estimate current occupancy rates, we used the values estimated in the *Draft Environmental Impact Statement for the Barred Owl Management Strategy* (USFWS 2023, p. 85). These rates are similar to the lower bounds of the estimated occupancy rates in 2018, and account for continued population decline that has occurred since 2018 (Table 15, above). Based on these low occupancy estimates for the Washington study areas, we estimate that only about 5 percent of the known spotted owl sites documented in the WDFW occurrence database are likely to still be occupied (Table NSO 5, above). While these occupancy rates appear to be very low, they are not entirely unexpected. Demographic monitoring surveys in the Rainier study area documented only one single male and one single female within Mt. Rainier National Park in 2021 (Rossi 2021, p. 5).

Spotted Owl Population Estimates based on Habitat Carrying Capacity

An alternative method for estimating the current spotted owl population is to use habitat modeling to evaluate landscape carrying capacity. To estimate the potential spotted owl population in Washington we used an estimate of the carrying capacity for spotted owl pair territories based on habitat configuration and occupancy rate of potential sites based on the occupancy levels from demographic studies (Davis et al. 2022, p. 37, USFWS 2023, p. 85). Spotted owl habitat is based on habitat models developed for the Northwest Forest Plan monitoring program and updated to reflect 2023 conditions. Habitat capacity was estimated using methods developed by Glenn et al. (2017) to identify areas that could support territorial spotted owl pairs, based on the amount of nearby nesting and roosting forest cover, topographic position, and territory spacing (Table 16). Based on this analysis, the amount of existing spotted owl habitat in the primary recovery units in Washington has the potential capacity to support over 2,100 pairs. However, due to the high densities of barred owls in Washington, only about 126 (6 percent) of the estimated potential spotted owl pair sites are likely to be currently occupied. Applying this same analysis to the WDNR HCP lands indicated a potential habitat capacity for up to 265 pairs (about 13 percent of the estimated capacity in Washington). Applying the current spotted owl occupancy rates, we estimate there are 17 pair sites on WDNR HCP lands that are likely to currently be occupied.

Table 16. Estimated number of spotted owl pairs in Washington based on habitat capacity.

Physiographic Province	**Estimated habitat carrying capacity on all lands (spotted owl pair territories)**	**Estimated habitat carrying capacity on WNDR HCP lands (spotted owl pair territories)**	**Estimated occupancy rate (2023)**	**Estimated number of spotted owl pairs (2023) (all lands)**	**Estimated of number of spotted owl pairs on WDNR HCP lands (2023)**
East Cascades	484	39	0.04	19	2
West Cascades	1,073	98	0.0615	66	6
Olympic Peninsula	554	128	0.0735	41	9
Totals	**2,111**	**265**	**n/a**	**126**	**17**

Notes: Habitat capacity and occupancy rates are from USFWS 2023, p. 85.

Spotted Owl Demographic Rates in Washington

Detailed monitoring information on spotted owl survival, reproduction, territory occupancy, and rates of population change were collected across three long-term demographic study areas in Washington from 1995 through 2018 (Franklin et al. 2021, entire). These study areas include portions of the Olympic Peninsula (Olympic), the western Cascades (Rainier) and the eastern Cascades (Cle Elum). In Washington, the estimated annual rate of population change ranged from 5.7 percent decline per year in the Rainier study area to 8.4 percent decline per year in the Cle Elum study area for the period from 1995 to 2017 (Franklin et al. 2021, pp. 11-13) (Table 17).

Table 17. Summary of spotted owl demographic vital rates in Washington.

Study Area	Average annual fecundity	Average annual adult survival	Average annual rate of population change
Cle Elum	0.907	0.839	0.916 (-8.4%)
Olympic	0.466	0.863	0.917 (-8.3%)
Rainier	0.502	0.877	0.943 (-5.7%)

Sources: Franklin et al. 2021, USFWS 2023, p. 91. Notes: Fecundity is the average number of female young fledged per female per year. Annual survival is the average value for an adult spotted owl to survive from one year to the next.

The estimated annual rate of population change incorporates annual survival, reproduction (fecundity), and recruitment (recruitment of new individuals into the breeding population). Recruitment values were not reported for study areas in Washington, but other studies have determined that approximately 10 percent of juveniles fledged survive to recruit into the breeding population (Glenn et al. 2010). In Washington, spotted owl reproduction, survival, and recruitment is not sufficient to sustain a stable population, and the primary factor causing these declines is competition with barred owls. The meta-analysis of spotted owl demography evaluated the effects of barred owl competition, habitat variables, and climate variables on spotted owl vital rates and concluded that the negative effect of barred owl competition is the primary factor driving declines in all of the key demographic indicators (Franklin et al. 2021, p. 13).

<u>The Effects of Barred Owl Competition</u>

The reduction in occupied spotted owl sites in Washington has coincided with the increasing barred owl population over the past 30 years. Given the relatively minor losses of spotted owl habitat on federal lands within the Washington demographic study areas, it is now apparent that competition with barred owls has had a profound negative effect on annual survival, recruitment, and occupancy rates for spotted owls in Washington, as it has throughout the species range (Franklin et al. 2021, pp. 11-13, 18).

The mechanism for the negative impact of barred owls on spotted owls is a combination of interference competition, where barred owls exclude spotted owls from breeding territories, and direct competition for habitat and food (Gutiérrez et al., 2007, p. 189; Hamer et al., 2007, p. 763; Wiens et al., 2014, p. 38). Franklin et al. (2021, p. 15) noted “Our study provides range-wide evidence that the negative consequences of interspecific competition with barred owl have increasingly overwhelmed dwindling populations of northern spotted owl since the last meta-analysis reported by Dugger et al. (2016).” In the absence of barred owl management, spotted owl populations are projected to continue to decline, and are likely to become extirpated if competition from barred owls is not ameliorated in the short term (Franklin et al. 2021, p. 19).

Barred owl removal experiments have demonstrated that local spotted owl populations can respond positively to reduced densities of barred owls. In response to these studies, the USFWS has recently proposed several alternatives to implement barred owl management across the range of the spotted owl with potential implementation to begin as early as 2025 (USFWS 2023). In the absence of barred owl management, the spotted owl will continue to decline in Washington and will likely become functionally extirpated in major areas of the state. The USFWS estimates that the current population of spotted owls in Washington will continue to decline and will be reduced by half within 10 years (Table 18).

Table 18. Estimates of spotted owl populations in Washington over 30 years without barred owl management.

Physiographic Province	**Demographic study area used to estimate population trend**	**Average annual rate of population change from demography study area**	**Estimated number of spotted owl pairs in 2023**	**Estimated pairs in 10 years (2033)**	**Estimated pairs in 20 years (2043)**	**Estimated pairs in 30 years (2053)**
Olympic Peninsula	Olympic	0.917	41	17	7	3
Western Washington Cascades	Rainier	0.943	66	37	20	11
Eastern Washington Cascades	Cle Elum	0.916	19	8	3	1
		Totals:	**126**	**62**	**30**	**15**

Source: Barred Owl Management Strategy DEIS (USFWS 2023, p. 91).

The estimates presented in Table 18 assume a simple continuation of the documented population trends from the demography studies completed in Washington and do not account for more complex population dynamics that can occur in small populations (USFWS 2023, p. 87). Estimated spotted owl populations below 10 pairs can be considered functionally extirpated (USFWS 2023, p. 90). Small populations are vulnerable to catastrophic events and genetic effects of inbreeding, already documented in Washington (Miller et al. 2018, Franklin et al. 2021, pp. 18-19). Populations below 20 pairs in an area as large as a province are at high risk of near-term extirpation (e.g., Eastern Washington Cascades). If the current trends continue, spotted owls will be functionally extirpated in Eastern Washington within 10 years, and on the Olympic Peninsula within 20 years.

Proposed strategies for barred owl management include several options described in the *Draft Environmental Impact Statement for the Barred Owl Management Strategy* (USFWS 2023, entire). Under the proposed barred owl management alternatives, the USFWS assumes that spotted owl populations within barred owl management areas have the potential to increase at rate of 0.5 percent per year (USFWS 2023, p. 87).

Under all barred owl management alternatives considered, spotted owl populations are projected to gradually increase over the next 30 years, compared to no barred owl management, where spotted owl populations are projected to continue to decline (USFWS 2023, p. 102).

9.3 Current Condition of the Species in the Action Area

The purpose of this section is to describe the current condition of the species and the species habitat within the action area.

Definitions of Terms used in this Analysis

Eastside Planning Units: Refers to WDNR lands within the Chelan, Klickitat, and Yakima planning areas (Figure 1).

OESF: Olympic Experimental State Forest (Figure 1).

Westside Planning Units: Refers to WDNR lands within the Columbia, North Puget, South Coast, South Puget, and Straits planning areas (Figure 1).

NRF Management Areas: Refers to HCP-designated areas that are to be managed to provide 50 percent of the designated area in spotted owl nesting, roosting, and foraging (NRF) habitat.

Dispersal Management Areas: Refers to HCP-designated areas that are to be managed to provide 50 percent of the designated area in spotted owl dispersal habitat.

DFC: Desired future condition. Refers to HCP designated areas within the Klickitat planning unit that have specific vegetation series that will be managed to provide 50 percent dispersal habitat (i.e., dispersal management areas).

PPDFC: Ponderosa pine desired future conditions. Refers to HCP designated areas within the Klickitat planning unit that have specific vegetation series that will be managed to provide dry open-canopy forest conditions. Management for dispersal habitat is not required in these areas.

SOMU: Spotted owl management units. Refer to specific designated units within NRF management or dispersal management areas.

LTFC: Long-term forest cover. Refers to areas deferred from regeneration timber harvest by HCP conservation strategies (e.g., riparian zones) or other WDNR policies (e.g., Natural Areas, etc.).

NRF: Nesting, roosting, foraging habitat. This acronym is used generically throughout the document to represent "suitable" spotted owl habitat. Refer to Appendix B – *Spotted Owl Habitat Definitions* for HCP specific definitions of spotted owl habitat used in different planning units.

Spotted Owl Sites Located on or Adjacent to WDNR-Managed Lands in 1997

At the time that the HCP was finalized in 1997, there were 283 spotted owl sites for which the regulatory owl management circles included some area of WDNR-managed lands. These sites were classified as Status 1: confirmed reproductive pairs; Status 2: two birds, pair status unknown; or Status 3: territorial single (WDFW Status 1, 2, or 3 sites). Spotted owl management circles represent a median home range area for a spotted owl pair. In the Washington Cascades, a circle with a 1.8-mile radius surrounding a spotted owl site center is used to represent the home range area. On the Olympic Peninsula, a 2.7-mile radius circle is used for this purpose.

Spotted owl territories that contain greater than or equal to 40 percent suitable habitat within a home-range circle are considered more likely to sustain successful spotted owl reproduction and occupancy than territories with less suitable habitat (USFWS 2011, p. III-44). In the 1997 Biological Opinion, the USFWS evaluated the effects to spotted owl sites using the 40 percent suitable habitat criteria. The USFWS anticipated that habitat loss from HCP-covered forest management that resulted in less than 40 percent suitable habitat remaining in an owl management circle would result in disruption of spotted owl nesting behaviors, and loss of territory viability, resulting in incidental take of spotted owls.

In the Westside and Eastside HCP planning units (excluding OESF), there were 223 known spotted owl sites, including 111 within designated NRF management areas, and 112 sites outside of designated NRF management areas. Incidental take was anticipated for 82 spotted owl sites located outside of NRF management areas, and 35 sites located within or near designated NRF management areas. Sites located outside of NRF management areas were not expected to remain viable (i.e., no longer able to support spotted owls) beyond the first 10 years of HCP implementation (USFWS 1997a, pp. 68, 75).

In the OESF there were 60 known spotted owl sites with WDNR managed lands within the owl management circles. Of these, 29 sites were not at risk of incidental take from the HCP forest management because habitat within the owl circles would be maintained either on federal or state-managed lands, while 31 sites were anticipated to be subject to incidental take (USFWS 1997a, p. 82-83).

In summary, of the 283 known owl sites with owl management circles that overlapped with WDNR lands, 146 sites (52 percent) were anticipated in the 1997 Opinion to be subject to incidental take from forest management under the HCP. Sites not subject to take included spotted owl management circles that had minor ownership overlap or minimal habitat located on WDNR lands.

In addition to known spotted owl sites, the USFWS estimated incidental take for projected unknown sites that could occur on or adjacent to WDNR managed lands over the 75-year life of the HCP. This estimation in the 1997 Opinion included 42 projected sites within westside planning units, and 23 projected sites within the eastside planning units.

Spotted Owl Surveys on WDNR HCP Lands

WDNR's HCP does not have a spotted owl survey requirement. However, WDNR has conducted some limited spotted owl monitoring on WDNR state-managed lands over the past twenty years.

OESF Surveys

From 1995 to 2003, WDNR conducted spotted owl monitoring in the OESF (WDNR 2010a, entire). This monitoring was intended to be complimentary to the federal demography study on the Olympic Peninsula and to provide baseline information for spotted owls in the OESF. The number of sites surveyed varied, from a high of 32 sites surveyed in 1997, with spotted owl occupancy documented at 8 sites (25 percent). By 2001, only 10 sites were monitored, with spotted owl occupancy documented at 2 sites. The last documented detection on a spotted owl site located on WDNR lands in the OESF was for a resident single owl detected in 2004. Subsequent monitoring on the adjacent federal demography study area documented a steady decline in occupied territories both within the Olympic National Park and Olympic National Forest. Mark-recapture monitoring in the federal study area ended in 2018. At that time, out of 92 sites surveyed, a total of 9 sites had spotted owls present, but only 3 sites had pairs detected (Lesmeister 2019, Gremel 2018). In 2019, the federal study area fully transitioned to passive acoustic monitoring using autonomous recording units (ARUs). Spotted owl detections at ARU stations ranged from 6 to 13 percent for 2018 – 2020, while barred owl detections ranged from 68 to 81 percent (Lesmeister et al. 2022).

Southwest Washington Surveys

In 2005-2006, WDNR conducted 2-year surveys for spotted owl sites in southwestern Washington (WDNR 2007b, entire). This survey effort included all known spotted owl sites located on WDNR lands in southwestern Washington, and all sites in designated NRF management areas in the Columbia and Siouxon NRF management areas. The survey area included 29 known spotted owl sites that had been documented in the early 1990s. The survey confirmed spotted owl occupancy at 6 of the 29 historic sites (a 20 percent occupancy rate), including 3 sites in the southwest Washington, and 3 sites in the western Cascades (WDNR 2007b, p. 24). The survey effort also documented barred owl occupancy at all of the spotted owl sites surveyed, including high densities of barred owls in the Columbia NRF management area. Following this survey effort, WDNR cooperated with the Weyerhaeuser Company to conduct a radio-telemetry study of spotted owls and barred owls in southwest Washington (NCASI 2010, entire). The study was able to capture and track two spotted owls from separate territories. By 2008, both spotted owls had abandoned their territories and were subsequently found dead. One spotted owl territory had 5 documented barred owl pairs, and the other at least 3 pairs. Based on the limited habitat in southwest Washington, and high occupancy by barred owls, we assume there are no resident territorial pair sites remaining on or near WDNR HCP lands in southwest Washington.

Klickitat Area Surveys

Many of the spotted owl territories in the Klickitat Planning area were surveyed as part of the Wenatchee federal spotted owl demography study in the late 1990s and early 2000's (Anthony et al. 2006, p. 7). The Wenatchee study area included many spotted owl sites with management circles that overlapped WDNR HCP land in the Klickitat Planning Unit. Results of some these surveys and other efforts were documented in the Klickitat Planning amendment, which included site-specific management plans for 11 known occupied sites in NRF management areas, 3 unoccupied sites in NRF management areas, and 1 site outside of NRF management area (WDNR 2004a, pp. 25-28). Monitoring efforts included demography surveys at 20 spotted owl sites from 2002 to 2008. Spotted owls were detected at 3 sites in 2006-2008, indicating a site occupancy rate of about 15 percent at that time (WDNR 2010b).

Estimated Spotted Owl Sites Located on or Adjacent to WDNR-Managed Lands in 2023

We used the WDFW database of spotted owl occurrences in Washington to identify spotted owl sites centers located on WDNR HCP lands, or site centers that were located within one homerange radius of WDNR HCP lands. This analysis identified 86 spotted owl site centers on WDNR HCP lands, and an additional 209 sites located within one homerange radius of WDNR HCP lands, for a total of 295 spotted owl sites (Table 19). Almost all of these spotted owl sites were documented during surveys that occurred in the 1990s.

Survey efforts in the past 20 years have been limited to spotted owl demography study areas, and some HCP-specific monitoring surveys conducted by WDNR in 2000s. Because the current status of all of these historic spotted owl sites is unknown, we applied the current estimated occupancy rates for spotted owl pair sites in Washington. Of the 295 spotted owl sites located on or adjacent to WDNR HCP lands, only 15 sites are likely to still be occupied (Table 19). These estimates do not account for individual, non-resident spotted owls that may still be present on the landscape.

Table 19. Summary of spotted owl sites on or adjacent to WDNR HCP lands in 2023.

HCP Planning Unit Name	Historic spotted owl status 1,2,3 site centers on WDNR lands	Spotted owl status 1,2,3 sites on adjacent ownerships within one homerange circle radius of WDNR lands	Total historic spotted owl status 1,2,3 owl circles with WDNR HCP lands	Estimated 2023 occupancy rate for pair sites	Estimated occupied pair sites in 2023 on or adjacent to WDNR HCP lands
CHELAN	1	21	22	0.04	1
COLUMBIA	24	15	39	0.06	2
KLICKITAT	14	17	31	0.04	1
N. PUGET	4	35	39	0.06	2
OESF	22	35	57	0.07	4
S. PUGET	3	13	16	0.06	1
S. COAST	5	16	21	0	0
STRAITS	8	35	43	0.07	3
YAKIMA	5	22	27	0.04	1
TOTALS	**86**	**209**	**295**		**15**

Notes: Estimated pair occupancy rates are from USFWS 2023, p. 85. The South Coast planning unit includes – 5 circles on Olympic Peninsula with HCP lands.

In summary, there are a total of 1,076 historic spotted owl sites documented in the WDFW occurrence database. Based on current spotted owl occupancy rates, we estimate that only 59 of the historic sites are likely to still be occupied statewide (Table 15, above). Of the remaining estimated occupied sites, 15 sites (27 percent) occur in areas where there is some overlap with WDNR lands (Table 19). Because most of the historic spotted owl sites in Washington are located on federal lands (82 percent) and most of the remaining habitat in Washington is on federal lands, we expect that the most occupied sites remaining in Washington are located on or near federal lands. The estimated number of occupied spotted owl sites on or near WDNR lands from this analysis (15 pairs) is similar to the number derived from the habitat capacity analysis for Washington (17 pairs) (Table 16, above).

9.4 Estimates of Spotted Owl Habitat on WDNR Lands

<u>Spotted Owl Habitat on WDNR Lands in 1997</u>

In 1997, there was an estimated 484,717 acres of suitable spotted owl NRF habitat on WDNR lands (USFWS 1997a, p. 47). This represented about 12 percent of the total estimated NRF habitat in Washington at that time (4.17 million acres). Most habitat on WDNR lands was located in the Westside planning units (358,364 acres) (USFWS 1997a, p. 61). Eastside planning units were estimated to have 67,400 acres (USFWS 1997a, p.72), and approximately 58,900 acres in the was estimated in the OESF (WDNR 1997, p. IV-90). We do not have estimates of the amount of NRF habitat that has been harvested over the past 27 years on the WDNR lands. Direct comparisons between the 1997 levels and current levels are not reliable, because the methods used to estimate habitat have changed over the course of the past 27 years.

A recent analysis of old-growth and structurally-complex forests on WDNR lands in western Washington indicates there has been little net change in the total amount of older forests on WDNR lands, but the distribution of older forests have shifted, with net losses (-2,083 acres per year) in areas managed for timber production, and net gains in riparian zones and habitat management areas (+1,989 acres per year) (Halofsky and Donato 2023, p. 1). In this analysis, the total area of structurally complex forests on WDNR lands in 1999 (~422,700 acres) is nearly the same as the estimates for 2017 (421,000 acres) (Halofsky and Donato 2023, p. 24). There was a net loss of approximately 6,500 acres of potential old-growth forest (-3 percent) across all WDNR lands in western Washington between 1999 (~181,300 acres) and 2017 (~174,800 acres) (Halofsky and Donato 2023, p. 24). This analysis illustrates the dynamic nature of forest succession, and the shifting distribution of structurally complex forests on WDNR lands relative to the HCP land-use designations.

Spotted Owl Habitat on WDNR Lands in 2023

We have two sources for estimates of spotted owl habitat on WDNR HCP lands. One source is WDNR, which tracks the amount of spotted owl habitat located within designated SOMUs. WDNR does not formally monitor spotted owl habitat outside of SOMUs. The other source of data is from habitat models developed for the Northwest Forest Plan monitoring program which classify the landscape into spotted owl cover types (Davis et al. 2022, entire). This data allows for comparison across broad ownerships and provides context for the total area of spotted owl habitat on WDNR land relative to federal lands and other ownerships.

Assumptions and Notes Regarding GIS Estimates

We used the best available GIS data to represent land ownership and spotted owl habitat across WDNR lands and other lands. We note here that the GIS values presented throughout this document should be viewed as approximate, even though they appear to be precise to the nearest acre. When we summarize the habitat information in narrative at broad landscape scales, we generally round the values to the nearest 1,000. We also note that there are inconsistencies in the acres of WDNR lands between tables. For example, the WDNR GIS data indicates 272,425 acres of HCP lands within the OESF (Table 20). When we analyzed this area with the Northwest Forest Plan data, we have a value of 273,053 acres of HCP lands in the OESF (Table 21). This difference is due to differences in the underlying GIS data representing land ownership, and we acknowledge those differences here, and therefore note that all values estimated from GIS should be interpreted as approximate values. Relationships such as the overall percentage of a landscape in habitat are accurate.

Spotted Owl Habitat Estimates from WDNR Forest Inventory Data

The amount of spotted owl habitat within HCP designated NRF and dispersal management areas is tracked by WDNR annually and summaries of these data are provided in the HCP annual reports (e.g., WDNR 2023a, pp. 4-9). In 1997, WDNR estimated there was over 104,000 acres of nesting/roosting forests within designated NRF management areas (WDNR 1997. p. IV.30). This included about 85,000 acres of nesting / roosting habitat in the westside planning units (not including OESF). This estimate was based on the best available information at the time. Subsequent analyses completed by WDNR for the HCP 5-year review indicated much lower amounts of nesting / roosting habitat, particularly in the Westside planning units (36,848 acres) (WDNR 2004b, p.33). WDNR attributed the significant differences to the forest inventory methods used to estimate habitat and recognized that many areas of "near habitat" exist but did not meet all criteria listed in the HCP habitat definitions (WDNR 2004b, p. 34). WDNR's current inventory indicates about 30,000 acres of existing nesting / roosting habitat in westside NRF areas. While the Columbia Planning Unit is near landscape thresholds for existing habitat, the North Puget planning area is far below the 50 percent landscape thresholds for meeting NRF management goals (Table 20). In the Eastside Planning Units, the Klickitat planning area is currently estimated to be above landscape thresholds for nesting /roosting habitat (59 percent), while other designated NRF areas on the Eastside currently have no nesting /roosting habitat (Table 20). All of the Eastside landscapes have been affected by wildfires (discussed below).

Table 20. Spotted owl habitat estimates in HCP designated spotted owl management areas based on WDNR forest inventory data.

HCP Planning Unit Name	Acres of WDNR designated NRF/OESF areas	Estimated nesting / roosting habitat in NRF area	Percent of NRF area in nesting / roosting habitat	Acres of WDNR designated dispersal / DFC area	Estimated dispersal habitat in dispersal management area	Percent of dispersal area in dispersal habitat
CHELAN	5,551	0	0%	0	0	0%
COLUMBIA	53,440	25,250	47%	31,584	20,439	65%
KLICKITAT	39,351	23,084	59%	32,034	18,839	59%
N. PUGET	110,691	4,758	4%	15,167	7,546	50%
OESF	272,425	110,591	41%	0	0	0%
S. PUGET	2,554	0	0%	78,088	42,430	54%
S. COAST	0	0	0%	0	0	0%
STRAITS	0	0	0%	0	0	0%
YAKIMA	13,074	0	0%	33,556	18,876	56%
TOTALS	**497,087**	**163,682**	**33%**	**190,428**	**108,131**	**57%**

Source: WDNR GIS data for spotted owl management units 2023. Notes: Klickitat NRF areas include "near NRF" as part of the habitat estimate. This table also includes dispersal habitat estimates for Klickitat ponderosa pine desired future condition (DFC) areas, which can provide dispersal habitat, but are no longer designated as dispersal areas. OESF spotted owl habitat = areas classified by WDNR as old-forest habitat, submature habitat, or young forest marginal habitat.

The OESF includes over 272,000 acres. The spotted owl conservation strategy in the OESF is to provide 20 percent old forest habitat, and 20 percent “structural” spotted owl habitat in each of the 11 SOMUs. WDNR estimates there is approximately 42,000 acres of old forest habitat that meet the HCP definitions for High Quality, Type A, or Type B, habitats on the OESF (about 15 percent of the entire landscape). Old forest habitat and other structural spotted habitat are estimated at over 110,000 acres (41 percent), which is currently above the HCP target to provide 40 percent threshold for spotted owl habitat (Table 20, above).

Table 20 (above) provides a high-level summary of habitat estimates based on WDNR forest inventory data. Detailed assessments of available habitat for each designated spotted owl management unit are provided in *Appendix E – Estimates of Spotted Owl Habitat on WDNR HCP Lands*.

Spotted Owl Habitat Estimates from Northwest Forest Plan Monitoring Data

Based on Northwest Forest Plan habitat models, there is approximately 3.23 million acres of suitable spotted owl nesting / roosting habitat in Washington including approximately 306,000 acres of habitat on WDNR HCP lands (Table 14, above). This represents about 9 percent of the total estimate nesting / roosting habitat in Washington, and about 2.4 percent of nesting / roosting habitat rangewide. Based on these data, about 97 percent of all WDNR HCP lands are within forest-capable lands, but currently 16 percent are classified as nesting / roosting habitat (Table 21). The overall low percentage of existing nesting / roosting habitat on WDNR lands reflects a history of extensive timber harvesting that occurred on these lands, and in some areas the combined effects to past harvest and habitat loss from wildfires. It is important to note that many areas classified as “suitable” occur in small, fragmented patches that are not likely to support resident spotted owls (e.g., South Coast planning unit), but may provide function to spotted owls to support dispersal movements.

Table 21. Estimates of spotted owl habitat on WDNR lands by HCP planning unit derived from Northwest Forest Plan monitoring data.

HCP Unit Name	Unsuitable habitat (acres)	Marginal habitat (acres)	Suitable and highly suitable nesting / roosting habitat (acres)	Not habitat capable (acres)	WDNR HCP lands - 2023 (acres)
CHELAN	8,433	2,562	2,605	3,741	17,340
COLUMBIA	149,829	71,073	64,099	3,441	288,442
KLICKITAT	32,673	26,997	34,382	2,178	96,229
N. PUGET	252,872	113,873	79,385	11,126	457,256
OESF	158,975	59,480	52,947	1,651	273,053
S. COAST	184,237	52,974	14,970	8,536	260,716
S. PUGET	96,516	57,809	21,945	1,861	178,130
STRAITS	76,241	29,263	21,520	895	127,919
YAKIMA	145,051	29,659	14,313	23,395	212,419
Totals	**1,104,826**	**443,689**	**306,165**	**56,824**	**1,911,504**
Percent	58%	23%	16%	3%	100%

Notes: Data presented in this table represent estimates of spotted owl habitat from habitat models developed for the Northwest Forest Plan monitoring program, representing 2023 conditions. Suitable and highly suitable categories represent forest types that typically support spotted owl nesting and roosting; marginal habitat represents forest types that are approaching suitable nesting-roosting habitat, unsuitable habitat represents forest types that spotted owls typically avoid for nesting and roosting. Not habitat capable represent non-forested areas (Davis et al. 2022; USFS 2023).

Assumptions Regarding Spotted Owl Habitat in the OESF

In the OESF, there is an estimated 59,480 acres of forest classified as "marginal" spotted owl habitat, and 52,947 acres of nesting / roosting forest (Table 21, above). Adding these two categories together yields 112,427 acres. This value is close to WDNR's estimate of 110,591 acres of spotted owl habitat in the OESF (Table 20, above). WDNR's classification of spotted owl habitat in the OESF includes "young-forest marginal" habitat, which provides suitable habitat to support spotted owl foraging, but lacks more complex structures associated with nesting habitat. Because of the close alignment between these two estimates, we are using both "marginal" and "suitable" and "highly suitable" cover-types to represent spotted owl habitat in the OESF. From this point forward in the document, the estimated amount of habitat on the OESF is represented as 122,427 acres (Table 22). By including these additional acres in the OESF, the total estimated nesting / roosting habitat on WDNR lands is 365,645 acres (Table 23).

Estimated Habitat Within HCP Designated Spotted Owl Management Areas

In total, over 195,000 acres of existing nesting / roosting habitat are in HCP designated spotted owl NRF management areas and the OESF (Table 22). HCP designated NRF management areas in the Westside planning units include over 166,000 acres. Based on the Northwest Forest Plan habitat model, there is approximately 54,000 acres of suitable nesting-roosting habitat located within these areas. HCP designated NRF management areas in the Eastside planning units include over 57,000 acres. Based on the Northwest Forest Plan habitat model, there is approximately 28,000 acres of suitable nesting-roosting habitat located within these areas.

Table 22. Spotted owl habitat estimates in HCP designated spotted owl management areas based on Northwest Forest Plan monitoring program data.

HCP Planning Unit Name	Acres of WDNR designated NRF areas	Estimated nesting / roosting habitat in NRF area	Percent of NRF area in nesting / roosting habitat	Acres of WDNR designated dispersal / DFC area	Estimated dispersal habitat in dispersal management area	Percent of dispersal area in dispersal habitat
CHELAN	5,551	1,697	31%	0	0	0%
KLICKITAT	39,351	23,711	60%	32,034	15,629	49%
YAKIMA	13,074	3,308	25%	33,556	13,443	40%
Eastside Totals	**57,976**	**28,716**	**50%**	**65,590**	**29,072**	**44%**
COLUMBIA	53,440	23,142	43%	31,584	22,327	71%
N. PUGET	110,691	30,498	28%	15,167	6,069	40%
S. PUGET	2,554	675	26%	78,088	44,619	57%
S. COAST	0	0	0%	0	0	0%
STRAITS	0	0	0%	0	0	0%
Westside Totals	**166,685**	**54,315**	**33%**	**124,839**	**73,015**	**58%**
OESF	**273,053**	**112,427**	**41%**	0	0	0%
HCP Totals	**497,714**	**195,458**	**39%**	**190,428**	**102,087**	**54%**

Notes: Data presented in this table represent estimates of spotted owl habitat from habitat models developed for the Northwest Forest Plan monitoring program, representing 2023 conditions (Davis et al. 2022; USFS 2023). Suitable and highly suitable categories were used to represent forest types that typically support spotted owl nesting and roosting. Suitable, highly suitable, and marginal habitat categories were used to estimate potential dispersal habitat.

Because the methods for estimating spotted owl habitat in these landscapes are derived from different data sources and methods, direct comparisons between the two habitat data sources are unreliable. For example, the amount of suitable NRF habitat in the Columbia planning unit based on WDNR data (25,250 acres) (Table 20, above) is comparable to the estimate derived from the Northwest Forest Plan model (23,142 acres). However, in the North Puget planning unit, the estimated the amount of suitable habitat based on WDNR data (4,758 acres) (4 percent) is far below the estimated 30,498 acres of “suitable and highly suitable” habitat based on the Northwest Forest Plan model.

It is important to note that the habitat estimates derived from the Northwest Forest Plan monitoring data are useful for comparison across broad landscapes, but we acknowledge that WDNR does not rely on these data for tracking NRF habitat within HCP designated spotted owl management areas. For this assessment, we are presenting both sources of information, but our evaluation of the HCP will be based primarily on the Northwest Forest Plan data, because it allows us to estimate the total amount of existing spotted owl habitat and habitat-capable lands across all WDNR HCP lands.

Spotted Owl Habitat Conserved under the HCP

To estimate the area of existing spotted owl nesting / roosting habitat that is conserved by various HCP conservation strategies or other WDNR policies, we evaluated habitat within mapped areas of LTFC. LTFC is defined as areas that are generally not available for regeneration timber harvesting but may be subject to some limited thinning treatments for habitat enhancement or restoration purposes. These areas include marbled murrelet occupied sites, and marbled murrelet occupied site buffers, marbled murrelet special habitat areas, interior core riparian buffers, unstable slopes, old-growth forest, Natural Area Preserves, and other deferrals (WDNR and USFWS 2019, Appendix G). In this assessment, LTFC generally excludes areas that are naturally non-forested (e.g., wetlands, alpine areas, etc.). LTFC deferrals are most extensive in the OESF (over 50 percent) where there is a high density of riparian, old-forest, and marbled murrelet deferrals. Estimated LTFC is not as extensive in Eastside planning units due to a lower density of riparian areas.

Areas of mapped LTFC include over 730,000 acres of WDNR lands, representing about 38 percent of all HCP lands. Approximately 66 percent of existing nesting / roosting habitat on WDNR lands is located within areas of LTFC, while about 33 percent is located within general management (GM) lands (Table 23). Not all existing habitat within GM lands is potentially available for harvest. In HCP designated NRF management areas existing NRF habitat is not available for harvest unless the amount of habitat within a designated SOMU exceeds the 50 percent landscape threshold. Estimates of existing nesting / roosting habitat that is potentially available for timber harvest over the remaining term of the HCP are summarized below in Table 23. For more a detailed assessment of each planning unit, refer to Appendix E.

Table 23. Estimates of existing spotted owl habitat potentially available for harvest over the remaining term of the HCP.

HCP Planning Unit	WDNR HCP lands - 2023 (acres)	Spotted owl nesting / roosting habitat (acres)	Areas of mapped long-term forest cover (LTFC) (acres)	Spotted owl nesting / roosting habitat within areas of LTFC (acres)	Nesting / roosting habitat in general management (GM) lands (acres)	Existing nesting roosting habitat potentially available for harvest in GM lands (acres)
CHELAN	17,340	2,605	2,417	705	1,900	430
COLUMBIA	288,442	64,099	104,493	31,569	32,530	23,047
KLICKITAT	96,229	34,382	26,426	14,959	19,423	13,020
N. PUGET	457,256	79,385	220,467	56,364	23,021	15,545
OESF	273,053	112,427	145,927	107,604	3,206	3,206
S. COAST	260,716	14,970	99,090	6,787	8,182	8,182
S. PUGET	178,130	21,945	69,075	10,625	11,319	11,095
STRAITS	127,919	21,520	49,267	12,131	9,389	9,389
YAKIMA	212,419	14,313	15,875	2,058	12,255	9,177
Totals	**1,911,504**	**365,645**	**733,037**	**242,802**	**121,225**	**93,091**
Percent	100% of lands	100% of habitat	38% of lands	66 % of habitat	33% of habitat	25% of habitat

Notes: Data presented in this table represent estimates of spotted owl habitat from habitat models developed for the Northwest Forest Plan monitoring program, representing 2023 conditions (Davis et al. 2022; USFS 2023). Values in this table are approximate estimates derived for all HCP lands within a specific planning unit.

9.5 Current Condition of Designated Critical Habitat

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

Much of the suitable nesting and roosting habitat within the critical habitat exists in fragmented patches due to past timber harvest, wildfire, disease, and other disturbances. Based on the spotted owl habitat data developed for the NWFP 25-year monitoring report (Davis et al. 2022), we estimate that in 2022, approximately 46.1 percent of the lands within CHUs contained suitable spotted owl nesting/roosting habitat (4.32 million acres), and that 29.0 percent (2.72 million acres) of the total designated critical habitat acres were highly suitable nesting/roosting habitat (Table 24). Our estimates also indicate that there are 4 percent (473,763 acres) less nesting/roosting habitat than there were in 2012 (Appendix D).

In Washington, there is approximately 2.95 million acres of spotted owl critical habitat designated within six CHUs. We estimate that approximately 44.4 percent of the total designated critical habitat in Washington contained suitable spotted owl nesting/roosting and foraging habitat (2.34 million acres), and that 24.0 percent (698,004 acres) of the total designated critical habitat acres are highly suitable nesting/roosting habitat. From 2012 to 2022, nesting/roosting habitat in the Washington CHUs declined by 2.54 percent (135,668 acres) with most of the losses occurring disproportionately in the Eastern Cascades. The effects of past timber harvest and wildfires that have grown in size, duration, and intensity over the past 20 years are largely attributed to the habitat losses. Among all the CHUs range-wide, those designated in Washington have approximately 40 percent (1.27 million acres) of areas that are currently unsuitable habitat (e.g., young forests or previously harvested) or are not habitat capable. For more details on estimates of spotted owl habitat within critical habitat units, physiographic provinces, and subunits, refer to *NSO Status of the Species and Critical Habitat* Appendix D.

Table 24. Summary of designated spotted owl critical habitat range-wide and baseline habitat conditions[1] by Critical Habitat Units as of 2022.

Critical Habitat Unit Name	Total designated CH (acres)	Unsuitable habitat (acres)	Marginal habitat (acres)	Suitable habitat (acres)	Highly suitable habitat (acres)	Not habitat capable (acres)	Percent nesting, roosting habitat in designated CH
North Coast Ranges and Olympic Peninsula	819,519	248,037	255,602	141,728	166,590	7,562	37.6
West Cascades North	542,146	124,482	118,037	145,273	138,660	15,694	52.4
West Cascades Central	899,154	220,989	220,149	195,849	248,689	13,478	49.4
West Cascades South	1,375,608	403,899	167,944	184,581	609,196	9,988	57.7
East Cascades North	1,359,263	596,391	287,883	218,305	211,865	44,820	31.6
East Cascades South	284,974	85,295	112,238	69,917	14,189	3,336	29.5
Oregon Coast Ranges	809,454	243,129	191,509	112,080	261,746	989	46.2
Redwood Coast	146,839	23,042	45,898	26,694	46,570	4,636	49.9
Klamath West	1,251,746	340,433	169,115	200,699	534,041	7,458	58.7
Klamath East	882,764	251,524	148,720	158,763	317,024	6,733	53.9
Interior California Coast	1,001,425	503,189	153,426	146,592	168,920	29,299	31.5
Grand Total	**9,372,892**	**3,040,410**	**1,870,520**	**1,600,481**	**2,717,490[2]**	**143,991**	**46.1**

Notes:

1. Suitable and highly suitable categories represent forest types that typically support spotted owl nesting and roosting; marginal habitat represents forest types that are approaching suitable nesting-roosting habitat and support dispersal, unsuitable habitat represents forest types that spotted owls typically avoid for nesting and roosting. Not habitat capable represent non-forested areas (Davis et al. 2022; USFS 2023).
2. Due to rounding errors associated with GIS, the acreage values reported here may differ slightly from values reported elsewhere. Spotted owl habitat estimates are approximate values derived from habitat maps developed for the NWFP 25-year monitoring report (Davis et al. 2022).
3. Spotted owl critical habitat as designated November 10, 2021 (86 FR 62606).

9.6 Factors Responsible for the Condition of the Critical Habitat in the Action Area

Critical habitat in the action area is associated with the North Coast Ranges and Olympic Peninsula (NCO Unit 1), West Cascades North (WCN Unit 4), West Cascades Central (WCC Unit 5), and East Cascades North (ECN Unit 7) CHUs. The CHUs and associated subunits are essential for the conservation of the species to meet the recovery criterion that calls for the continued maintenance and recruitment of spotted owl habitat.

The designation of critical habitat in Washington identified approximately 225,751 acres of WDNR state lands managed under the 1997 WDNR HCP as essential areas for spotted owl conservation. Because these lands are managed under an approved HCP issued under section 10(a)(1)(B) of the ESA, these lands are excluded from critical habitat by description in the final rule (77 FR 71973-71975). Therefore, this analysis is focused on the condition of designated critical habitat on federal lands adjacent to WDNR-managed lands.

The action area for designated critical habitat is based on the potential effects to the primary constituent elements (PCEs) (also known as the physical and biological features) of the critical habitat. We use a distance of 100 meters (328 feet) to account for the most significant physical and biological effects along clearcut boundaries due to the loss of individual trees to windthrow, reduced forest canopy cover, and altered forest composition (Chen et al. 1992, pp. 390-391, van Rooyen et al. 2011, p. 549). Based on habitat maps developed for the NWFP 25-year monitoring report (Davis et al. 2022) and GIS-analysis, we estimated there is approximately 12,100 acres of designated critical habitat located within a distance of 328 feet (proximity buffer) of WDNR-managed lands (Table 25). The spotted owl habitat in these areas is widely distributed along the perimeters of thirteen critical habitat subunits within the four CHUs. The majority of habitat is located adjacent to HCP Planning Units west of the Cascade Crest. Of the total acres designated as critical habitat in Washington, less than 1 percent occur within 328 feet of WDNR-managed lands.

Table 25. Summary of spotted owl critical habitat located within 328 feet to WDNR-managed lands.

Critical Habitat Subunit	Total area in CHU subunit (acres)	Designated CH located within 328 ft of WDNR HCP lands (acres)	Percent of designated CH located within 328 ft of WDNR HCP Lands	Total nesting / roosting habitat in CHU subunit (acres)	Percent of designated CHU in nesting / roosting habitat	HCP Planning Unit
ECN 1	101,656	80	0.08%	24,332	23.9%	Chelan
ECN 2	60,087	35	0.06%	5,415	9.0%	
ECN 3	301,220	995	0.33%	112,334	37.3%	
ECN 4	223,282	468	0.21%	78,950	35.4%	Yakima
ECN 5	201,140	721	0.36%	66,869	33.2%	
ECN 6	81,842	553	0.68%	48,327	59.0%	Klickitat
NCO 1	293,469	1,961	0.67%	126,638	43.2%	OESF
NCO 2	213,697	1,694	0.79%	93,821	43.9%	Straits
WCC 1	225,272	886	0.39%	95,448	42.4%	S. Puget
WCC 2	279,420	171	0.06%	136,978	49.0%	Columbia
WCC 3	394,462	1,349	0.34%	212,112	53.8%	
WCN 1	438,247	2,850	0.65%	238,410	54.4%	North Puget
WCN	103,899	336	0.32%	45,524	43.8%	
Totals	**2,917,693**	**12,100**	**0.41%**	**1,285,158**	**44.0%**	

The primary factors responsible for the condition of critical habitat in the action area resulted from forest management projects and natural disturbance. Current and past timber harvest and wildfires have resulted in the fragmentation of spotted owl across major portions of the action area. The primary agents of natural disturbance in forested areas are wildfire, insect outbreaks, and tree diseases that are likely to become more frequent under changing climatic conditions. A brief discussion of the four CHUs are below. Further descriptions of the status of CHUs and subunits that are designated in Washington are found in the December 2012 Final Rule for designation of revised critical habitat for spotted owl (77 FR 71875 72068).

In the North Coast Ranges and Olympic Peninsula and Western Cascades North and Central regions, the climate is characterized by high rainfall and cool to moderate temperatures. Variation in elevation between valley bottoms and ridges is relatively low in the Coast Ranges, creating conditions favorable for development of contiguous forests. In contrast, the Olympic and Cascade ranges have greater topographic variation with many high-elevation areas supporting permanent snowfields and glaciers.

Spotted owl nesting habitat in these regions is mostly limited to areas with large trees with defects such as cavities, broken tops, or mistletoe (*Arceuthobium* spp.) brooms. The subset of foraging habitat that is not nesting/roosting habitat generally had slightly lower values than nesting habitat for canopy cover, tree size and density, and canopy layering. Prey species, primarily northern flying squirrels (*Glaucomys sabrinus*) are associated with mature to late-successional forests, resulting in small differences between nesting/roosting and foraging habitats.

Threats specific to subunits NCO-1, NCO-2, WCC-1, WCC-2, WCN-1, and WCN-2 include current and past timber harvest, competition with barred owls, isolation on a peninsula, and stand conversion. Additional threats also include wildfires and windthrow that have resulted in some losses to nesting/roosting and foraging habitat in the subunits (77 FR 71920, 71924-71925).

The Eastern Cascades North region is characterized by a continental climate (cold, snowy winters and dry summers) and a high frequency of natural disturbance due to wildfires and outbreaks of forest insects and pathogens. Terrain in portions of this region is glaciated, mountainous, and steeply dissected. In Washington, ponderosa pine and Douglas-fir forests are dominant at low elevations, whereas Douglas-fir/grand fir mixed conifer forest are characteristic of mid elevations, and silver fir, hemlock, and subalpine fir are characteristic at higher elevations.

Relative to other portions of the spotted owls' range, nesting and roosting habitat in this region includes relatively younger and smaller trees, likely reflecting the common usage of dwarf mistletoe brooms as nesting platforms. Forest composition that includes high proportions of Douglas-fir is also associated with this nesting structure. Foraging habitat in this zone generally resembles nesting and roosting habitat, with reduced canopy cover and tree size, and reduced canopy layering. High prey diversity suggests relatively diverse foraging habitats are used. Barred owls, which have been present for over 30 years in the northern portions of this zone, preferentially occupy valley-bottom habitats, possibly compelling spotted owls to establish territories on less productive, mid-slope locations (Singleton et al. 2010, pp. 289, 292).

Threats specific to subunits ECN-1, ECN-2, ECN-3, ECN-4, ECN-5, and ECN-6 include current and past timber harvest; competition with barred owls; removal or modification of habitat by high severity wildfires, insects, and diseases (77 FR 71927-71929).

9.7 Conservation Role of the Action Area for Spotted Owls

The conservation role of WDNR HCP lands for spotted owl was defined at the time the HCP was created to support the conservation and recovery of spotted owl populations in Washington. WDNR's conservation objective for the spotted owl is to provide habitat that makes a significant contribution to demographic support, maintenance of species distribution, and facilitation of dispersal. These objectives are expected to be achieved through designation of specific spotted owl management landscapes, located in key landscape areas within close proximity to federal reserves designated under the Northwest Forest Plan.

9.8 Climate Change

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

The following discussion is a summary of the stressors associated with climate change that are most relevant to the action area. Detailed information on the mechanisms of climate change that are likely to affect spotted owls is provided in USFWS's 2011 *Revised Recovery Plan for the Northern Spotted Owl* (USFWS 201, pp. III-5 - III-11) and Appendix D: *Status of the Species: Northern Spotted Owl and Northern Spotted Owl Critical Habitat*.

<u>Wildfires and Insects</u>

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

The area burned annually by wildfires in the Pacific Northwest is expected to double or triple by the 2080s (Littell et al. 2010, p. 140). Wildfires are now the primary cause of spotted owl habitat loss on federal lands. In Washington, over 98,000 acres of spotted owl nesting / roosting habitat loss was attributed to wildfires from 1994 to 2017, including over 89,000 acres of habitat loss in the East Cascades (Davis et al. 2022, p. 32).

Many of the same factors that are leading to changing fire regimes are also leading to increases in forest insect outbreaks. Tree mortality from insect outbreaks (e.g., bark beetles, mountain pine beetle, western spruce budworm, etc.) has also been a significant cause of habitat loss in eastern Washington, with over 28,000 acres of nesting / roosting habitat attributed to insects (Davis et al. 2022, p. 32). This value underestimates the total area impacted by insect outbreaks, because many of the affected areas were harvested in response to the outbreaks. Widespread insect outbreaks in the early 2000's was a significant issue behind the administrative amendment to re-allocate HCP designated NRF and dispersal management areas in the Klickitat Landscape (WDNR 2004, p.18).

To estimate the impact of wildfires on WDNR HCP lands, we used data from the National Interagency Fire Center (NIFC) for wildfires for the period from 1997 through 2021. We restricted this analysis to the range of the spotted owl in Washington. In total, over 1.3 million acres burned in Washington, including over 49,000 acres of burned areas on WDNR HCP lands. Burned areas included over 7,400 acres within HCP designated NRF management areas (Table 26).

Table 26. Summary of wildfires within the range of the spotted owl in Washington (1997 - 2021).

HCP Planning Unit	Total burned area within range of spotted owl in WA (all lands) (acres)	Burned area within WDNR HCP lands (acres)	Burned area within HCP designated NRF management areas (acres)
CHELAN	833,319	7,443	671
COLUMBIA	28,372	846	846
KLICKITAT	87,120	4,290	393
NORTH PUGET	24,248	0	0
OESF	2,848	0	0
SOUTH COAST	169	0	0
SOUTH PUGET	24,537	94	0
STRAITS	11,488	303	0
YAKIMA	306,728	36,379	5,496
Totals	**1,318,827**	**49,355**	**7,406**

Source: NIFC 2023. GIS data for wildfire perimeters for years 1997 through 2021.

The wildfires over the past 25 years have resulted in significant loss of habitat on both WDNR lands and on adjacent federal lands. In the Yakima planning unit, nearly 5,500 acres of designated NRF areas have burned, representing 42 percent of the NRF-designated area in that planning unit. Portions of HCP designated NRF areas in the Chelan and Yakima planning units that were originally designated to contribute to existing nesting / roosting habitat located on adjacent federal lands are now disconnected, and isolated, with essentially no habitat remaining in the HCP-designated NRF area, or on adjacent federal lands (e.g., Naneum NRF area).

Along with the increasing risk of catastrophic wildfire is the increasing demand for forest management treatments (e.g., thinning, prescribed burning) on public lands to reduce wildfire risk and improve forest resiliency for a hotter, dryer climate. WDNR estimates that between 800,000 and 1.16 million acres of forest treatments (32 to 47 percent of priority landscape) are needed across public lands (state and federal) in eastern Washington to improve forest resilience (WDNR 2020b, p.36). The need to reduce fire risk and improve forest health is likely to result in loss and degradation of existing spotted owl habitat, especially in dry forests where spotted owl habitat has increased with fire suppression over the past century. We are not able to predict to what extent these treatments will affect spotted owl habitat, but the USFWS recognizes that the increasing risk of wildfire is a significant threat to spotted owls, and that active forest management can be effective in reducing fire risk (USFWS 2011, pp. III-20 – 21).

With over 40 years remaining in the initial term of the HCP (2067), and an ever-increasing risk of wildfire, particularly in the East Cascades, the projected increase in wildfire risk and severity associated with climate change poses a significant risk to achieving HCP landscape objectives for spotted owl conservation.

<u>Forest Vegetation Zones and Habitat Sustainability</u>

Natural vegetation communities are influenced by the interaction of climate (e.g., temperature, precipitation) and topography (e.g., elevation, aspect, latitude). Natural vegetation communities described as forest zones develop in response to these variables. In the Pacific Northwest, forest zones and species distributions are projected to shift as summer temperature increases, seasonal dry periods lengthen, and snow/rain precipitation patterns change (Halofsky et al, 2023, p. 2).

In the East Cascades, spotted owl habitat is currently distributed across a broad range of forest zones, from higher elevation "cold forests" to lower elevation open canopy dry forest zones. The existing distribution of spotted owl habitat reflects the prevailing climate of the past century as well as fire suppression and forest management practices. As the climate warms, the frequency and extent of high-severity wildfires is increasing, and landscape suitability to sustain large wildfires is projected to increase under all climate change scenarios (Davis et al. 2017, p. 179).

Most spotted owl nesting / roosting habitat in the East Cascades is associated with mid-elevation dry or moist mixed conifer forests zones (Douglas-fir, ponderosa pine, and grand fir vegetation series) which historically supported frequent low to moderate severity wildfires (Halofsky et al. 2023, p. 5). Analysis of the historic conditions in the East Cascades indicates 18 to 25 percent of forests within dry and moist conifer forest zones supported spotted owl nesting / roosting habitat (Halofsky et al. 2023, 16.). This is well below the current conservation strategy to develop or maintain 50 percent habitat in HCP designated NRF management areas.

The climate change analysis suggests an upward elevation shift in forest zones as the future becomes warmer and drier. Much of the area that is currently dry mixed-conifer forest is projected to transition to the warmer open canopy dry forest zone that is unlikely to support spotted owl nesting / roosting habitat (Halofsky et al. 2023, 16.). At the scale of the East Cascades analysis area, the study estimates a 30 percent decline in spotted owl habitat -capable area by the end of the analysis period due to climate change (2040-2070) (p. 16). One of the primary implications of the shift in forest zones is the response of forest vegetation to disturbance – burned areas that previously supported one vegetation series (e.g., moist mixed conifer forest), are not likely to support the same forest type in the future.

We used the forest zone data developed by Halofsky et al. (2023) to evaluate the current composition of the Eastside NRF management areas. Currently, 86 percent of these areas are located within dry or moist mixed conifer zones. As the future climate shifts towards warmer and dryer conditions, the area capable of sustaining open dry canopy forests will increase substantially, and the projected area within dry and moist conifer zones is projected to decrease to 38 percent of the designated NRF areas (Table 27).

Table 27. Current and projected future distribution of forest vegetation zones within East Cascades HCP designated NRF management areas.

Time period	Cold Forest (acres)	Dry Mixed Conifer Forest (acres)	Moist Mixed Conifer Forest (acres)	Open Canopy Dry Forest (acres)	Unclassified (acres)	HCP designated NRF management (acres)
Current Forest Zones (present climate 2010)	1,372	16,225	33,773	3,614	2,981	57,964
Percent of NRF area	**2%**	**28%**	**58%**	**6%**	**5%**	**100%**
Projected Future Forest Zones (2040-2070)	0	12,744	9,420	32,819	887	57,964
Percent of NRF area	**0%**	**22%**	**16%**	**57%**	**2%**	**100%**

Source: Halofsky et al. 2023. Values here should be viewed as approximate only, due to uncertainties associated with future conditions.

Some HCP designated NRF areas currently have relatively high amounts of spotted owl habitat (e.g., Husum – 60 percent nesting / roosting habitat) that are the result of the climate, fire history, fire suppression, and forest management choices of the past century. Given the projected increases in area burned by wildfires and shifts in forest zones, the HCP objective to maintain 50 percent of this area in NRF habitat is likely at high risk of failure due to climate change. Similarly, the expectation that existing nesting / roosting habitat on adjacent federal reserves will be maintained or increased in dry zone forests is unrealistic, because much of the dry forest within the federal reserves is increasingly susceptible to wildfire and insect outbreaks (Gaines et al. 2022, p. 12).

Assessments for climate -driven shifts in vegetation zones have been completed for western Washington (Halofsky et al. 2018, entire). Similar to the eastside analysis, there is a predicted upward expansion of the driest low-elevation forest types and a predicted contraction of subalpine forests. Middle elevations forest types were projected to be relatively stable, and likely resistant to significant change in the absence of stand-replacing disturbances. The primary stressor associated with climate change in the western Washington forests is the projected increase in wildfire frequency and severity, and increased loss of existing late-successional forests in the higher elevation forest zones (Halofsky et al. 2018, p. 17). Recent wildfires over the past two decades limited impacts to spotted owl nesting / roosting habitat in western Washington (< 10,000 acres, Davis et al. 2022, p. 32). However, historic fires in the region were quite large, and fires in western Oregon in 2020 demonstrate that under the right conditions, wildfire can rapidly burn across large areas (Gaines et al. 2022, p. 2).

Effects of Climate Change on Spotted Owl Demography

Potential changes in temperature and precipitation have important implications for spotted owl reproduction and survival. Wet, cold weather during the winter or nesting season, particularly the early nesting season, has been shown to negatively affect spotted owl reproduction (Olson et al. 2004, p. 1039, Dugger et al. 2005, p. 863), survival (Franklin et al. 2000 pp. 576-577, Olson et al. 2004, p. 1039, Glenn et al. 2011, p. 1279), and recruitment (Glenn et al. 2010, pp.2446-2547). Cold, wet weather may reduce reproduction and/or survival during the breeding season due to declines or decreased activity in small mammal populations so that less food is available during reproduction when metabolic demands are high (Glenn et al. 2011, pp. 1288-1289). Cold, wet nesting seasons may increase the mortality of nestlings due to chilling and reduce the number of young fledged per pair per year (Franklin et al. 2000, p.557, Glenn et al. 2011, p. 1286). Drought or hot temperatures during the summer have also been linked to reduced spotted owl recruitment (Glenn et al. 2010, p. 2549). Drier, warmer summers and drought conditions during the growing season strongly influence primary production in forests, food availability, and the population sizes of small mammals that spotted owls prey upon (Glenn et al. 2010, p. 2549). In summary, spotted owl survival and reproduction in any given year can be affected by variations in seasonal weather patterns, and these fluctuations are likely to become more frequent due to climate change.

9.8.1 Climate Change Summary

In summary, climate change is a significant threat to conservation of spotted owl habitat in East Cascades dry forests. The combined stressors associated with increased severity and size of large wildfires, increased propensity for insect outbreaks, and increasing societal pressure to implement landscape-scale forest risk reduction treatments on public lands all point to likely decreases in existing spotted owl habitat. Further, the area of forest land capable of sustaining spotted owl habitat is projected to decrease substantially across the East Cascades, and current policies to maintain and restore nesting / roosting habitat in reserve areas may not be attainable. Additionally, the fluctuation of seasonal weather patterns due to climate change is likely to negatively affect spotted owl reproduction and survival in some years.

9.9 Summary of the Environmental Baseline

The spotted owl population in Washington is rapidly declining to extirpation due to the negative effects of competition with barred owls. The estimated spotted owl population has been reduced to approximately 5 percent of the population that existed in the early 1990’s, including within large landscapes that have had no significant reduction in existing nesting / roosting habitat (e.g., Olympic National Park, Mt. Rainier National Park). We estimate that there are as few as 126 pairs of spotted owls remaining in Washington in 2023, which represents about 4 percent of the estimated range-wide population. Of the 126 pairs remaining in Washington, we estimate that up to 17 pairs (13 percent) have potential for some territorial overlap with WDNR HCP lands. In the absence of barred owl management, the remaining spotted owl population in Washington is projected to decline by 50 percent within 10 years.

There is approximately 365,000 acres of spotted owl nesting / roosting on WDNR lands. This represents about 10 percent of the estimated nesting / roosting habitat in Washington, and about 3 percent of the species habitat range wide. Existing HCP conservation strategies and other policy deferrals (e.g., old-growth, natural areas, etc.) are expected to maintain over 272,000 acres of the existing nesting / roosting habitat (75 percent), while about 25 percent of habitat (~93,000 acres) is in areas that may be subject to timber harvest over the remaining term of the HCP (~43 years).

The HCP spotted owl conservation strategy designates 224,000 acres of NRF management landscapes in the Cascades, with an objective of providing 50 percent nesting / roosting habitat (~112,000 acres). The current baseline of nesting / roosting habitat in the designated NRF areas is estimated at 53,000 acres (24 percent) (WDNR data) to 83,000 acres (37 percent) (NWFP data). The HCP designated 190,000 acres as dispersal landscapes, with an objective of providing 50 percent dispersal habitat (95,000 acres). The current baseline of dispersal habitat in designated dispersal areas is estimated at 102,000 acres (54 percent) (NWFP data) to 108,000 acres (57 percent) (WDNR data).

In the OESF, the HCP strategy is to provide 20 percent of the landscape in old forest habitat, and 40 percent of the landscape in structural spotted owl habitat (~109,000 acres). The current baseline of spotted owl nesting \ roosting habitat is estimated at 112,000 acres (NWFP data) to 110,000 acres (41 percent) of structural spotted owl habitat (WDNR data). While the OESF landscape is above the 40 percent threshold, most of the individual SOMUs are below habitat thresholds, indicating the distribution of spotted owl habitat in the OESF will shift over the remaining term of the HCP as owl habitat develops in some SOMUs, and “excess” habitat in SOMUs that are above threshold is reduced by future timber harvest. No reduction in existing old forest habitat from timber harvest is anticipated because existing old forest is in conserved areas (LTFC).

Designated NRF areas in the West Cascades have the capacity to develop additional nesting-roosting habitat over the remaining term of the HCP. Designated NRF areas in the East Cascades are likely to be significantly affected by the effects of climate change, wildfire, and management efforts to reduce wildfire risk. Climate change projections indicate a substantial reduction in areas capable of sustaining spotted owl habitat in the East Cascades, creating a high level of uncertainty regarding the future capability of NRF areas to maintain or achieve targeted habitat levels.

10 EFFECTS OF THE ACTION: Spotted Owl and Designated Spotted Owl Critical Habitat

ESA implementing regulation 50 CFR 402.02 provides that “The effects of the action are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (50 CFR 402.17).”

The following effects analysis is divided into two major parts. In Part I of the Effects Analysis, we describe the effects of ongoing HCP implementation to spotted owl habitat on WDNR HCP lands, we provide estimates of existing habitat that may be harvested over the remaining term of the HCP, and we estimate habitat gains in areas conserved by the HCP. In Part II of the Effects Analysis, we describe the anticipated biological effects of ongoing HCP implementation to spotted owl numbers, reproduction, and distribution in Washington.

10.1 Effects Analysis Part I: Estimates of Spotted Owl Habitat Losses and Gains

The analysis of the effects of continued implementation of the HCP is based on an evaluation of the effects to spotted owl habitat. A habitat-based approach is a common practice of the USFWS in biological opinions and in the development of HCPs. As described in the *Environmental Baseline*, we used assessments based on WDNR's forest inventory data and assessment based on NWFP habitat monitoring, which allowed us to estimate habitat conditions across the entire WDNR HCP landscape.

A habitat-based approach to evaluating effects is appropriate due to the status of the spotted owl in Washington. As spotted owls have declined to near extirpation in Washington due to competition with barred owls, the area of habitat occupied by spotted owls is far below the existing estimated carrying capacity of the habitat. For this assessment, we estimated potential habitat losses and habitat gains to determine whether habitat capacity to support spotted owl conservation and recovery in Washington will change because of continued HCP implementation.

<u>Methods and Assumptions Used to Estimate Spotted Owl Habitat Losses and Gains</u>

This analysis is focused on the amount of spotted owl NRF habitat that occurs on WDNR HCP lands, where NRF habitat may be subject to timber harvest, and where NRF habitat has the potential to develop in areas conserved by the HCP. The amount and distribution of NRF habitat in a landscape is the best available indicator of landscape capacity to support spotted owl conservation.

For this assessment, we used WDNR's data-base of areas deferred from regeneration timber harvest by various HCP conservation strategies and other WDNR policy deferrals. These areas are referred to as LTFC. LTFC is defined as areas that are generally not available for regeneration timber harvesting. These areas include marbled murrelet occupied sites, marbled murrelet occupied site buffers, marbled murrelet special habitat areas, RMZs, unstable slopes, old-growth forest, Natural Area Preserves, and other deferrals (WDNR and USFWS 2019, Appendix G). In this assessment, LTFC generally excludes areas that are naturally non-forested (e.g., wetlands, alpine areas, etc.).

Some areas within LTFC are available for commercial thinning treatments for habitat enhancement or restoration purposes. These treatments can include riparian forest management, or treatments in mid-seral stands to promote or enhance spotted owl habitat development. The configuration of LTFC can vary from narrow stringers in riparian management zones, to large deferrals that encompass thousands of acres (e.g., marbled murrelet special habitat areas).

It is important to note that outside of specific land use designations, the mapped area of LTFC is approximate (e.g., estimates of riparian management zones and unstable slopes). LTFC can be subject to localized impacts for road construction across riparian areas, yarding corridors, etc., but these impacts are generally highly localized and limited in scale.

WDNR HCP lands that are located outside of mapped LTFC are classified as GM lands. For this assessment, we assume that GM lands are where the majority of WDNR commercial timber harvesting occurs, and we assume that all timber harvest conducted is in full compliance with HCP directives, WDNR policies for sustainable harvest, and the Washington Forest Practices rules (Title 222 WAC).

Specific Assumptions

For this assessment, we used the following assumptions:

Existing NRF habitat: We used the spotted owl habitat cover type maps developed for Northwest Forest Plan monitoring to represent existing NRF habitat. Cover type classifications of "suitable" and "highly suitable" were selected to represent NRF habitat. Suitable and highly suitable categories represent forest types that typically support spotted owl nesting and roosting (Davis et al. 2022, p. 9). We assume that existing NRF habitat conserved within areas of LTFC will remain on the landscape over the remaining term of the HCP (2067).

Marginal habitat: Represents forest types that are approaching suitable nesting-roosting habitat, (Davis et al. 2022, p. 9). We use marginal habitat to represent areas that currently provide spotted owl dispersal habitat or young forest marginal habitat. We assume that areas of existing marginal habitat that are conserved in LTFC are likely to transition into suitable NRF habitat over the remaining term of the HCP (four decades - 2067). In the OESF, we included marginal habitat as part of the existing baseline to represent "young forest marginal", based on the close comparison of this data with WDNR's forest inventory data for the OESF.

NRF management areas: If the current amount of habitat within a designated NRF management area is below the 50 percent landscape threshold, we assume that all existing NRF habitat in the landscape will be conserved until the 50 percent threshold is met, including all existing NRF habitat within GM lands. We also assume that existing marginal habitat in GM lands will be managed to develop NRF habitat up to the 50 percent threshold (i.e., if the NRF area is below threshold, we assume it will reach the NRF threshold by 2067. If the current amount of NRF habitat within the NRF designated area is above the 50 percent threshold, we assume NRF habitat will be harvested from with GM lands in the NRF area.

Dispersal management areas: We assume that existing NRF habitat within dispersal management areas that is located outside of LTFC will be harvested, while existing NRF habitat and marginal habitat within LTFC will remain on the landscape, with marginal habitat areas transitioning to NRF habitat over the remaining term of the HCP. There is no requirement for WDNR to conserve existing NRF habitat within dispersal management areas outside of LTFC, but many areas of existing NRF habitat may be retained to meet landscape dispersal objectives.

Landscape Assessment vs. SOMU Assessment: We chose to evaluate habitat losses and gains at the scale of entire HCP planning units, calculating values for all designated NRF areas, dispersal areas, and areas with no spotted owl role within each HCP planning unit, rather than evaluate each individual spotted owl management unit separately (SOMUs). We recognize this generalizes the analysis to a broader landscape scale but conclude that this level of analysis is sufficient for estimating impacts (habitat loss) and mitigation (habitat gains) across the entire HCP area. Detailed assessments of NRF and dispersal habitat in SOMUs are provided in Appendix E – *Assessment of Spotted Owl Habitat on WDNR HCP Lands.*

LTFC and GIS Estimates: The areas of mapped LTFC are the best available information representing various deferrals. It is important to note that outside of specific land use designations (e.g., Natural Area Preserves, or marbled murrelet special habitat areas) the map of LTFC is approximate, and the specific footprint of these areas can change with improvements in forest inventory data or field verification. In the tables below, we present GIS summaries as specific values to the nearest acre, but these in fact are approximate values, and should be interpreted as such.

Example: North Puget Landscape Habitat Assessment

The North Puget HCP planning unit is the largest planning area with over 457,000 acres of WDNR HCP lands. North Puget includes HCP designated NRF management areas (~110,000 acre) (24 percent), dispersal management areas (~15,000 acres) (3 percent), and over 331,000 acres that have no designated spotted owl role (72 percent). The North Puget landscape also include 220,000 acres of LTFC, including large areas conserved for marbled murrelets and Natural Resource Conservation Areas, and extensive areas of RMZs.

About 71 percent of the existing NRF habitat is in areas of LTFC, while 29 percent is within GM Lands (~23,000 acres). Because the designated NRF management landscape is currently below threshold for NRF, none of the existing NRF habitat in GM lands within the NRF area is available for harvest. Accounting for both habitat loss in GM lands, and habitat gains in LTFC and designated NRF management areas, we estimate that NRF habitat will increase from about 79,300 acres (17 percent) to approximately 133,800 acres (29 percent), a potential net gain of about 54,000 acres of NRF habitat by the end of 70-year HCP term in 2067 (Table 28).

To evaluate habitat losses and habitat gains in the context of mitigation, we calculated the difference between habitat losses and habitat gains and summarized the distribution of habitat gains vs. losses within NRF management areas and other HCP areas (Table 29). In North Puget, the estimated habitat that will be maintained or restored in NRF management areas (~55,000 acres) exceeds estimated habitat losses outside of NRF areas (~15,500 acres), and overall amounts of NRF habitat across the entire North Puget is projected to increase (Table 29).

Below are example tables that summarize estimated habitat losses and gains in the North Puget landscape (Table 28, Table 29). We produced similar tables for each landscape planning unit. These table are provided in Appendix E - *Assessment of Spotted Owl Habitat on WDNR HCP Lands.*

Table 28. North Puget landscape – assessment of estimated spotted owl habitat losses and gains.

HCP Mgmt.	WDNR HCP lands - 2023 (acres)	Long-term forest cover (LTFC) (acres)	50 % threshold for NRF or Dispersal	Existing NRF habitat (acres)	Existing NRF habitat in LTFC	Existing marginal habitat in LTFC	Existing NRF habitat in GM lands	Existing NRF habitat amount that exceeds 50% threshold	Existing NRF habitat available for harvest (GM lands outside of LTFC)	Estimated NRF habitat in 2067 (acres)
NRF Mgmt.	110,629	69,306	55,315	30,498	23,022	20,367	7,476	-24,817	0	55,315
Disp. Mgmt.	15,158	5,815	7,579	2,248	1,055	1,566	1,193	0	1,193	2,621
No owl role	331,469	145,346	0	46,640	32,287	43,631	14,353	0	14,353	75,917
Totals	**457,256**	**220,467**	**0**	**79,385**	**56,364**	**65,564**	**23,021**	**0**	**15,545**	**133,853**
Percent	100%	48%	14%	**17%**	71%	14%	29%	0%	**20%**	**29%**

Notes: Habitat is based on spotted owl habitat cover type models developed for the Northwest Forest Plan, and updated to 2023 conditions (Davis et al. 2022, USFS 2023).

Table 29. North Puget landscape – summary of estimated habitat gains and losses in spotted owl management areas.

HCP Mgmt.	WDNR HCP lands - 2023 (acres)	Existing NRF habitat (acres)	Current percent of land in NRF habitat	Estimated NRF habitat losses (acres)	Estimated NRF habitat gains (above existing baseline)	Difference (gains minus losses) (acres)	Estimated NRF habitat in 2067 (acres)	Percent of land in NRF in 2067
NRF Mgmt.	110,629	30,498	28%	0	24,817	+24,817	55,315	50%
Disp. Mgmt.	15,158	2,248	15%	1,193	374	-819	2,621	17%
No owl role	331,469	46,640	14%	14,353	29,278	+14,925	75,917	23%
Totals	**457,256**	**79,385**	**17%**	**15,545**	**54,468**	**+38,923**	**133,853**	**29%**

Notes: Habitat is based on spotted owl habitat cover type models developed for the Northwest Forest Plan, and updated to 2023 conditions (Davis et al. 2022, USFS 2023).

10.1.1 Estimates of Habitat Loss and Habitat Gains Across the WDNR HCP Landscape

At the scale of all HCP lands, we estimated approximately 93,000 acres of existing NRF habitat is located in GM lands with a potential for timber harvest over the next 4 decades. There is a projected net gain of 101,000 acres of NRF habitat across all areas over the same time period. Total NRF habitat is projected to increase from 19 percent of HCP lands to about 24 percent of HCP lands (Table 30).

Table 30. Summary of estimated NRF habitat loss and gains across all WDNR HCP lands.

HCP Unit	WDNR HCP lands - 2023 (acres)	Existing NRF habitat (acres)	Current percent of HCP lands in NRF habitat	Estimated NRF habitat losses (acres)	Estimated NRF habitat gains (above existing baseline) (acres)	Difference (gains minus losses)	Estimated NRF habitat in 2067	Percent of HCP lands in NRF in 2067
Chelan	17,340	2,605	15%	430	2,132	+1,702	4,736	27%
Columbia	288,442	64,099	22%	23,047	5,088	-17,959	69,187	24%
Klickitat	96,229	34,382	36%	13,020	0	-10,469	23,914	25%
North Puget	457,256	79,385	17%	15,545	54,468	+38,923	133,853	29%
OESF	273,053	112,427	41%	3,206	0	-3,206	109,221	40%
South Coast	260,716	14,970	6%	8,182	17,604	+9,422	32,574	12%
South Puget	178,130	21,945	12%	11,095	14,963	+3,868	36,908	21%
Straits	127,919	21,520	17%	9,389	5,127	-4,262	26,646	21%
Yakima	212,419	14,313	7%	9,177	15,489	+6,312	29,802	14%
Totals	**1,911,504**	**365,645**	**19%**	**-93,091**	**+101,196**	**+8,105**	**466,841**	**24%**

Note: Expected gains in NRF habitat that accrue from marginal habitat areas conserved in LTFC are not included in this table (refer to Table NSO 16, above for example). It is possible for losses to exceed gains, and still have a projected net increase in habitat by the end of the HCP due to marginal habitat within LTFC transitioning to NRF habitat.

10.1.2 Habitat Change in Westside Planning Units and OESF

NRF habitat gains are projected to exceed NRF losses in all Westside HCP units except the OESF. The OESF is currently projected to have 41 percent NRF and young forest marginal habitat, slightly exceeding the 40 percent landscape threshold. As noted in the *Environmental Baseline*, the distribution of NRF habitat in the OESF will shift over time as habitat develops in some SOMUs that are currently below threshold and is harvested in SOMUs that are above threshold. At the scale of the entire OESF, the net change in habitat is minor (~3,200 acres) and dispersed across a large landscape area.

Similar to the North Puget area, the total amount of estimated NRF habitat loss in the Columbia planning unit (~23,000 acres) is exceeded by the amount of NRF habitat maintained in the designated NRF management areas (~26,700 acres).

Most of the projected habitat loss in the Westside planning units (~49,800 acres) (74 percent) is located in landscapes with no designated spotted owl role (Table 31). Significant portions of the Columbia, South Puget, and North Puget planning units are located in the Western Washington Lowlands physiographic province, which was not prioritized for spotted owl conservation in the HCP. No habitat loss is projected in the designated NRF management areas from this broad-scale analysis. We acknowledge that there are two NRF management SOMUs in the Columbia planning unit that WDNR inventory indicates are above threshold (~4,200 acres) (Appendix E - *Estimates of Spotted Owl Habitat on WDNR HCP Lands*).

Table 31. Distribution of estimated habitat losses by spotted owl management designation in Westside HCP planning units.

HCP Mgmt.	**Columbia**	**North Puget**	**South Puget**	**South Coast**	**Straits**	**Total**	**Percent**
NRF Mgmt.	0	0	0	0	0	0	0
Disp. Mgmt.	8,095	1,193	8,103	0	0	17,390	**26%**
No owl role	14,952	14,353	2,992	8,182	9,389	49,868	**74%**
Totals	**23,047**	**15,545**	**11,095**	**8,182**	**9,389**	**67,259**	**100%**

10.1.3 Habitat Change in Eastside Planning Units

NRF habitat gains are projected to exceed NRF losses in the Chelan and Yakima planning units, with modest net increases in total NRF habitat projected in these areas (Table 30, above). Given the ongoing stressors associated with increasing risk of wildfire and climate change, there is a high level of uncertainty as to whether or not designated NRF areas will meet expected thresholds in these two units. If designated NRF areas are not subjected to large wildfires, the analysis indicates these NRF management areas currently have capability of meeting NRF habitat thresholds within the initial term of the HCP.

In the Klickitat planning area, existing NRF habitat is projected to decline from an estimated 36 percent (~34,300 acres) to 25 percent (23,900 acres), a net decline of about 10,400 acres (Table 32). The designated NRF management areas currently have 60 percent NRF habitat, exceeding the 50 percent landscape threshold required by the HCP. Existing NRF habitat located in designated DFC and Ponderosa Pine Desired Future Condition (PPDFC) areas is also expected to decline where NRF habitat occurs outside of LTFC areas. As described in the Klickitat HCP amendment, DFC areas with the appropriate vegetation series will be managed to provide for spotted owl dispersal (50 percent dispersal), and PPDFC areas will be managed for open canopy dry forest conditions, which is not expected to sustain spotted owl NRF or dispersal habitat over the long-term (WDNR 2004, pp. 11-14).

Table 32. Summary of expected habitat changes in the Klickitat planning area.

HCP Mgmt.	WDNR HCP lands - 2023 (acres)	Existing NRF habitat (acres)	Current percent of HCP lands in NRF	Estimated NRF habitat losses (acres)	Estimated NRF habitat gain (above existing baseline) (acres)	Difference (gains minus losses)	Estimated NRF habitat in 2067	Percent of HCP lands in NRF in 2067
NRF Mgmt.	39,346	23,711	60%	4,038	0	-4,038	19,673	50%
DFC	15,981	3,023	19%	2,554	0	-1,831	1,192	7%
PPDFC	15,976	3,039	19%	2,641	0	-2,081	958	6%
No owl role	24,926	4,609	18%	3,787	0	-2,519	2,091	8%
Totals	**96,229**	**34,382**	**36%**	**13,020**	**0**	-10,469	**23,914**	**25%**

Notes: Habitat is based on spotted owl habitat cover type models developed for the Northwest Forest Plan, and updated to 2023 conditions (Davis et al. 2022, USFS 2023).

As noted in the *Environmental Baseline*, the current high levels of NRF habitat in the Klickitat planning area is at high risk of loss to severe wildfire and climate change effects. Recent wildfires in the Klickitat area burned over 87,000 acres, including over 4,200 acres of WDNR HCP lands. The White Salmon, Trout Lake, and Little White Salmon areas are all recognized as high priority landscapes for wildfire risk reduction and resiliency treatments in both state and federal forest health initiatives (WDNR 2020b, pp15-20, USFS 2022, p.29).

It is reasonable to expect that WDNR HCP lands in the Klickitat planning unit (and all eastside units) will continue to be actively managed to reduce fire risk and increase forest resiliency. Given that the designated NRF area is currently above threshold, we expect that barring large wildfires, these landscapes will be managed to maintain the 50 percent NRF habitat thresholds for the remaining term of the HCP.

10.1.4 Wildfire and Climate Change

The climate change projections for changes in the East Cascades forest vegetation zones present a challenging future for maintaining spotted owl NRF habitat across much of the East Cascades landscape. Climate change is increasing wildfire risk and severity across the western Washington landscape as well. Up to this point, HCP strategies which call for maintaining 50 percent of specific landscapes in NRF or dispersal habitat offers WDNR flexibility in landscape management choices and provides some ability for the agency to adapt to natural disturbances such as wildfire events. If future wildfire events burn through large areas of HCP designated NRF landscapes, the USFWS and WDNR will need to address those changes through the HCP modification process as outlined in the HCP Implementation Agreement.

10.1.5 Rates of NRF Habitat Loss and NRF Habitat Gain

The HCP has no requirements related to the rate of timber harvest on HCP lands beyond normal requirements for sustainable harvest practices, and compliance with other relevant law and policy. As summarized in the *Description of the Proposed Action*, WDNR completed timber harvests on an average of about 15,900 acres per year across all HCP lands over the past 10 years. This total includes both regeneration harvests and various thinning treatments and represents an average of about 1.4 percent of GM lands harvested / thinned per year across all areas.

We have no reliable way to predict how much NRF habitat may be harvested in any given year or area. For this assessment we assume that areas of NRF habitat that are outside of LTFC and designated NRF management areas will be harvested commensurate with average timber harvest rates. We also assume that NRF habitat gains (existing marginal habitat areas in LTFC or NRF management areas) will transition into NRF habitat at a similar rate. This is a reasonable assumption, because many areas of marginal habitat likely already meet HCP definitions for "young forest marginal" habitat. Additionally, the analysis completed by Halofsky and Donato (2023) indicated similar rates of loss and gain of "structurally complex forest" over the first 18 years of HCP implementation.

As summarized above (Table 30), we estimated there is about 93,000 acres of existing NRF habitat that has the potential to be harvested over the remaining term of the HCP (43 years), and we estimate habitat gains of about 101,000 acres of NRF. If we divide these values by 43 years, we get an average loss of 2,163 acres of NRF per year, and an average gain 2,353 acres per year, with an overall net habitat gain of 186 acres per year across all HCP lands. This is a coarse generalization of the rate of habitat change. The only HCP units where NRF habitat is projected to be reduced from current levels is in the OESF (41 percent current, vs. 40 percent future), and the Klickitat unit (36 percent current, vs. 25 percent future). The estimated average rate of NRF habitat decline in the Klickitat unit equates to less than 1 percent per year.

10.1.6 Dispersal Habitat in Designated Spotted Owl Dispersal Landscapes

As summarized in the *Environmental Baseline*, most of the HCP designated dispersal or DFC areas are currently at or above thresholds for dispersal habitat. Barring major wildfire events, the current baseline of NRF and dispersal forests are sufficient to meet or exceed HCP thresholds for dispersal areas over the remaining term of the HCP. The locations of the dispersal management areas align with landscape recommendations and objectives to conserve spotted owl habitat on nonfederal lands in Washington within Spotted Owl Special Emphasis Areas designated under the Washington Forest Practices Rules (WAC 222-16-086).

There are two phases of spotted owl dispersal: transience and colonization (Miller et al. 1997, p. 140). The transience phase refers to rapid movements across the landscape such as dispersal away from a natal site. Habitat required for transience can include both NRF habitat or dispersal stands (i.e., young forest, or mid-seral forest stands with sufficient canopy cover to support owl movement) (Miller 1997, p. 145). Colonization refers to habitat areas used as temporary homerange by subadult or nonbreeding spotted owls that have not yet recruited into the breeding population. These non-resident birds are commonly referred to as “floaters.” Juvenile and submature spotted owls may spend 2 to 5 years as non-resident floaters before recruiting into territorial population (Forsman et al. 2002, p. 26). These nonresident floaters may occupy several different temporary territories before recruiting into the resident breeding population (Forsman et al. 2002, pp. 13-15). In addition to juvenile and submature floaters, there is increasing evidence that resident spotted owls are being displaced from their territories by barred owls (Jenkins et al. 2021, p. 12). Floaters generally rely on patches of NRF habitat for roosting and foraging, but these patches can be smaller and occur in more fragmented landscapes than those used by breeding spotted owls.

The HCP dispersal habitat designations and definitions align most closely with the transience phase of dispersal, and we expect these areas will continue to provide for movement of spotted owls across WDNR lands. The modified dispersal strategy in the South Puget landscape revised the HCP definitions for dispersal habitat, including definitions for movement habitat, and MoRF (WDNR 2009, pp. 2-4). The MoRF habitat definition provides for more complex forest structure, and includes features such as snags, down wood, and canopy layers, which are likely to provide better foraging conditions for spotted owls (Appendix B - *Spotted Owl Habitat Definitions*). The South Puget dispersal area (~78,000 acres) is by far the largest of the designated dispersal landscapes. The modified strategy includes an objective to restore or maintain 35 percent of the South Puget dispersal landscape as MoRF habitat.

In addition to dispersal habitat maintained in designated dispersal management areas, the amount of dispersal-capable forest will increase in areas of LTFC over the remaining term of the HCP, as areas that were previously harvested mature into mid-seral and mature forest stands. The completion of the marbled murrelet long-term strategy, the policy to protect old-growth stands, along with increased areas conserved in NAPs and NRCAs has substantially increased the amount of land conserved under the HCP since it was plan was originally signed in 1997. LTFC comprises 43 percent of the Westside planning units, and 53 percent of lands in the OESF. Designations of LTFC areas that conserve larger patches of NRF habitat (e.g., murrelet special habitat areas) provide important habitat areas to support the colonization phase of spotted owl dispersal. The projected increase in NRF habitat within LTFC over the remaining term of the HCP will contribute to maintaining dispersal habitat in areas with no designated spotted owl role.

10.1.7 Habitat Capacity to Support Spotted Owls

Habitat capacity is an index of the amount of habitat needed to support a pair of spotted owls. The values produced are estimates, based on species habitat relationships. There are various approaches to estimating habitat carrying capacity. In the *Summary of the Status of the Species*, we presented a summary of habitat capacity estimates that were developed from a landscape habitat capacity model (Glenn et al. 2017) for *the Draft EIS for the Barred Owl Management Strategy* (USFWS 2023, p.85). The capacity modelling was used to estimate the maximum potential habitat carrying capacity for spotted owl pairs across the range of the spotted owl and estimate current spotted owl population sizes based on observed demographic trends across the range of the species (USFWS 2023, p. 85). The values derived from this modeling process generated a high estimate of potential carrying capacity on WDNR lands (~265 pairs), excluding all WDNR lands located in Western Washington Lowlands province (~529,500 acres).

To assess capacity across all WDNR lands, we chose to apply a simple index to account for the average amount of spotted owl nesting roosting habitat in Washington generally recognized as the minimum required to sustain a spotted owl pair territory:

1. Olympic Peninsula: The minimum amount of habitat required for a spotted owl pair territory is 5,863 acres (40 percent of a 2.7-mile radius circle). Because neighboring spotted owl territories commonly overlap, we used a value equal to 75 percent of the total area required to support a territory ~ 4,400 acres.
2. Washington Cascades: The minimum amount of habitat required for a spotted owl pair territory is 2,605 acres (40 percent of a 1.8-mile radius circle). Because neighboring spotted owl territories commonly overlap, we used a value equal to 75 percent of the total area required to support a territory ~ 1,950 acres.

We applied these average rates to the amount of NRF habitat on WDNR HCP lands to calculate an index of potential habitat carrying capacity. These estimates are approximate, and do not account for habitat configuration or arrangement, or include habitat on adjacent federal or nonfederal lands (Table 33).

Table 33. Estimates of change in spotted owl carrying capacity on WDNR HCP lands.

HCP Unit	Existing NRF habitat (acres)	Existing habitat capacity (spotted owl pairs)	Estimated NRF habitat in 2067	Estimated future habitat capacity (spotted owl pairs)	Net change in habitat capacity (spotted owl pairs)	Average habitat area per pair (acres)
Chelan	2,605	1	4,736	2	+1	1,950
Columbia	64,099	33	69,187	35	+3	1,950
Klickitat	34,382	18	23,914	12	-5	1,950
North Puget	79,385	41	133,853	69	+28	1,950
OESF	112,427	26	109,221	25	-1	4,400
South Coast	14,970	3	32,574	7	+4	4,400
South Puget	21,945	11	36,908	19	+8	1,950
Straits	21,520	5	26,646	6	+1	4,400
Yakima	14,313	7	29,802	15	+8	1,950
Totals	**365,645**	**145**	**466,841**	**191**	**+46**	

In summary, habitat carrying capacity to support spotted owls is projected to increase from 145 sites to 191 sites, an increase of 32 percent over existing carrying capacity. This is not a population projection or a population estimate, just a simple estimate of habitat carrying capacity. Over the remaining term of the HCP, there will be a net increase in habitat carrying capacity in all HCP units except the OESF (-1) and Klickitat (-5). On the Olympic Peninsula, reduction in capacity in the OESF is potentially offset by a net increase in capacity in the Straits

(+1). In the East Cascades, reduction in capacity in the Klickitat (-5) is potentially offset by projected increases in the Chelan (+1) and Yakima (+8), barring major wildfire impacts. In the West Cascades, a substantial increase in habitat capacity is projected in the North Puget (+28) and South Puget (+8) landscapes.

10.2 Summary of Spotted Owl Habitat Losses and Gains

The amount of spotted owl habitat that existed on WDNR lands in 1997 was estimated at 484,700 acres, which represented about 11 percent of the estimated habitat in Washington at that time (USFWS 1997a, p. 47). The contemporary WDNR HCP as modified by the marbled murrelet long-term strategy, the policy that protects old-growth stands, and other deferrals is projected to maintain or restore NRF habitat across a larger area of the WDNR HCP lands than was originally estimated. Existing NRF habitat (~93,000 acres) will continue to be removed by HCP-covered timber harvest over the remaining term of the HCP (43 years). Over the same period, there is a projected net gain (~101,000 acres) in NRF habitat, indicating that habitat losses (impacts) will be replaced by habitat gains (mitigation) at the scale of the HCP lands. Habitat carrying capacity to support spotted owls on HCP lands will be maintained or restored at provincial scales, with losses in capacity in one portion of a province replaced by gains in other areas of the same province (e.g., Olympic Peninsula). Barring catastrophic habitat loss from wildfire or climate change, the HCP lands are projected to have over 466,000 acres of habitat at the end of the HCP term (2067), which is comparable to the estimated habitat that existed at the beginning of the HCP.

10.3 Effects to Designated Spotted Owl Critical Habitat

When determining whether an action is likely to adversely affect critical habitat, the effects of a proposed action should be evaluated at a scale that is relevant to the spotted owl life-history functions supplied by the PCEs of critical habitat (77 FR 71939). The PCEs identified in the revised spotted owl critical habitat rule include (1) forest types in early-, mid-, or late-seral stages that support the spotted owl across its geographic range; (2) nesting and roosting habitat; (3) foraging habitat; and (4) dispersal habitat (77 FR 72051-72052).

<u>Evaluation Criteria</u>

Spotted owl critical habitat is not designated on WDNR HCP-covered lands. However, there are many areas where WDNR managed lands border adjacent critical habitat located on federal lands. HCP-covered activities, including regeneration timber harvesting, may affect, and is likely to adversely affect spotted owl critical habitat due to edge effects.

Clearcut timber harvesting creates a high contrast edge along the boundary between the harvested areas and adjacent forested stands. Exposed clearcut edges alter light, moisture, and temperature gradients in adjacent old-forest stands for distances of up to 240 meters (787 feet) (Chen et al. 1993, p. 291, 1995, p. 74). We use a distance of 100 meters (328 feet) to account for the most significant physical and biological effects along clearcut boundaries due to the loss of individual trees to windthrow, reduced forest canopy cover, and altered forest composition (Chen et al. 1992, pp. 390-391, van Rooyen et al. 2011, p. 549).

The creation of edges, such as those associated with clearcut boundaries, has been shown to increase wind damage, as trees once protected by neighboring trees are now exposed to greater wind forces (Roberts et al. 2007, p. 285). Under certain environmental conditions, windthrow can be severe (Nowacki and Kramer 1998, p. 1). Windthrow usually occurs in the first few years after harvesting, particularly where more susceptible trees are exposed to stronger winds because of timber harvesting. Windthrow damage can extend into adjacent stands for hundreds of feet (Sinton et al. 2000, p. 2547), although most damage is usually concentrated within the first 30 to 60 feet of the cutting boundary edge (Strathers et al. 1994, p. 9). Lanquaye (2003, pp. 67-68) found that most windthrow damage (loss of trees) occurred within the first 25 meters (82 feet), but in some areas extended up to 75 meters (246 feet) into adjacent stands. In summary, the extent of windthrow damage is highly variable. We use a distance of 100 meters (328 feet) to evaluate potential edge effects but recognize that most significant windthrow damage is likely to occur at distances of 25 meters (82 feet) or less.

10.3.1 Effects to PCE 1 – Forest Types in Early-, Mid-, Or Late-Seral Stages That Support the Spotted Owl

As described above, we use a distance of 328 feet to account for the most significant effects to the PCEs of spotted owl critical habitat that are adjacent to WDNR-managed land where timber harvest or other forest removal activities may occur. Based on our proximity buffer, we estimate there are 12,100 acres of designated critical habitat adjacent to WDNR-managed lands (Table 34). Habitat exposed to edge effects are distributed along the perimeters of thirteen critical habitat subunits. Discounting 214 acres that are not capable of being spotted owl habitat, approximately 11,886 acres of forest types in PCE 1 are “habitat capable” of developing into dispersal or suitable nesting/roosting and foraging habitat or are currently in late-successional forest habitat. Natural forest types in PCE 1 include western hemlock *(Tsuga heterophylla),* western red cedar (*Thuja plicata*), Douglas-fir (*Pseudotsuga menziesii*), and ponderosa pine (*Pinus ponderosa*) plant associations.

Forest stands within the proximity buffer are likely to be degraded due to windthrow, breakage, or other edge effects associated with timber activities conducted on adjacent WDNR-managed lands. Apart from edge effects, no timber removal on federal land will occur. We anticipate that adverse effects to PCE 1 will be temporary and short-term (50-year) as young- and mid- seral stands are expected to regenerate and eventually develop into late-successional forest habitat. Given the HCP's spotted owl conservation strategy to restore and maintain habitat capable of supporting spotted owl populations and distribution on adjacent federal land, we expect effects to PCE 1 to be beneficial over the long-term (50-years). No effects are expected where PCE 1 are adjacent to LTFC areas.

Table 34. Summary of designated spotted owl critical habitat subunits and forest cover types[1] used to classify spotted owl habitat that are adjacent to WDNR HCP lands.

Critical Habitat Subunit	Total area in CHU subunit (acres)	Designated CH within 328 ft of WDNR HCP lands (acres)	Unsuitable	Marginal	Suitable	Highly Suitable	Not Habitat Capable	HCP Planning Unit
ECN 1	101,656	80	51	2	11	2	14	Chelan
ECN 2	60,087	35	28	2	2	0	3	
ECN 3	301,220	995	459	214	168	119	35	
ECN 4	223,282	468	212	109	63	82	2	Yakima
ECN 5	201,140	721	473	147	52	30	19	
ECN 6	81,842	553	86	181	84	202	0	Klickitat
NCO 1	293,469	1,961	534	766	272	378	11	OESF
NCO 2	213,697	1,694	372	702	350	257	12	Straits
WCC 1	225,272	886	213	193	138	342	0	S. Puget
WCC 2	279,420	171	56	54	48	11	2	Columbia
WCC 3	394,462	1,349	219	444	325	353	8	
WCN 1	438,247	2,850	636	667	743	738	66	N. Puget
WCN 2	103,899	336	119	63	68	45	41	
Totals	**2,917,693**	**12,100[2]**	**3,459**	**3,545**	**2,325**	**2,558**	**214**	

Notes:

1. Suitable and highly suitable categories represent forest types that typically support spotted owl nesting, roosting, and foraging, highly suitable habitat represents forest types that support nesting and roosting only, marginal habitat represents forest types that are approaching suitable nesting-roosting habitat and support dispersal, unsuitable habitat represents forest types that spotted owls typically avoid for nesting and roosting. Not habitat capable represent non-forested areas (Davis et al. 2022; USFS 2023).
2. Due to rounding errors associated with GIS, the acreage values reported here may differ slightly from values reported elsewhere. Spotted owl habitat estimates are approximate values derived from habitat maps developed for the NWFP 25-year monitoring report (Davis et al. 2022).
3. Spotted owl critical habitat as designated November 10, 2021 (86 FR 62606).

10.3.2 Effects to PCE 2 – Nesting and Roosting Habitat

Based on our proximity buffer, we estimate there are 4,883 acres of potential spotted owl nesting/roosting and foraging habitat (i.e., suitable, and highly suitable habitat) that will be exposed to edge effects from timber harvest occurring adjacent to suitable spotted owl habitat stands. We anticipate that windthrow will adversely affect PCE 2 through habitat degradation due to the loss of overstory canopy cover from a reduction in the number of large diameter trees and breakage. The extent of wind damage and increased tree mortality from drought stress may be exacerbated over the 50-years from climate change. Considering these effects spread across the 4,883 acres, we anticipate that windthrow will result in altered forest composition and structure that is associated with spotted owl nesting/roosting habitat and are likely to primarily occur within the West Cascades North and West Cascade Central subunits where it is a known disturbance. Where windthrow does occur in the action area, effects to PCE 2 will be most likely and most noticeable within 25 meters (80 feet) of timber harvest edges; however, some adverse effects may extend up to 328 feet. As forest stands regenerate over time, we expect that windthrow effects are likely to diminish and will become more difficult to detect over a 50-year period. Habitat that is adjacent to areas in LTFC are not expected to be affected due to the existing conservation commitments under the 1997 HCP.

10.3.3 Effects to PCE 3 –Foraging Habitat

We estimate that 2,325 acres within 328 feet of WDNR-managed lands contain potential spotted owl foraging habitat (i.e., suitable habitat in Table 34, above). Adverse effects described to PCE 2 above also apply to PCE 3. However, foraging habitats are anticipated to retain many of the forest structures and features necessary to maintain their function of providing prey for spotted owls (e.g., fallen trees, downed woody debris). Recovery of the foraging function is also anticipated to be more rapid than the degradation of suitable nesting/roosting habitat.

10.3.4 Effects to PCE 4 – Dispersal Habitat

We estimate that there are approximately 3,545 acres of potential dispersal habitat within the proximity buffer (PCE 4) (i.e., marginal habitat in Table 34, above). We expect that the habitat will be impacted by windthrow effects associated with timber activities on WDNR-managed lands. However, we do not expect that losses in the number of trees will cause a reduction in overstory canopy cover below 40 percent or result in the degradation of PCE 4. Because spotted owls do not rely on overstory canopy cover in dispersal habitat and may use adjacent habitat for dispersal, any impacts to PCE 4 from windthrow effects will be insignificant. We do not expect that effects to PCE 4 will alter the capability of critical habitat subunits to support the movement of spotted owls across the landscape.

10.3.5 Summary of Effects to Designated Spotted Owl Critical Habitat

Critical habitat subunits in Washington encompass over 2.95 million acres in 4 CHUs. Habitat degradation of an estimated 4,883 acres located within 328 ft of WDNR-managed lands is considered an adverse effect to critical habitat due to the reduction in the number of large diameter trees, loss in overstory canopy cover, and altered forest composition and structure associated with spotted owl nesting / roosting and foraging habitat. In the context of forest successional processes, effects to PCE 1, PCE 2, and PCE 3 are expected to be short-term (50-years) and temporary because as forested stands regenerate, we expect that edge effects will rapidly diminish and over a 50-year period become difficult to detect. The affected stands are broadly distributed along the boundaries of thirteen affected critical habitat subunits and represents a cumulative total of about 0.11 percent of the current estimated nesting/roosting and foraging habitat within spotted owl designated critical habitat range-wide. Critical habitat that is adjacent to areas in LTFC are not expected to be affected by HCP covered activities because these areas are being conserved by the HCP. Due to the limited acres adversely effected and the dispersed nature of effects along the boundary of several critical habitat subunits, windthrow effects will not reduce the capability of the subunits to support spotted owl reproduction, connectivity, or recovery at the scale of the critical habitat subunit, the critical habitat unit, or range wide. The conservation role of critical habitat to provide for well-distributed and inter-connected spotted owl nesting populations will not be significantly reduced by the effects of covered activities on WDNR-managed lands.

10.4 Effects Analysis Part II: Effects to Spotted Owls

Continued implementation of the HCP is likely to result in negative effects to spotted owls from covered activities, such as timber harvesting and road construction in areas where habitat occupied by spotted owls is removed or degraded through timber harvesting. HCP implementation will also result in beneficial effects to long-term spotted owl conservation by maintaining or increasing habitat capacity on lands adjacent to federal reserves in key locations, and by actively managing forests in high-risk landscapes to reduce the risk of catastrophic wildfire and improve forest health and resiliency for drought and climate change.

Timber harvesting, road construction, and other forest management activities can result in both direct and indirect effects to spotted owls. These effects can include the direct loss of nesting and foraging habitat, disruption of nesting and foraging behaviors from disturbance, displacement from established territories, and potential for direct injury or mortality of eggs or chicks. Habitat effects can also include reductions in landscape capacity to spotted owl dispersal and demographic support. All of these effects were evaluated by the USFWS in our original assessment of the HCP (USFWS 1997a, pp. 59-87).

10.4.1 Background Information - Effects of Habitat Loss to Spotted Owls

Timber harvest can directly affect spotted owls by reducing the total amount of suitable NRF habitat within a spotted owl's home range. The result may be that the spotted owls continue to persist at the territory, but marginal habitat conditions in the territory compromise the spotted owls' ability to survive and successfully reproduce. In areas with extensive habitat loss (whether from timber harvest, wildfire, or other disturbance), spotted owls will eventually abandon a territory, or succumb to starvation or predation (Forsman et al. 1984, p. 18, Rockweit et al 2017, p. 1579). Habitat loss reduces spotted owl access to primary prey species such as northern flying squirrels. Flying squirrels naturally occur at low densities and are closely associated with closed-canopy forests (Wilson and Forsman 2013, p. 81). Forest management that removes closed canopy forest reduces flying squirrel populations, and these effects can persist for many years (Wilson and Forsman 2013, p. 79). Habitat loss within the home range also increases the potential for negative competitive interactions with barred owls, which also prey on the same species as spotted owls (Dugger et al. 2011, p. 2459. Wiens et al. 2014, p. 24).

Spotted owls in Washington use large annual home range areas that vary from less than 3,000 to more than 30,000 acres (Hanson et al. 1993, p. 19). Home range areas encompass all forest types, but the size of a spotted owl home ranges decreases with increasing amounts of available NRF habitat in the surrounding landscape (Forman et al. 2005, pp. 373-374). Because the actual configuration of a home range is rarely known, a circle centered on a spotted owl activity center is used to identify the area approximating the median annual home range. The median annual home range for a spotted owl pair on the Olympic Peninsula is represented by a 2.7-mile radius circle (USFWS 1990, p. 11; 1993, p. 1). In the Washington Cascades, a 1.8-mile radius circle is used for this purpose. Within the annual home range there is a core area of concentrated habitat use during the nesting season (Bingham and Noon 1997, p. 129). Prior to the onset of barred owls, spotted owl monitoring indicated that established spotted owl territories were fairly stable, and that some territories may be occupied by different pairs of spotted owls over many years (Forsman et al. 1984, p. 19). The actual nest-tree used within a territory may change from year to year, but alternate nest trees are usually located within the same general core area. In the Washington Cascades, a 0.7-mile radius circle has been used to represent spotted owl core areas. On the Olympic Peninsula, core use areas encompass a 1.4-mile radius around an established activity center (Forsman et al. 2005, p. 370).

Habitat loss from forest management that significantly reduces the total amount of available NRF habitat within a spotted owl's home-range is considered by the USFWS to represent a significant habitat modification that impairs essential behaviors, including spotted owl breeding, feeding, or sheltering (i.e., incidental take). The USFWS uses minimum habitat thresholds for suitable NRF habitat (e.g., ≥ 40 percent NRF habitat within the median home range circle, and ≥ 50 percent suitable habitat within a spotted owl core area) as tool to evaluate the effects of forest management on spotted owls (USFWS 1990, p. 11; 1993, p. 1). These same values are applied in the Washington Forest Practices rules for the protection of spotted owl habitat in designated Spotted Owl Special Emphasis Areas (WAC-222-041).

The 40 percent suitable habitat threshold is a guideline that the USFWS employs for analysis purposes and is not an absolute indicator of territory viability. Bart and Forsman (1992, p. 98) found that spotted owls in some landscapes were capable of reproducing in areas with as little as 20 percent suitable habitat within the home range. However, annual survival rates for spotted owls decline significantly when suitable NRF habitat is less than 20 percent at the core-area scale (Dugger et al. 2005, p. 874). Sites with more NRF habitat are more likely to remain occupied or become colonized by spotted owls, and have higher nesting productivity (Dugger et al. 2016, pp. 96-97). In the absence of barred owls, the amount of old forest habitat at the core of spotted owl home ranges most strongly influences the probability of spotted owl occupancy over time (Dugger et al. 2011, p. 2463). The likelihood that a site would be abandoned by spotted owls increases with decreasing amounts of old forest at the core, and this effect is compounded where barred owls are detected indicating that as suitable habitat decreases within a home-range, the likelihood for negative competitive interactions between the two species increases (Dugger et al. 2011, p. 2463).

Felling of suitable NRF habitat during the nesting season also creates a potential risk of direct injury or mortality to spotted owl nestlings or eggs (e.g., an undocumented nest could be felled, or a felled tree could strike an adjacent tree with a nest). In extreme cases, tree felling can result in direct mortality of spotted owls. Such cases are rare, but direct mortality due to timber felling has been documented (Forsman et al. 2002, p. 18).

In summary, if a forest management action results in the removal of NRF habitat within an occupied spotted owl management circle to less than 40 percent within the home range, or to less than 50 percent of NRF habitat within a core area, the USFWS concludes that the action is a significant habitat modification that is reasonably certain to result in incidental take of spotted owls. If a spotted owl management circle is below these thresholds, but is still occupied by spotted owls, any additional removal of NRF habitat within the circle is considered incidental take.

Background Information on Disturbance Effects

In addition to effects of habitat loss or degradation, the noise and activity associated with timber harvest, road construction, and other forest management actions can disrupt normal spotted owl behaviors such as incubation or feeding of young. In prior analyses of disturbance effects to spotted owls, we concluded that significant disturbance (disruption of nesting behaviors) can occur when noise or project activity occurs within close proximity (e.g., from 65 yards to 0.25 mile depending on the activity) to an active spotted owl nest during the early nesting season (March 1 to July 15) (USFWS 2020, pp. 96-99). Early nesting season behavior includes nest site selection, egg laying, incubation, and brooding of nestlings to the point of fledging (Forsman et al. 1984, pp. 32-38).

Noise and visual disturbance can disrupt normal spotted owl behaviors by causing spotted owls to flush from a nest or roost (Delaney et al. 1999, p.67, Delaney and Grubb 2003, p. 22, U.S. Air Force 2012, App. F., p. 4-17). Disturbance can also result in physiological effects, including increased levels of stress-related hormones including glucocorticoids (GCs) and corticosterone (Hayward et al. 2011; Temple and Guttierez 2004; Wasser et al. 1997). While there is some evidence that exposure to road traffic or nearby logging activity can result in short-term increased levels of GCs in spotted owls, the response of individuals varied widely by sex, breeding status, and time of year (Hayward et al. 2011, p. 7, Temple and Guttierez 2004, pp. 544-545, Wasser et al. 1997, p. 1021). GC levels in spotted owls vary over the course of the nesting season, being highest in males early in the breeding cycle, and highest in females when nestlings are fledging, and decreasing in both sexes after young have fledged (Wasser et al. 2005, p. 131). While physiological stress responses are not well understood, disturbance that occurs during the early portion of the nesting cycles poses a greater risk for negative physiological responses (Wasser et al. 2005, p. 134).

In summary, forest management actions, and other related activities introduce increased levels of noise and human activity into the environment. If these activities occur near an active spotted owl nest during the early nesting season, the USFWS is reasonably certain such activities can disrupt normal nesting behaviors, resulting in incidental take due to risk of reduced hatching success, reduced fitness of individuals, or reduced survival of nestlings.

10.5 Summary of the Effects to Spotted Owls as Evaluated in 1997

The following section is a summary of the analysis of effects to spotted owls completed for the 1997 HCP (USFWS 1997a). We provide this summary in the context of reviewing the effects of the HCP that have already occurred over the past 27 years of HCP implementation, and to provide context for the analysis of the effects of continued implementation of the HCP.

10.5.1 Estimates of Spotted Owl Incidental Take - 1997

In our prior analysis of the HCP, we anticipated that individual spotted owls would be directly affected by loss of NRF habitat within territories, exposed to disturbance effects, and acknowledged the risk for direct mortality of eggs or young if an active nest site was harvested during the breeding season (USFWS 1997a, p. 69). Of the 283 known sites with spotted owl management circles that overlapped with WDNR lands, 148 sites (52 percent) were anticipated to be subject to incidental take from habitat loss and disturbance associated with WDNR timber harvest and related forest practices. Spotted owl sites not subjected to incidental take included spotted owl management circles that had minor ownership overlap or minimal habitat located on WDNR lands. This included many sites on adjacent federal lands, where the majority of the existing NRF habitat in the spotted owl circles was located on federal lands (USFWS 1997a, p. 83).

In addition to known spotted owl sites, the USFWS estimated incidental take for projected unknown sites that could occur on or adjacent to WDNR managed lands over the 70-year life of the HCP. This estimation included 51 projected sites within westside planning units, and 52 projected sites within the eastside planning units (USFWS 1997a, p. 129). The USFWS also anticipated incidental take of spotted owls associated with disturbance from both timber harvest (26,675 acres per year) and non-timber related actions (e.g., quarries, road use permits, recreation) (1,060 acres per year) (USFWS 1997a, p. 129). These estimates were based in part on an assumption that WDNR would conduct timber harvest (regeneration harvest and thinning) on an average of 50,000 acres per year (USFWS 1997a, p. 84). The USFWS anticipated that most spotted owl sites located outside of designated NRF management areas would receive no protections. These sites were not expected to remain occupied beyond the first 10 years of HCP implementation (USFWS 1997a, p. 67). There is no HCP requirement for spotted owl surveys, so there was an expectation that some occupied nest patches would be harvested, resulting in the direct killing of a limited number of spotted owl eggs or young.

10.5.2 Effects to Spotted Owl Distribution - 1997

The distribution of spotted owls in Washington was expected to decrease as habitat outside of designated NRF management areas was harvested. The decrease in spotted owl distribution was anticipated in the peripheral areas of the spotted owls' range in Washington (e.g., southwest Washington, eastern portions of the East Cascades). Within designated NRF management areas, about half of the existing spotted owl territories were expected to be lost due to timber harvest. Conservation measures to protect designated nest patches in Westside areas, along with HCP commitments that maintained or restored up to 50 percent of these areas in NRF habitat was expected to continue to provide demographic support for spotted owl pairs in on or near federal reserves conserved under the Northwest Forest Plan (USFWS 1997a, p. 71). Spotted owl habitat was expected to decline significantly on WDNR outside of NRF management areas but was expected to be maintained or increase within NRF management areas, and within certain watersheds within the OESF that were below target thresholds for old forest and owl habitat.

10.5.3 Conservation Role of the HCP for Spotted Owls - 1997

The primary expectation behind the spotted owl conservation strategy in 1997 was that it would be implemented in concert with the Northwest Forest Plan over a period of 100 years, and that the demographics of the spotted owl population located on federal lands would be supported by NRF habitat maintained in HCP designated NRF management areas. Designated dispersal areas were expected to provide connectivity to allow for movement of spotted owls between federal reserves (USFWS 1997a, p.71, p. 80). These strategies in concert with habitat conservation in federal reserves was expected to provide for the conservation and recovery of the spotted owl over a period of 100 years. The mitigation value of the HCP spotted owl conservation was expected to increase over the life of the HCP as habitat conditions in NRF management areas and in the OESF improved along with increasing habitat within federal reserves. In 1997, the USFWS reported that WDNR lands supported 8 percent of known spotted owl sites in Washington, and about 11 percent of the estimated NRF habitat in the state, while over 80 percent of known spotted owl sites, and over 65 percent of the estimated habitat in the Washington was located on federal lands (USFWS 1997a, pp. 46-47). Based on the distribution of owls and owl habitat, and the expectations about the conservation role of the Northwest Forest Plan, the USFWS concluded that the HCP strategy was not likely to jeopardize the spotted owl (USFWS 1997a, p.127).

The expectation in 1997 was that spotted owl habitat within federal reserves would gradually increase over time, providing the primary support for spotted owl conservation and recovery in Washington. Spotted owl populations on federal lands managed under the Northwest Forest Plan were projected to continue declining for up to 50-60 years, and then eventually stabilize as younger second-growth forest in reserves matured into suitable habitat. The assumption that the spotted owl population would continue to decline under the Northwest Forest Plan was based on the spotted owl demographic projections available at the time, and the recognition that populations would continue to be affected by habitat loss both within lands managed under the Northwest Forest Plan, and on nonfederal lands. The expectations about spotted owl population decline and eventual stabilization under the Northwest Forest Plan did not account for the effects of barred owls (Lesmeister et al., 2018), or the effects of climate change and increasing risk for large, catastrophic wildfires across the range of the spotted owl (Gaines et al., 2022).

10.5.4 Protection of Habitat in Status 1 Spotted Owl Management Circles

In hindsight, it is clear now that the number of occupied spotted owl territories (~148 sites) estimated to have incidental take in the first decades of HCP implementation was overestimated. To be clear, the estimated number of spotted owl sites was accurate, based on the best information available at that time. However, the number of occupied territories was rapidly declining, so many sites with anticipated incidental take would have been abandoned by spotted owls before they were affected by HCP-covered timber harvest. For example, spotted owl occupancy was already rapidly declining due to barred owls (e.g., by 2006, there were only 3 occupied territories remaining in the Columbia NRF management area out of the original 24 sites, with almost no loss of existing habitat in the NRF management areas (WDNR 2007b). Additionally, WDNR implemented a policy decision (WDNR 1999), and later, a Settlement Agreement (WDNR et al. 2006) to protect NRF habitat within many Status 1 spotted owl management circles (both within and outside of NRF management areas). The 1999 policy and the Settlement Agreement remained in effect in the Westside planning units from 1999 to 2019, reducing timber harvest impacts, and protecting existing NRF habitat in many spotted owl management circles that were originally estimated to be subject to harvest under the terms of the HCP.

The policy to protect habitat in Status 1 spotted owl circles was suspended in the Westside units in 2019 with the completion of the *FEIS for the Establishment of a Sustainable Harvest Level Western Washington* (WDNR 2019a, p. 4-30). The 1999 policy to protect habitat in Status 1 spotted owl territories continues to remain in effect in the East Cascades HCP units. However, WDNR is now proposing to discontinue this policy, and revert to just implementing the HCP conservation strategy to better address forest health and fire risk issues in the region (WDNR 2023b, pp. 11-12). A final WDNR agency decision on this policy is expected in late 2024, or early 2025 and will be included in an EIS for evaluating sustainable harvest levels in the eastern Washington (WDNR 2023a, p.21). With spotted owl occupancy now estimated to be as low as 5 percent for historic sites and with most occupied sites expected to be located on federal lands, the likelihood that WDNR's policy change will directly affect occupied spotted owl territories is very low, but not entirely discountable.

10.6 Effects of Continued Implementation of the HCP to Spotted Owls

The effects of continued HCP implementation to individual spotted owls (e.g., loss of habitat, reduced survival and reproduction) is the same as the effects previously described in 1997, however, these effects are magnified due to barred owl competition. Where local habitat is reduced by harvest or natural disturbance, the loss of habitat increases the probability of negative competitive interactions between the two species, but the ultimate outcome remains the same, individual spotted owls affected by habitat loss are likely to experience reduced annual survival rates and reduced reproductive success. Unless all habitat within a territory is lost at once (e.g., wildfire), the affected spotted owls are likely to persist at the territory until they eventually succumb to the pressures of reduced habitat (e.g., Rockweit et al. 2017); or, they are forced to abandon their territory and either die of starvation (e.g., NCASI., 2010), or become non-breeding floaters (e.g. Jenkins et al 2019). While any reduction in the available habitat within a spotted owl territory has the potential to increase these negative outcomes, there are no new thresholds for habitat management. Where known occupied territories exist, the USFWS continues to recommend maintaining habitat within spotted owl management circles at or above previously established thresholds (USFWS 2011, III-4). Additionally, the USFWS recommends maintaining existing high-quality NRF habitat on the landscape wherever it occurs (USFWS 2011, III-67).

As described above, the effects of forest management on individual spotted owls (e.g., habitat loss) are the same as previously considered. However, because the spotted owl population in Washington has declined to low levels, the effects of forest management to remaining spotted owl populations may be greater than what was previously considered in 1997.

10.6.1 Spotted Owl Management Circles

As presented in the *Environment Baseline*, there are 295 historic spotted owl management circles that have some overlap with WDNR HCP lands (1 acre or greater). Due to the rapid decline of spotted owls in Washington from the effects of competition with barred owls, we estimate that only 15 of these sites (5 percent) are likely to be currently occupied with spotted owl pairs, and most of the remaining occupied territories are likely to have activity centers located on adjacent federal lands (Table 19, above).

Due to the low occupancy rates of spotted owls in Washington, we chose not to conduct an analysis of NRF habitat levels within spotted owl management circles. Because there has been limited spotted owl survey effort in Washington, we have almost no current information on where active spotted owl sites are located. The most recent spotted owl occupancy data documented in the WDFW database is from 2018. While it was once reasonable to assume that sites occupied within the past 10 years could still be occupied, that is no longer a reasonable assumption given the rapid rate of spotted owl decline in Washington. Surveys in federal demographic study areas were discontinued in 2018, with a transition to passive monitoring with ARUs (Lesmeister 2022). While this data has indicated low levels of spotted owl occupancy in certain areas, this information is generally not available for land managers in a timely manner to inform management decisions.

Barring extensive habitat loss from wildfire or harvest, habitat amounts are no longer a reliable indicator for spotted owl occupancy in spotted owl management circles, because there are many examples of spotted owl sites in the demographic study areas where there are high levels of suitable habitat, but spotted owls were displaced from these areas by barred owls (Mangan et al 2019, p. 20). Conversely, there is also evidence that spotted owls have been displaced from suitable NRF habitat into areas of marginal habitat located at higher elevations (Gremel 2015), on steep slopes (Jenkins et al. 2019), or on the margins of the species range in dry forest habitats less favored by barred owls (Singleton 2015).

Alternatively, landscape carrying capacity models (e.g., Glenn et al. 2017) can be used to predict a potential number of spotted owl sites for a specific area. If a model predicts habitat capacity of for 100 pair sites, but we know the occupancy rate is only 5 percent, there would reasonably be only 5 occupied territories out of a potential of 100. However, without spotted owl surveys, there is no reliable way of identifying where the occupied habitat is located. The utility of this type of modelling is to evaluate potential changes in habitat capacity, such models are not reliable for identifying specific locations where individual spotted owls are likely to be affected by site-specific forest management actions. Recognizing these limitations, we chose to use the estimated number of occupied spotted owl pair sites on WDNR HCP lands from the statewide capacity analysis (17 pairs) (Table 16, above), to evaluate the effects of continued HCP implementation.

10.6.2 Estimating Effects to Spotted Owl Numbers and Reproduction in Washington

To estimate the effect of ongoing WDNR forest management to the remaining spotted owl populations in Washington, we used a simple deterministic model that used the average demographic rates documented for the West Cascades to represent the baseline rate of population change in Washington, assuming no future barred owl management (Franklin et al 2021, USFWS 2023, p.91).

To estimate the potential effects of ongoing HCP implementation, we assumed that spotted owls in territories affected by forest management have a 5 percent reduction in annual survival rates for adults and a 5 percent reduction in annual fecundity (reproduction). These assumptions are based on past research that determined that survival rates for spotted owls decline with decreasing amounts of NRF habitat within their core areas (e.g., Wiens et al, 2014, p. 29, Dugger et al. 2005, p. 874). Habitat influence on reproduction rates is not consistently associated with the amount of NRF habitat in core areas, but reproduction is negatively affected by competition with barred owls (Rockwiet et al. 2023, p.19). We note that there are no specific thresholds for the relationship between habitat amounts and spotted owl demographic rates in the published literature – these values are typically presented graphically as asymptotic curves that increase or decrease with the amount of NRF habitat within a spotted owl core area (e.g., Dugger et al. 2005, p. 875). Applying a 5 percent reduction in annual survival and fecundity is a reasonable assumption to reflect these relationships.

As noted above, we chose to use the estimated number of occupied spotted owl pair sites on WDNR HCP lands from the statewide capacity analysis (17 pairs) (Table 16, above), to evaluate the effects of continued HCP implementation. In this assessment, we assume 66 percent of current occupied pair sites (11 pair territories) are in NRF management areas, or on adjacent federal lands with only minor overlap with WDNR general forest management. This value (66 percent) is derived from the estimates of existing spotted owl NRF habitat located within NRF management areas or other HCP deferrals (Table 23, above). We assume that 34 percent (6 pair sites) of the estimated pair sites are located in areas that will be subject to timber harvesting at sufficient levels to affect annual survival and reproduction within the next 10 years (Table 35).

Table 35. A comparison of projected spotted owl population sizes on the WDNR HCP-covered lands with and without forest management effects.

Management Scenario	Estimated number of spotted owl pairs in 2023	Estimated pairs in 10 years (2033)	Estimated pairs in 20 years (2043)	Estimated pairs in 30 years (2053)
Baseline spotted owl population trend with no land management effects.: This scenario assumes all pairs have an average survival rate of 0.877 and an annual fecundity rate of 0.502	17	9	5	3
Estimated HCP land management effects: 5 % reduction in annual survival and fecundity for 6 owl pairs over 10 years: This scenario assumes that 6 out of 17 total pairs in the starting population have 5% reduced survival (0.833) and fecundity (0.477), while the remaining 11 pairs have the baseline demographic rates.	17	8	4	2

Notes: Both scenarios apply the baseline demographic values documented for the Western Washington Cascades (Franklin et al. 2021, USFWS 2023, p. 91).

When we project the baseline rate of spotted owl population decline with no additional land management effects, the population on WDNR HCP-covered lands declines from 17 pairs to 9 pairs within 10 years due to the negative effects of barred owl competition. With assumed HCP land management effects, the population remaining in 10 years is 8 pairs, due to the assumed slight decrease in annual survival rates for the adult spotted owls in affected territories. Without barred owl management, the Washington spotted owl population is projected to decline from 126 pairs in 2023, to 62 pairs within 10 years (2033) (Table 18, above). If we add in the estimated effects of continued HCP implementation, the projected spotted owl population in Washington in 10 years is 61 pairs (-2 percent difference).

As noted in the *Status of the Species*, the estimated spotted owl population remaining in Washington now represents approximately 4 percent of the range-wide population (Table 12, above). The range-wide population is currently estimated at over 3,500 hundred pairs, indicating the species still has potential for long-term recovery through implementation of barred owl management and habitat conservation efforts.

The estimates presented above are based on the current distribution of spotted owl NRF habitat on the HCP-covered lands. Most NRF habitat that is potentially available for harvesting is located on lands with no spotted owl conservation role under the HCP. Remaining habitat in these areas is highly fragmented and has a low likelihood of spotted owl occupancy. On average, WDNR conducts timber harvest on less than 1 percent of the HCP lands per year (~15,600 acres on average, all harvest types) and individual harvest units in any given year are dispersed across a broad landscape of over 1.9 million acres. Additionally, we expect that most of the remaining occupied territories are likely to be located on federal lands with little to no influence from WDNR land management.

We completed this analysis to estimate the effects of ongoing HCP implementation to the remaining spotted owl population in Washington. As stated above, the analysis is a simple estimate that assumes a consistent rate of population decline across the entire period and does not represent the complexities of small population dynamics. The conclusion we draw from this assessment is that the ongoing impacts of barred owl competition on the spotted owl population in Washington are so severe and pervasive, that the effects of WDNR forest management are nearly immeasurable against the baseline rate of spotted owl population decline.

10.6.3 Effects of Forest Management to Non-Resident Spotted Owls

The number of non-resident spotted owls (floaters) remaining in the Washington population is unknown. Past assessments of spotted owl survival and recruitment indicate that about 10 percent of juvenile spotted owls fledged each year survive to eventually recruit into the resident population of breeding pairs (Glenn et al. 2010). In addition to subadults, there is an increasing portion of adult spotted owls that have been displaced from the resident population by barred owls (Jenkins et al 2019). If we assume that the non-resident population is 10 to 20 percent of the resident pair population (126 pairs), there would be approximately 26 to 50 non-resident spotted owls in Washington. We expect that non-resident spotted owls are associated with the general distribution of NRF habitat. WDNR currently manages about 9 percent of the NRF habitat in Washington, so the number of non-resident owls on WDNR lands is likely on the order of 2 to 5 owls.

Similar to resident pairs, the effects of NRF habitat removal to non-resident owls include reduced access to prey, displacement from colonization NRF habitat patches, and increased risk of competitive interactions with barred owls. These types of effects can represent a significant habitat modification that impairs essential behaviors such as feeding and sheltering for affected individuals. While we recognize these are potential effects, we lack the ability to quantify these effects beyond simple estimates of decreases or increases in NRF habitat areas across the WDNR landscape. As noted in the previous analysis on habitat losses and gains, we expect there will be both declines and increases in NRF habitat over the remaining term of the HCP, with expected net gains in NRF habitat in most landscapes. Given the current low density of non-resident spotted owls on the landscape, and the rapidly declining resident population, effects of forest management (e.g., disruption of essential feeding or sheltering) to non-resident spotted owls is not reasonably certain to occur.

10.6.4 Effects of Removal of Unoccupied Habitat

Habitat loss in historic spotted owl territories that were previously occupied reduces the total available NRF habitat within the territory to support future colonization of the site by territorial spotted owls. In the absence of landscape-scale conservation plans to provide for spotted owls, the USFWS continues to recommend the protection of habitat within historic sites to allow for the potential for spotted owl recolonization of these areas, along with the protection of existing high-quality habitat (USFWS 2011). Because the WDNR owl conservation strategy is a landscape-scale conservation plan, the USFWS determined in 1997 that the HCP was likely to provide support to spotted owl conservation and recovery efforts on adjacent federal lands without a mandate to maintain habitat in spotted owl management circles.

With the decline of the spotted owl in Washington, there are now large landscape areas that are no longer occupied by the species, illustrating the importance of long-term conservations plans like the WDNR HCP to provide for the conservation of spotted owl habitat regardless of species occupancy. In the absence of an HCP or other regulatory mechanism (e.g., Forest Practices rules for SOSEAs), unoccupied spotted owl habitat can be harvested. Because these habitats are not occupied, there are no effects to individual spotted owls that would conform to the USFWS's regulatory definitions of incidental take.

The long-term effect of the loss of unoccupied habitat is the reduction in the historic range and distribution of the species, and a reduction in habitat area to support future spotted owl conservation and recovery. In the 1997 opinion, the USFWS anticipated there would be a reduction in the species habitat and distribution due to habitat loss outside of designated NRF management areas. Those predictions were accurate, as there has been a substantial reduction in habitat on nonfederal lands in the Western Washington Lowlands province (Davis et al 2022, p. 31). Extensive habitat loss and the effects of barred owl competition have led to the presumed extirpation of spotted owls from the southwest Washington landscape (west of I-5). Based on the lack of federal lands in this landscape, there are currently no expectations that these lands are essential for the conservation and recovery of the species – this area is not included in alternatives considered for barred owl management (USFWS 2023).

The loss of unoccupied NRF habitat can reduce the recovery potential for spotted owls if the loss occurs in landscapes that are essential for spotted owl conservation and recovery (e.g., federal lands managed under the Northwest Forest Plan, and certain nonfederal lands in areas that lack federal lands). This is the basis for the USFWS's recommendations to maintain high-quality spotted owl habitat (USFWS 2011). Continued implementation of the HCP will result in the loss of unoccupied NRF habitat. However, the WDNR policy that protects all old-growth stands will provide substantial protection for high-quality NRF habitat, wherever it occurs, and as described in the previous sections, we estimated that current conservation deferrals and strategies will maintain about 75 percent of existing NRF habitat.

The HCP commitments to maintain or restore spotted owl NRF habitat in key geographic locations in the Washington Cascades and on the Olympic Peninsula, regardless of species occupancy, will continue to be critical to supporting spotted owl recovery efforts in Washington.

10.7 Summary of the Effects to Spotted Owls

Continued implementation of the HCP has the potential to affect a maximum of about 13 percent of the remaining spotted owl population in Washington (17 pairs out of a total of 126 pairs). Because most of the spotted owl habitat remaining on the HCP-covered lands is in HCP conservation areas, we estimate that up to 6 pairs sites may be subject to timber harvesting over the next 10 years. These impacts would result in a slight reduction (-2percent) of the projected future spotted owl population remaining in Washington within 10 to 20 years. Within 10 years, the actual effects of forest management are likely to be much less than this because most remaining spotted owls are likely to be located only on federal lands, with little potential for direct impact from WDNR forest management. The effects of HCP forest management to spotted owls numbers and reproduction are not distinguishable from the ongoing background rate of spotted owl decline that is occurring due to barred owl competition. The original estimates of incidental take for the HCP (145 known sites, and 70 projected future sites) far exceed the amount of incidental take that has occurred, or is likely to occur in the future, because almost all habitat impacts have occurred in areas that have been abandoned by spotted owls since the first decade of HCP implementation. The reduction in the amount and extent incidental take is the direct result of the widespread loss of spotted owls from barred owl competition. In the context of continued spotted owl decline, the long-term, landscape-scale conservation provided by the HCP will be critical to maintaining habitat in key locations to support spotted owl conservation and recovery efforts in Washington.

11 CUMULATIVE EFFECTS: Spotted Owl and Designated Spotted Owl Critical Habitat

Cumulative effects are those effects of future State or private activities, not involving federal activities, that are reasonably certain to occur within the action area of the federal action subject to consultation (50 CFR 402.02). Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

11.1 Forest Practices

Nonfederal forested lands in Washington are managed primarily for timber production. Private timber harvest in Washington must comply with the Washington Forest Practices Act (RCW 76.09) as well as the Washington Administrative Code with respect to the Washington Forest Practices Rules (WAC 222). Suitable spotted owl habitat on nonfederal lands is protected by the Washington Forest Practices Rules in State-designated Spotted Owl Special Emphasis Areas (SOSEAs). Within SOSEAs, the Forest Practices rules provide protection for up to 40 percent of habitat located within Status 1, 2, or 3 spotted owl management circles. Habitat located outside of spotted owl management circles in SOSEAs can be harvested. There are no restrictions on the harvest of habitat located outside of SOSEAs, other than seasonal restrictions related to timber harvesting within the best 70 acres of habitat surrounding a spotted owl activity center (WAC 222-10-041).

The USFWS completed a formal consultation on the Forest Practices rules associated with forest management in riparian management zones for aquatic species covered under the WDNR Forest Practices Habitat Conservation Plan (FPHCP). In that assessment, we concluded that essentially all spotted owl habitat located on nonfederal lands that was not associated with spotted owl management circles within SOSEAs or other forest practices deferrals (e.g., riparian management zones, unstable slopes, and occupied marbled murrelet sites) would eventually be lost due to timber harvest (USFWS 2006, pp. 414-415).

The assessment estimated that about 24 percent of estimated habitat at that time was located in known spotted owl management circles, but that only 12 percent of the habitat acres was located in owl management circles located in SOSEAs. Overall, 88 percent of the spotted owl habitat estimated on the private nonfederal lands was not associated with known owl circles in SOSEAs, indicating that over 500,000 acres of spotted owl habitat in Washington, dispersed across the four provinces was at risk of harvest. This was approximately 16 percent of the estimated total spotted owl habitat in Washington at that time (USFWS 2006, p. 414). The spotted owl is not a covered species under the FPHCP; therefore, the USFWS did not anticipate or authorize incidental take of spotted owls associated with the implementation of the FPHCP, and specifically, implementation of the Forest Practices rules associated with riparian zone management. Any unauthorized incidental take would violate the prohibitions in Section 9 of the ESA and would therefore invalidate the FPHCP coverage (USFWS 2006, p. 418).

Because the spotted owl is not a covered species under the FPHCP, the ongoing loss of suitable, unoccupied habitat on nonfederal lands that do not have individual HCPs or Safe Harbor Agreements is a cumulative effect that has occurred (baseline) and is reasonably certain to continue to occur. Timber harvest on nonfederal lands is the single greatest source of habitat loss in Washington, with over 514,000 acres of habitat loss attributed to timber harvest on nonfederal lands for the period from 1993 – 2017 (Davis et al. 2022, p. 31).

The USFWS determined that forest practices on private lands covered under the FPHCP “may affect, and are likely to adversely affect” spotted owls, but we concluded that these effects are not likely to jeopardize the continued existence of spotted owls (USFWS 2006, p. 418). This conclusion was based on the finding that occupied spotted owl sites on the nonfederal lands would continue to be managed to avoid incidental take of individual spotted owls, and that the designation of SOSEAs, and habitat protection within SOSEAs was consistent with the recommendations in the draft spotted owl recovery plan (USFWS 1992) for spotted owl conservation on nonfederal lands (USFWS 2006, pp. 418-419). The draft recovery plan recommendations included: 1) providing habitat (suitable or dispersal) to support the conservation of spotted owls in federal reserves in areas where nonfederal lands are mixed with federal lands; 2) providing for clusters of breeding pairs on nonfederal lands in locations where federal lands are not adequate to provide for recovery; 3) provide habitat for existing spotted owl pairs to avoid incidental take of those owls as defined by the ESA; and 4) providing dispersal habitat for connectivity between federal reserves (USFWS 1992). The development of the Forest Practice rules for spotted owls, and the designation of SOSEAs under the Forest Practices Act were developed with the objective of meeting the draft recovery plan recommendations for the conservation of spotted owls on nonfederal lands (Hansen et al. 2003).

In summary, the cumulative effects to spotted owls from ongoing forest practices have reduced and will continue to reduce the amount and distribution of unoccupied spotted owl habitat on nonfederal lands in Washington. This loss is not unexpected based on the policy decisions and recommendations for spotted owl conservation made in the 1990’s regarding the role of the Northwest Forest Plan to provide for conservation and recovery of spotted owls, and the emphasis of the Forest Practices rules to provide for protection of spotted owl habitat in landscapes determined to be important for supporting recovery efforts on federal lands through the designation of SOSEAs.

11.2 Development

The human population in Washington is growing quickly, with an estimated increase of 700,000 people between 2008 and 2020 (Washington Department of Ecology 2016). Rapid population growth is expected to continue. As human population growth continues, there is increasing demand for residential and recreation developments in forested landscapes. These areas are commonly referred to as the wildland urban interface (WUI), which is defined as areas where infrastructure and other human development meets or intermixes with undeveloped wildlands or forests. In Washington, and throughout the west, the need to reduce risk of wildfire in WUI areas is one of the primary drivers for the prioritization of landscape-level fire risk reduction treatments (WDNR 2020b, entire, USFS 2022, pp. 18-20, 38). Risk reduction and fuel treatments are reasonably certain to result in a reduction of existing spotted owl habitat in the East Cascades of Washington in the coming decades. Most of these treatments will be federally funded and will therefore be subject to consultation under section 7 of the ESA. As discussed in prior sections, fuels reduction treatments may result in local degradation or removal of spotted owl habitat but can also reduce risk of habitat loss from catastrophic wildfire events (USFWS 2011).

11.3 Cumulative Effects to Designated Spotted Owl Critical Habitat

Private lands and other non-WDNR-managed lands in the action area are managed primarily for timber production and may also affect adjacent designated spotted owl critical habitat. Private timber harvest must comply with the Washington Forest Practices Act (RCW 76.09) as well as the Washington Administrative Code with respect to the Washington Forest Practices Rules (WAC 222). The USFWS completed a formal consultation on the Washington State Forest Practices Rules in 2006 and anticipated that there would be some degradation and loss of suitable spotted owl habitat in CHUs from windthrow effects from adjacent private-land timber harvest. Although the USFWS determined that windthrow from adjacent private timber harvest "may affect, and is likely to adversely affect" designated spotted owl critical habitat, we concluded that these effects are not likely to destroy or adversely modify spotted owl critical habitat (USFWS 2006, p. 419). Because these effects have already been addressed through section 7 consultation, they are not considered as cumulative effects.

12 INTEGRATION AND SYNTHESIS OF EFFECTS: Spotted Owl and Designated Spotted Owl Critical Habitat

The Integration and Synthesis section is the final step in assessing the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action and the cumulative effects to the status of the species and critical habitat, and the environmental baseline, to formulate our biological opinion as to whether the proposed action is likely to: (1) appreciably reduce the likelihood of both survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution; or (2) result in the destruction or adverse modification of critical habitat.

12.1 Summary of the Current Status of the Species and Environmental Baseline

Spotted owl populations continue to decline, especially in the northern parts of the species' range. Over the past two decades it has become apparent that competition from the barred owl is now the primary driver behind spotted owl population declines, greatly overwhelming the impacts of habitat loss or degradation over the past 25 years. Habitat conservation remains important for the conservation and recovery of the spotted owl, and loss of large areas of habitat due to catastrophic wildfires also poses a significant threat to the species. In 2020, the USFWS concluded that listing the spotted owl as an endangered species was warranted due to the combined stressors of barred owl competition and increasing risk of catastrophic wildfire in the face of climate change. The revised spotted owl recovery plan emphasizes maintaining all high-quality habitat that currently exists regardless of land use allocation or ownership, to buffer against the negative effects of competitive interactions with barred owls.

The spotted owl population in Washington is rapidly declining to extirpation due to the negative effects of competition with barred owls. The estimated spotted owl population has been reduced to approximately 5 percent of the population that existed in the early 1990's, including within large landscapes that have had no significant reduction in existing NRF habitat (e.g., Olympic National Park, Mt. Rainier National Park). We estimate that there are as few as 126 pairs of spotted owls remaining in Washington in 2023, which represents about 4 percent of the estimated range-wide population. Of the 126 pairs remaining in Washington, we estimate that up to 17 pairs (13 percent) are associated with WDNR HCP lands. In the absence of barred owl management, the remaining spotted owl population in Washington is projected to decline by over 40 percent within the next 10 years and is likely to be extirpated from large areas of Washington within the next 20 years. The USFWS completed a multi-year barred owl removal experiment and has determined that barred owl removal can reverse local population declines for spotted owls. In 2023, the USFWS released a draft EIS with several alternatives for barred owl management strategies, but whether barred owl management will be implemented in Washington is unknown at this time.

There is approximately 365,000 acres of spotted owl nesting / roosting on WDNR lands. This represents about 10 percent of the estimated nesting / roosting habitat in Washington, and about 3 percent of the species habitat range wide. Existing HCP conservation strategies and other protected areas on WDNR HCP lands are expected to maintain over 272,000 acres of the existing NRF habitat (67 percent), while about 33 percent of habitat (~93,000 acres) is in areas that may be subject to timber harvest over the remaining term of the HCP (~43 years).

12.2 Summary of the Proposed Action

The proposed action is the continued implementation of a previously issued incidental take permit for the 1997 WDNR State Lands HCP for the remainder of the 70-year permit term (2067). WDNR manages over 1.9 million acres of state lands within the range of the spotted owl in Washington. Over the past 10 years, WDNR has conducted timber harvest on an average of about 15,600 acres per year. This includes regeneration harvest and commercial thinning treatments, including restoration thinning treatments to promote the development of spotted owl habitat in some landscapes. The current level of timber harvest (15,600 acres/year) is far below the estimated 50,000 acres of timber harvest per year that was originally estimated in 1997.

The HCP spotted owl conservation strategy designates 224,000 acres of NRF management landscapes in the Cascades, with an objective of providing 50 percent nesting / roosting habitat (~112,000 acres). The current baseline of nesting / roosting habitat in the designated NRF areas is estimated at 53,000 acres (24 percent) (WDNR data) to 83,000 acres (37 percent) (NWFP data). The HCP designated 190,000 acres as dispersal landscapes, with an objective of providing 50- percent dispersal habitat (95,000 acres). The current baseline of dispersal habitat in designated dispersal areas is estimated at 102,000 acres (54 percent) (NWFP data) to 108,000 acres (57 percent) (WDNR data).

In the OESF, the HCP strategy is to provide 20 percent of the landscape in old forest habitat, and 40 percent of the landscape in structural spotted owl habitat (~109,000 acres). The current baseline of spotted owl nesting \ roosting habitat is estimated at 112,000 acres (NWFP data) to 110,000 acres (41 percent) of structural spotted owl habitat (WDNR data). While the OESF landscape is above the 40 percent threshold, most of the individual SOMUs are below habitat thresholds, indicating the distribution of spotted owl habitat in the OESF will shift over the remaining term of the HCP as owl habitat develops in some SOMUs, and “excess” habitat in SOMUs that are above threshold is reduced by future timber harvest. No reduction in existing old forest habitat from timber harvest is anticipated.

Designated NRF management areas in the West Cascades have the capacity to develop additional nesting-roosting habitat over the remaining term of the HCP. Designated NRF areas in the East Cascades are likely to be significantly affected by the effects of climate change, wildfire, and management efforts to reduce wildfire risk and improve forest health. Climate change projections indicate a substantial reduction in areas capable of sustaining spotted owl NRF habitat in the East Cascades, creating a high level of uncertainty regarding the future capability of eastside NRF areas to maintain or achieve targeted habitat levels. Because the conservation strategy calls for restoring or maintaining 50 percent NRF habitat within NRF management areas, the HCP has some adaptive capacity to adjust to habitat losses from wildfires or other natural disturbances that are likely to increase with climate change.

12.3 Summary of Estimated Spotted Owl Habitat Losses and Gains

The amount of spotted owl habitat that existed on WDNR lands in 1997 was estimated at 484,700 acres, which represented about 11 percent of the estimated habitat in Washington at that time. The contemporary WDNR HCP as modified by the marbled murrelet long-term strategy, the policy that protects old-growth stands, and other harvest deferrals is projected to maintain or restore NRF habitat across a larger area of the WDNR HCP lands than was originally estimated. Existing NRF habitat (~93,000 acres) will continue to be removed by HCP-covered timber harvest over the remaining term of the HCP (43 years). Over the same period, there is a projected net gain (~101,000 acres) in NRF habitat, indicating that habitat losses will be replaced by habitat gains at the scale of the HCP lands. Habitat carrying capacity to support spotted owls on HCP lands will be maintained or restored at provincial scales, with losses in capacity in one portion of a province replaced by gains in other areas of the same province (e.g., Olympic

Peninsula). Barring catastrophic habitat loss from wildfire or climate change, the HCP lands are projected to have over 466,000 acres of habitat at the end of the HCP term (2067), which is comparable to the estimated habitat that existed at the beginning of the HCP.

12.4 Summary of the Effects to Spotted Owls

Continued implementation of the HCP has the potential to affect a maximum of about 13 percent of the remaining spotted owl population in Washington (17 pairs out of a total of 126 pairs). Because most of the spotted owl habitat remaining on the HCP-covered lands is in HCP conservation areas (67 percent), we estimate that up to 6 pairs sites may be subject to timber harvesting over the next 10 years. These impacts would result in a slight reduction (-2%) of the projected future spotted owl population remaining in Washington within the next 10 to 20 years. Within 10 years, the actual effects of forest management are likely to be much less than this because most remaining spotted owls are likely to be located only on federal lands, with little potential for direct impact from WDNR forest management. The effects of HCP forest management to spotted owls numbers and reproduction are not distinguishable from the ongoing background rate of spotted owl decline that is occurring due to barred owl competition.

The original estimate of incidental take of spotted owls for the HCP (148 known sites, and 52 projected future sites) far exceeds the amount of incidental take that has occurred, or is likely to occur in the future, because almost all habitat impacts have occurred in areas that have been abandoned by spotted owls since the first decade of HCP implementation. The reduction in the amount and extent estimated incidental take is a direct result of the widespread loss of spotted owls from barred owl competition.

12.5 Summary of the Cumulative Effects

The cumulative effects to spotted owls from ongoing forest practices has reduced and will continue to reduce the amount and distribution of unoccupied spotted owl habitat located on nonfederal lands in Washington. Spotted owl habitat protection on nonfederal lands is generally limited to specific spotted owl management circles located in key landscape areas determined to be important for supporting spotted owl conservation and recovery efforts on federal lands.

The reduction in habitat distribution is primarily in peripheral areas of the species range with limited federal ownership (e.g., southwest Washington), and is not expected to affect long-term spotted owl conservation and recovery efforts on federal lands.

In the East Cascades, the need to reduce the risk of wildfire in wildland urban interface areas is likely to increase in response to increased human population and development. Fire risk and fuels reduction are likely to result in local degradation or loss of spotted owl habitat. These treatments may also reduce the risk of habitat loss from catastrophic wildfire events.

12.6 Effects to Spotted Owl Survival and Recovery

It is now clear that without barred owl management, spotted owls are likely to become extirpated in Washington over the next two to three decades. Recovery of the spotted owl in Washington will be dependent upon implementation of barred owl management, and habitat conservation in barred owl management areas. Barred owl management is likely to be focused on federal lands, because most of the species' habitat in Washington is located on federal lands (80 percent). There is an estimated 3.5 million acres of spotted owl habitat in Washington, representing about 28 percent of the species estimated habitat range-wide (12.6 million acres). Due to the severe and pervasive effects of barred owl competition, only about 4 percent of the range-wide spotted owl population remains in Washington (126 pairs out of an estimated range-wide population of 3,573 pairs). Over 70 percent of the remaining spotted owl population is now located in California, where the effect of barred owl competition is currently not as severe as it is in the northern parts of the species range.

When we project the baseline rate of spotted owl population decline with no additional land management effects, the population on WDNR HCP-covered lands declines from 17 pairs to 9 pairs within 10 years. With assumed management effects, the population remaining in 10 years is 8 pairs, due to the assumed decrease in annual survival rates for the adult spotted owls in affected territories. Without barred owl management, the Washington spotted owl population is projected to decline from 126 pairs in 2023, to 62 pairs within 10 years (2033) (Table 18, above). If we add in the estimated effects of continued HCP implementation, the projected spotted owl population in Washington in 10 years is 61 pairs (-2 percent difference). The effect of continued implementation of the HCP to spotted owl numbers and reproduction is immeasurable in the context of the ongoing population decline in Washington and would have no influence on population trends or recovery potential in other portions of the species' range.

Over the remaining term of the HCP, there will be continued gradual loss of NRF habitat on the HCP lands (93,000 acres), but this habitat loss is expected to be replaced by a net gain in NRF habitat over the same period (101,000 acres). Habitat carrying capacity to support spotted owls on HCP lands will be maintained or restored at provincial scales, with losses in capacity in one portion of a province replaced by gains in other areas of the same province (e.g., Olympic Peninsula). Barring catastrophic habitat loss from wildfire or climate change, the HCP lands are projected to have over 466,000 acres of habitat at the end of the HCP term (2067), which is comparable to the estimated habitat that existed at the beginning of the HCP.

Considering the scale of both habitat effects (losses and gains) and the population effects associated with the proposed action, and the cumulative effects, we do not expect a measurable reduction in spotted owl numbers, reproduction, or distribution in Washington, or within the listed range of the species. In the context of continued spotted owl decline, the long-term, landscape-scale conservation provided by the HCP will be critical to maintaining habitat in key locations to support spotted owl conservation and recovery efforts in Washington.

12.7 Summary of the Effects to Designated Spotted Owl Critical Habitat

Critical habitat subunits in Washington encompass over 2.95 million acres in 4 CHUs. Habitat degradation of an estimated 4,883 acres located within 328 feet of WDNR-managed lands is considered an adverse effect to critical habitat due to the reduction in the number of large diameter trees, loss in overstory canopy cover, and altered forest composition and structure associated with spotted owl nesting/roosting and foraging habitat. In the context of forest successional processes, effects to PCE 1, PCE 2, and PCE 3 are expected to be short-term (50-years) and temporary because as forested stands regenerate, we expect that edge effects will rapidly diminish and over a 50-year period become difficult to detect. The affected stands are broadly distributed along the boundaries of 13 affected critical habitat subunits and represents a cumulative total of about 0.11 percent of the current estimated nesting / roosting and foraging habitat within spotted owl designated critical habitat range-wide. Critical habitat that is adjacent to areas in LTFC are not expected to be affected by HCP covered activities because these areas are being conserved by the HCP. Due to the limited acres adversely affected and the dispersed nature of effects along the boundary of several critical habitat subunits, windthrow effects will not reduce the capability of the subunits to support spotted owl reproduction, connectivity, or recovery at the scale of the critical habitat subunit, the critical habitat unit, or range wide. The conservation role of critical habitat to provide for well-distributed and inter-connected spotted owl nesting populations will not be significantly reduced by the effects of covered activities on WDNR-managed lands.

13 CONCLUSION: Spotted Owl and Designated Spotted Owl Critical Habitat

After reviewing the current status of the spotted owl and designated spotted owl critical habitat, the environmental baseline for the action area, the ongoing effects of the HCP, and the cumulative effects, it is the USFWS's Opinion that the continued implementation of the HCP, is not likely to jeopardize the continued existence of the spotted owl and is not likely to destroy or adversely modify designated critical habitat.

14 STATUS OF THE SPECIES: Bull Trout and Designated Bull Trout Critical Habitat

14.1 Summary of the Status of Bull Trout

In November 1999, the USFWS listed all populations of bull trout within the coterminous U.S. as a threatened species pursuant to the ESA (64 FR 58910, November 1, 1999). We had previously listed (63 FR 31647, June 10, 1998; 64 FR 17110, April 8, 1999) three separate DPSs of bull trout in the Columbia River, Klamath River, and Jarbidge River basins. Our 1999 listing of the Coastal-Puget Sound populations (Olympic Peninsula and Puget Sound regions) and Saint Mary-Belly River populations (east of the Continental divide in Montana), together with previous listings, addressed all bull trout in the coterminous U.S. (64 FR 58910, November 1, 1999). These five population segments were considered disjunct and geographically isolated from one another with no genetic interchange between them due to natural and man-made barriers. At the time of the 1999 listing, for the purposes of consultation and recovery, we recognized these distinct population segments as interim recovery units (64 FR 58910, November 1, 1999).

Since listing, advances in genetics techniques and increased genetic sampling of bull trout have improved our understanding of the genetic structure and relationships among bull trout populations throughout the coterminous U.S. (USFWS 2015a, pp. 20-21). Studies by Spruell et al. (2003), Whitesel et al. (2004), and Ardren et al. (2011), informed the USFWS's recovery strategy for bull trout.

The six recovery units (RUs) identified in the 2015 recovery plan reflect this most-recent information and analysis and were first described in the 2010 proposed critical habitat rule (75 FR 63898-64070, October 18, 2010). The six RUs include the: 1) Coastal; 2) Klamath; 3) Mid-Columbia; 4) Upper Snake; 5) Columbia Headwaters; and 6) Saint Mary (USFWS 2015a. p. 49). Each of the six RUs are further organized into multiple geographic regions and these geographic regions contain multiple bull trout core areas, which are mapped as non-overlapping watershed-based polygons, and each core area includes one or more local populations. Core areas are functionally similar to bull trout meta-populations, in that bull trout within a core area are much more likely to interact, both spatially and temporally, than are bull trout from separate core areas. A core area may include many local populations.

A local population is defined as a group of bull trout that spawn within a particular stream or portion of a stream system. A local population is the smallest group of bull trout that is known to represent an interacting reproductive unit and may include more than one stream if the recovery team determined that this grouping constitutes an interacting reproductive unit. Where specific spawning location information was lacking, some local populations were identified that include bull trout in a complex of tributaries, or where multiple age classes have been observed, and where suitable spawning habitat occurs. Within a local population, all or most of the accessible tributaries are occupied by bull trout (USFWS 2004, p. 21).

Within the coterminous United States, we currently recognize 109 currently occupied bull trout core areas, which comprise 600 or more local populations (USFWS, 2015a, p. 34). Where conditions allow for movement from spawning streams to larger downstream waters, bull trout may migrate between or outside core areas. Therefore, the USFWS has also identified several marine or main-stem riverine habitat areas outside of core areas that provide foraging, migrating, and overwintering (FMO) habitat, some of which may be shared by bull trout originating from multiple core areas. These shared FMO areas support the viability of bull trout populations by contributing to successful overwintering survival and dispersal among core areas (USFWS, 2015a, p. 35).

Throughout its range, the bull trout is threatened by the combined effects of past and ongoing habitat degradation, fragmentation, and alteration (associated with dewatering, road construction and maintenance, mining, grazing, the blockage of migratory corridors by dams or other diversion structures, and poor water quality); incidental angler harvest; entrainment; and introduced non-native species (64 FR 58910, November 1, 1999). Because of its reliance on cold water, the bull trout is particularly vulnerable to the effects of climate change. Since the listing of bull trout, there has been very little change in the general distribution of bull trout in the coterminous United States, and we are not aware that any known, occupied bull trout core areas have been extirpated (USFWS 2015a, p. 35).

For a detailed account of bull trout biology, life history, threats, demography, and conservation needs, refer to Appendix F: Status of the Species: Bull Trout.

14.2 Summary of the Status of Designated Bull Trout Critical Habitat

Bull trout critical habitat was designated in the coterminous United States in 2010. The condition of bull trout critical habitat varies across the species range from poor to good. Although still relatively widely distributed across its historical range, the bull trout occurs in low numbers in many areas. Overall bull trout abundance is "stable" range wide (USFWS 2015a, p. iii). However, 81 core areas have 1,000 or fewer adults, with 24 core areas not having surveys conducted to determine adult abundance (USFWS 2008, p. 22). In addition, 23 core areas have declining populations, with 66 core areas having insufficient information (USFWS 2015a, p. 2). These values reflect the condition of bull trout habitat. The decline of bull trout is primarily due to habitat degradation and fragmentation, blockage of migratory corridors, poor water quality, past fisheries management practices, impoundments, dams, water diversions, and the introduction of nonnative species (63 FR 31647, [June 10, 1998]; 64 FR 17112, [April 8, 1999]).

There is widespread agreement in the scientific literature that many factors related to human activities have impacted bull trout and their habitat and continue to do so. Among the many factors that result in habitat degradation, those that appear to be particularly significant and have resulted in a legacy of degraded habitat conditions are as follows:

1. Fragmentation and isolation of local populations due to the proliferation of dams and water diversions that have eliminated habitat, altered water flow and temperature regimes, and impeded migratory movements (Dunham and Rieman 1999, p. 643; Rieman and McIntyre 1993, p.7);
2. Degradation of spawning and rearing habitat and upper watershed areas, particularly alterations in sedimentation rates and water temperature, resulting from forest and rangeland practices and intensive development of roads (Fraley and Shepard 1989, p. 141; The Montana Bull Trout Scientific Group (MBTSG) 1998, pp. ii-v, 20-45);

3. The introduction and spread of nonnative fish species, particularly brook trout (*S. fontinalis*) and lake trout (*S. namaycush*), as a result of fish stocking and degraded habitat conditions, which compete with bull trout for limited resources and, in the case of brook trout, hybridize with bull trout (Leary et al. 1993; Rieman et al. 2006);
4. In the Puget Sound and Olympic Peninsula geographic regions where anadromous bull trout occur, degradation of main-stem river FMO habitat, and the degradation and loss of marine nearshore foraging and migration habitat due to urban and residential development; and
5. Degradation of FMO habitat resulting from reduced prey base, roads, agriculture, development, and dams.

For a detailed account of the status of designated bull trout critical habitat, refer to Appendix G: Status of Designated Critical Habitat: Bull Trout.

15 ENVIRONMENTAL BASELINE: Bull Trout and Designated Bull Trout Critical Habitat

Regulations implementing the ESA (50 CFR 402.02) define the environmental baseline as follows: The condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline.

The USFWS identifies six RUs within the range of the bull trout. The action area is located within portions of the Coastal Recovery Unit (Coastal RU), in western Washington. The Coastal RU is divided into three major geographic regions: the Olympic Peninsula, Puget Sound, and Lower Columbia River basins. The Olympic Peninsula and Puget Sound geographic regions also include their associated marine waters (Puget Sound, Hood Canal, Strait of Juan de Fuca, and Pacific Coast), which are critical in supporting the anadromous / amphidromous life history form, unique to the Coastal Recovery Unit. Amphidromous refers to fishes that regularly migrate between freshwater and marine waters for purposes other than spawning (i.e., foraging). While the term anadromous is commonly used for bull trout, amphidromous is a more accurate classification. Each geographic region is further divided into core areas (Figure 2).

A core area is comprised of a core habitat (i.e., habitat that could supply all the necessary elements for the long-term security of bull trout including spawning and rearing, foraging, migrating, and overwintering habitat) and a core population (USFWS 2004, p. 19). The USFWS has identified habitat in core areas by function. Some habitat in core areas is recognized as spawning and rearing (SR) habitat; other habitat is recognized for its use by foraging, migrating, and overwintering bull trout (FMO). The USFWS has also recognized the value of Shared FMO habitat that is found outside core areas (non-Core) (Figure 3).

There are 10 shared FMO areas that occur outside of core area boundaries that may be used by bull trout originating from multiple core areas (Figure 3). These include a variety of marine, estuarine, and freshwater habitats outside of natal core areas. These shared FMO areas are particularly important to the anadromous and fluvial life history forms due to their complex migratory patterns associated with foraging and overwintering. These shared FMO areas are also critical to maintaining or reestablishing the expression of the anadromous life-history behavior within the recovery unit.

The Puget Sound region contains eight core areas (Chilliwack River, Nooksack River, Upper Skagit River, Lower Skagit River, Stillaguamish River, Snohomish and Skykomish Rivers, Chester Morse Lake, and Puyallup River) (57 local populations). The Olympic Peninsula region contains six core areas (Dungeness River, Elwha River, Hoh River, Queets River, Quinault River, and Skokomish River) (10 local populations). The Lower Columbia River region has 2 of 7 core areas located within Washington, and only Lewis River core area is found within the action area. Therefore, the action area is primarily within the Olympic and Puget Sound geographic regions and the Lewis River Core Area (#15 in Figure 2) of the Lower Columbia River region. Although the Lower Columbia River Region in Washington also contains the Klickitat Core Area (#16 in Figure 2) and White Salmon historical core area, they are found on the east side of the Cascade Crest and as such are not included in the action area.

The aquatic action area is defined as streams and waterbodies within lands managed under the HCP and downstream waters extending to major lakes or the marine environment. This is a complex network that is too intricate to describe herein. As such, the following sections describing the environmental baseline for bull trout are devoted to a general description of the baseline of the Coastal RU, with specific emphasis on the core areas (Figure 2) that that include WDNR HCP-covered lands.

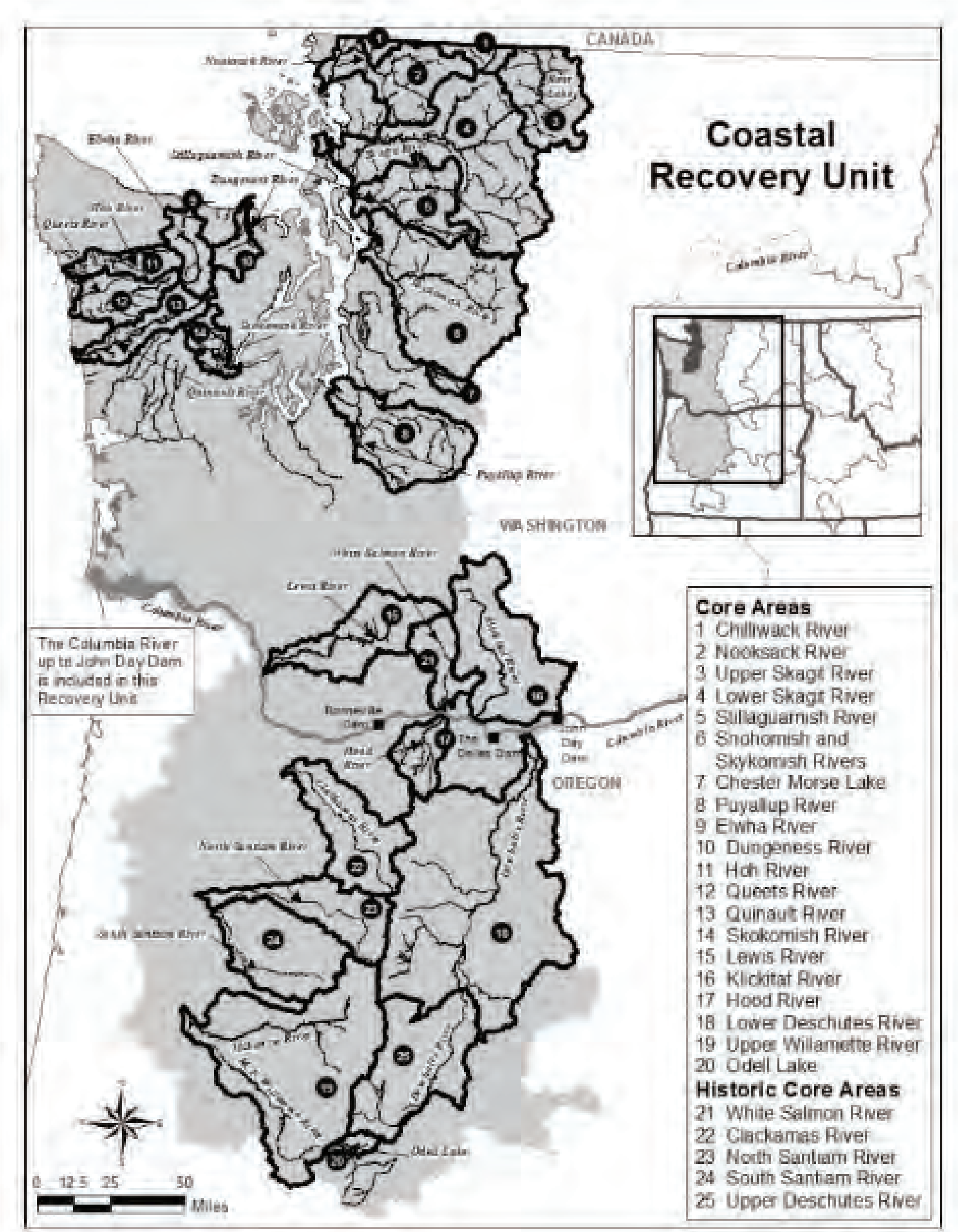

Figure 2. Map of the Coastal Recovery Unit (Core Areas) for bull trout (USFWS 2015b, Figure A-1 p. A-2).

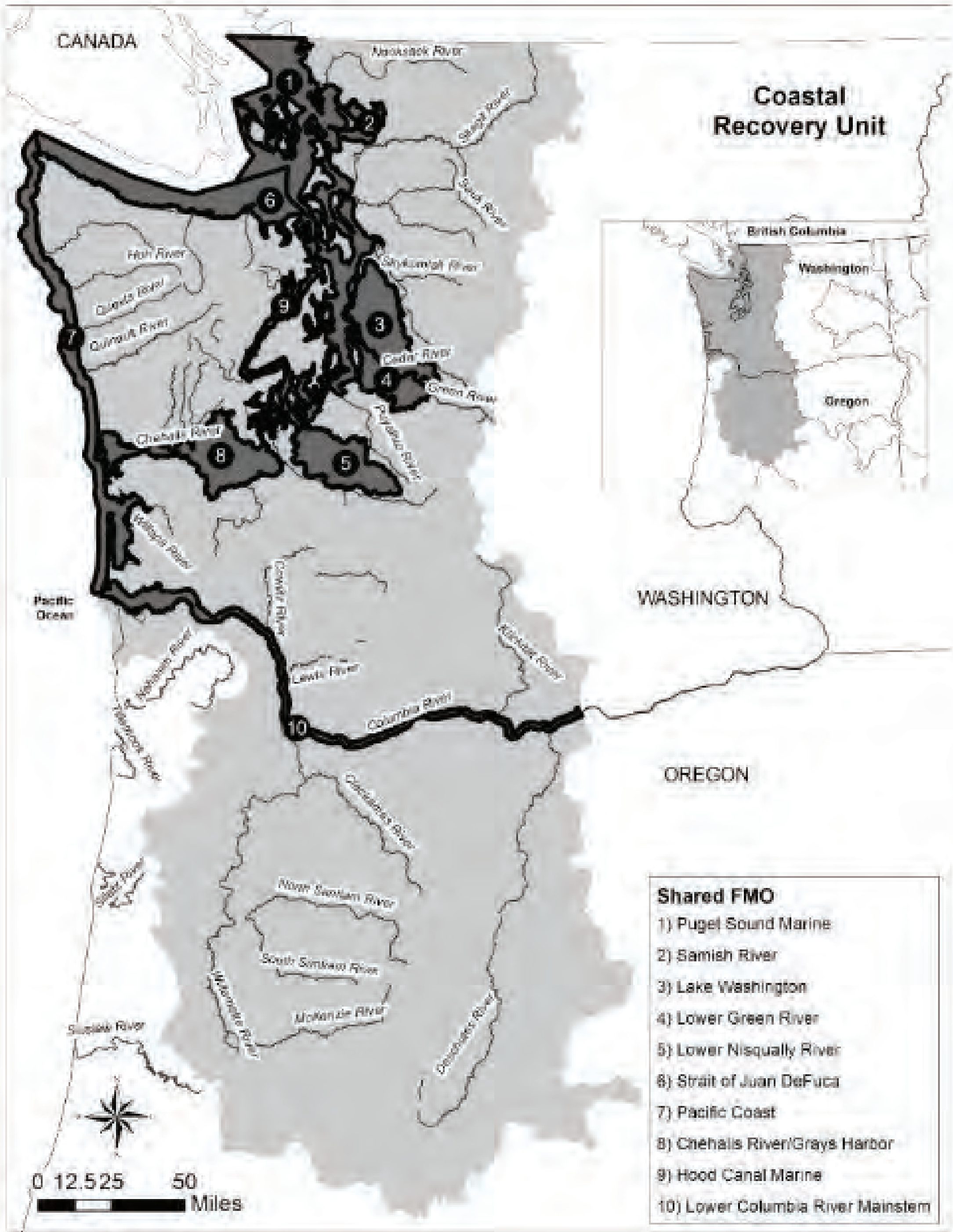

Figure 3. Map of the Coastal Recovery Unit (Shared FMO) for Bull Trout (USFWS 2015b, Figure A-2 p. A-5).

Unique to the Puget Sound and Olympic Peninsula regions of this recovery unit is the use of nearshore marine and estuarine habitats and the frequent use of a number of independent (i.e., separated by marine waters so not directly connected to a core area), non-natal river or creek basins for foraging and overwintering by anadromous bull trout. Two of these shared FMO areas (Lower Nisqually River and Chehalis River/Grays Harbor-Satsop River) likely supported spawning populations of bull trout in the past based on historical accounts. Only migratory individuals from other core areas are believed to currently use these systems and in much lower numbers.

In the Lower Columbia River region of the recovery unit, the mainstem Columbia River provides productive foraging habitats for migratory bull trout and critical connectivity among core areas for potential gene flow and population refounding. Current bull trout presence in the lower mainstem Columbia River may reflect the strength of local populations within regional core areas and the presence of suitable migration corridors between core areas and the Columbia River. There are fewer occurrences of bull trout in the Columbia River where poorer habitat conditions and passage barriers exist in these core area tributaries (Willamette, Lewis, Hood, Klickitat, and Deschutes Rivers) and/or contain reduced population levels. Greater use of the mainstem Columbia River is expected as habitat conditions improve, and bull trout population abundances increase through implementation of the recovery plan. The lower section of the Columbia River is very large, and it is difficult to sample and detect bull trout in their current low numbers, consequently information on their period of use is limited.

15.1 Current Condition of Bull Trout in the Action Area

Since listing in 1999, bull trout abundance has been identified as relatively stable range wide (USFWS 2015a, pp. 7-8). No specific bull trout abundance or density estimates have been established for any core areas within the action area. The status and prognosis for bull trout in core areas is variable (USFWS 2015b, p. A-6).

15.1.1 Puget Sound Region

In the Puget Sound region, bull trout populations are concentrated along the eastern side of Puget Sound with most core areas concentrated in central and northern Puget Sound. Although the Chilliwack River core area is considered part of this region, it is technically connected to the Fraser River system and is transboundary with British Columbia, making its distribution unique within the region. Most core areas support a mix of anadromous and fluvial life-history forms, with at least two core areas containing a natural adfluvial life history (Chilliwack River core area [Chilliwack Lake] and Chester Morse Lake core area). Overall demographic status of core areas generally improves as you move from south Puget Sound to north Puget Sound (Table 36). Although comprehensive trend data are lacking, the current condition of core areas within this region are likely stable overall, although some at depressed abundances. Two core areas (Puyallup River and Stillaguamish River) contain local populations at either very low abundances (Upper Puyallup and Mowich Rivers) or that have likely become locally extirpated (Upper Deer Creek, South Fork Canyon Creek, and Greenwater River). Connectivity among and within core areas of this region is generally intact. Most core areas in this region still have significant amounts of headwater habitat within protected and relatively pristine areas (e.g., North Cascades National Park, Mount Rainier National Park, Skagit Valley Provincial Park, Manning Provincial Park, and various wilderness or recreation areas).

Table 36. Current condition of bull trout core area populations in the Puget Sound region in the action area.

Core areas	Number & distribution of local populations	Adult abundance	Productivity	Connectivity	Life history forms
#1 Chilliwack River	Three local populations have been identified in the United States portion of this core area: 1) Upper Chilliwack River (including Easy, Brush, and Indian Creeks), 2) Little Chilliwack River, and 3) Silesia Creek.	Near, or in excess of, 100 adults	At risk of extirpation	Migratory bull trout likely are present in most of the local populations	Adfluvial, fluvial and, potentially, resident and anadromous
#2 Nooksack River	Ten local populations are recognized within the Nooksack River core area	Adult abundance is estimated between 250 to 1,000 individuals	Currently, there is insufficient information to determine a trend in the size of the core area population	There is connectivity among most of the local populations, except for the Middle Fork Nooksack River. The Bellingham Diversion Dam on the Middle Fork Nooksack River obstructs fish movement into and out from the reach occupied by the Upper Middle Fork Nooksack River local population	Fluvial and anadromous are the most abundant life history forms in the Nooksack River core area.
#4 Lower Skagit River	Twenty local populations; spawning habitat	between 5,000 and 10,000 individuals; not considered at risk from genetic drift	at "low risk" for extirpation	no connectivity barriers between 18 of the 20 local populations;	fluvial, adfluvial, resident, and anadromous
#5 Stillaguamish River	Three local populations are recognized within the Stillaguamish core area: Upper Deer Creek, South Fork Stillaguamish River, and Canyon Creek; a fourth potential population North Fork Stillaguamish River, spawning and rearing, but spawning habitat generally limited	<1,000 adults; At risk of genetic drift	At risk of extirpation	Generally good connectivity, but need to maintain connectivity between somewhat isolated local populations	Primarily anadromous and fluvial; resident also

Core areas	Number & distribution of local populations	Adult abundance	Productivity	Connectivity	Life history forms
#6 Snohomish and Skykomish Rivers	Four local: 1) North Fork Skykomish River (including Goblin and West Cady Creeks), 2) Troublesome Creek (resident form only), 3) Salmon Creek, and 4) South Fork Skykomish River; spawning and rearing, foraging	Between 500 and 1,000 adults; South Fork Skokomish River, Salmon Creek and Troublesome Creek are at risk from inbreeding depression; unknown for Troublesome Creek	At increased risk of extirpation due to declining productivity	Connectivity between three population; lack of connectivity with Troublesome Creek is a natural condition	Fluvial, resident, and anadromous
#8 Puyallup Core Area	Five local populations occur in the Puyallup core area: 1) Upper Puyallup and Mowich Rivers, 2) Carbon River, 3) Upper White River, 4) West Fork White River, and 5) Greenwater River; spawning habitat present but reproduction there is unknown	Counts generally not available; White River fewer than 100 adults in each local population	increased risk of extirpation	Connectivity between populations, but overall low abundance of migratory life forms	Anadromous, fluvial, and potentially resident
#7 Chester Morse Lake –	Owned and managed under an approved HCP by the City of Seattle.				

15.1.2 *Olympic Peninsula Region*

In the Olympic Peninsula region, distribution of core areas is somewhat disjunct, with only one located on the west side of Hood Canal on the eastern side of the Peninsula, two along the Strait of Juan de Fuca on the northern side of the peninsula, and three along the Pacific Coast on the western side of the peninsula. Most core areas support a mix of anadromous and fluvial life history forms, with at least one core area also supporting a natural adfluvial life history (Quinault River core area [Quinault Lake]). Another adfluvial population is associated with Lake Cushman (reservoir) in the upper North Fork Skokomish drainage. Demographic status of core areas is poorest in Hood Canal and Strait of Juan de Fuca, while core areas along the Pacific Coast of Washington likely have the best demographic status in this region (Table 37). The connectivity between core areas in these disjunct regions is believed to be naturally low due to the geographic distance between them. Internal connectivity is currently poor within the Skokomish River core area (Hood Canal) and is being restored in the Elwha River core area (Strait of Juan de Fuca). Most core areas in this region still have their headwater habitats within relatively protected areas (Olympic National Park and wilderness areas). The recovery team identified 10 local populations in the 6 core areas (USFWS 2004, p. iv), and additionally identified 2 potential local populations: Brown Creek in the Skokomish core area and Little River in the Elwha core area. Both Brown Creek and Little River are connected to bull trout occupied habitat, have suitable water temperatures, and would provide additional local populations in core areas that have two or fewer identified local populations (McHenry, M. in *litt*. 2003; Ogg, L. pers. comm. 2003).

All confirmed bull trout observations on the Olympic Peninsula have occurred within anadromous or formerly anadromous reaches of streams or rivers. Bull trout have not been observed upstream of historical anadromous barriers, and the resident life-history form of bull trout has not been documented on the Olympic Peninsula. Bull trout are not likely to occupy 1st or 2nd order streams on the Peninsula and are often able to move farther downstream to avoid certain stressors.

Table 37. Current condition of bull trout core area population in the Olympic Peninsula region.

Core areas	Number & distribution of local populations	Adult abundance	Productivity	Connectivity	Life history forms
#9 Elwha River	Two local populations and one potential local population; Elwha headwaters and downstream of Carlson Canyon; further analysis needed to determine if spawning is happening	<1,000 adults; At risk of genetic drift	No data	Elwha Dam removed, good connectivity between river mouth and headwaters	Anadromous, fluvial, and resident
#10 Dungeness River	Two local populations; Dungeness River and Gray Wolf River; spawning, rearing, FMO	<100 spawning individuals per year; At risk of genetic drift	At high risk of extirpation	Some impairments to connectivity, but migratory bull trout persist in both local populations	Anadromous and fluvial
#11 Hoh River	Two local populations; Hoh River above the confluence with the South Fork Hoh River, and south Fork Hoh River; spawning and rearing	500 <1,000 adults; At risk of genetic drift	At risk of extirpation	Barriers such as culverts, mainstem disconnected from off-channel habitats, impassable barriers; but enough connectivity for migratory bull trout to persist	Anadromous and fluvial
#12 Queets River	One local population; Queets River and associated tributaries upstream from the confluence with Tshletshy Creek; rearing and FMO	500 <1,000 adults; At risk of genetic drift	At risk of extirpation	No barriers to movement on mainstem, but barriers present in some tributaries	Fluvial, resident, and anadromous
#13 Quinault River	Two local populations; North Fork Quinault River and its associated tributaries, and upper mainstem Quinault River, upstream from the confluence with the North Fork Quinault River; spawning and rearing does occur	500 <1,000 adults; At risk of genetic drift	At risk of extirpation	Adequate connectivity between the two local populations and throughout the core area	Fluvial, adfluvial, anadromous and, possibly, resident
#14 Skokomish River	Two local populations have been identified: 1) North Fork Skokomish River (including Elk and Slate Creeks), and 2) South Fork Skokomish River (including Church Creek).	The Skokomish core area likely contains fewer than 1,000 spawning adults per year.	The South Fork Skokomish local population is at risk from inbreeding depression because it is believed to contain fewer than 100 spawning adults per year	Connectivity between the two local populations has been completely blocked since the 1920s by the two Cushman Dams. Fish passage infrastructure became operational in 2016. The effectiveness of the fish passage facilities and their use by bull trout is being evaluated.	Fluvial, adfluvial, and resident

Lower Columbia River Region

In the Lower Columbia River region, the majority of core areas are distributed along the Cascade Crest on the Oregon side of the Columbia River. Only two of the seven core areas in this region are in Washington. Most core areas in the region historically supported a fluvial life-history form, but many are now adfluvial due to reservoir construction. However, there is at least one core area supporting a natural adfluvial life history (Odell Lake) and one supporting a natural, isolated, resident life history (Klickitat River [West Fork Klickitat]). Status is highly variable across this region, with one relative stronghold (Lower Deschutes core area) existing on the Oregon side of the Columbia River. The Lower Columbia River region also contains three watersheds (North Santiam River, Upper Deschutes River, and White Salmon River) that could potentially become re-established core areas within the Coastal Recovery Unit. Although the South Santiam River has been identified as a historical core area, there remains uncertainty as to whether or not historical observations of bull trout represented a self-sustaining population. Current habitat conditions in the South Santiam River are thought to be unable to support bull trout spawning and rearing. Adult abundances within the majority of core areas in this region are relatively low, generally 300 or fewer individuals.

Adfluvial bull trout, is the only life history that has been documented in the Lewis River subbasin based on field sampling over the past four decades. Bull trout in the Lewis River are considered to be predominantly adfluvial, migrating from tributary spawning and rearing areas to reservoirs to forage and rear. There has been no confirmation of any resident (i.e., non-migratory) populations to date. Currently, populations of bull trout within the Lewis River core area are found in tributaries associated with Yale and Swift reservoirs (Table 38). Spawning and juvenile rearing occur in Cougar Creek (Yale population), and in Rush and Pine creeks (Swift population). Numerous bull trout have been detected making movements into the Muddy River, a stream network where no spawning or early life stages have been documented (Hudson et al. 2019, p. 10).

A number of potential limiting factors have been identified for bull trout in the Lewis River including spawning/rearing habitat, connectivity, reservoir conditions, forage base, handling impacts during research and monitoring activities, illegal fishing harvest and indirect (i.e., catch-and release) angling impacts, and interspecific competition (Hudson et al. 2019, p 37). Many of the tributaries in the Lewis River core area have excessive stream gradient or high water temperature, other factors identified include a lack of instream complexity and excessive stream depth. The current spawning distribution in the Lewis River subbasin above Swift Reservoir is restricted to the coldest available habitat (i.e., Pine and Rush creek watersheds) which suggests that stream temperature is limiting the distribution of spawning and rearing habitat in the subbasin (Hudson et al. 2019, p 45).

Table 38. Current condition of bull trout in the Lewis River core area.

Core areas	Number & distribution of local populations	Adult abundance	Productivity	Connectivity	Life history forms
#15 Lewis River	Three local populations are known to occur in the Lewis River core area: Cougar Creek, Rush Creek, and Pine Creek	<1000 adults; at risk of genetic drift	at increased risk of extirpation.	Lack of passage at hydroelectric facilities within the Lewis River core area has fragmented populations	adfluvial

15.2 Current Condition of Bull Trout Habitat in the Action Area

Since the time bull trout was listed in 1999, Federal, state, and private actions occurring have resulted in adverse and beneficial effects to bull trout. Beneficial actions, among others, include forest stand and watershed improvement through growth and forest thinning's; riparian restoration; replacement of fish-passage barriers; fish-habitat improvement projects; section 10(a)(1)(B) permits for HCPs addressing forest-management practices and associated road maintenance; and a variety of restoration projects completed by individuals or partnerships. Adverse effects have occurred from actions such as new and ongoing development; agriculture; dike maintenance; transportation projects involving construction of roads and bridges; dredging in harbors, rivers, and near-shore areas; many activities associated with urban areas and associated infra-structure; as well as other activity types described below under Factors responsible for the condition of the habitat.

15.2.1 Olympic Peninsula Region

Development and related impacts (e.g., flood control, flood plain disconnection, bank armoring, channel straightening, and loss of instream habitat complexity) along mainstem river corridors are most common in the Dungeness River core area and to some extent in parts of the Quinault River core area. Transportation networks, both improved roads and forest roads have had significant impacts to several core areas in this region. Most prominent impacts are related to stream-adjacent roads that have direct impacts to stream banks and channels as these roads periodically fail and are maintained or reconstructed. In the Skokomish River core area, an extensive history of road building and intense timber harvest has resulted in significant aggradation of the South Fork and mainstem Skokomish Rivers, key migratory corridors for bull trout. In three core areas (Dungeness River, Elwha River, and Skokomish River), instream flows or aggraded channels have seasonal impacts that threaten connectivity between spawning and rearing habitats and foraging migration and overwintering habitats.

In three core areas (Dungeness River, Elwha River, and Skokomish River), instream flows or aggraded channels have seasonal impacts that threaten connectivity between spawning and rearing habitats and foraging migration and overwintering habitats.

Distribution of Bull Trout Habitat on the Olympic Peninsula

On the Olympic Peninsula there are 8 bull trout core areas that encompass over 1.2 million acres of lands. About 66 percent of the land within the core areas is federal, while 13 percent of the land base is on WDNR HCP-covered lands (Table 39). The core areas with significant WDNR land ownership include the Hoh River (25 percent) and the Queets River (36 percent). Both of these core areas are located in the OESF.

Table 39. Summary of land ownership within Olympic Peninsula bull trout core areas.

Bull Trout core area	WDNR HCP lands (acres)	Federal lands (acres)	Other Ownerships (acres)	All Ownerships (acres)	Percent of core area in WDNR HCP lands
Dungeness River	5,516	104,001	21,369	130,886	4 %
Elwha River	7,455	188,101	10,109	205,666	4 %
Hoh River	47,500	110,202	33,385	191,088	25 %
Queets River	102,606	141,925	43,878	288,408	36 %
Quinault River	382	176,903	102,510	279,795	0.1%
Skokomish River	1,576	105,887	45,527	152,990	1 %
Totals	**165,036** (13%)	**827,019** (66 %)	**256,778** (21 %)	**1,248,833** (100 %)	**13 %**

Known, occupied bull trout habitat within the 8 Olympic Peninsula bull trout core areas includes over 586 miles of rivers and streams (Table 40). Approximately 7 percent of the total bull trout habitat within the Olympic Peninsula core areas is located on WDNR HCP-covered lands, including 38.3 miles of FMO habitat, and 5.5 miles of bull trout SR habitat (Table 40). Of the 224 total miles of known SR habitat on the Olympic, only 2 percent (5.5 miles) is located on WDNR HCP-covered lands (Table 40).

The Dungeness River and Hoh River core areas have the largest percent of SR and FMO habitats located on HCP-covered lands. The Queets River core area has a large percent of FMO habitat on HCP lands (20 percent), but no SR habitat, which is all located on federal lands. The Elwha River, Skokomish River, Quinault River core areas on HCP lands have very little to no SR and FMO habitats on HCP covered lands (Table 40).

Table 40. Distribution of bull trout habitat in the Olympic Peninsula region by core area.

Bull Trout Core Area	Habitat type	Bull trout habitat on WDNR HCP lands (miles)	Bull trout habitat on federal lands (miles)	Bull trout habitat on other ownerships (miles)	Totals for all ownerships (miles)	Percent of bull trout habitat on WDNR HCP lands
Dungeness River	**Total Habitat Miles**	**3.3**	**27.9**	**18.0**	**49.2**	**6.8%**
	FMO	0.2	5.7	16.1	21.9	1.0%
	Spawning & Rearing	3.1	22.3	1.9	27.3	11.4%
Elwha River	**Total Habitat Miles**	**0.5**	**62.9**	**16.1**	**79.6**	**0.6%**
	FMO	0.1	6.7	14.2	21.0	0.5%
	Spawning & Rearing	0.4	56.2	2.0	58.5	0.6%
Hoh River	**Total Habitat Miles**	**14.7**	**57.2**	**45.4**	**117.3**	**12.5%**
	FMO	12.7	2.0	42.1	56.8	22.3%
	Spawning & Rearing	2.0	55.3	3.3	60.6	3.3%
Queets River	**Total Habitat Miles**	**25.1**	**95.1**	**36.3**	**156.5**	**16.1%**
	FMO	25.1	65.8	36.3	127.3	19.7%
	Spawning & Rearing	0.0	29.3	0.0	29.3	0.0%
Quinault River	**Total Habitat Miles**	**0.0**	**60.1**	**44.3**	**104.3**	**0.0%**
	FMO	0.0	22.2	44.3	66.4	0.0%
	Spawning & Rearing	0.0	37.9	0.0	37.9	0.0%
Skokomish River	**Total Habitat Miles**	**0.1**	**33.8**	**45.3**	**79.2**	**0.2%**
	FMO	0.1	10.7	43.7	54.5	0.2%
	Spawning & Rearing	0.0	23.1	1.7	24.7	0.0%
All Olympic Region Core Areas	**Total Habitat Miles**	**43.8**	**337.0**	**205.4**	**586.2**	**7%**
	FMO	38.3	113.0	196.6	347.9	11%
	Spawning & Rearing	5.5	224.0	8.8	238.3	2%

Notes: Bull trout habitat is summarized from GIS data for the 2010 final bull trout critical habitat designation. Data represents rivers and streams and does not include lakes or marine shorelines. Data includes areas of known bull trout occupancy, and includes areas designated as critical habitat and areas excluded from the final critical habitat designation.

Occupied bull trout habitat within shared FMO watersheds located outside of bull trout core areas includes over 256 miles of rivers and streams on the Olympic Peninsula. Approximately 5 percent of the total bull trout FMO habitat in these shared FMO watersheds is located on WDNR HCP-covered lands (Table 41). Most of the shared FMO habitat located outside of core areas is located on non-federals lands (89 percent).

Table 41. Distribution of bull trout habitat in shared FMO watersheds in the Olympic Region.

Bull Trout FMO Watershed	Habitat type	Bull trout habitat on WDNR HCP lands (miles)	Bull trout habitat on federal lands (miles)	Bull trout habitat on other ownerships (miles)	Totals (miles)	Percent of FMO habitat on WDNR HCP lands
Bell Creek	FMO	0.0	0.0	5.9	5.9	0.0%
Goodman Creek	FMO	6.9	9.7	8.0	24.6	28.1%
Humptulips River	FMO	0.2	0.0	30.1	30.2	0.6%
Kalaloch Creek	FMO	0.7	3.2	3.4	7.2	9.2%
Lower Chehalis River	FMO	0.1	0.0	35.5	35.6	0.2%
Moclips/Copalis Rivers	FMO	0.7	0.0	40.4	41.1	1.7%
Morse Creek	FMO	3.5	0.3	18.8	22.6	15.4%
Raft River	FMO	0.0	0.0	10.9	10.9	0.0%
Satsop River	FMO	0.0	2.3	42.0	44.3	0.0%
Wishkah River	FMO	0.0	0.0	34.0	34.0	0.0%
Totals		**12.0**	**15.5**	**229.0**	**256.5**	**4.7%**

Notes: Bull trout habitat is summarized from GIS data for the 2010 final bull trout critical habitat designation. Data represents rivers and streams and does not include lakes or marine shorelines. Data includes areas of known bull trout occupancy, and includes areas designated as critical habitat and areas excluded from the final critical habitat designation.

WDNR HCP General Management Allocations in Olympic Region Bull Trout Watersheds

As described in the description of the proposed action, there are two riparian conservation strategies – the OESF riparian strategy, and the riparian conservation strategy for the Westside planning units. The OESF encompasses over 272,000 acres of WDNR HCP-covered lands. Of these there are two core areas (Hoh River and Queets River) and two shared FMO watersheds (Goodman Creek and Kalaloch Creek) that are managed under the OESF riparian strategy (Table 42). The total HCP-covered lands included in these watersheds is approximately 68,500 acres, which represents about 25 percent of the HCP-covered lands in the OESF. All other areas in the OESF are located outside of known bull trout watersheds. In the OESF, much of the land area is deferred from regeneration timber harvest and is mapped by WDNR as long-term forest cover (LTFC). In the bull trout core areas on the OESF, over 55 percent of the land is in LTFC. Much of the LTFC is associated with RMZs, but LTFC also includes deferrals for old-growth and the marbled murrelet long-term conservation strategy (Table 42).

Table 42. Summary of WDNR HCP management within Olympic Peninsula bull trout core area watersheds and FMO watersheds.

Bull Trout Core Area	HCP Planning Unit	General Management Lands (acres)	Long-Term Forest Cover (acres)	WDNR State HCP Lands (acres)	Percentage of WDNR Lands in LTFC
Dungeness River	Straits	3,722	1,797	5,519	32.6%
Elwha River	Straits	4,452	3,006	7,458	40.3%
Hoh River	**OESF**	21,137	26,433	47,570	55.6%
Queets River	**OESF**	38,709	64,072	102,781	62.3%
Quinault River	South Coast	254	129	383	33.6%
Skokomish River	Straits	1,020	563	1,583	35.6%
Core Area Totals		**69,294**	**96,000**	**165,294**	**58 %**
Shared FMO Areas (freshwater streams and rivers)					
Bell Creek	Straits	110	113	222	50.7%
Humptulips River	South Coast	2,105	1,232	3,337	36.9%
Morse Creek	Straits	10,702	6,840	17,542	39.0%
Goodman Creek	**OESF**	5,984	7,032	13,016	54.0%
Moclips/Copalis Rivers	South Coast	3,204	1,532	4,736	32.3%
Lower Chehalis River	South Coast	6,496	5,975	12,470	47.9%
Kalaloch Creek	**OESF**	2,664	4,301	6,966	61.7%
Wishkah River	South Coast	586	366	952	38.4%
FMO Area Totals		**29,050**	**25,680**	**54,730**	**47 %**

Notes: Long-term forest cover (LTFC) refers to areas deferred by policy or HCP requirements from variable retention timber harvesting. LTFC includes old-growth, marbled murrelet conservation areas, NAPs, NRCAs, riparian management zones, or other deferrals.

15.2.2 Puget Sound Region

In 2000, it was estimated that one third of Puget Sound's shoreline had been modified, with over half of the main basin of Puget Sound having been altered (PSWQAT 2000). Although efforts to remove armoring have since been implemented, overall shoreline armoring continues to increase in Puget Sound (PSP 2013). Nearly 100 percent of the Duwamish estuary and Elliott Bay shoreline has been modified by some type of armoring (BMSL *et al*. 2001). Over 98 percent of the historic intertidal and subtidal habitat in Commencement Bay is reported to have been lost (WSCC 1999). In areas where nearshore habitats currently remain intact or only partially modified, development continues to threaten these habitats (PSP 2013). Specific recovery actions in the Puget Sound region may include removing or modifying artificial structures such as bulkheads, riprap, dikes, and tide gates; restoring tidal flow to coastal wetlands; contaminant remediation; or restoring eelgrass beds, kelp beds, and other nearshore habitats or processes.

Throughout Puget Sound, development, and related impacts (e.g., flood control, flood plain disconnection, bank armoring, channel straightening, loss of instream habitat complexity) along mainstem river corridors are common. Some of the most complex and costly restoration actions will be required to restore more natural features and functions to these areas. Several core areas continue to be impacted by past forest management practices (harvest and roads). Since the time of listing, these impacts have and are anticipated to continue to decline as contemporary forest management practices and restoration actions are implemented.

Distribution of Bull Trout Habitat in the Puget Sound Region

In the Puget Sound region there are 8 bull trout core areas that encompass over 4.8 million acres of lands. Only 7 of the core areas include some WDNR HCP-covered lands. The Upper Skagit River core area does not contain any HCP-covered lands but is acknowledged here as part of the total Puget Sound region core areas. About 53 percent of the land within these core areas is federal, while 9 percent of the land base is on WDNR HCP-covered lands (Table 43). The core areas with significant WDNR land ownership include the Nooksack River (16 percent) and the Stillaguamish River (18 percent).

Table 43. Summary of land ownership within the Puget Sound region bull trout core areas.

Bull Trout Core Area	**WDNR State HCP Lands (Acres)**	**Federal Lands (Acres)**	**Other Ownerships (Acres)**	**All Ownerships (Acres)**	**Percent of Core Area in WDNR HCP Lands**
Chester Morse Lake	73	229	52,087	52,389	0.1%
Chilliwack River	6,138	101,057	45,455	152,650	4 %
Lower Skagit River	86,170	903,359	363,888	1,353,417	6 %
Nooksack River	77,656	164,302	256,867	498,825	16 %
Puyallup River	1,080	272,387	391,205	664,673	0.2%
Snohomish & Skykomish Rivers	167,851	488,693	515,831	1,172,375	14 %
Stillaguamish River	80,546	176,550	193,852	450,949	18 %
Upper Skagit River	0	475,341	12,387	487,728	0 %
Totals	**419,515** (9%)	**2,581,918** (53%)	**1,831,573** (38%)	**4,833,006** (100%)	**9%**

Table 44. Distribution of bull trout habitat in the Puget Sound Region by bull trout core area.

Bull Trout Core Area	Habitat type	Bull trout habitat on WDNR HCP lands (miles)	Bull trout habitat on Federal lands (miles)	Bull trout habitat on Other Ownerships (miles)	Totals for All Ownerships (miles)	Percent of bull trout habitat on WDNR HCP lands
Chester Morse Lake	**Total Habitat Miles**	**0.0**	**0.0**	**16.6**	**16.6**	**0.0%**
	FMO	0.0	0.0	4.1	4.1	0.0%
	Spawning & Rearing	0.0	0.0	12.5	12.5	0.0%
Chilliwack River	**Total Habitat Miles**	**0.0**	**0.0**	**29.8**	**29.8**	**0.0%**
	FMO	0.0	0.0	0	0.0	0.0%
	Spawning & Rearing	0.0	0.0	29.8	29.8	0.0%
Lower Skagit River	**Total Habitat Miles**	**14.6**	**247.4**	**293.0**	**555.0**	**2.6%**
	FMO	13.7	60.9	287.4	361.9	3.8%
	Spawning & Rearing	0.9	186.5	5.6	193.1	0.5%
Nooksack River	**Total Habitat Miles**	**24.6**	**42.7**	**222.1**	**289.4**	**8.5%**
	FMO	3.5	0.0	144.3	147.8	2.4%
	Spawning & Rearing	21.1	42.7	77.8	141.7	14.9%
Puyallup River	**Total Habitat Miles**	**0.8**	**108.4**	**215.8**	**325.0**	**0.3%**
	FMO	0.0	0.0	162.3	162.3	0.0%
	Spawning & Rearing	0.8	108.4	53.5	162.8	0.5%
Snohomish & Skykomish Rivers	**Total Habitat Miles**	**15.4**	**64.7**	**228.9**	**308.9**	**5.0%**
	FMO	13.2	12.4	216.2	241.8	5.5%
	Spawning & Rearing	2.2	52.3	12.7	67.1	3.2%
Stillaguamish River	**Total Habitat Miles**	**22.8**	**53.7**	**161.5**	**238.0**	**9.6%**
	FMO	10.0	3.8	133.7	147.5	6.8%
	Spawning & Rearing	12.8	49.9	27.7	90.4	14.1%
All Puget Region core areas w/ WDNR HCP lands	**Total Habitat Miles**	**78.2**	**516.9**	**1167.6**	**1762.7**	**4.4%**
	FMO	40.4	77.0	948.0	1065.4	3.8%
	Spawning & Rearing	37.8	439.9	219.6	697.3	5.4%

Notes: Bull trout habitat is summarized from GIS data for the 2010 final bull trout critical habitat designation. Data includes areas of known bull trout occupancy, and includes areas designated as critical habitat and areas excluded from critical habitat designation.

Known, occupied bull trout habitat within the 7 Puget Sound bull trout core areas that contain HCP-covered lands includes over 1,762 miles of rivers and streams (Table 44). Approximately 4 percent of the total bull trout habitat within the Puget Sound bull trout core areas is located on WDNR HCP-covered lands, including 40.4 miles of FMO habitat, and 37.8 miles of bull trout SR habitat (Table 44). Of the 697 total miles of known SR habitat in the Puget Sound core areas, about 5 percent (37.8 miles) is located on WDNR HCP-covered lands (Table 44).

The Nooksack River and Stillaguamish River core areas have the largest percentage of bull trout SR habitats located on HCP-covered lands (15 percent and 14 percent, respectively). While the Chilliwack and Chester Morse core areas contain a small percentage of HCP-covered lands, and there are no known bull trout streams on HCP-covered lands in these watersheds.

Occupied bull trout habitat within shared FMO watersheds located outside of bull trout core areas includes over 127 miles of rivers and streams in the Puget Sound region. Approximately 0.2 percent of the total bull trout FMO habitat in these shared FMO watersheds is located on WDNR HCP-covered lands in the Lower Green River (Table 45). Almost all of the shared FMO habitat located outside of core areas in the Puget Sound regions is located on non-federals lands (97 percent).

Table 45. Distribution of bull trout habitat in shared FMO watersheds in the Puget Sound region.

Shared FMO Watershed	Habitat type	Bull trout habitat on WDNR HCP lands (miles)	Bull trout habitat on federal lands (miles)	Bull Trout habitat on other ownerships (miles)	Total (miles)	Percent of FMO habitat on WDNR HCP lands
Lake Washington	FMO	0.0	0.0	0.4	0.4	0.0%
Lower Green River	FMO	0.3	0.0	62.1	62.4	0.5%
Lower Nisqually River	FMO	0.0	3.3	26.8	30.1	0.0%
Samish River	FMO	0.0	0.0	34.2	34.2	0.0%
Totals		**0.3**	**3.3**	**123.5**	**127.1**	**0.2%**

Notes: Bull trout habitat is summarized from GIS data for the 2010 final bull trout critical habitat designation. Data includes areas of known bull trout occupancy, and includes areas designated as critical habitat and areas excluded from critical habitat designation.

WDNR HCP General Management Allocations in Puget Sound Bull Trout Watersheds

HCP-covered lands in the Puget Sound region are managed under riparian conservation strategy for the Westside planning units. Within the bull trout core areas, approximately 48 percent of the HCP-covered land is deferred from regeneration timber harvest and is mapped by WDNR as LTFC. The remaining 52 percent of lands are comprised of upland areas that may be subject to regeneration timber harvesting (Table 46). In the shared FMO watersheds, the amount of LTFC is slightly less at 42 percent.

Table 46. Summary of WDNR HCP management within the Puget Sound region of the bull trout core area watersheds and FMO area.

Core area	HCP Planning Unit	General management lands (acres)	Long-term forest cover (acres)	WDNR HCP lands (acres)	Percentage of WDNR lands in LTFC
Chester Morse Lake	North Puget	71	2	73	3%
Chilliwack River	North Puget	2,715	3,427	6,143	56%
Lower Skagit River	North Puget	48,925	37,293	86,218	43%
Nooksack River	North Puget	41,339	36,395	77,734	47%
Puyallup River	South Puget	801	280	1,081	26%
Snohomish & Skykomish Rivers	North Puget	76,668	91,259	167,928	54%
Stillaguamish River	North Puget	46,433	34,171	80,604	42%
Core Area Totals		**216,952**	**202,829**	**419,781**	**48%**
Shared FMO watersheds (freshwater rivers and streams)					
Lake Washington	South Puget	4,227	7,376	11,604	64%
Lower Green	South Puget	7,104	2,862	9,966	29%
Lower Nisqually	South Puget	9,545	6,411	15,956	40%
Samish	North Puget	8,221	4,220	12,441	34%
FMO Area Totals		**29,097**	**20,870**	**49,967**	**42%**

Notes: Long-term forest cover (LTFC) refers to areas deferred by policy or HCP requirements from variable retention timber harvesting. LTFC includes old-growth, marbled murrelet conservation areas, NAPs, NRCAs, riparian management zones, or other deferrals.

15.2.3 Lower Columbia Region

Of the seven occupied bull trout core areas located in the Lower Columbia Region, only the Lewis River core contains WDNR HCP-covered lands. Ongoing habitat threats related to hydropower dams are present in the Lewis River core. Dams have hampered natural fluvial processes such as wood routing and sediment transport, resulting in oversimplified mainstem reaches that are lacking pools and instream channel complexity. They have also resulted in entrainment and changes in temperature regimes.

Habitat threats from residential development, transportation systems, and forest practices affect four core areas in this region. Spawning and rearing habitats and migratory corridors continue to be degraded from a range of related impacts such as sedimentation, channel instability, channel simplification, reduced instream flows, and increases in water temperature. The Lewis River core area has a key local population (Pine Creek) that also continues to recover from persistent adverse impacts from the eruption of Mount St. Helens, principally, simplified channel structure and channel instability.

WDNR HCP Lands and General Management Allocations in the Lewis River Core Area

The Lewis River core area encompasses over 531,000 acres. Most of this area (61 percent) is located on federal lands, and about 11 percent is WDNR HCP covered lands (Table 47). Known, occupied bull trout habitat within the Lewis River core area includes over 60 miles of rivers and streams (Table 48). Approximately 2.4 percent of the total bull trout habitat within the Lewis River core area is located on WDNR HCP-covered lands, including 1.4 miles of FMO habitat. There is approximately 15 miles of bull trout SR habitat in the Lewis River core area, but none of these streams are located on WDNR HCP-covered lands. HCP-covered lands in the Lewis River are managed under the riparian conservation strategy for the Westside planning units. Approximately 39 percent of the HCP-covered land is deferred from regeneration timber harvest and is mapped by WDNR as LTFC. The remaining 61 percent of lands are comprised of upland areas that may be subject to regeneration timber harvesting (Table 49).

Table 47. Summary of land ownership within the Lewis River bull trout core area.

Bull Trout Core Area	**WDNR State HCP Lands (Acres)**	**Federal Lands (Acres)**	**Other Ownerships (Acres)**	**All Ownerships (Acres)**	**Percent of Core Area in WDNR HCP Lands**
Lewis River	60,443	322,062	149,398	531,903	11%
Percent of Core Area	11%	61%	28%	100%	

Table 48. Distribution of bull trout habitat type by land ownership within Lower Columbia region core area watersheds.

Bull Trout Core Area	**Habitat type**	**Bull trout habitat on WDNR HCP lands (miles)**	**Bull trout habitat on federal lands (miles)**	**Bull trout habitat on other ownerships (miles)**	**Totals for all ownerships (miles)**	**Percent of bull trout habitat on WDNR HCP lands**
Lewis River	**Total Habitat Miles**	**1.4**	**25.0**	**34.2**	**60.7**	**2.4%**
	FMO	1.4	19.7	24.2	45.4	3.2%
	Spawning & Rearing	0.0	5.3	10.0	15.3	0%

Notes: Bull trout habitat is summarized from GIS data for the 2010 final bull trout critical habitat designation. Data includes areas of known bull trout occupancy, and includes areas designated as critical habitat and areas excluded from critical habitat designation.

Table 49. Summary of WDNR HCP management within the Lower Columbia region of the bull trout core area watersheds.

Core Area	General Management Lands (acres)	Long-Term Forest Cover (acres)	WDNR State HCP Lands (acres)	Percentage of WDNR Lands in LTFC
Lewis River	37,269	23,731	61,000	39%

Notes: Long-term forest cover (LTFC) refers to areas deferred by policy or HCP requirements from variable retention timber harvesting. LTFC includes old-growth, marbled murrelet conservation areas, NAPs, NRCAs, riparian zones, or other deferrals.

15.3 Factors Responsible for Condition of the Species

Within the Coastal RU, historical and current land-use activities and fisheries management have impacted bull trout. Some of the historical activities, especially water diversions, hydropower development, forestry, agriculture, fisheries management, and residential and urban development within the core areas, may have significantly reduced important migratory populations of bull trout. Lasting effects from some, but not all, of these early land and water developments still limit bull trout production in core areas (USFWS 2015d). Historical (20^{th} century and earlier) forestry activities still locally impact bull trout through decreased recruitment of large wood, increased water temperatures from reduced shading, lack of pools and habitat complexity, and increased sedimentation from timber harvesting on unstable slopes, and forest road construction. However, effects from historical harvest and roads are declining, and contemporary forest practices minimize the effects of timber harvest and road management.

Land-management activities that depress bull trout populations and degrade habitat include some aspects of road construction and maintenance, residential development and urbanization, forest management, and agriculture practices (USFWS, 2015). Agriculture practices impact bull trout through added inputs of nutrients, pesticides, herbicides, sediment, reductions in the extent of riparian vegetation, reduced stream flows, decreased recruitment of large wood, and reduced habitat complexity by diking, stream channelization, and bank hardening (USFWS 2004). Within Puget Sound, shoreline armoring is increasing and likely to be a common response to sea level rise in developed areas (Mauger and Vogel 2020, p. 34; Shirk et al. 2021, p. 13). Armoring negatively impacts shoreline dynamics and nearshore fish habitat important to the anadromous form of bull trout.

Water-management activities that depress bull trout populations and degrade habitat include water withdrawal and some aspects of operation and maintenance of dams and other diversion structures (USFWS 2015d). Water withdrawals can reduce base flows, increase instream temperatures, and reduce availability of cover and complex habitats. Dams and diversion structures impede or limit bull trout migration, entrain individuals, and impair downstream habitat in the Dungeness and Skokomish river core areas. Climate change is expected to further exacerbate the growing water demand especially in summer months for both agricultural and development purposes across the Northwest, but particularly within the Columbia River Basin, placing further strain on available instream flows for fish (Mote et al. 2003, pp. 54–62; Bumbaco et al. 2022, entire). While hydroelectric dams present a physical barrier between bull trout and their native spawning grounds and local populations, water diversion can substantially affect water quality and quantity and limit bull trout populations as well by affecting stream flow, water temperature, and sediment delivery. Irrigation diversions have been documented to entrain fish.

Development and urbanization have affected bull trout through reduced water quality, alterations in hydrology, reduced riparian shading, sedimentation, and reduced channel complexity caused by increased bank hardening and channel constrictions. Historical and current incidental mortality of bull trout from tribal and recreational fisheries remain a concern, as does illegal intentional harvest. The combination of the above effects, in conjunction with small population size and isolation, remains a concern for bull trout particularly in the face of ongoing changes in climate.

Implementation of Coastal Recovery Unit Conservation Measures

Since the listing of bull trout, numerous conservation measures have been and continue to be implemented within the Coastal Recovery Unit. These measures are being undertaken by a wide variety of local and regional partnerships, including State fish and game agencies, State and federal land management and water resource agencies, Tribal governments, power companies, watershed working groups, water users, ranchers, and landowners. Generally, salmon recovery actions also function to improve habitat for bull trout; often spawning and rearing habitat for salmon and steelhead is concurrently used as FMO habitat by bull trout. Moreover, the restoration of Chinook and steelhead, as well as other salmon runs in the Coastal Recovery Unit, also benefits bull trout by providing eggs, carcasses, and juvenile salmonids as forage items. However, it should be noted that although the distribution of bull trout does overlap with the distribution of salmon and steelhead, bull trout recovery may require greater or additional conservation and protection actions of headwater tributary habitats used for bull trout spawning and rearing than may have been identified under salmon and steelhead recovery. Bull trout consistently migrate to the furthest accessible upstream habitats in their natal watersheds and require some of the coldest and cleanest water conditions for parts of their life cycle, so protection and restoration of these areas is a critical component for this species recovery. Recovery efforts in these headwater habitats will ultimately complement the recovery of salmon and steelhead by helping sustain adequate habitat conditions further downstream.

Some of the most significant conservation measures for bull trout that have been implemented since the listing are related to dam relicensing. FERC relicensing of major hydropower facilities in this recovery unit has provided opportunities for development of upstream and downstream fish passage or for complete dam removal (Elwha and Glines Canyon dams on Elwha River).

15.4 Current Condition of Bull Trout Critical Habitat in the Action Area

Critical habitat for bull trout within the Coastal RU is designated on federal lands (National Forests and National Parks), and on non-forested, non-federal lands (e.g., agricultural areas, and urban areas). Critical habitat for bull trout was proposed on state and private forest lands throughout the Coastal RU, but these areas were excluded from the final designation in Washington because these lands have existing HCPs that address bull trout. The result is that designated bull trout critical habitat that is located outside of federal lands is not a continuous designation but is comprised of thousands of isolated segments. The bull trout stream miles summarized in Tables 39, 40, 43, 44, and 47 include all designated critical habitat within the action area, as well as areas excluded from the final critical habitat designation. In general, bull trout streams located on federal lands are designated as critical habitat, and in most areas, are located upstream from WDNR HCP-covered lands. Bull trout streams on other ownerships in general are located downstream from WDNR HCP-covered lands and include both designated streams in non-forested areas and excluded streams on private forest lands.

The condition of bull trout critical habitat largely reflects the condition of habitat more generally and varies across the action area range from poor to good. Although still relatively widely distributed across its historic range, the bull trout occurs in low numbers in many areas, and populations are considered depressed or declining across much of its range (Ratliff and Howell 1992, entire; Schill 1992, p. 40; Thomas 1992, p. 28; Buchanan et al. 1997, p. vii; Rieman et al. 1997, pp. 15-16; Quigley and Arbelbide 1997, pp. 1176-1177). This condition reflects the condition of bull trout habitat. The decline of bull trout is primarily due to loss of PCEs that result in habitat degradation and fragmentation, blockage of migratory corridors, poor water quality, past fisheries management practices, impoundments, dams, water diversions, and the introduction of nonnative species (USFWS 1998, pp. 31648-31649; USFWS 1999, p. 17111).

15.4.1 Factors Responsible for Condition of Critical Habitat

There is widespread agreement in the scientific literature that many factors related to human activities have impacted bull trout and their habitat and continue to do so. Among the many factors that contribute to the degradation of primary constituent elements (PCEs), those which appear to be particularly significant and have resulted in a legacy of degraded habitat conditions are as follows: 1) fragmentation and isolation of local populations due to the proliferation of dams and water diversions that have eliminated habitat, altered water flow and temperature regimes, and impeded migratory movements (Dunham and Rieman 1999, p. 652; Rieman and McIntyre 1993, p. 7); 2) degradation of spawning and rearing habitat and upper watershed areas, particularly alterations in sedimentation rates and water temperature, resulting from forest and rangeland practices and intensive development of roads (Fraley and Shepard 1989, p. 141; MBTSG 1998, pp. ii - v, 20-45); 3) the introduction and spread of nonnative fish species, particularly brook trout and lake trout, as a result of fish stocking and degraded habitat conditions, which compete with bull trout for limited resources and, in the case of brook trout, hybridize with bull trout (Leary et al. 1993, p. 857; Rieman et al. 2006, pp. 73-76); 4) in the Coastal-Puget Sound region where amphidromous bull trout occur, degradation of mainstem river FMO habitat, and the degradation and loss of marine nearshore foraging and migration habitat due to urban and residential development; and 5) degradation of FMO habitat resulting from reduced prey base, roads, agriculture, development, and dams.

Summary of Bull Trout Habitat on WDNR-HCP Covered Lands

In summary, bull trout is a threatened species that has a restricted distribution within select watersheds within the action area. Bull trout habitat has been degraded by the legacy of past land and water management practices, and populations have been isolated or fragmented by the construction of dams. Contemporary forest practices, fish passage improvements, and watershed restoration actions (including dam removals) are leading to improved connectivity and habitat conditions in many areas. At the scale of the westside planning units and the OESF, about half (48 percent) of the HCP-covered lands are located within bull trout watersheds (Table 50). Almost all HCP-covered lands within the North Puget planning units occur within bull trout watersheds, and 62 percent of the HCP-covered lands within the OESF are in bull trout watersheds.

Table 50. Summary of WDNR HCP lands in bull trout watersheds by planning unit.

HCP Planning Unit	WDNR HCP lands in bull trout core area watersheds (acres)	WDNR HCP lands in bull trout shared FMO watersheds (acres)	WDNR HCP lands in all bull trout watersheds (acres)	Total WDNR HCP Lands - 2023 (acres)	Percent of WDNR HCP lands in bull trout watersheds
COLUMBIA	60,443	0	60,443	288,442	21%
N. PUGET	418,434	12,356	430,790	457,256	94%
S. COAST	382	21,476	21,858	260,716	8%
S. PUGET	1,080	37,364	38,444	178,130	22%
STRAITS	14,548	17,749	32,297	127,919	25%
OESF	150,106	19,975	170,081	273,053	62%
Totals	**644,993**	**108,920**	**753,913**	**1,585,516**	**48%**

Because bull trout are limited to select streams and rivers within the occupied watersheds, a relatively minor amount of the known, occupied bull trout habitat (rivers and streams) is located on the HCP-covered lands (5 percent). The HCP-covered lands contain approximately 5 percent of the total available bull trout SR habitat, and 5 percent of the available bull trout FMO habitat located within the Coastal Recovery unit core areas that overlap with HCP-covered lands (Table 51).

Table 51. Summary of bull trout habitat by region with WDNR HCP covered lands in the coastal recovery unit.

Bull Trout Coastal Recovery Unit Region	Bull trout habitat type	Total bull trout core area habitat (all ownerships) (miles)	Bull trout habitat on WDNR HCP lands	Percent of total bull trout habitat on WDNR HCP lands
Olympic Region (6 core areas, 10 shared FMO watersheds)	Core Area SR:	238.3	5.5	2%
	Core Area FMO:	347.9	38.3	11%
	Shared FMO:	256.5	12.0	5%
	Totals:	**842.7**	**55.8**	**7%**
Puget Sound Region (8 core areas, 4 shared FMO watersheds)	Core Area SR:	697.3	37.8	5%
	Core Area FMO	1065.4	40.4	4%
	Shared FMO	127.1	0.3	0%
	Totals	**1,889.8**	**78.5**	**4%**
Lower Columbia Region (Lewis River core area)	Core Area SR	15.3	0.0	0%
	Core Area FMO	45.4	1.4	3%
	Totals	**60.7**	**1.4**	**2%**
All Coastal RU Areas with WDNR HCP-covered lands	Core Area SR	950.9	43.3	5%
	Core Area FMO	1458.7	80.1	5%
	Shared FMO	383.6	12.3	3%
	Totals	**2,793.2**	**135.7**	**5%**

Notes: Totals in this table only include watersheds with WDNR HCP covered lands. Bull trout habitat is summarized from GIS data for the 2010 final bull trout critical habitat designation. Data includes areas of known bull trout occupancy, and includes areas designated as critical habitat and areas excluded from critical habitat designation.

15.5 Conservation Role of the Action Area

Bull trout core areas and shared FMO areas all play a critical role in the recovery of bull trout in the Coastal Recovery Unit (RU) (USFWS 2015d). Rivers, lakes, and tributary stream habitats provide essential spawning, rearing, foraging, migrating, and overwintering habitat for bull trout. The action area includes the only RU containing the amphidromous life-history form of bull trout and thereby represents a unique ecological setting for the species.

The Coastal RU is essential to the conservation of bull trout because these populations are significantly different genetically from the four RUs east of the Cascade Range and the Klamath RU. The Olympic Peninsula and Puget Sound areas are isolated from other RUs. Some populations within this RU exhibit the amphidromous life history form; they co-occur with Dolly Varden in the northern portion of the RU; they co-occur with coastal populations of anadromous salmonids; and they occur in a coastal climate and vegetative condition west of the Cascade Range that is different from the four RUs to the east; loss of this RU would result in a significant gap in the range of bull trout; and the entire RU has or could have a shared evolutionary future by migrating among populations over long periods of time.

While most of the bull trout SR habitat within the Coastal RU is located on federal lands, aquatic habitats on the WDNR HCP-covered lands are essential for the conservation and recovery of bull trout, particularly in core areas and shared FMO watersheds where WDNR lands comprise a significant portion (i.e., 10 percent or more) of the available bull trout habitat.

15.6 Climate Change

Consistent with USFWS policy, our analyses under the ESA include consideration of ongoing and projected changes in climate. The term “climate” refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2014a, pp. 119-120). The term “climate change” thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2014a, p. 119). Various types of changes in climate can have direct or indirect effects on species and critical habitats. These effects may be positive, neutral, or negative, and they may change over time. The nature of the effect depends on the species’ life history, the magnitude and speed of climate change, and other relevant considerations, such as the effects of interactions of climate with other variables (e.g., habitat fragmentation) (IPCC 2014b, pp. 64, 67-69, 94, 299). In our analyses, we use our expert judgment to weigh relevant information, including uncertainty, in our consideration of various aspects of climate change and its effects on species and their critical habitats. We focus in particular on how climate change affects the capability of species to successfully complete their life cycles, and the capability of critical habitats to support that outcome.

Climate change is already occurring, and is projected to continue (IPCC 2018, entire). Human activities, particularly carbon dioxide emissions from use of fossil fuels, have already contributed to an increase of approximately 1° C (1.8° F) in global warming from pre-industrial levels, which is likely to reach 1.5°C (2.7°F) in the next 30 years if warming continues to increase at the current rate (IPCC 2018, p. 4). Across the Pacific Northwest, water temperatures in free-flowing streams have increased by about 0.2 °C [0.36 °F] per decade since 1980, due to air temperature increases and flow reduction (Isaak et al. 2011, pp. 499–524).

Climate Change Effects to Water Quantity and Seasonal Runoff

All the demographic needs of bull trout are intricately connected to their habitat needs. Climate change is having a profound effect on bull trout through impacts to seasonal water quality, riparian quality, and habitat quantity, which in turn are affecting essential spawning, rearing and FMO habitats. Bull trout are particularly vulnerable to declines in snowpack and snow water which affect stream flow and timing, as well as water quality (e.g., temperature). In many mountain watersheds, the water stored within the snowpack accounts for a significant portion of the seasonal runoff that contributes to streamflow (Hamlet et al. 2007, pp. 1469– 1472). From 1950 to 1997, snowpack in mountain watersheds declined by more than half in some regions due to changing precipitation patterns and increasing temperature (Ryan et al. 2014, p. 236; Hamlet et al. 2005, pp. 39–42). This reduction in seasonal snowpack is expected to shift the volume and timing of stream flows, leading to increased peak river flows in some areas. Additionally, climate change is causing snowmelt to happen earlier, which is causing earlier runoff each year.

Across the western United States, water stored in snowpack is projected to decline by 25 percent by 2050. A low-to-no snow climate scenario could occur within 35 to 60 years if greenhouse gas emissions continue, with potentially catastrophic impacts on the water system (Siirila-Woodburn et al. 2021, p. 800). If so, it will impact the spatiotemporal partitioning of water, including precipitation stores (e.g., surface water, soil moisture, and groundwater) and fluxes (e.g., evapotranspiration, runoff, and streamflow) (Siirila-Woodburn et al. 2021, p. 808). Other modeling efforts indicate loss of snowfall and snowpack will be variable across the landscape with some high elevation areas predicted to have below average projected warming rates and climate change having a weaker impact on snowpack particularly in some high elevation areas closer to the inter-mountain west (Ikeda et al. 2021, entire; Isaak et al. 2023, entire). In the Pacific Northwest, climate models project warmer air temperatures, with increases in winter precipitation, decreases in summer precipitation, and precipitation more likely to fall as rain rather than snow (ISAB 2007, pp. 15–17).

The predicted shift in the volume and timing of stream flows are likely to decrease bull trout reproduction and recruitment. Streambed scour caused by flooding during October through March can lead to the destruction of redds, mortality of eggs or alevins, or displacement of recently emerged fry (Shellberg et al. 2010, pp. 630-638; Wenger et al. 2011, pp. 89, 997), and the projected changes in hydrology are expected increase these risks (Bean et al. 2014, p. 523-524; Goode et al. 2013, p. 757). The increases in risk are expected to be highest in those areas that will experience more rain-on-snow events in the future and in confined valleys (Goode et al. 2013, pp. 756, 759). In rain-dominated watersheds, fall and winter flooding is likely to increase in frequency and magnitude and elevate the risks to redds, eggs, alevins, and fry (Halofsky et al. 2011, p. 46).

Climate Change Effects to Water Temperature

Increases in air temperature due to climate change is leading to increases in water temperature, and this will impact bull trout because it is dependent on cold water for all its life stages (between 2°C to 12°C). For example, cool water temperatures during early life history results in higher bull trout egg survival and faster fry growth rates (Pratt 1992, pp. 5–7). Bull trout spawning is also typically triggered when water temperatures drop below 9°C in the fall (McPhail and Baxter 1996, p. 6; WDFW et al. 1997, p. 18; Tennant et al. 2015, p. 1). Climate change is leading to higher overall water temperatures, especially in the summer, which may reduce habitat available below the thermocline in lakes and in headwater areas of rivers. A study of changing stream temperatures over a 13-year period in the Boise River basin estimated an 11 to 20 percent loss of suitable coldwater bull trout spawning and early juvenile rearing habitats (Isaak et al. 2010, pp. 1350–1371). Moreover, warming in lake environments will lengthen the summer period, which may result in shortened spring and fall periods (Shuter and Meisner, 1992. p. 12). If coldwater-dependent fish must remain in suboptimal habitats for longer durations, growth rates could be negatively affected (Burns 1971, pp. 44–57) due to competition for both space and prey resources. Bull trout will likely experience this effect, as fluvial, adfluvial, and anadromous bull trout rely upon seasonal access to prey resources in large rivers, lakes and marine waters, respectively (Shuter and Meisner 1992, p. 11).

As water temperatures within rivers rise, many coldwater-dependent species, including bull trout, may move or migrate to aquatic ecosystems at higher elevations (Hari et al. 2006, entire; Isaak and Young 2023, entire). Climate change can accelerate shifts in species' population distributions (Eby et al. 2014, entire; LeMoine et al. 2020, entire). Bull trout connectivity in mountain watersheds and access to upstream habitat are often limited by natural and artificial barriers (Hari et al. 2006, entire). Changes in water temperature at different elevations can also result in a reduction of range and population abundance (Hari et al. 2006, entire), given bull trout require cold water temperatures, especially in spawning and rearing habitat. While the effects of climate change are generally predicted to be negative, some locations will likely be more resilient than others.

With increasing water temperatures, salmonids have been observed to have increased mortality rates following injuries (Boyd et al. 2010, p. 903; Schisler and Bergersen 1996, pp. 572-575), so it is likely that individual bull trout will experience reduced capacity to recovery from injury as they spend more time in warmer water. Warm water may also stress salmonid immune systems, leading to increased susceptibility to disease, and in turn, increased risk of predation (Sauter et al. 2001, pp. 19-20). Furthermore, some disease-causing organisms that infect salmonids, such as the introduced parasite that causes whirling disease, become more virulent in warmer water (Rahel et al. 2008, p. 555). In combination, these factors are likely to reduce bull trout survival rates.

Where contaminants, such as marine algal toxins, are present within bull trout habitat, it is expected that their toxic effects to bull trout will be magnified by the temperature increase. Cold water fishes, including salmonids, are among the organisms that respond more quickly or more severely to contaminants with increasing temperatures (Patra et al. 2014, pp. 1811-1814; Cairns et al. 1975, pp. 268-274). Concentrations of these toxins that were tolerable in the past may, in the future, lead to some level of risk, and concentrations causing serious health effects may be lower in the future than they have been historically. Although these toxins are expected mostly in marine waters, outside of the action area, they will affect the health of anadromous bull trout that spawn in the action area.

Warming water is also expected to affect interactions between the invasive brook trout and bull trout. Brook trout is native to the eastern United States and has been observed to displace bull trout and hybridize with them. The effects of climate change to brook trout are likely to be similar to the effects to bull trout, but somewhat weaker (Wenger et al. 2011, pp. 995-999). Because both species are likely to be similarly affected, but the effects to bull trout are expected to be more severe, future climate change may offer a competitive advantage to brook trout (Rieman et al. 2007, p. 1562). In other words, even though climate change is expected to be detrimental to brook trout, climate change is also likely to exacerbate the negative effects to bull trout that result from brook trout presence (Davenport 2018, p. 36). Because these negative effects include hybridization, as streams warm, risks to the genetic integrity of the bull trout population will increase.

Climate Change Effects to Trophic Interactions

Climate change is likely to affect the forage (aquatic invertebrates and fish) availability for bull trout. Changes in winter flooding, especially where the hydrological regime shifts from transitional to rain-dominated, will affect populations of aquatic invertebrates, potentially altering the availability of food for bull trout fry. Many of the changes described above will have broadly similar effects to bull trout and other salmonid species, though bull trout are likely to be more sensitive to increases in water temperature and other anadromous salmonids are likely to be more affected by ocean conditions. Because bull trout forage on salmon eggs, carcasses, and fry, negative effects of climate change on salmon will indirectly affect bull trout by reducing the availability of prey. Climate change will also likely cause the decline of forage fish availability in the marine environment, reducing the availability of marine prey for anadromous bull trout.

Climate Change Effects to Marine Habitat Conditions

Anadromous bull trout within the action area will be affected by changes in marine habitat conditions, outside of the action area. Changes include warming water temperatures, alterations in upwelling, hypoxia, and acidification. Sea surface temperatures are rising and the warming is expected to continue, with increases between 2.2 °F (1.2 °C) and 5.4 °F (3 °C) projected for Puget Sound, the Strait of Georgia, and the Pacific Coast between the late 20th century and mid- or late-21st century (Mote and Salathé 2010, p. 16; Riche et al. 2014, p. 41; USGCRP 2017, p. 368). Marine heat waves, such as the 2014-2015 "Blob," have been observed and are likely to be repeated (Bond et al. 2015, p. 3414; Leising et al. 2015, pp. 36, 38, 6; NMFS 2016, p. 5; NMFS 2019), though the nearshore waters used by bull trout are not always affected by widespread marine heatwaves (NMFS 2016, p. 7). Patterns of upwelling, in which cold, acidic, and nutrient rich waters rise from the lower ocean layers to the surface, may be changing, with some evidence for a trend toward shorter, more intense upwelling seasons (Bakun 1990, entire; Bograd et al. 2009, pp. 2-3; Bylhouwer et al. 2013, p. 2572; Foreman et al. 2011, p. 8; Sydeman et al. 2014, p. 78-79; Taboada et al. 2019, p. 95).

Deoxygenation in the marine waters near the action area is likely to affect anadromous bull trout that spawn in the action area. Hypoxic and anoxic events, in which the lack of dissolved oxygen creates a dead zone, have occurred in Puget Sound, in Hood Canal, and along Washington's outer coast (PSEMP Marine Waters Workgroup 2017, p. 22; PSEMP Marine Waters Workgroup 2016, p. 15). These dead zones have expanded into shallower depths and areas closer to shore, and impacts are expected to increase rapidly (Chan et al. 2016, p. 4; Somero et al. 2016, p. 15). Hypoxia is not expected to be a major stressor in the freshwater habitats but does and will continue to affect the coastal marine waters during the summer, when bull trout are present there. The consequences of hypoxic exposure for adult bull trout are not known. It is not clear whether or to what degree salmonids avoid hypoxic areas (Burt et al. 2012, p. 615; Whitmore et al. 1960, pp. 20-23). If bull trout do not or cannot avoid hypoxic waters, they may suffer consequences such as reduced swimming ability or reduction in heart function, as have been observed in other salmonids (Farrell et al. 1998, p. 2183; Gamperl et al. 2001, p. R1759).

Acidification in the marine waters near the action area is also likely to affect anadromous bull trout that spawn in the action area. Acidification results when carbon dioxide in the air dissolves in surface water and is the direct consequence of increasing carbon dioxide emissions (IPCC 2014a, pp. 41, 49). Both the surface and upwelled waters of North Pacific Ocean have become more acidic due to carbon dioxide emissions (Feely et al. 2008, pp. 1491-1492, Murray et al. 2015, pp. 962-963), and this trend is expected to continue (Byrne et al. 2010, p. L02601; Feely et al. 2009, pp. 40-46). Ocean acidification is now expected to be irreversible at timescales relevant to any planning timeframe (IPCC 2014a, pp. 8-9, 49; IPCC 2019, pp. 1-4, 1-7, 1-14). The effects of ocean acidification on bull trout are unknown but may be similar to those observed for other salmonids. For example, pink salmon entering acidified seawater experience reductions in growth and capacity for exercise, likely resulting in lower survival rates (Ou et al. 2015, pp. 953-954). Coho salmon entering acidified seawater experience changes in olfaction and behavior that are likely to reduce their ability to find prey and avoid predators (Williams et al. 2019, p. 970). In the coming decades, bull trout returning from marine waters may suffer from impairments related to hypoxic exposures and ocean acidification, potentially leading to reductions in fitness.

Climate Change Effects on Wildland Fire Frequency and Severity

Climate change will also likely increase the magnitude and frequency of wildland fires, especially in drier areas such as those found east of the Cascade Mountains (Bisson et al. 2003, pp. 216–217). In several studies on the influence of habitat characteristics and their linkages to fire, terrestrial landscapes, and climate (Falke et al. 2015, pp. 313–316; Hessburg and Agee, pp. 30–32), bull trout appeared to have adapted to previous fire disturbances by inhabiting a large area and adapting to changes in their environment. Increases in fire and other forest disturbances can be beneficial to bull trout. For example, increases in disturbances that kill trees will increase the amount of large wood added to streams, which has a variety of benefits including creating hiding cover for bull trout, and creating pools that increase groundwater exchange and hold cool water. Landslides and debris flows following disturbances are also expected to add sediment, gravel, and cobble that are necessary to form appropriate substrates for the complex habitats used for spawning, incubation, and rearing. However, the projected increase in scope and intensity of fires in the future may have a substantial negative impact on bull trout through continued habitat loss, fragmentation of aquatic systems, and the introduction and expansion of exotic and invasive species (Bisson et al. 2003, pp. 218–219).

Climate Change Effects to Bull Trout Abundance and Distribution

As climate change progresses and stream temperatures warm, coldwater refugia will be critical to the persistence of many bull trout populations. Thermal refugia are important for providing bull trout with patches of suitable habitat during migration through or to make feeding forays into areas with greater than optimal temperatures. Large lakes within the range of bull trout will provide continued coldwater refugia and ideal growth conditions under moderate climate change. Localized features, such as groundwater inputs, that also create coldwater refugia may be less subject to the warming that is projected (Baxter and Hauer 2000, p. 1476; Isaak et al. 2016b, p. 4375). However, projected reductions in coldwater refugia for bull trout will likely result in decreases in overall population abundance (Shuter and Meisner, 1992. p. 12). This will also likely put bull trout populations at greater risk from forest fires and other natural disturbances that could further isolate populations and limit their abundance and distribution (Shuter and Meisner 1992, p. 12).

Uncertainties are associated with predictions of the timing, location, and magnitude of future climate change. The intensity of effects will vary based on the region (ISAB 2007, p 7). Several studies indicate that climate change has the potential to affect ecosystems in nearly all streams throughout the range of bull trout (ISAB 2007, p. 13; Battin et al. 2007, p. 6722; Rieman et al. 2007, pp. 1558–1561). Bull trout may not be able to adapt to or avoid the warming of streams and rivers resulting from climate change. Due to the differences in landform and geographic location across the range of bull trout, some populations face higher risks than others. Bull trout in the southern edge of its range, at lower elevation, and/or areas with currently degraded water temperatures are at higher risk of adverse effects from current and future climate change (Dunham et al. 2003, entire) and populations in the northern areas of the species range may expand due to reduced cold-limiting conditions which currently exist (Mochnacz et al. 2022, p. 14).

A patch occupancy model, used to examine spatial and temporal dynamics of populations, indicated that in the Rocky Mountain region, “regional improvements in bull trout status were difficult to achieve in realistic restoration strategies due to the pervasive nature of climate change and the limited extent of restoration actions given their high costs” (Isaak et al. 2022, p. 1). Climate change will likely limit the distribution and core population size of bull trout in the future, increasing the risk of isolating and reducing genetic diversity between core areas. Therefore, losses in connectivity may accelerate the rate of extirpation of local bull trout populations beyond that resulting from changes in stream temperature alone (Rieman et al. 2007, pp. 1559–1560).

In summary, climate change has the potential to profoundly alter the aquatic ecosystems upon which the bull trout depends via alterations in stream flow and timing, stream temperature, and an increase in the frequency and magnitude of catastrophic wildfires in adjacent terrestrial habitats (Bisson et al. 2003). Bull trout will likely experience reduced habitat suitability related to warming; reduced success of reproduction and recruitment related to winter flooding; and more frequent disturbance events that can lead to increased sediment loads, simplification of habitat, and magnified local warming for a period of several years. These same disturbance events can also have beneficial effects, in that they add elements of complex aquatic habitat, such as cobble and large wood, to the affected streams, but the balance of costs to benefits is not clear. Anadromous bull trout may experience health effects due increased toxic effects to contaminants and to hypoxic and acidified conditions in their marine habitats, and all life history forms are likely to experience reductions or shifts in forage availability. Warming water is also expected to affect interactions between the invasive brook trout and bull trout with increasing risk to the genetic integrity of the bull trout population.

As bull trout distribution contracts, patch size decreases, and connectivity is truncated, bull trout populations currently connected may face increasing isolation, which could accelerate the rate of local extinction beyond that resulting from changes in stream temperature alone (Rieman et al. 2007). As climate change progresses and stream temperatures warm, coldwater refugia will be critical to the persistence of many bull trout populations. Due to variations in landform and geographic location across the range of the bull trout, it appears that some populations face higher risks than others. For example, bull trout in areas with currently degraded water temperatures and/or at the southern edge of its range may already be at risk of adverse impacts from current as well as future climate change. In contrast, bull trout in northern latitudes may be more resilient as it is predicted to expand their range as habitat suitability increases in areas currently unsuitable due to cold temperature limitations (Mochnacz et al. 2022, p. 14). However, other factors such as the projected increase in scope and intensity of fires in the future may have a substantial negative impact on bull trout through continued habitat loss, fragmentation of aquatic systems, and the introduction and expansion of exotic and invasive species (Bisson et al. 2003, pp. 218–219).

15.6.1 Expected Climate Change Effects in the Coastal Recovery Unit

Although the availability of spatially explicit climate predictions is limited for the Coastal RU, there are some models that provide insight into the expected future condition of bull trout habitat within specific geographic regions.

Puget Sound Region

In the Puget Sound region, Battin et al. (2007) used a series of linked models of climate, land cover, hydrology, and salmon population dynamics to investigate the impacts of climate change on Chinook salmon habitats within the Snohomish River Basin. Their model results project negative impacts from climate change will be most pronounced in relatively pristine, high-elevation streams in this system. These impacts include higher water temperatures, lower spawning flows, and, most importantly, increased magnitude of winter peak flows within the Snohomish River Basin and in hydrologically similar watersheds throughout the region (Battin et al. 2007).

Although the ultimate impact of climate change on bull trout populations in the Puget Sound region remains uncertain, these results from a species with similar habitat needs indicate that bull trout spawning and rearing areas are particularly vulnerable to future climate change impacts, especially due to the narrow distribution of spawning sites within this and other similar systems. In addition, glacial outburst floods believed to be caused by climate change have negatively impacted known tributary spawning sites in the Puyallup River core area (B. Wright, *in litt*. 2015a). Output scenarios from the recent Climate Shield model by Isaak et al. (2015), which predicts peak summer temperatures in watersheds throughout the range of bull trout, indicate that the Stillaguamish River, Snohomish and Skykomish Rivers, and Chester Morse Lake core areas may be the least likely within the Puget Sound region to have persistent cold water remaining to support juvenile bull trout by 2040 (Isaak et al. 2015).

Associated sea-level rise is also anticipated to exacerbate existing impacts to marine shorelines of Puget Sound. Responses to sea-level rise are expected to include additional shoreline protection efforts to maintain urban and residential infrastructure which will result in additional degradation of habitat.

Olympic Peninsula Region

In the Olympic Peninsula region, climate change is accelerating the rate of glacial retreat in the Olympic Mountains. Reduced glacial runoff contribution to summer streamflow will directly impact stream habitats in bull trout core areas through higher stream temperatures and lower summer base flows (Riedel et al. 2015). Output scenarios from the recent Climate Shield model by Isaak et al. (2015) indicate that the Quinault River and Skokomish River core areas may be the least likely within the Olympic Peninsula region to have persistent cold water remaining to support juvenile bull trout by 2040 (Isaak et al. 2015). As in the Puget Sound region, anticipated responses to sea-level rise are expected to further degrade critical marine nearshore habitats.

Lower Columbia Region

In the Lower Columbia River region, output scenarios from the recent Climate Shield model by Isaak et al. (2015) indicate that, although there will likely be significant reductions in cold water for most core areas, which could lead to local extirpation of some local populations, some cold-water areas will persist within all core areas to support juvenile bull trout by 2040 (Isaak et al. 2015). The Lewis River is water temperature challenged, i.e., bull trout spawning and rearing is likely limited by stream temperature (Hudson 2019).

15.6.2 Effects of Climate Change on Bull Trout Critical Habitat

One objective of the final critical habitat rule was to identify and protect those habitats that provide resiliency for bull trout use in the face of climate change. Over a period of decades, climate change may directly threaten the integrity of the essential physical or biological features of bull trout critical habitat. Protecting bull trout strongholds and cold water refugia from disturbance and ensuring connectivity among populations were important considerations in addressing this potential impact. Additionally, climate change may exacerbate habitat degradation impacts both physically (e.g., decreased base flows, increased water temperatures) and biologically (e.g., increased competition with non-native fishes).

Many of the PCEs for bull trout may be affected by increased water temperatures within the environment. The effects will vary greatly depending on a number of factors which include which toxic substance is present, the amount of temperature increase, the likelihood that critical habitat would be affected (probability), and the severity and intensity of any effects that might occur (magnitude). The ability to assign the effects of gradual global climate change bull trout critical habitat or to a specific location on the ground is beyond our technical capabilities currently.

16 EFFECTS OF THE ACTION: Bull Trout and Designated Bull Trout Critical Habitat

Section 7 implementing regulations found at 50 CFR 402.02 provide that "The effects of the action are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (50 CFR 402.17)."

Bull trout habitat use within the HCP-covered lands is associated with both spawning and rearing (SR), in tributary streams, and foraging, migration, and overwintering (FMO) habitats within mainstem river channels and the lower sections of major tributary streams. Water quality, habitat complexity, and stream productivity (stream biota) are all directly influenced by watershed conditions and riparian processes (Sweeney and Newbold 2014, p. 560). For this analysis, we examine how ongoing HCP implementation affects riparian function and aquatic habitat conditions within the action area, then we relate how these watershed-scale effects are likely to affect bull trout individuals and populations.

16.1 Riparian Management Zones

As described in the project description, the riparian conservation strategies associated with the westside planning units and the OESF are designed to provide ecological functions that are important for creating, restoring, and maintaining aquatic habitats. A primary component of the riparian conservation strategies is the designation of riparian management zones (RMZs). RMZs consist of an interior core riparian buffer, and an exterior wind buffer where applicable. RMZs along fish-bearing waters (Types 1 – 3) are based on an average site-potential tree height (Table 52).

Table 52. Summary of average RMZs for Westside Planning Units and the OESF.

	Westside Units		**OESF**	
Water Types	**Average riparian interior core buffer width**	**Exterior buffer width (where applied)**	**Average (default) interior buffer width**	**Exterior buffer width (where applied)**
Types 1- 2 (state shorelines and fish-bearing streams)	145 ft	100 ft	150 ft	80 ft
Type 3 (fish-bearing streams)	145 ft	0 / 50 ft	100 ft	80 ft
Type 4 (non-fish bearing streams, ≥ 2 ft wide)	100 ft	n/a	100 ft	80 ft
Type 5 (non-fish bearing, < 2 ft wide)	See notes	n/a	See notes	n/a

Notes: All RMZs are measured from the outer margin of the 100-year floodplain. RMZs widths for Type 1-3 are based on a 100-year site-potential tree height. Type 3 waters in Westside units > 5 ft wide may receive an exterior wind buffer of 50 ft, streams < 5 ft wide do not have exterior buffers applied. Type 5 waters in Westside units located on unstable soils may be buffered to protect unstable slopes. In the OESF, Type 5 waters receive an RMZ width necessary to protect identifiable channels and unstable ground.

Assumptions Regarding HCP-Covered Timber Harvest in RMZs vs. Upland Areas

As described in the *Description of the Proposed Action*, over the 10-year period from 2013 through 2022, WDNR reported a cumulative total of over 159,600 acres of timber harvest across all HCP units, indicating an average annual harvest rate of 15,961 acres per year (Table 2). In the Westside planning units (including the OESF), WDNR timber harvest averaged about 14,500 acres per year. In the Westside units, over 80 percent of the reported timber harvest was variable retention harvest (Table 3). In the OESF, the amount of commercial thinning treatments (55 percent) and variable retention harvest (45 percent) is nearly equal (Table 3). Where the timber harvest is variable retention harvest, WDNR generally does not conduct timber harvest within the RMZs, except for road-stream crossings as necessary.

For commercial thinning treatments, WDNR may apply a commercial thinning treatment within the middle or outer zones of the RMZ consistent with the 2006 RFRS guidelines for Type II or Type III thinning (i.e., maintain a RD greater than 35, unless there is a special exemption to allow an RD of 30) (Table 9). However, WDNR reported that for the period from 2012 to 2022, approximately 3,500 acres of RMZs had been thinned to accelerate development of complex forest structure (WDNR 2023, p. 11). This equates to average of about 318 acres of RMZ restoration thinning per year dispersed across the 5 Westside planning units and the OESF combined.

Estimates of WDNR RMZ Compliance

Our estimates of RMZ compliance are derived from implementation monitoring reports prepared by WDNR. WDNR has published several implementation monitoring reports over the period from 2003 through 2024.

Compliance monitoring completed by WDNR in 2006 for the Westside planning units reported that 11 of 61 RMZs (18 percent) were not compliant with minimum RMZ buffer widths (Munzing 2007, p. 16). The majority of RMZs measured in this study (64 percent) had widths that exceeded HCP requirements (Munzing 2007, p. 24). In many examples, the RMZs that failed to meet minimum average width requirements were close to meeting the minimum requirements (e.g., within a few ft.), or, exceeded width requirements in some portions of an RMZ, and did not meet width requirements in other portions of the same RMZ. WDNR concluded that while overall compliance levels were relatively high, the RMZs that were too narrow (4 of 12) provided less than 60 percent of the required width and did not meet the intent of the HCP requirements for protecting streams and habitat (WDNR 2007, p. 25).

WDNR completed a similar compliance monitoring effort in 2007 for the OESF, where they measured 72 RMZs (WDNR 2008, p.16). This assessment found that the average total buffer width (interior and exterior buffers were not differentiated) applied in the OESF was 160 ft for Type 3 streams, 89 ft for Type 4 streams, and 50 ft for Type 5 streams (WDNR 2008, p. 22). All RMZ buffers associated with Type 5 streams were applied in areas with unstable slopes. While the majority of the measured RMZs followed HCP requirements, 29 percent were not (WDNR 2008, p. 22). RMZ buffers on Type 3 streams were mostly in compliance (79 percent), and in many cases exceeded minimum required widths (WNDR 2008, p. 20). Application of RMZs on Type 4 streams was less consistent. Half of the RMZ buffers measured on Type 4 streams had RMZs widths of less than 100 ft (WDNR 2008, p.23).

Subsequent monitoring reports published by WDNR in 2013 and 2023 found that RMZ buffer widths managed for RFRS restoration treatments were equal to or greater than required by the HCP (WNDR 2013, p. 17, WDNR 2023c, p. 14). The 2023 monitoring report noted that while riparian buffer widths were in full compliance, only 70 percent of riparian thinning treatments were in full compliance for meeting down wood requirements (WDNR 2023c, p. 1). The authors noted that errors related to compliance are related to contract administration, and when these issues are discovered, the agency works with contractors to mitigate at the site of the contact error (WDNR 2023c, p. 11).

The Olympic Forest Coalition (OFCO 2023, entire) conducted informal monitoring for WDNR timber sales in the OESF over the period from 2004 to 2022. This assessment included a review of 194 timber sales, 131 implemented from 2004 to 2016, and 63 implemented from 2017 to 2022. One of the objectives of the assessment was to determine if there was a difference in application of RMZs under the 2016 OESF plan, compared to prior years of HCP implementation. While it is not clear how the authors determined what was considered an interior core riparian buffer vs. an exterior wind buffer, they provide estimates of total average RMZs widths applied by stream type (Figure 4).

Table 4: OESF Riparian Buffer Widths, 2004-2022. Source: OFCO Database									
Stream Type	**Expected Buffers, HCP, BiOP**			**Pre-OESF Land Plan *(OFCO Data 2004-16)***			**Post-OESF Land Plan (*OFCO Data 2017-22*)**		
	Interior	Exterior	**TOTAL**	Interior	Exterior	**TOTAL**	Interior	Exterior	**TOTAL**
Type 1	150	150	**300**	80	124	**204**	235	0	**235**
Type 2	150	150	**300**	68	141	**208**	197	10	**208**
Type 3	100	150	**250**	52	123	**173**	112	13	**125**
Type 4	100	50	**150**	40	41	**81**	109	8	**117**
Type 5		50	**50**	17	27	**41**	22	4	**26**

Figure 4. Summary of average RMZ widths applied in the OESF as reported by OFCO (2023, p.3).

Because OFCO (2023) did not report on the methods used to derive these estimates we are not able to compare or verify the estimates presented here. Based on the information presented, it appears that the average RMZ widths for Type 3 streams decreased after 2016 (from 173 ft to 125 ft average), but still exceeded the HCP expected RMZ width of 100 ft. The average width for Type 4 RMZs appears to have increased from 81 ft (below HCP minimum) to 117 ft, which exceeds the HCP width for this type (Figure 4, above).

Application of Exterior Wind Buffers

On the OESF, WDNR reports that when the HCP was first implemented, OESF managers typically applied a single multi-purpose buffer to streams (150 ft for Type 3, 100 ft for Type 4, and buffers for Type 5 sufficient to protect unstable slopes), and the exterior buffers were rarely ever applied (WDNR 2008, pp. 7-8).

In the Westside planning units, we have no recent estimates of how often exterior wind buffers are applied. None of the areas sampled for RMZ compliance by WDNR in 2006 had exterior wind buffers applied (Munzing 2007, pp. 7-8). In 2004, WDNR evaluated a total of 41 streams segments for application of RMZs and exterior wind buffers. Of this sample 11 stream segments did not qualify for wind buffers (Type 3 streams less than 5 ft wide), 22 stream segments did not have exterior buffers, and 8 stream segments (19 percent) had an exterior wind buffer applied (WNDR 2005a, p. 17). This report also included an assessment of windthrow in 20 RMZs without exterior buffers. This assessment found windthrow rates ranged from 0-10 percent in RMZs without wind buffers, and 5 to 60 percent in areas with wind buffers applied (WNDR 2005a, p. 17). The authors note these were qualitative estimates.

Analysis Assumptions Regarding RMZ Management

We note the deficiencies in RMZ compliance reported by WDNR above but assume for the purposes of this analysis that WDNR has corrected the RMZ compliance issues documented through its prior implementation monitoring efforts. We acknowledge that there will be occasions where RMZ management is not 100 percent consistent with HCP requirements, as noted by WDNR in the 2022 annual report (WDNR 2023, p.14). We note that these compliance deviations are site specific, generally limited in scale, and are likely to be immeasurable in effect to the covered species in the context of all HCP-covered activities. Biologically, the difference between a 90 ft buffer vs. a 100 ft buffer on a Type 4 stream are likely to be immeasurable in most instances, and based on the monitoring reports, there appear to many instances where minimum RMZs widths are exceeded, resulting in wider RMZs than required.

Variable Retention Harvest: Based on the above information, we assume that WDNR maintains the full HCP-required RMZs for interior-core riparian buffers as a no-harvest area in locations where there is variable retention harvest in the adjacent uplands.

Commercial Thinning: Based on above information, we assume that WDNR conducts RMZ commercial thinning in full compliance with the RFRS, which maintains an RD of greater than 35, or a minimum of 100 trees per acres, whichever is greater, with no timber harvest allowed within the inner 25 ft of the RMZ. The RFRS only applies to the Westside planning units, it does not apply to the OESF. However, the 2016 OESF forest plan specifies that to maintain shade, WDNR does not thin any area of the interior-core buffer below an average of RD 35 (WDNR 2016a, p. 3-32).

Exterior Wind Buffers: With the exception of one implementation monitoring report (WDNR 2005a), we have no published information to indicate how often or to what extent WDNR has applied exterior wind buffers in the past. Based on the implementation monitoring reports, it appears that WDNR rarely applies exterior wind buffers. As described in the FEIS for the 2016 OESF plan, WDNR expects only 1 percent of the RMZs in the OESF will require an exterior buffer (WDNR 2016b, p. 3-93). In the HCP, WDNR estimated that exterior buffers would be applied on 75 to 85 percent of riparian areas in the OESF (WDNR 1997, p. IV. 118). Based on WDNR monitoring reports this level of application of exterior wind buffers was never applied (WDNR 2008, pp. 7-8). For this analysis, we assume that exterior wind buffers are rarely applied, with the understanding that WDNR will develop a monitoring program to evaluate the effectiveness of the wind risk modelling to reduce the need for exterior buffers (Appendix A – *Correspondence with WDNR*).

16.1.1 Background Information – Sources of Large Wood Recruitment

A primary objective of RMZs is to provide for large wood recruitment to stream channels. Large wood in streams enhances the quality of habitat for salmonids and contributes to channel stability (Bisson et al. 1987, p. 143). It creates pools and undercut banks, deflects stream flow, retains sediment, stabilizes the stream channel, increases hydraulic complexity, and improves productivity (Murphy 1995, pp. 23-24). Research into wood recruitment from stream-adjacent areas in the Pacific Northwest indicates that up to 70 percent of wood pieces recruited from mature conifer forests, and 90 percent of the wood from mature hardwood forests, originates from within 15 meters (50 ft) of the stream bank (McDade et al. 1990, p. 330). Source distances of 20 meters (66 ft) and 30 meters (100 ft) correspond with 80 and 90 percent of the total recruitment, respectively, for woody debris from mature conifer forests (McDade et al. 1990, p. 330).

In areas with steep terrain, landslides and debris flows are also important mechanisms for delivering large wood from hillslopes to streams (Reeves et al. 2003, p. 1363, Benda et al. 2005,

p. 835). Benda et al. (2005, pp. 845-846) suggest that in managed forest landscapes, there is increased delivery (via debris flows) of residual large wood in the decades following the harvest of old-growth stands, but these processes are likely to give way (over decades) to smaller debris flows carrying smaller wood pieces. Debris flow deposits assume a greater relative importance in logjam formation in managed forests due to the inability of small, locally recruited wood from young riparian forests to provide stable foundations for logjam development (Benda et al. 2005, p. 845).

While recruitment of large wood from landslides is important, the primary mechanism for wood recruitment to channels is through bank erosion and windthrow. Long (1987) studied large-wood recruitment mechanisms for an entire fourth-order basin in the Oregon Coast range with a history of active mass wasting, logging, and fire. Near-stream riparian sources contributed 41 percent of large-wood pieces by windthrow and 19 percent by bank cutting, while landslides contributed only 2 percent.

Effects of HCP Implementation on Large Wood Recruitment

In the Westside planning units, the HCP-defined RMZs for all fish-bearing streams are based on a 100-year site-potential tree height or a minimum of 100 ft, whichever is greater. By providing an RMZ that is based on the average height of mature trees, the HCP required RMZs provide for nearly 100 percent of potential sources for large wood that could be recruited to a stream channel. In the OESF, there are similar RMZ requirements for fish-bearing streams, except for Type 3 streams, which have a minimum RMZ width of 100 ft. Based on the literature review provided above, a 100 ft wide RMZ is expected to provide for at least 90 percent or more of available large wood sources for potential recruitment to stream channels. As noted above, average RMZ widths on the OESF for Type 3 streams typically exceeded the minimum 100 ft RMZ width. Similar conclusions can be drawn regarding the minimum 100 ft RMZ width for Type 4 non-fish bearing streams in both the Westside planning units and the OESF, a 100 ft RMZ provides for over 90 percent of potential wood sources recruited to streams.

Similarly, the protections for unstable slopes and the application of RMZs for Type 5 streams that will retain forests on the sites deferred from regeneration timber harvesting and will maintain future sources of large wood for potential delivery to downslope areas in the event of future landslides or debris flows.

Commercial thinning in RMZs for riparian restoration treatments is a minor component of overall HCP-management, representing less than 10 percent of the average commercial thinning acres harvested annually. For example, on the OESF from 1997 to 2020 (23 years), WDNR estimated 317 acres of riparian restoration thinning had been completed within 50 Type 3 watersheds, representing about 5 percent of the total riparian area in those watersheds (WDNR 2022b, p. 16).

Thinning young conifer stands in RMZs can result in a slight reduction in potential wood recruitment that occurs through natural tree mortality. However, the thinning prescriptions for Type II or Type III retain a high relative density of trees (RD 35, or 100 tpa, whichever is greater) which maintains a high level of potential wood sources in managed RMZ segments.

Because RMZ restoration treatments occur at levels that are far below the estimated 1 percent per year listed in the 2006 RFRS, we conclude that riparian restoration thinning likely has minor effects to large wood recruitment and is likely to accelerate development of riparian forest characteristic to meet the desired future condition for RMZs.

Overall, riparian enhancement treatments are expected be beneficial to future large wood recruitment. Type II and III treatments do cause a temporary reduction in riparian tree density and potential large wood recruitment, but the post treatment condition of acceleration of overstory conifers in conjunction with retaining snags, down wood, and remnant trees will ultimately lead a higher quality, diameter, density, and ecological function of wood that will be recruited into the stream in the long term. Conifer release and conifer conversion results in a short-term loss of wood recruitment by reducing riparian hardwood density but would promote the growth of large conifers that would provide greater ecological benefit and longevity for large wood in the future.

In summary, we conclude that the effects of HCP implementation on providing riparian function for large wood input to streams, when conducted in full compliance with HCP requirements, will maintain or restore ecological function of RMZs to provide for large wood recruitment to streams in over 95 percent of RMZ management applications. The only exceptions are instances of conifer conversion, harvest of "allotted acres" in the OESF, and locations where road-stream crossings are required. These exceptions are a minor component of RMZ management under the HCP.

Summary of HCP Effects to Large Wood Recruitment

WDNR reported the status and trends monitoring of riparian and aquatic habitat in the OESF for the period from 2013-2020 (WDNR 2022b). The monitoring is designed to characterize habitat conditions of Type 3 streams on WDNR-managed lands across the OESF, compared to conditions in "reference watersheds" where at least 80 percent of the watershed area has never been harvested (WDNR 2022b, p. 13). While this monitoring is specific to the OESF, the trends detected there are likely reflective of general trends elsewhere on HCP-covered lands.

Comparing the percentage of in-stream wood pieces by decay class and diameter class for WDNR-managed and reference watersheds, the distribution is generally similar for diameter classes up to 32 inches (80 cm). However, for the largest diameter class (≥32 in. (80 cm); 80 percent of pieces in WDNR-managed watersheds are in advanced decay classes 3 and 4 whereas only 45 percent of pieces in reference watersheds are in decay classes 3 and 4 (WDNR 2022, p. 35). This implies that streams in the reference watersheds have received more recent inputs of large-diameter logs, as 55 percent of the pieces in that diameter class are only in decay classes 1 and 2. This is likely a result of the residual effects of historical riparian timber harvest practices which removed most of the mature riparian forest in the OESF (WDNR 2022, p. 35).

The frequency of in-stream wood pieces was compared among streams based on the count of pieces per 328 ft (100 m) of stream. In the 50 WDNR managed watersheds, the overall average frequency of in-stream wood was 49.1 pieces per 328 ft (100 m) (WDNR 2022b, p. 28). Frequency of in-stream wood in the 12 reference watersheds averaged 48.8 pieces per 328 ft

(100 m). In the 50-WDNR managed watersheds, the overall average diameter of in-stream logs was 15.3 in. (38.9 cm) compared to a mean of 15.2 inches in the reference watersheds (WDNR 2022b, p. 32).

Between 2013 and 2020 there was a slight decrease in average wood diameter. This decrease in average diameter is likely a result of the addition of new, small-diameter pieces of wood to streams in recent years, particularly red alder (WDNR 2022b, p. 31). It is less likely that the observed decrease in average diameter is caused by decay or loss of large-diameter pieces, as large conifer logs in streams decay relatively slowly. Long-term, the diameter of trees in the riparian forest will ultimately determine the range of log sizes in streams, as discussed in depth by Martens et al. (2020).

Although WDNR observed short-term fluctuations of in-stream wood frequency in the WDNR-managed watersheds, the more advanced decay of wood in the largest diameter class—relative to that of unmanaged watersheds—suggests a reduced supply of large-diameter pieces in recent decades (WDNR 2022b, p.35). The simplest explanation for the decrease is that historical harvest of riparian forests—prior to the initiation of riparian forest protections in the 1980s and 1990s—interrupted the historical cycle of large wood input to streams. In-stream wood in second-growth forests has a greater proportion of alder than in-stream wood of old-growth forests (Bilby and Ward 1991). This shift from old-growth, conifer-dominated riparian forests to younger riparian forests with more red alder appears to have significant implications for the amount and size of wood entering streams over time (Martens et al. 2020). The effects of legacy riparian management practices are likely to continue to persist for decades, but these conditions are gradually improving as young forests in RMZs grow and mature over time.

Effects of HCP Implementation on Large Wood Recruitment in Bull Trout Habitat

As previously described in the *Environment Baseline*, the condition of bull trout habitat in the action area is degraded in many locations due to historical timber harvest that removed old-growth forest from over 80 percent of the landscape in western Washington. As described above, these legacy effects have resulted in a reduction in the abundance of habitat-forming large wood pieces in streams, simplified instream habitat conditions with fewer pools and cover for rearing and reduced primary productivity in many streams. Clear-cut timber harvesting in RMZs along fish-bearing streams is a historical practice that rarely occurs on WDNR HCP-covered lands since 1997, or on private lands in Washington managed under the Washington Forest Practices Rules since 2001. The only exceptions are hardwood conversions (which can clear hardwood trees to within 25 ft of the edge of the floodplain). Hardwood conversions continue to occur for riparian restoration purposes but are uncommon relative to other RMZ management activities.

All of the known, occupied bull trout streams that occur on the WDNR HCP-covered lands are classified as Type 1 or Type 2 streams. There may be a few exceptions where bull trout occur in Type 3 streams on WDNR-managed lands, but none that we have identified. The Type 1 and Type 2 RMZs adjacent to occupied bull trout streams are the most protective provided under the HCP, offering the greatest protection for potential large wood recruitment. These larger streams and rivers often occur in productive areas resulting in wider site-potential tree height buffer widths. The RMZ begins at the outer margin of the 100-year floodplain, and on major streams such as the Hoh River in the OESF, the floodplain can extend outward from the active channel for several hundred feet (WDNR 1997, p. IV. 58). In 1997, WDNR estimated that Type 1 and Type 2 streams represented less than 5 percent of the stream miles on WDNR-managed lands (WDNR 1997, p. IV-59). This estimate is consistent with our current estimates of the distribution of bull trout habitat associated with WDNR-HCP covered lands. As summarized in the Table 51, only about 5 percent of the total available spawning and rearing habitat, and 5 percent of the total available FMO habitat associated with bull trout core areas in western Washington is located on WDNR HCP-covered lands.

Considering the wide natural variability of instream large wood across the action area through time, the reduction in large wood recruitment associated with limited riparian restoration thinning, or conifer conversion treatments is so minor as to be insignificant in terms of measurable effects to bull trout habitat, and by extension to individual bull trout. In stream-adjacent areas that are currently dominated by young conifer plantations, Type I or Type II restoration thinning will have long-term beneficial effects for riparian functions. Under the HCP, the condition of RMZs along all fish-bearing streams is expected to improve as trees are left to mature, thereby increasing average tree size, and providing future sources of large wood. The short-term effects of the HCP on large wood input to individual stream segments affected by hardwood conversion, in terms of effects to bull trout habitat is immeasurable, while the long-term effects of RMZ restoration thinning treatments are likely to be beneficial in meeting desired future conditions.

16.1.2 Background Information – Riparian Influences on Stream Temperature

Riparian vegetation is one of the most important factors controlling water temperature in streams, especially during summer months (Everest and Reeves 2007, p. 10). The effect of riparian vegetation on stream temperature varies by stream size and season of the year. Small, forested streams that are heavily shaded by riparian vegetation are most strongly influenced by riparian forest conditions. The water temperature of large rivers is less affected by riparian vegetation. Most available solar radiation reaches the surface of large streams, but diel temperature variations are minimized by stream depth and volume of flow (Everest and Reeves 2007, p. 11). Changes in the density of riparian vegetation along large rivers have less effect on aquatic biota than along small or mid-size streams. Most benefits of shading by streamside vegetation are derived within about 30 m (98 ft) of streams although distance varies by stream size and topographic features (Everest and Reeves 2007, p. 11).

Timber harvesting can increase solar radiation in the riparian zone as well as wind speed and exposure to air from clearings, typically causing increases in summer air, soil, and stream temperatures and decreases in relative humidity (Moore et al. 2005, p. 813). Stream temperature increases following forest harvesting are primarily controlled by changes in riparian shade but also depend on stream hydrology and channel morphology (Moore et al. 2005, p. 813). No-cut riparian buffers can decrease the magnitude of stream temperature increases and changes to riparian microclimate. A review by Sweeney and Newbold (2014, p. 576) concluded that riparian buffer widths of 20 m (66 ft) or wider keep stream temperatures within 2°C of a fully forested watershed, but full protection from measurable temperature increases is not assured unless buffer width exceeds 30 m (98 ft).

In addition to direct shading, the microclimate surrounding streams and riparian zones also may affect stream temperatures. Specific features of microclimate (e.g., soil moisture, solar radiation, soil temperature, air temperature, windspeed, and relative humidity) are influenced by edge effects from adjacent clearcut timber harvesting (Chen et al. 1995). Maintenance of air temperature and windspeed, factors that can influence stream temperatures, may require a buffer width >100 m (328 ft) to maintain riparian forest microclimates (Everest and Reeves 2007, p. 12). One of the few studies to measure the microclimate gradient within stream buffers found that, in western Oregon, the microclimate gradient from the stream to the edge of the 100-ft (30-m) forested buffers was similar to the gradient in unharvested stands (Rykken et al. 2007, p. 270). The authors proposed that the lack of a significant edge effect from adjacent clearcut harvest was a result of the stream's influence on microclimate in the riparian zone, which extended out to a distance of 20 m (66 ft) from the stream (Rykken et al. 2007, p. 278).

The amount of total watershed area harvested is also correlated with increased stream temperature. A comparative study in the Hoh River basin found that water temperatures in small streams were more likely to exceed a summer maximum temperature of 16˚C (60.8 ˚F) as the total area harvested (within the past 40 years) increased above 50 percent of the subwatershed area (Pollock et al. 2009, p. 151).

The influence of timber harvest along headwaters streams on downstream temperatures is complex. Janisch et al. (2012) evaluated water temperature in response to different timber harvest treatments along headwater streams on WDNR- managed lands in southwest Washington. In the first year after logging, daily maximum temperatures during July and August increased in clearcut catchments by an average of 1.5 ˚C, in patch-buffered catchments by 0.6 ˚C, and in continuously buffered catchments by 1.1 ˚C (Janisch et al. 2012, p. 302). Temperature responses were highly variable within treatments. The analyses showed that the amount of canopy cover retained in the riparian buffer was not a strong explanatory variable. Instead, the type of stream (intermittent or perennial), and stream substrate were important factor for temperature response. Streams with longer surface-flowing extent above the monitoring station and streams with substantial stream-adjacent wetlands, both of which were usually characterized by fine-textured streambed sediment, were thermally responsive. Overall, the area of surface water exposed to the ambient environment was the strongest predictor for measurable temperature response (Janisch et al. 2012, p. 312).

Effects of HCP Implementation to Stream Temperature

Based on the literature review provided above, an RMZ buffer width that is ≥ 100-ft with mature forest is expected to provide 100 percent of the streamside shade sources required to maintain stream water temperature. Under the HCP, all RMZs for Type 1 through Type 4 streams meet or exceed this width. The only exceptions to this are limited RMZs associated with Type 5 streams. Type 5 streams only receive RMZ buffers where they are located on unstable slopes.

Type 5 streams are non-fish bearing streams that are less than 2 ft wide. These streams can be perennial, or ephemeral depending on where they are located. We expect that based on the findings of Janisch et al (2012, p. 302) and Gomi et al. (2006, p. 1) that Type 5 perennial streams harvested without the application of an RMZ buffer can lead to measurable increases in water temperature downstream of the timber harvest area. Gomi et al (2006, p. 10) noted that riparian buffers of 10 m to 30 m wide along headwater streams appeared to be effective in minimizing stream temperature increases.

To estimate the amount of the stream network that may be subject to timber harvesting without RMZs in bull trout watersheds, we used WDNRs GIS data for stream types and mapped LTFC to estimate the proportion of Type 5 streams that are located within mapped RMZs or other deferrals.

In bull trout core areas, Type 5 streams represent 32 percent of the total streams located on the HCP-covered lands. At the scale of all bull trout core areas, approximately 63 percent of the Type 5 streams are located within areas of mapped LTFC (e.g., unstable slopes, RMZs, and other deferrals, such as murrelet conservation areas) (Table 53). Based on this analysis, up to 37 percent of the Type 5 streams may be subject to timber harvest with minimal or no RMZ buffers (1,581 miles of streams). The Queets River and Hoh River core areas in the OESF have the highest percentage of Type 5 streams located within LTFC (79 percent and 69 percent). As noted above, the Type 5 streams that are most sensitive to temperature increases from forest management are streams with perennial flow. We have no estimate for the portion of Type 5 waters that support perennial flow.

Table 53. Total stream miles by stream type on WDNR HCP-covered lands located within bull trout core areas.

Bull Trout Core Area / Region	**Types 1, 2, or 3 streams (miles)**	**Type 4 streams (miles)**	**Type 5 streams (miles)**	**Type 5 Streams within mapped LTFC (miles)**	**Percent of Type 5 streams within mapped LTFC**	**Total stream miles on HCP-covered lands**
Dungeness River	22	18	18	8	44%	58
Elwha River	23	63	51	22	44%	137
Hoh River (**OESF**)	235	310	305	209	69%	850
Queets River (**OESF**)	524	645	639	505	79%	1,808
Quinault River	2	1	2	1	38%	5
Skokomish River	8	5	8	3	39%	20
Olympic Region total stream miles	**814**	**1,042**	**1,023**	**748**	**73%**	**2,880**
Percent of total stream miles	**28%**	**36%**	**36%**	**~**	~	100%
Chilliwack River	9	64	30	18	60%	104
Lower Skagit River	261	971	483	227	47%	1,716
Nooksack River	189	914	434	242	56%	1,538
Puyallup River	3	5	6	3	50%	14
Snohomish & Skykomish Rivers	564	1458	892	543	61%	2,913
Stillaguamish River	326	761	423	205	49%	1,510
Puget Region totals stream miles	**1,353**	**4,173**	**2,269**	**1,238**	**55%**	**7,794**
Percent of total stream miles	**17%**	**54%**	**29%**	**~**	~	100%
Lower Columbia (Lewis River)	152	504	361	178	**49%**	**1,017**
Percent of total stream miles	15%	50%	36%	~	~	100%
Total stream miles (all core areas on HCP covered lands)	**2,981**	**6,258**	**4,316**	**2,734**	**63%**	**13,334**
Percent of total miles	**22%**	**46%**	**32%**	**~**	**~**	**100%**

Notes: Source: WDNR GIS data (2023) for streams and water-type classifications and mapped LTFC (timber harvest deferrals). Streams represented in this data include all streams. Most of the streams identified in this table are not known to support bull trout but are tributary streams within bull trout core areas.

In bull trout shared FMO watersheds areas, Type 5 streams represent 35 percent of the total streams located on the HCP-covered lands. At the scale of all bull trout shared FMO areas, approximately 59 percent of the Type 5 streams are located within areas of mapped LTFC (Table 54). Similar to bull trout core areas, shared FMO watersheds in the OESF have high percentage of Type 5 streams in LTFC (e.g., Kalaloch Creek – 80 percent). Based on this analysis, up to 41 percent of the Type 5 streams may be subject to timber harvest with minimal or no RMZ buffers (236 miles of streams).

Table 54. Total stream miles by stream type on WDNR HCP-covered lands located within bull trout shared FMO areas.

Bull Trout Shared FMO Area / Region	**Stream Types 1, 2, or 3 (miles)**	**Stream Type 4 (miles)**	**Stream Type 5 (miles)**	**Stream Type 5 within mapped LTFC (miles)**	**Percent of Type 5 Streams within mapped LTFC**	**Total stream miles on HCP-covered lands**
Bell Creek	0.0	0.9	0.5	0.3	55%	1.4
Goodman Creek **(OESF)**	90	60	86	63	74%	236
Humptulips River	14	10	13	6	48%	37
Kalaloch Creek **(OESF)**	35	48	48	38	80%	131
Lower Chehalis River	86	27	56	29	52%	168
Moclips/Copalis Rivers	13	0	9	5	56%	22
Morse Creek	71	94	86	39	45%	250
Wishkah River	0.7	1.7	1.2	0.8	65%	3.6
Olympic Region total stream miles	**309**	**241**	**299**	**181**	**61%**	**848**
Olympic Region percent of stream miles	36%	28%	35%	~	~	100%
Lake Washington	24	102	69	50	73%	194
Lower Green River	18	78	52	26	50%	148
Lower Nisqually River	88	65	103	62	60%	255
Samish River	19	136	53	20	39%	207
Puget Sound region total (stream miles)	**149**	**379**	**276**	**158**	**57%**	**805**
Puget Sound region percent of total miles	18%	47%	34%	~	~	100%
Total stream miles (all shared FMO areas with HCP-covered lands)	**458**	**620**	**575**	**340**	**59%**	**1,653**
Percent of all stream miles	28%	38%	35%	~		100%

Notes: Source: WDNR GIS data (2023) for streams and water-type classifications and mapped LTFC (timber harvest deferrals). Streams represented in this data include all streams. Most of the streams identified in this table are not known to support bull trout but are tributary streams within bull trout core areas.

The RMZs for Type 1-4 streams are likely to provide a high level of shade and temperature regulation function to larger streams. However, to achieve 100 percent function for temperature regulation along small forest streams, a no-cut buffer of at least 30 m (98 ft) would be required for all streams, including perennial headwater streams (Gomi et al. 2006, p. 10, Everest and Reeves 2007, p. 11).

WDNR monitored stream temperatures in 50 Type 3 watersheds in the OESF from 2013-2020 (WDNR 2022b). The stream temperature metric used for regulatory thresholds is the maximum 7-day average of the daily maximum temperature (7-DADmax). This is the average of peak daily temperatures during the 7-day period of the year when those peak temperatures have the highest average. The threshold 7-DADmax temperature used by relevant to the 50 monitored WDNR-watersheds is the 16.0 °C (61 °F). The 16.0 °C threshold applied to core summer salmonid habitat in WAC 173-201A-200) (Figure 5).

Table 200 (1)(c)
Aquatic Life Temperature Criteria in Fresh Water

Category	Highest 7-DADMax
Char Spawning and Rearing*	12°C (53.6°F)
Core Summer Salmonid Habitat*	16°C (60.8°F)
Salmonid Spawning, Rearing, and Migration*	17.5°C (63.5°F)
Salmonid Rearing and Migration **Only**	17.5°C (63.5°F)
Nonanadromous Interior Redband Trout	18°C (64.4°F)
Indigenous Warm Water Species	20°C (68°F)

*Note: Some streams have a more stringent temperature criterion that is applied seasonally to further protect salmonid spawning and egg incubation. See (c)(iv) of this subsection.

Figure 5. Aquatic life temperature criteria defined by the Washington State Department of Ecology in WAC 173-201A-200.

Core summer salmonid habitat characteristics are criteria to support summer (June 15 - September 15) salmonid spawning or emergence, or adult holding; use as important summer rearing habitat by one or more salmonids; or foraging by adult and subadult native char (bull trout). Other common characteristic aquatic life uses for waters in this category include spawning outside of the summer season, rearing, and migration by salmonids (WAC 173-201A-200 (1)(a)(ii)).

On the OESF, 7-DADmax averaged 14.4 °C across the WDNR-managed watersheds, with a maximum of 16.4 °C (WDNR 2022b, pp. 76-77). Among the reference watersheds, 7-DADmax averaged 15.0 °C with a maximum of 16.7 °C. The slightly warmer temperatures in the reference watersheds may have been influenced by higher average solar exposure of south-facing watersheds. For the WDNR-managed watersheds, there were 329 observations of 7-DADmax in the analysis; of these, less than 5 percent of observations exceeded the 16.0 °C threshold for core summer salmonid habitat (WDNR 2022b, p. 76).

Among the natural factors tested as predictors of stream temperature, year, watershed solar exposure, and bedrock substrate were all found to influence 7-DADmax. Average 7-DADmax varied among years, ranging from a low of 14.1 °C in 2013 and 2019 to a high of 14.9 °C in 2015 (WDNR 2022b, p. 77). WDNR also evaluated whether the percentage of unharvested forest in a watershed influenced water temperature. In contrast to the results reported by Pollock et al (2009), the WDNR analysis found that streams draining watersheds dominated by unharvested forest were not cooler than streams draining WDNR-managed watersheds containing a mosaic of forest stand conditions (WDNR 2022b, p. 81). The primary factors influencing water temperature in these watersheds was solar exposure and bedrock substrate.

In the OESF study sites, there was little variation in the level of available stream shade. With the exception of one reach that had 67 percent shade, all of the reaches in WDNR-managed watersheds fell within a range of 85 to 100 percent shade. Due to the high level of available shade in the study areas, stream shade was not the primary factor influencing water temperature (WDNR 2022b, p. 79). The consistently high degree of stream shading in WDNR-managed watersheds is apparently a result of HCP implementation of RMZs. The stream buffers, combined with the maritime climate, are likely the key reasons why the monitored streams remained relatively cool in summer in the OESF. Monitoring riparian microclimate gradients in the OESF yielded similar results – canopy shade was not a strong predictor in observed microclimates because all sites monitored had high level of over-story canopy cover (87 – 98 percent (WDNR 2022b, p. 87).

Background Information - Effects of Stream Temperature to Bull Trout

A well-documented facet of bull trout biology is the species' requirement for cold water. Bull trout require a narrow range of cold temperature conditions to reproduce and survive and are regarded as having one of the lowest temperature tolerances among salmonids (Selong et al. 2001 p. 1032). Species, such as bull trout, that have a narrow thermal "niche" are likely to be affected by even small increases in stream temperatures, particularly summer maximum temperatures (Dunham et al. 2003, p. 901). The metabolism of fishes increases with temperature up to an optimum temperature level, above which metabolism decreases (Lagler et al. 1977, p. 157). For bull trout, optimal temperatures for growth and development are in the range of 10 ˚C to 14 ˚C (Selong et al. 2001, p. 1033). As temperatures increase above 16 ˚C, bull trout begin to experience thermal stress in the form of reduced growth rate and reduced food consumption, and these functions rapidly decline as water temperature increases above 16 ˚C. At temperatures greater than 21 ˚C, bull trout survival declines, as fish become thermally stressed to the point that they stop feeding (Selong et al. 2001, p. 1033). Because metabolic costs rise exponentially with temperature, even small decreases in feeding and growth can lead to reduced competitive ability and disease tolerance (Selong et al. 2001, p. 1033).

The temperature requirements of bull trout vary by life-cycle stage, with the young generally being most sensitive to increases in the temperature of their environment (Buchanan and Gregory 1997; Johnson and Jones 2000), while adults are more sensitive to changes in the amount and distribution of thermal refugia as a result of changes in stream temperatures. Thermal refugia is primarily found at the confluence of small or moderate tributaries with larger, more-productive streams, in deep pools, or in areas of hyporheic or groundwater upwelling.

Spawning areas are often associated with cold-water springs, groundwater-infiltration sites, and streams with the coldest summer temperatures (Pratt 1992; Rieman and McIntyre 1993; Rieman et al. 1997; Baxter and Hauer 2000). It is well-documented that spawning is initiated as temperatures drop to 9 degrees C or lower and increases in temperature during that period can interrupt or postpone spawning activity (Ratliffe and Howell 1992; Sexauer and James 1993; Brenkman 1998; Kraemer 1994). In areas where streams freeze in winter, spawning in groundwater-infiltration areas may actually ensure that the incubating eggs in the gravel remain in relatively constant cold water with little diel fluctuation and are not affected by anchor ice. Survival of bull trout eggs incubated at 2, 4, 6, 8, and 10 degrees C varies and is highest at 2 and 4 degrees C with mortality sharply increasing above 6 degrees C (McPhail and Murray 1979).

Juvenile bull trout survival, growth, and distribution are strongly influenced by water temperature. Numerous studies indicate that juvenile bull trout are associated with cold water and this relationship is most likely a very critical one (McPhail and Baxter 1996). Juvenile fish move far less than sub-adult or adult fish and tend to reside in the same stream segments or local stream networks for several years. Because juvenile bull trout tend to reside in the same area for a number of years, usually in headwater streams, increases in temperature could decrease the amount of thermally suitable habitat within their limited home range (McPhail and Baxter 1996; Rieman and Chandler 1999). Juvenile bull trout are rarely found at temperatures exceeding 15 degrees C (Rieman and McIntyre 1993; Buchanan and Gregory 1997). In their study, Saffel and Scarnecchia (1995) suggest that high water temperatures may be physically constraining to bull trout. This is supported by the findings of McPhail and Murray (1979) where bull trout fry grew larger and had better survival at low water temperatures (4 degrees C).

Adult bull trout can tolerate short-term exposures to temperatures above 20 ˚C during migration (Swanberg 1997, p. 742, Howell et al. 2010, p. 96), but temperatures in this range are clearly above optimal levels for this species. In some cases, where stream temperatures are unfavorable, bull trout may seek thermal refugia associated with stream confluences (Swanberg 1997, p. 742), while in other instances, thermal refugia may not be available, and the fish must migrate through habitats where temperatures are well above optimal levels (Howell et al. 2010, p. 103). The population effects of the relatively warm water temperatures experienced by some migratory bull trout are unknown but may be linked to overall low populations of bull trout in watersheds that are highly altered by land management practices (Howell et al. 2010, p. 104).

Summary of Expected Temperature Effects to Bull Trout from HCP Implementation

In summary, bull trout are highly sensitive to increases in water temperature. Slight increases in water temperature can affect bull trout growth, metabolism, and reproduction. The relationship between upland timber harvest and increases in stream water temperature are highly complex. Based on the literature review presented above, we conclude that the RMZs applied for Type 1 through 4 streams are sufficient to maintain stream shade and riparian microclimates under most circumstances. Monitoring of water temperature on the OESF in Type 3 streams indicated that summer exceedance of 16 ˚C occurred less than 5 percent of the time, and that observed temperature exceedances were related to watershed orientation (e.g., south facing) rather than stream shading. With climate change, the frequency of temperature exceedances is likely to increase, but the degree to which upland timber harvest on WDNR lands may influence the rate or frequency of temperature exceedances is unknown.

The RMZs provided by the HCP are expected to maintain temperature in most cases. The greatest risk for temperature increases from HCP-covered activities is timber harvest along headwater streams (Type 5) where no RMZ buffer is required. As noted above (Table 54), approximately 1,581 miles (37 percent) of the Type 5 streams within bull trout core area watersheds are not located in areas with mapped LTFC and may be subject to regeneration timber harvest. The Type 5 streams that are most sensitive to temperature changes are perennial streams with fine-textured stream sediments (Janisch et al. 2012, p. 302). We do not have information to quantify the number of Type 5 streams that are perennial vs. ephemeral, etc., or to what extent occupied bull trout habitat may be influenced by temperature increases associated with timber harvesting along Type 5 streams. However, given the total extent of Type 5 streams without mapped RMZ buffers in bull trout core areas (1,582 miles), we conclude that bull trout are likely to be exposed to increased summer temperatures in some instances. These effects would be local to specific sites and are likely to subside relatively quickly as forests regenerate in the harvested areas.

Forest management activities that increase stream water temperatures are considered to be a significant habitat modification, which can result in both direct and indirect effects to bull trout by causing thermal stress. Thermal stress is a sublethal effect which can lead to reduced feeding, growth, and survival of individual bull trout, and even minor increases in water temperature reduce the quality of stream habitat to provide thermal refugia and support healthy populations of other salmonids that provide prey for bull trout.

16.1.3 Water Quality Contamination – Application of Herbicides

WDNR uses herbicides for vegetation management and site preparation purposes (WDNR 1997, p. IV.206). Big-leaf maple, red alder, and other native shrubs are considered undesirable in areas targeted for establishment of conifer stands. In addition to site preparation, herbicides may be used to control invasive, non-native plants. Invasive plants create a host of adverse environmental effects including displacement of native plants, reduction in habitat and forage for native species, increased soil erosion, reduced water quality, and reduced soil productivity (USFS 2005, p. 1-1). Degraded water quality associated with herbicide applications within or adjacent to stream channels can occur as a result of overspray, foliar rinse by rainfall, erosion, leaching, and site inundation.

Effects of HCP Implementation on Water Quality – Herbicide Applications

The HCP-covered activities include aerial spraying of herbicides for site preparation. WDNR reported that the five-year average for herbicide applications for the period from 2018 – 2022 was 9,164 acres for the Westside planning units and the OESF (WDNR 2023a, p. 31). Aerial applications average about 3,200 acres per year, and ground-based applications average about 6,000 acres per year. In addition to site preparation, WDNR applied an average of 2,200 acres of herbicide per year for vegetation management purposes (WNDR 2023a, p. 31). The application of herbicides for HCP-covered activities follows the Washington Forest Practices Rules for application of forest chemicals (WAC 222-38-020). These rules require a no-spray buffer adjacent to streams and wetlands that is equivalent or greater than the width of the HCP-defined RMZs, for aerial applications. WAC 222-38-040 prohibits direct entry of forest chemicals into waters or wetlands, except segments of non-fish bearing streams with no surface water present.

Application of forest herbicides may cause adverse effects to fish that are exposed either through accidental application to waters via aerial drift, overspray, or runoff from unbuffered stream segments or roadside ditches that are connected to streams. Herbicides commonly used in Washington forestry site preparations include glyphosate, triclopyr, picloram and 2,4-D. Acute (short-term) exposures to high concentrations of these herbicides can result in direct mortality in fish, while chronic (long-term) exposures at low concentrations can result in sublethal effects including impaired growth rates and impaired olfactory function (Tierney et al. 2006, p. Fairchild et al. 2007, p. 1, Fairchild et al. 2008, p. 623). Under most application scenarios, when herbicides are applied at the recommended rates, and no-spray buffers are adhered to, the actual concentrations of herbicide reaching streams are well below concentrations that would result in adverse effects to fish (Fairchild et al. 2007, p. 1).

Effects of Herbicide Applications to Bull Trout

For this analysis, we are using exposure risk to glyphosate to represent risks to fish associated with the forest herbicides. Glyphosate has been extensively studied and is commonly used by state and federal agencies within riparian areas and within streams to treat infestations of the highly invasive Japanese knotweed. Although glyphosate is less toxic to fish than 2,4-D or triclopyr in terms of concentrations that lead to direct mortality of fish, salmonids are sensitive to low concentrations of glyphosate which can impair olfaction from brief exposures at low concentrations (Tierney et al. 2006, p. 2809).
Acute exposure to low concentrations of glyphosate can result in sublethal effects to salmonids in the form of impaired olfactory function, which is a critical physiological function in salmonids, enabling behaviors such as imprinting and return migration (Tierney et al. 2006, p. 2809). Juvenile coho salmon exposed to glyphosate concentrations of 0.1 mg/l for a period of 30 minutes did not demonstrate any adverse effects. However, short-term (10 minute) exposures to other glyphosate concentrations, ranging from 1 mg/l to 100 mg/l, showed significant neurophysiological effects through the impairment of olfaction. Considering these data, our analysis assumes sublethal effects due to exposure to glyphosate can occur at concentrations ≥ 0.1 mg/l.

Acute (short-term) exposures to high concentrations of glyphosate can result in direct mortality in fish, while chronic (long-term) exposures at low concentrations can result in sublethal effects including impaired growth rates and impaired olfactory function which is a critical physiological function in salmonids, enabling behaviors such as feeding, orientation, imprinting and return migration (Tierney et al. 2006, p. 2809, Fairchild et al. 2007, p. 1, Fairchild et al. 2008, p. 623). Impaired olfaction may alter survivorship, because essential behaviors such as alarm and avoidance reactions are linked to olfaction in salmonids (Tierney et al. 2006, Rehnberg et al. 1985).

On the HCP-covered lands, use of forest chemicals would generally occur in upland areas away from fish-bearing streams. In most instances, the standard conservation measures for broadcast applications will prevent herbicides from reaching fish-bearing waters in sufficient concentrations to affect individual bull trout. On the HCP-covered lands, known occupied bull trout habitat is associated primarily with rivers or large tributary streams classified as Type 1 or Type 2 waters. These areas are low risk areas for bull trout exposure due to the large size of the river channels and relatively high base flows. Bull trout present in these areas are most likely to be associated with habitat that provides sufficient depth, flow, and cover that measurable water quality contamination from forest chemicals is unlikely to occur. Water quality contamination associated with riparian herbicide treatments would be short-term (lasting minutes to hours) and limited to the immediate location of a treatment site. Even if toxicity indices for fish are temporarily exceeded at a treatment site, exposure to bull trout in most situations is unlikely due to the association of bull trout with larger streams and rivers on the HCP-covered lands.

In summary, forest chemical applications may temporarily degrade water quality and result in sublethal effects to individual bull trout exposed to sufficient concentrations of herbicide. Given the scope of herbicide applications used on the HCP-covered lands (~11,000 acres per year), we conclude that exposure risk to bull trout is very low but is not entirely discountable. The probability of exposure of individual bull trout to toxic levels of herbicide is low but may occur under certain situations. The duration of exposure is expected to be brief (minutes to hours), and the effects of the exposure would be short-term impairment of normal behaviors such as olfaction, respiration, and predator avoidance.

16.1.4 Hydrologic Effects: Peak and Base Flows

Timber harvest can affect both peak and base flows based on location within a watershed, and the proportion of basin forest that has been altered by roads and timber harvest (Grant et al. 2008, p. 6). Maximum increases in peak flows generally occur in the first 1 to 5 years after timber harvest, but significant changes in peak/base flows have been detected in Pacific Northwest forests for up to 35 years after harvest (Jones and Post 2004, p. 1).

Background Information - Base Flows

Timber harvest affects base flows by reducing the rate of evapotranspiration from forest vegetation. This can increase the amount of water that infiltrates the soil and ultimately reaches the stream. Therefore, streams draining in recently logged areas generally see increased summer base flows (Keppeler 1998, Lewis et al. 2001).

Segura et al. (2020, p.1) documented that streamflow from a watershed with 40- to 53-yr-old Douglas-fir plantations was 25 percent lower on average, and 50 percent lower during the summer months, relative to a reference watershed containing mature/old-growth forest. Low flow deficits persisted over six or more months of each year. Contemporary clearcut timber harvesting with riparian buffers in these plantation stands resulted in a 76 percent increase in summer baseflow in the first five years following timber harvest. The initial increases in base flow declined back to the low levels observed prior to timber harvest within 7 years and remained lower than summer base flows in the mature/old forest reference watershed (Segura et al. p. 8). The authors conclude that the rate of transpiration of young trees, growing in dense plantation stands is substantially greater than transpiration rates in mature / old-growth stands. These results indicate that contemporary forest practices, including 40-to-50-year rotations of Douglas-fir plantations with riparian buffers, are likely to lead to persistent low-flow deficits due to the high rates of evapotranspiration in plantation forests (Segura et al. 2020, p. 10).

In a similar long-term study by Peery and Jones (2017, p. 1) average summer streamflow (July through September) in basins with 34- to 43-year-old plantations of Douglas-fir was 50 percent lower than streamflow from reference basins with 150- to 500-year-old forests dominated by Douglas-fir, western hemlock, and other conifers. The authors in this study concluded that young conifers, which have higher sapwood area and higher sapflow per unit of sapwood area, have higher rates of evapotranspiration than old trees of conifer species. Summer streamflow increased initially after then harvest, then fell below pre-treatment levels within 15 years after timber harvest and these low flow deficits persisted and intensified for 50 years as the Douglas-fir plantations regenerated in the harvested watersheds (Perry and Jones 2017, p.8). The size of canopy openings explained the magnitude and duration of initial summer streamflow surpluses and subsequent streamflow deficits. The authors noted that plantations that are 20 acres or larger are likely to develop streamflow deficits (Perry and Jones, 2017, p. 10). The authors note that despite the effects of climate change in the Pacific Northwest (e.g., increased air temperature), the water yields from the mature / old-growth reference basins have not changed over the 60-year monitoring period (Peery and Jones, p. 10).

The implications for fish habitat are clear: harvest of young forest plantation stands can result in short-term increases in summer base flows, resulting in increased habitat availability for fish through increased wetted areas within stream channels (Segura et al. 2020, p. 10). However, these increases in base flow are short-term (5-10 years) and occur at a local level. Managed forest landscapes with a high percentage of watershed area in forest plantations have significantly reduced base flows (i.e., as much as 50 percent in these studies), and reduced area of available fish habitat in wetted stream channels during summer low-flow periods, relative to base flow in watersheds with mature or old-growth forest (Perry and Jones 2017, p. 10). Gronsdahl et al. (2019, p. 3166) suggest a 20 to 50 percent reduction in fish habitat availability is possible in some small streams because of decreased summer low flows associated with regenerating young stands. In a review of studies by Coble et al., reductions in base flow resulted in little to no change in aquatic biota in some areas, and while other studies have documented declines in fish and macroinvertebrate communities (Coble et al. 2020, p. 13). How the effects of forest management on base flow in headwater basins scale up to larger catchment areas is complex, and not well understood (Coble et al. 2020, pp. 13-14).

Background Information - Peak Flows

A review of hydrologic studies by Grant et al. (2008, p. 35) concludes that watersheds located within the transient rain-on-snow zone are the most sensitive to peak flow changes. A clearcut harvest level of approximately 15 to 19 percent within a small drainage area (10 km^2 - 2,471 acres) is sufficient to cause a detectable increase in peak flows (e.g., 10 percent or greater), but that these changes are only detectable during low to moderate peak flow events. Harvest effects on peak flow were detectable when at least 29 percent of a watershed was clearcut in the coastal rain-dominated zone (Grant et al. 2008, p. 34). Peak flows during extreme weather events are so variable that even though the flows may be influenced by forest management, these changes are not measurable. As basin area increases to the subwatershed scale ($10km^2$ – 500 km^2), the ability to detect change in flow diminishes because the magnitude of increase is typically less than the inter-annual variability of peak flow events in the watershed (Grant et al. 2008, p. 38).

Changes to peak flows are also influenced by factors other than harvest, including overall basin condition; the age and pattern of forest stands within a larger basin; and the location, age, and extent of road networks (Grant et al. p. 37). Forest roads can modify drainage density by extending the total length of effective surface flow, or stream channel network (Wemple et al. 1996). Two summaries of recent research studies on roads in forested areas demonstrate that roads can have significant effects on peak flows if roads are improperly constructed and if their drainage networks are allowed to become connected to the stream network through improper construction or inadequate maintenance or abandonment procedures (CMER 2004, pp. 6-8).

Effects of Ongoing HCP Implementation to Peak Flows

For the westside planning units, the HCP specifies that WDNR must minimize the adverse impacts to salmonid habitat caused by rain-on-snow floods (WDNR 1997, p. IV.68). The HCP directs that two-thirds (67 percent) of the WDNR-managed forest lands in drainage basins in the significant rain-on-snow zone will be maintained in forest that is hydrologically mature. Hydrologically mature is defined as a well-stocked conifer stand at age 25 or older (WDNR 1997, p. IV.68). This prescription is applied to drainage basins that are approximately 1,000 acres or larger in size. The criteria to maintain at least 67 percent as hydrologically mature forest (and conversely, allow up to 33 percent hydrologically immature forest). The regression analysis completed by Grant et al (2008, p. 35) indicates that a harvest level of 33 percent in the rain-on-snow zone could result in an increase in peak flow of approximately 15 to 25 percent above the pre-harvest baseline.

In the OESF, WDNR evaluates hydrologic condition at the scale of the Type 3 watersheds, which are small drainages on the order of 500 – 2,000 acres (WDNR 2016a, p. 3-25). WDNR's stated objective in the OESF forest plan is to maintain enough hydrologically mature forest in Type 3 watersheds to avoid a detectable increase (e.g., 10 percent or greater over unmanaged conditions) in peak flows. The OESF evaluation criteria is based on the Grant et al. (2008, pp. 35-36) findings that changes to peak flow become detectable only when more than 40 percent of a watershed is harvested in the rain-dominated zone, and more than 20 percent of the watershed is harvested in the rain-on-snow zone (WDNR 2016b p. 3-64). WDNR estimates that hydrologically immature forests will comprise less than 25 percent of each Type 3 watershed with implementation of the HCP under the 2016 OESF forest land plan (WDNR 2016b, p. 3-73). In 2016, WDNR estimated that 83 percent of Type 3 watersheds were in a low impact condition relative to peak flows, and about 4 percent of Type 3 watersheds were in a high-impact condition for peak flows, and they projected that over the next decades, the number of Type 3 watersheds in a high impact condition would remain at less than 5 percent in the OESF (WDNR 2016b, p. 3-74).

Effects of Ongoing HCP Implementation to Base Flows

The HCP does not contain standards to address protection of base flows. Base flows are affected by recent clearcuts (base flows increase with new clearcuts) and the amount of young or mid-seral plantation stands in a watershed (base flows decrease with forest regeneration). In the OESF, WDNR estimated that about 4 percent of the HCP-covered lands (11,400 acres) were in ecosystem initiation phase of stand development (i.e., recently harvested stands) (WDNR 2016b, p. 3-34). These recently harvested stands are likely to result in short-term increases in base-flows at the scale of individual Type 3 watersheds.

Approximately 54 percent of the OESF forests are in competitive exclusion phases (mid-seral, dense stands) of development, these areas are expected to have reduced base flow conditions due to high rates of evapotranspiration in dense stands of young trees. Only 11 percent of stands in the OESF were classified as structurally complex (i.e., old-growth or similar) (WDNR 2016b, p. 3-34). The amount of forest in competitive exclusion stages on the OESF is projected to gradually decline over time as WDNR harvests these stands for timber, or stands are retained and transition into mature forest (WDNR 2016b, 3-42). In many watersheds, the areas deferred from harvest in LTFC exceed 50 percent of the HCP-covered lands. These areas will contribute to increased mature forest on the HCP covered lands over time. In the OESF, LTFC covers over 58 percent of HCP covered lands in the bull trout core areas (Table 55). Across most of the HCP-covered lands, lands that are outside of LTFC (general management lands) are available for regeneration timber harvesting and will likely be maintained in early-seral to mid-seral conifer plantations (e.g., 20 to 60 years), which will contribute to summer low-flow water deficits across much of the HCP-covered watersheds. At scale of all bull trout watersheds within the HCP-covered lands, approximately 51 percent of these lands are available for general management (Table 55), indicating that a significant portion of the HCP-covered lands will be maintained in forest conditions that result in significant water low-deficits.

Table 55. Summary of HCP-covered general management lands within bull trout watersheds.

Bull Trout Areas	Total WDNR HCP-covered lands (acres)	HCP general management lands (acres)	Percent of HCP-covered lands in general management	Long-term forest cover (acres)	Percentage of WDNR HCP-covered lands in LTFC
Olympic core area totals	165,294	69,294	42%	96,000	58%
Olympic shared FMO area totals	54,730	29,050	53%	25,680	47%
Puget Sound core area totals	419,781	216,952	52%	202,829	48%
Puget shared FMO area totals	49,967	29,097	58%	20,870	42%
Lewis River core area	61,000	37,269	61%	23,731	39%
Totals for all HCP-covered bull trout areas	750,772	381,662	51%	369,110	49%

Effects to Bull Trout from Peak/Base Flow Conditions on HCP-covered Lands

The influences of timber harvest, road density, and forest conditions on peak/base flows is complex. The HCP provides specific conservation measures to reduce the potential for increases in peak flows in rain-on-snow zones in the Westside planning units by limiting the area of hydrologically immature forest. Based on the information presented above, we expect that under most circumstances, these measures will be effective at minimizing hydrologic effects to peak flows but acknowledge that the 1997 HCP standard (33 percent) exceeds the 20 percent value indicated in the contemporary literature for maintaining baseline hydrology in small subbasins. Because the 1997 HCP standard exceeds the estimated thresholds for detectable hydrologic effects, we conclude that bull trout habitat in the Westside planning units, in some instances, may be subjected to increased peak flows.

On the OESF, the risk for increased peak flows from HCP-management is lower due to WDNR's policy to limit hydrologic impacts. However, based on WDNR's projections, approximately 3-5 percent of the Type 3 watersheds per decade may be in a high impact condition for peak flows for the next few decades (WDNR 2016b, p. 3-74). This level of risk is quite low, given the limited distribution of bull trout spawning habitat within the OESF.

High flows can provide desirable conditions for fish migration and spawning, and form new channels by stream meandering, side-channel activation, and renewal of riparian and floodplain vegetation (Wald 2009). However, high flows can increase scouring of the streambed, which can increase the mortality of salmonid eggs and alevins, resulting in decreased reproduction for salmonids, including bull trout (Goode et al. 2013, p. 750). Over the remaining term of the HCP, climate change is projected to increase the frequency and severity of winter storms leading to increased peak flows in some areas. The increase in risk is expected to be highest in those areas that will experience more rain-on-snow events in the future and in confined valleys (Goode et al. 2013, pp. 756, 759). Based on the above information, we conclude that HCP covered timber harvest will, in some limited circumstances result in increased peak flows that will affect bull trout spawning habitat located on the HCP-covered lands. These effects are likely to be sporadic, and widely dispersed in spatial extent due to the dispersed nature of WDNR timber harvest patterns in any given decade. The effect to bull trout is reduced reproduction at specific sites through loss of eggs or alevins from stream scouring events. Based on the conservation measures in place to minimize peak flows, we would expect less than 1 percent of bull trout spawning habitat on the HCP-covered lands would be affected by increased peak flows. We also acknowledge that timber harvest can lead to increased runoff during summer months, leading to increased wetted area available for bull trout and other salmonids, leading to short-term (5-10 years) beneficial effects in the affected areas, but the extent of such increases is likely limited due to the high level of forest plantations on the HCP-covered lands.

HCP-effects to base flows are estimated to be much more significant than peak flow effects due to the high percentage of HCP-covered lands that are in young forest plantations. Based on the information presented above, we expect that over 50 percent of HCP-covered lands are likely to be subject to reduced base flows, and these effects are persistent and will last for decades. Over the remaining term of the HCP, climate change is projected to reduce winter snowpack and increase the severity and frequency of summer droughts, leading to projected reductions in streamflows. With the exception of a few areas that are primarily in mature / old growth stands that are deferred from harvest, essentially all known occupied bull trout habitat is likely to be affected by water deficits associated with managed forest landscapes. The magnitude of these effects will vary at the scale of small subbasins (e.g., Type 3 watersheds) and levels of mature forest in the subbasin. The effects to bull trout include reduced access to rearing habitat and reduced prey species productivity. Where summer rearing habitat is reduced, it reduces overall productivity of streams to support all salmonids, including bull trout. Additionally, it is likely that bull trout reproduction is also reduced by water deficits. Bull trout spawning areas that are inundated during winter months may be subject to partial dewatering as stream runoff subsides during summer months. We expect this is a small effect, as most of the known bull trout spawning streams on the HCP-covered lands are in larger Type 2 streams. In summary, we conclude that all occupied bull trout habitat on the HCP-covered lands is affected by reduced streamflows associated with managed forest landscapes, but the magnitude of these effects in terms of total reductions in summer base flows is unquantifiable due to the complex nature of this effect.

16.1.5 Sediment and Turbidity

Ground disturbance and subsequent erosion associated with timber harvesting, road construction, road maintenance, and road use can result in increased sediment loading to streams and increased turbidity, which can degrade water quality and aquatic habitat conditions at multiple scales, including site-specific scales, subbasin scales, and watershed scales. Suspended sediment in small streams is highly variable and is strongly influenced by the underlying geology of a site (Gomi et al. 2005, p. 883). Despite this variability, a number of watershed studies have documented increases in suspended sediment yield following timber harvest and road construction, and these effects increase with increasing area of roads and length of unbuffered stream reaches in headwater streams (Gomi et al. 2005, p. 893). These effects can persist for several years to decades following harvest (Gomi et al. 2005, p. 892). In the following section, we discuss the activities that will result in ground disturbance and downstream effects in both the westside units and the OESF.

Background Information - Sediment Loading from Timber Harvest

Soil disturbance from timber harvest in riparian and upland areas would occur primarily as a result of yarding activities when the trees are dragged along the ground surface to landings, or where ground-based logging would include the construction of skid trails (Rashin et al. 2006, p. 1322, Hassan et al. 2005, p. 855). Not all surface erosion reaches stream channels, but conduits such as roads, ditches, and skid trails increase this probability, particularly if riparian buffer strips are not left between exposed areas and stream channels (Gomi et al. 2005; Rashin et al. 2006). After evaluating the effectiveness of previous Washington Forest Practices Rules in controlling sediment-related, water-quality effects, Rashin et al. (2006, p. 1325) concluded a 10 m (33 ft) setback for ground disturbance can be expected to prevent sediment delivery to streams from about 95 percent of harvest-related erosion features.

Effects of HCP Implementation on Sediment Loading from Timber Harvest

The HCP riparian conservation strategies minimize potential for sediment inputs associated timber harvest ground disturbance through the application of RMZs on all Type 1-4 waters (≥100 ft wide). Exceptions for timber harvesting include allowance for narrow yarding corridors through RMZs, which require a minimum of full suspension cable yarding across Type 1 – 3 streams (> 25 feet from the edge of the 100-year floodplain) (WAC 222-30-060).

The primary source of sediment input to stream from timber harvest is logging adjacent to Type 5 waters with limited or no RMZ buffers. For Type 5 streams not associated with unstable slopes, no RMZ buffer is required, and protection is limited to the application equipment limitation zones (ELZs). In accordance with WAC 222-30-021, WDNR applies a 30-ft wide ELZ to all streams (including Type 5 streams) regardless of whether the stream is on stable ground or potentially unstable slopes or landforms (WDNR 2016a, p. 3-29). The ELZ is measured outward horizontally from the outer edge of the 100-year floodplain. In terms of ground disturbance, the 30-ft wide ELZ protects stream banks and soils within the ELZ from ground-based yarding equipment. However, trees can be felled and yarded out of the ELZs, and in some instances, this will result in ground disturbance and damage to stream banks, and routing of additional sediment into small, headwater stream channels.

As presented in Table 54, approximately 37 percent (1,582 miles) of the Type 5 streams in bull trout core areas are not associated with mapped RMZ buffers. Given the extent of the Type 5 streams on the managed landscape, we conclude that ground disturbance from tree felling and yarding along Type 5 streams without RMZ buffers contributes to additional soil erosion and sediment inputs that will ultimately be transported and deposited to downstream reaches, including areas of bull trout spawning and rearing habitat, and in streams that provide spawning habitat for other salmonids that provide prey for bull trout. We conclude that the RMZs provided by the HCP, along with implementation of ELZs, is effective at minimizing sediment routing to streams from timber harvest ground disturbance under most circumstances but recognize that ground disturbance along Type 5 streams remains a source of additional sediment inputs from HCP-covered actions.

Background Information - Sediment Loading from Riparian Windthrow

Timber harvest often results in an increased risk of windthrow in adjacent riparian buffers. Grizzel and Wolf (1998, p. 216) studied riparian buffer strips adjacent to clearcuts on small, non-fish bearing streams in northwestern Washington and reported that an average of 33 percent of riparian buffer trees were affected by windthrow. Mobbs and Jones (1995) survey of riparian management zones in coastal western Washington showed windthrow was significantly higher on Type 4 Waters than for all other water types. Based on these studies, the risk of windthrow in narrow riparian buffers strips adjacent to clearcuts is relatively high. Generally, windthrow is not a significant source of sediment delivery to streams due to the small amounts of disturbed soil and the fact that the windthrown trees often create their own sediment traps (Rashin et al., p.1323). In a review of various sediment sources associated with timber harvest, Rashin et al. 2006, p. 1322) reported that windthrow features, which had the most frequent instances of soil disturbance in terms of numbers of features, accounted for only 3 percent of the exposed soil associated with sediment delivery to streams, due to the relatively small size of erosion scars associated with windthrow and a low frequency of delivery to stream channels.

Rashin and others (2006, p. 1324), examined windthrow rates along both clearcut and partial-cut (thinning) timber harvests and found an average windthrow rate of 9.7 trees/100 m along clearcut edges, compared to an average of 0.7 trees /100 m in partial cut harvests. The windthrow rate in the partial harvest units was similar to that found in unmanaged control sites, indicating that risk of windthrow (and sediment delivery to streams) from commercial thinning treatments is low, relative to regeneration timber harvest.

Effects of HCP Implementation on Riparian Windthrow

The HCP riparian conservation strategies minimize potential for sediment inputs directly to streams from windthrow through the application of RMZs on all Type 1-4 waters, and on Type 5 streams located on unstable soils. In addition to RMZ buffers, the HCP provides for the application of exterior buffers added to the windward side of RMZ buffers streams in areas determined by WDNR to have a high risk of windthrow. Where applied, exterior buffers will enhance protection and stability of RMZs. In westside planning units, the HCP does not require application of exterior wind buffers on small Type 3 streams (< 5 ft), or on Type 4 streams, leaving these areas more vulnerable to soil disturbance from windthrow. The areas with the greatest potential for sediment delivery to streams from riparian windthrow is from RMZ buffers associated with Type 5 streams located on unstable slopes. We note there are anecdotal observations of windthrow in RMZs associated with Type 5 streams (e.g., OFCO 2023a, p. 18), but we have no quantitative information to estimate the extent of windthrow in RMZs, or how often windthrow on the HCP-covered lands results in sediment delivery to streams (Figure 6).

Figure 6. Example of blowdown associated with a riparian buffer on a Type 5 stream in the OESF. Source: OFCO 2023a.

We have no published information to indicate how often or to what extent WDNR has applied exterior wind buffers in the past. Based on the implementation monitoring reports, it appears that WDNR rarely applied exterior wind buffers. As described in the FEIS for the 2016 OESF plan, WDNR expects only 1 percent of the RMZs in the OESF will require an exterior buffer (WDNR 2016b, p. 3-93). In the HCP, WDNR estimated that exterior buffers would be applied on 75 to 85 percent of riparian areas in the OESF (WDNR 1997, p. IV. 118). Based on WDNR monitoring reports this level of application of exterior wind buffers was never applied (WDNR 2008, pp. 7-8). For the purpose of this analysis, we assume that exterior wind buffers are rarely applied, with the understanding that WDNR will develop an adaptive management monitoring program within one year to evaluate the effectiveness of the wind risk modelling to reduce the need for exterior buffers (Appendix A – *Correspondence with WDNR*).

We conclude that the RMZs provided by the HCP (with or without the application of exterior buffers) are effective at minimizing sediment routing to streams from riparian windthrow under most circumstances. We recognize that ground disturbance from windthrow along some Type 4 or Type 5 streams is a source of additional sediment inputs from HCP-covered actions, but expect these effects are relatively low relative to sediment input from roads and timber harvest along Type 5 streams without RMZ buffers.

The purpose of exterior wind buffers is to protect the integrity of RMZ buffers on Type 1, 2, and 3 waters in areas prone to windthrow. As described in the previous sections, the interior core RMZs provided by the HCP provide for stream shade, large wood inputs, stream bank protection, and sediment filtering functions along fish-bearing streams, and we conclude that the interior core RMZs are effective at minimizing the effects of timber harvesting in upland areas under most circumstances, with or without the application of exterior buffers. The amount and extent of windthrow in RMZ buffers due to a lack of exterior wind buffers on the HCP covered lands has not been quantified, as well as the degree to which windthrow may have affected fish habitat quality. Windthrow is an important mechanism for delivering large wood to stream channels. Extreme cases of windthrow associated with catastrophic wind events, such as the storm in December 2007 which resulted in thousands of acres of windthrow across forests in western Washington, including over 1,300 acres within RMZs (WDNR 2008a, p. 1.4) can result in loss of riparian habitat function through reductions in overstory shade and sediment input from ground disturbance, but these types of catastrophic wind events are relatively rare.

The HCP and the Implementation Agreement anticipate the development of a monitoring and adaptive management program to assess the effectiveness of exterior wind buffers and to make adjustments based on that monitoring, where appropriate (WDNR, 1997, p. IV.73). WDNR has committed to the development of a windthrow monitoring and adaptive management program to evaluate the effectiveness of current procedures to maintain functional riparian buffers within the next year (Appendix A).

Background Information - Sediment Loading from Forest Roads

Surface erosion from road surfaces, cutbanks, and ditches can be a significant source of sediment input to streams. Increased sediment delivery to streams after road building has been well documented in the research literature in the Pacific Northwest (Gucinski et al. 2001, p. 23). Erosion from road surfaces varies greatly depending upon road surface material, slope, drainage, and use. Reid and Dunne (1984, p. 1759) found that gravel forest roads generated up to 300 tons of sediment/mile/year from surface erosion on the Olympic Peninsula, but more typical rates averaged 6.1 tons of sediment generated per mile for lightly used gravel roads, and 0.82 tons for abandoned roads.

The significance of road sediment sources for stream water quality depends upon whether they are connected to the stream by a direct channel such as a roadside ditch, gully, or overland flow. If sources are not connected, sediments are deposited on the forest floor without reaching a stream (Gomi et al. 2005, p. 888). Road sediments reach streams in two ways: roadside ditches which drain directly to streams, and roadside ditches that connect to relief culverts which drain onto the forest floor (Wemple et al. 1996, p. 1195). In Pacific Northwest, the amount of road surface sediment that reaches streams is highly variable but is generally on the order of 30 to 40 percent (Gomi et al. 2005, p. 889).

Increased sediment loading from the roads will occur each year that road construction and active timber hauling is occurring. After roads are closed, suspended sediment loading within recently logged subbasins need a recovery time of 3 to 6 years before returning to baseline levels. Based on this, we expect elevated levels of road-related suspended sediments will be present in all areas where new roads are constructed.

Watersheds with high road densities typically have degraded aquatic habitat conditions. Impacts from road density may include increased delivery of fine sediment to streams due to a change in the timing, magnitude, duration, and spatial distribution of water runoff flows (Potyondy and Geier 2011, p. 27). Dunham and Rieman (1999. p.649) found the increasing density of roads at the landscape level is negatively correlated with bull trout occurrence.

Evaluation Criteria – Road Density and Stream-Adjacent Roads

Road density is used to assess the general impacts of roads to aquatic habitat. Road densities that are less than 1 mi/mi^2 are considered to have minimal aquatic habitat impacts, while road densities that exceed 2.4 mi/mi^2 are considered to have a high impact on aquatic habitat due to high densities of stream crossings and stream-adjacent roads (Potyandry and Greier 2011, pp. 26-27). This level of road density as an index for aquatic habitat is supported by research that found that the percentage of fine sediment in spawning gravels increased above natural levels when more than 2.5 percent of the basin area was covered by roads (Cedarholm et al. 1981, p. 25).

The road surface erosion model developed by Dube et al. (2004, p. A-3) assumes that road segments that drain to the forest floor over 200 ft away from a stream do not deliver sediment to streams. This assumption is based on a review of several studies which found a range of sediment transport distances of 30 ft to 550 ft, with road surface sediment moving less than 150 ft in nearly all cases. Based on this information, we use a distance of 200 ft to estimate the extent of bull trout habitat that is exposed to chronic sediment inputs from road surface erosion and runoff associated with stream-adjacent roads.

Effects of HCP Implementation: Forest Roads

There are a total of 5,738 miles of roads on the HCP-covered lands located within bull trout watersheds. WDNR roads include 4,931miles within bull trout core areas (Table 56) and 807 miles of roads located within bull trout shared FMO watersheds (Table 57).

Average road density on HCP-covered lands in the bull trout core area watersheds ranges from 4.3 mi/mi^2 (Queets River) to 7.8 mi/mi^2 (Puyallup River). Across all bull trout watersheds combined road densities average 4.9 mi/mi^2 in core areas and 4.7 mi/mi^2 in shared FMO watersheds. Based on the criteria listed above, we conclude that all bull trout habitat on the HCP-covered lands is likely degraded by road surface erosion associated with high road densities and stream adjacent roads.

A total of 16.4 miles of roads (15.6 miles in the core areas and 0.8 miles within shared FMO watershed) are located within 200 ft of known, occupied bull trout streams. This represents a small fraction of the total WDNR managed roads in these watersheds (0.3 percent), indicating that relatively few WDNR roads are located in close proximity to occupied bull trout streams. This estimate does not include all of the other stream adjacent roads along Type 1 – 3 streams in these watersheds that are fish-bearing but are not known to support bull trout. A total of 40 stream crossings (38 in bull trout core areas and 2 in Shared FMO) occur over bull trout streams on HCP land (Tables 55, 56).

The effects of forest roads on aquatic habitats are chronic and pervasive, but road system upgrades completed by WDNR are correcting issues associated with poor drainage and road surface erosion. Consistent with the forest practices rules, WDNR has developed and completed road maintenance and abandonment plans (RMAPs) for roads on all state trust lands in the OESF and the Westside Planning Units. WDNR completed a full stream-crossing assessment in 2001 and a road assessment for all HCP-covered lands in 2006. WDNR completed its required RMAP work statewide as required by the Washington Forest Practices Rules in October 2021 (WDNR 2022, p. A-25).

Correct implementation of current forest practices rules for road maintenance is expected to minimize runoff water and sediment delivery to typed waters (WDNR 2016b. p. 3-161). Dubé (2010) found that as forest management roads brought up to RMAP standards, they showed decreased sediment delivery to streams. Despite the improvements to the forest road system completed over the past 27 years, WDNR concluded in its analysis of roads in the OESF that there was a high potential for fine sediment delivery to streams from roads, but then concluded that the effectiveness of current forest practices standards for roads mitigated road effects to a level of “non-significance” (WDNR 2016b, p. 3-157). While the USFWS agrees that the current standards for roads have greatly reduced potential for sediment delivery, we maintain that adverse effects from road surface erosion are persistent and will continue to degrade habitat for bull trout and other salmonids on the HCP-covered lands.

Table 56. Summary of WDNR road miles within bull trout core areas.

Bull Trout Core Area	WDNR HCP lands within bull trout core area (acres)	Total roads on WDNR HCP lands (miles)	Average road density on WDNR HCP lands (road miles per square mile)	Roads on WDNR HCP lands located within 200 ft of bull trout streams (miles)	Number of road - stream crossings over bull trout streams
Chester Morse Lake	73	0.7	5.8	0	0
Chilliwack River	6,143	46.7	4.9	0	0
Dungeness River	5,519	40.7	4.7	0	0
Elwha River	7,458	63.0	5.4	0	0
Hoh River	47,570	334.9	4.5	2.3	6
Lewis River	61,000	411.2	4.3	0.6	1
Lower Skagit River	86,218	724.6	5.4	2.4	1
Nooksack River	77,734	663.5	5.5	5.9	21
Puyallup River	1,081	13.1	7.8	0.1	0
Queets River	102,781	694.8	4.3	1.1	5
Quinault River	383	2.5	4.2	0.0	0
Skokomish River	1,583	14.5	5.9	0.0	0
Snohomish & Skykomish Rivers	167,928	1,261.2	4.8	2.6	1
Stillaguamish River	80,604	659.6	5.2	0.6	3
Totals	**646,075**	**4,931.1**	**4.9**	**15.6**	**38**

Notes: Road miles are estimates derived from GIS data for mapped roads on WDNR HCP lands. Not all roads may be open or accessible.

Table 57. Summary of WDNR road miles within bull trout shared FMO watersheds.

Bull Trout FMO Area	WDNR HCP lands within bull trout core area (acres)	Total roads on WDNR HCP lands (miles)	Average road density on WDNR HCP lands (road miles per square mile)	Roads on WDNR HCP lands located within 200 ft of bull trout streams (miles)	Number of road / stream crossings over bull trout streams
Bell	222	0.3	0.7	0	0
Goodman	13,016	84.4	4.2	0.6	1
Humptulips	3,337	30.2	5.8	0.1	0
Kalaloch	6,966	53.8	4.9	0.0	0
Lake Washington	11,604	52.7	2.9	0.0	0
Lower Chehalis	12,470	88.0	4.5	0.0	0
Lower Green	9,966	88.7	5.7	0.0	0
Lower Nisqually	15,956	110.6	4.4	0.0	0
Moclips/Copalis	4,736	36.3	4.9	0.1	1
Morse	17,542	133.4	4.9	0.0	0
Samish	12,441	119.6	6.2	0.0	0
Wishkah	952	9.4	6.3	0.0	0
Totals	**109,208**	**807.4**	**4.7**	**0.8**	**2**

Notes: Road miles are estimates derived from GIS data for mapped roads on WDNR HCP lands. Not all roads may be open or accessible.

<u>Background Information – Sediment Loading from Culvert and Bridge Installations/Removals</u>

Culvert installations disturb streambanks and streambed material, often resulting in increased turbidity and fine sediment accumulations at the affected sites. While culvert replacement and removal is beneficial to habitat connectivity, it does cause downstream sediment effects that degrades water quality and habitat. Foltz et al. (2008, p. 329) monitored suspended sediment concentrations at 11 culvert removal projects in small streams in Idaho and Washington. They found that suspended sediment and turbidity was highest within 20 m (66 ft) of the project site and decreased by an order of magnitude at a distance of 100 m (328 ft) downstream. Although there was a significant reduction in turbidity at 100 m downstream, turbidity levels still exceeded water quality standards at this distance. At 810 m (2,657 ft, or 0.5 mi) downstream, suspended sediment concentrations had returned to near background levels. These studies provide empirical evidence to indicate that significant sediment plumes are likely to occur at distances exceeding 100 m downstream from stream crossings, though all but the finest sediments fall out of suspension within a distance of 810 m (0.5 mi).

Lachance et al. (2008, p. 1826) quantified fine sediment accumulations in stream substrate downstream of new culvert installations in low-gradient trout spawning streams. This study found that significant fine sediment (less than 2 mm) accumulations occurred up to 200 m (656 ft) downstream from culvert installations. Peak accumulations occurred directly below the culvert sites (within 20 m). Embedded sediments were lowest in the first weeks after construction, peaked at one full year after construction, and gradually decreased at 2 to 3 years post construction. Elevated levels were still present at 3 years post-construction. The downstream distance at which substrate embeddedness was expected to return to background levels varied, depending upon site conditions, but ranged from 358 to 1442 m below the culvert sites (Lachance et al. 2008, p. 1835).

These data indicate that there is a significant difference in the effects of culvert installations with regard to suspended sediments and substrate embeddedness. Suspended sediment and turbidity peaked at culvert installation/removal sites within 24 hours after construction (Foltz et al. 2008, p. 339). Downstream fine sediment embeddedness did not peak until a full year after construction and was generally 2 to 5 times higher than background levels observed above the culverts (Lachance et al. 2008, p. 1835). The delayed response in substrate embeddedness was attributed to erosion of the road fill and road surface in the immediate vicinity of the culvert. This observation is supported by Rashin et al. (1999, p. 68) who reported an average of 131 m^3 of sediment was delivered directly to streams from newly constructed road surfaces and fill erosion at each stream crossing over the first 11 to 20 months following road construction.

Effects of HCP Implementation: Stream Crossings and Fish Barrier Removals

We did not quantify the total number of all road stream crossings in the bull trout watersheds. Based on the total miles of streams (~13,344 miles of streams – all types) (Table 53, Table 54), and high road densities on the HCP-covered lands, we estimate there are hundreds of stream crossing in the bull trout watersheds. Because bull trout are limited in their distribution on the HCP-covered lands, most fish-bearing streams within the bull trout watersheds do not contain bull trout but support other fish species. As noted above, we identified a total of 40 stream crossings over known, occupied bull trout streams, 38 crossing in core areas, and 2 crossing in shared FMO watersheds.

Culvert installations and removals occur as needed during road reconstruction, or new road construction. On average, WDNR constructed 77 miles of new roads, and reconstructed 61 miles of roads per year for the period from 2013 - 2022 in the westside units and OESF (Table 5). In addition to stream crossings needed for new road construction, WDNR committed to remediating fish passage barriers under the RMAPs agreements. During the period from 2013 -2022, WDNR replaced 481 fish-passage barriers culverts across the entire HCP-covered lands, including 463 fish barriers in the westside / OESF. Since 2022, the WDNR has identified a total of 19 newly discovered fish barriers on WDNR-managed lands that require correction. WDNR is committed to remediating fish passage barriers within 6 years of their identification, and inspecting fish passage culverts every 10 years. The removal of fish barrier culverts can result in adverse effects to bull trout and other fish due to increased sediment inputs to streams, but also results in beneficial effect for fish as it restores habitat connectivity. The number of culverts that will be removed or replaced by WDNR per year is unknown, as many culvert sites in current and future land acquisitions have not yet been discovered.

Following culvert installations, both fine and course sediments at the disturbed site will be subject to scouring and deposition. Due to seasonal restrictions for in-water work in fish-bearing waters, sediment generated in-water construction would generally not occur during bull trout spawning periods. Seasonal restrictions for in-water work will typically avoid direct impacts to adult bull trout. Indirect effects after culvert installation can result in mortality of bull trout eggs, larval fish, and age 0-fry if deposited if road sediments are deposited in spawning areas through increased substrate embeddedness, or loss of redds due to scouring effects. Egg survival depends upon a continuous supply of well oxygenated water through the streambed gravels (Cederholm and Reid 1987). Deposition of fine sediments can reduce the water flow through the substrate and, therefore, reduce oxygen to eggs and larval fish which can decrease egg survival, decrease fry emergence rates (Bash et al. 2001; Cederholm and Reid 1987; Chapman 1988), and delay the development of larval fish (Everest et al. 1987).

Based on the information presented above, we expect that each culvert replacement degrades stream habitat for up to 0.5 miles downstream from the culvert, although most severe effects are limited to the immediate area downstream from the culvert within a distance of 330 ft (Foltz et al. 2013, p.11). Fish passage barrier removals result in short-term water quality impacts associated with increased turbidity and sediment but are beneficial for restoring habitat function and access to all life stages. The number of fish passage barrier culverts present on WDNR HCP land are decreasing through these efforts and are expected to continue to decrease over the course of HCP implementation.

Effects to Bull Trout Associated with Fish Capture and Handling

Fish capture and handling for bridges and culverts can result in lethal or sublethal effects to bull trout. Fish capture and handling associated with culverts or bridges is covered under Section 10(a)(1)(A) permits issued to WDNR from the Region 6 USFWS office. The effects of capture and handling of bull trout are covered under a Regional Programmatic Consultation, and therefore, will not be addressed further in this consultation. Culvert installation is, however, expected to adversely affect bull trout through by degrading habitat (stream substrates) downstream from road crossings.

Effects to Bull Trout from Turbidity and Fine Sediment

In the preceding sections, we have described how forest management activities under the HCP can result in soil erosion and sediment loading in streams. These effects are most strongly driven by road use, road construction, and road-stream crossings, but increased sediment loading also results from timber harvesting, windthrow in riparian buffers, and increased sediment yield. The increased sediment loading affects stream productivity by degrading water quality (turbidity) and increasing the amount of fine sediment in stream substrates (substrate embeddedness).

Specific effects of sediment on fish and their habitat can be put into three classes (Newcombe and MacDonald 1991, pp. 72-73):

1. *Lethal*: Direct mortality to any life stage, reduction in egg-to-fry survival, and degradation of spawning or rearing habitat. These effects damage the capacity of aquatic habitats to produce fish and sustain populations.
2. *Sublethal*: Reduction in feeding and growth rates, decrease in habitat quality, reduced tolerance to disease and toxicants, respiratory impairment, and physiological stress. While not leading to immediate death, may produce mortalities and population declines over time.
3. *Behavioral*: Avoidance and distribution, homing and migration, and foraging and predation. Behavioral effects change the activity patterns or alter the kinds of activity usually associated with an unperturbed environment. Behavioral effects may lead to mortality or population declines over time.

Forest management activities that degrade water quality and aquatic habitat conditions through increased fine sediment loading are a significant habitat modification, which can result in both direct and indirect effects to bull trout through reduction in spawning success due to increased fine sediment in stream substrates, decrease in rearing habitat quality, respiratory impairment, and physiological stress (USFWS 2010). Increases in fine sediments in streams also affects productivity for other salmonids and other native fishes which provide prey for bull trout. Declines in bull trout populations are strongly associated with declines in salmon populations throughout the listed range of the species, due to importance of salmon as a prey base to support bull trout populations (USFWS 2004a, p. 108).

Individual bull trout are likely to be exposed to increased levels of suspended sediment/turbidity caused by the forest management activities described above. This exposure will occur episodically in the form of slight to moderate increases in turbidity in managed areas, which is then transported downstream. These areas may be used by bull trout for spawning and rearing, or for foraging, migration, and overwintering habitat. The effects to individual bull trout range from mortality of incubating eggs and reduced spawning success, and sublethal effects in the form of physiological stress resulting from intermittent exposures to increased suspended sediment and turbidity, and a reduced prey base, all of which can affect the normal behaviors of individual bull trout, including breeding, feeding, and sheltering.

Summary of the Effects to Bull Trout as Evaluated in 1998

The following section is a summary of the analysis of effects to bull trout completed for the HCP (USFWS 1998a). We provide this summary in the context of reviewing the effects of the HCP that have already occurred over the past 27 years of HCP implementation, and to provide context for the analysis of the effects of continued implementation of the HCP.

16.1.6 Estimates of Bull Trout Incidental Take - 1998

In our prior analysis of the HCP, the USFWS concluded that HCP implementation would result in incidental take of bull trout from the effects of timber harvest and related activities, including road building, stream crossings, canopy removal, and potential increases in sediments and temperature which may impact bull trout at a number of life-history stages (USFWS 1998a, pp. 59-60).

Effects to numbers of individual bull trout that may occur were unknown, so the USFWS used the extent of bull trout habitat on covered lands and estimates of covered activities as measures to estimate the amount and extent of bull trout incidental take. The extent of bull trout habitat on the HCP-covered lands was estimated to be 501 miles for rivers and streams, including: 121 miles in the OESF, and 380 miles in the westside planning units. Bull trout habitat estimates in the westside units included 90 miles in the Lower Columbia River distinct population segment (DPS), and 289 miles in the Coastal DPS (USFWS 1998a, p. 60).

Incidental take of bull trout was associated with estimates of forest management within the RMZ buffers (both interior buffers and exterior buffers) and with road construction and maintenance. The USFWS estimated that about 1 percent of the HCP riparian buffers would be entered per year over the term of the HCP. Riparian entries included selective harvest, riparian thinning, and timber yarding corridors. On the OESF the USFWS estimated that up to 2,000 acres of thinning may occur in riparian buffers per year; in the westside units, the estimate was 1,145 acres per year. Riparian restoration (e.g., hardwood conversion) activities were estimated on about 5 percent of the total riparian buffer areas (~ 158 acres per year). Incidental take of bull trout associated with forest roads included an average of 29 miles of roads constructed and 30 to 60 miles or roads upgraded or removed per year.

In the 1998 Opinion, the USFWS concluded that because bull trout distribution is not continuous, only a fraction of the acres and activities described above had the potential to impact bull trout, and that incidental take of bull trout would be rare and localized (USFWS 1998a, p. 61). The USFWS went on to state that the HCP, if properly implemented, was expected to result in long-term benefits to bull trout through the riparian conservation strategies and road management provisions (USFWS 1998a, p. 62).

Summary of the Effects of Ongoing HCP Implementation to Bull Trout

Bull trout habitat use within the HCP-covered lands is associated with spawning and rearing habitat (43 stream miles), and foraging, migration, and overwintering habitat (93 miles) (Table 51). The distribution of bull trout within the HCP covered lands is limited to these specific watersheds, and a relatively small percentage of the total stream miles within these watersheds. There are over 13,300 miles of streams (all stream types) on the HCP-covered lands in the bull trout watersheds (Table 53, Table 54). Of these, approximately 2,776 miles are fish-bearing streams. There are 136 miles of known, occupied bull trout streams on the HCP-covered lands in these watersheds, which represents about 5 percent of the total fish-bearing streams in these watersheds. We acknowledge that bull trout may occur in other accessible fish-bearing streams, but our estimates of the effects to bull trout are based on the known distribution of occupied bull trout habitat. As a threatened species, bull trout have limited distribution and limited abundance relative to other salmonids in western Washington. The significance of the hundreds of miles of other fish-bearing streams in these watersheds is that they support a diverse assemblage of fish species that contribute to the available bull trout prey base within bull trout occupied habitats.

Due to the complex and interactive nature of the effects of forest management on aquatic habitats we conclude that essentially all bull trout habitat within the HCP-covered lands has been affected by past forest management, either directly or indirectly, and all bull trout habitat has the potential to continue to be affected by on-going HCP-covered activities over the remaining term of the HCP. Effects to bull trout and bull trout habitat include limited adverse habitat effects (generally site-specific) and beneficial effects (both at the site scale and watershed scale) through the following key habitat indicators:

Riparian Large Wood

The interior-core RMZ buffers for streams provided by the HCP maintain and restore riparian large wood sources for all fish-bearing streams. Short-term effects to large wood inputs from riparian thinning treatments are insignificant, and long-term effects of the HCP RMZs will be beneficial to bull trout and other salmonids as trees in RMZs mature and develop the desired future conditions for fully functional riparian forests.

Stream Temperature

The interior-core RMZs buffers for Type 1-4 streams provided by the HCP are maintaining and/or restoring stream temperature in almost all cases. Approximately 37 percent of the Type 5 streams within bull trout core area watersheds may not require RMZ buffers and may be subject to regeneration timber harvest, which in some limited instances will result in increases in stream temperature downstream of the harvested areas. These effects would be highly localized to specific sites and are likely to subside relatively quickly as forests regenerate at the affected sites. Even minor increases in summer maximum water temperature reduce the quality of stream habitat and can result in sublethal effects to bull trout (e.g., reduced growth and feeding) and reduced productivity for other species that provide prey for bull trout. Projected increases in summer temperature associated with climate change increase the potential for timber harvest to affect stream temperature in areas without RMZ buffers.

Water Quality –Forest Chemicals

Forest chemical applications may temporarily degrade water quality and result in sublethal effects to individual bull trout exposed to herbicide. The probability of exposure of individual bull trout to toxic levels of herbicide is very low but may occur under certain situations. The duration of exposure is expected to be brief (minutes to hours), and the effects of the exposure would be short-term impairment of normal behaviors such as olfaction, respiration, and predator avoidance. These effects are generally not measurable or quantifiable.

Hydrologic Effects – Peak Flows

The HCP conservation measures and the OESF plan are designed to minimize the potential for increases in peak flows from timber harvest. However, the HCP-covered timber harvest will, in some limited circumstances result in increased peak flows that could affect bull trout spawning habitat located on the HCP-covered lands. These effects are likely to be sporadic, and widely dispersed in spatial extent due to the dispersed nature of WDNR timber harvest patterns in any given decade. Peak flow events are likely to increase in frequency with climate change over time. The effect to bull trout is reduced spawning success at specific sites through loss of eggs or alevins from stream scouring peak flow events. Based on the HCP conservation measures in place to minimize peak flows, and the limited distribution of bull trout spawning habitat on the HCP-covered lands, we expect less than 1 percent of bull trout spawning habitat on the HCP-covered lands would be affected by increased peak flows.

Hydrologic Effects – Base Flows

HCP-effects to base flows are estimated to be more extensive and long-lasting than peak flow effects. Over 50 percent of the HCP-covered lands within the bull trout watersheds are likely to be maintained in young-forest plantations, which have high rates of evapotranspiration, resulting in significant reductions in summer base flows (up to 50 percent) in headwater streams, relative to summer base flows originating from watersheds with old-growth forest. These effects are long-lasting (50 years or more). All known occupied bull trout habitat is likely to be affected by summer water deficits associated with managed forest landscapes to some degree. The effects to bull trout include reduced access to rearing habitat and reduced prey species productivity. Base flow events are likely to increase in intensity with the effects of climate change over time. Where summer rearing habitat is reduced, it reduces overall productivity of streams to support all salmonids, including bull trout. The magnitude of these effects in terms of total reductions in summer base flows and reduced wetted stream area for bull trout are unquantifiable at this time due to the complex nature of this effect.

Sediment from Timber Harvest

The interior-core RMZ buffers provided by the HCP (with or without the application of exterior buffers) are effective at minimizing sediment routing to streams from timber harvest where RMZs are applied. Approximately 37 percent of the Type 5 streams in bull trout core areas are not associated with RMZ buffers. Equipment limitation zones within 30 ft of all streams minimize ground disturbance from equipment, but do not eliminate ground disturbance from tree removal. Given the extent of the Type 5 streams on the managed landscape, we conclude that ground disturbance from tree felling and yarding along Type 5 streams without RMZ buffers contributes to additional soil erosion and sediment inputs that will ultimately be transported and deposited to downstream reaches, including areas of bull trout spawning and rearing habitat, and in streams that provide spawning habitat for other salmonids that provide prey for bull trout.

Sediment from Forest Roads and Stream Crossings

Forest roads are the primary source of fine sediment inputs to bull trout habitat on the HCP-covered lands. WDNR has implemented road improvements across all the HCP-covered lands designed to minimize sediment delivery to streams. However, the HCP-covered lands continue to have high road densities which even with improved road standards will continue to deliver sediment to streams. Stream-adjacent roads and stream crossings are conduits for direct sediment input to streams, and culvert installations and replacements result in short-term turbidity plumes and long-term increases in fine sediments in stream substrates for up to

0.5 miles downstream from the stream crossing, including areas of bull trout spawning and rearing habitat, and streams that provide spawning habitat for other salmonids that provide prey for bull trout.

Habitat Connectivity - Fish Passage Barriers Removals

Through implementation of the HCP, and implementation of the Washington Forest Practices RMAPs program, WDNR has replaced hundreds of fish passage barrier culverts on the HCP-covered lands, resulting in restored habitat connectivity within hundreds of fish-bearing streams, increasing habitat capacity to support bull trout and other fish that provide bull trout prey species.

Interactive and Synergistic Effects

All components of the HCP conservation strategies, coupled with improved forest road standards, have greatly reduced the impacts of the forest management relative to the historic forest practices that occurred on state lands prior to HCP implementation. Adverse effects to individual bull trout and bull trout habitat within the HCP-covered lands (and affected areas downstream of covered lands) are not attributable to any single habitat indicator, specific timber harvest unit, or individual road segments. It is the additive and synergistic effects of all forest management activities at the scale of subwatersheds that leads to the degradation of fish habitat and reduced productivity for native fishes, including bull trout. The additive effects of ongoing forest management (timber harvest, high road densities, hundreds of road stream-crossings, etc.), coupled with the projected impacts of climate change lead us to the conclusion that adverse effects to bull trout have occurred, and will continue to occur on the HCP-covered lands, but these effects are limited, and nearly unquantifiable in terms of the impacts to bull trout numbers, reproduction, and distribution.

Effects to the Olympic Peninsula Region of the Coastal Recovery Unit

Total bull trout habitat in core areas and shared FMO watersheds include a total of over 842 miles of rivers and streams on the Olympic Peninsula. Bull trout habitat on the HCP-covered lands includes a total of about 56 miles (7 percent) (Table 51). There is approximately 5.5 miles of bull trout spawning habitat on the HCP-covered lands, representing about 2 percent of the total available bull trout spawning habitat on the Olympic Peninsula. Bull trout core areas and shared FMO watersheds in the OESF have a high percentage of lands that are deferred from harvest for various purposes (e.g., murrelets, old-growth, RMZs). There are 3.4 miles of stream-adjacent roads within 200 ft of bull trout streams and 11 stream crossings. The habitat effects associated with the HCP are not anticipated to alter current patterns of bull trout distribution or habitat use within the Olympic Peninsula region. The affected waters continue to support a diverse assemblage of native fishes, including salmon populations that are deemed productive enough to sustain commercial fisheries.

The HCP implementation will result in both degradation and beneficial effects to aquatic habitat and bull trout within the affected areas. Although this action will result in a short-term degradation of bull trout habitat in some localized areas, the magnitude of the effects are limited in scale and dispersed within the affected subbasins. Because HCP conservation strategies are effective at minimizing most land-management effects to aquatic habitat, we do not expect the effects of the action to measurably influence bull trout distribution, numbers, or reproduction within the Olympic Peninsula region.

Effects to the Puget Sound Region of the Coastal Recovery Unit

Total bull trout habitat in core areas and shared FMO watersheds include a total of over 1,889 miles of rivers and streams in the Puget Sound region. Bull trout habitat on the HCP-covered lands includes a total of about 78.5 miles (4 percent) (Table 51). There is approximately 38 miles of bull trout spawning habitat on the HCP-covered lands, representing about 5 percent of the total available bull trout spawning habitat in the Puget Sound watersheds. There are 11.6 miles and 26 stream crossings within 200 ft of bull trout streams. The habitat effects associated with the HCP are not anticipated to alter current patterns of bull trout distribution or habitat use within the Puget Sound region. The affected waters continue to support a diverse assemblage of native fishes, including salmon populations (albeit some stocks are listed as threatened) that are deemed productive enough to sustain commercial fisheries.

HCP implementation will result in habitat degradation and in beneficial effects to aquatic habitat and bull trout within the affected areas. Although this action will result in a short-term degradation of bull trout habitat in some localized areas, the magnitude of the effects is limited in scale and dispersed within the affected subbasins. Because HCP conservation strategies are effective at minimizing most land-management effects to aquatic habitat, we do not expect the effects of the action to measurably influence bull trout distribution, numbers, or reproduction within the Puget Sound region.

Effects to the Lower Columbia Region of the Coastal Recovery Unit

The Lower Columbia Basin region contains several core areas in Oregon, and one core area in Washington (Lewis River core area). There are approximately 61 miles of bull trout rivers and streams in the Lewis River, in addition to three major reservoirs. The HCP-covered lands have 1.4 river miles of bull trout habitat (2 percent) all in FMO areas (Table 51). There are 0.6 miles and 1 stream crossing within 200 ft of bull trout streams. The habitat effects associated with the HCP are not anticipated to alter current patterns of bull trout distribution or habitat use within the Lewis River core area or the Lower Columbia Basin region. The primary factors affecting bull trout in the Lewis River are the 3 hydroelectric dams, and the legacy effects of the 1980 Mt. St. Helens eruption. Because the effects of the action are sublethal, intermittent and limited to FMO habitats, we do not expect the effects of the action to measurably influence bull trout distribution, numbers, or reproduction within the Lower Columbia region.

16.2 Effects to Designated Bull Trout Critical Habitat

The action area is found within the Coastal Recovery Unit, which has three Critical Habitat Units (CHUs), namely the Olympic Peninsula CHU, the Puget Sound CHU and Lower Columbia River Basins CHU.

Critical habitat for bull trout within the Coastal Recovery Unit (RU) is designated on federal lands (National Forests and National Parks), and on non-forested, non-federal lands (e.g., agricultural areas, and urban areas). Critical habitat for bull trout was proposed on state and private forest lands throughout the Coastal RU, but these areas are excluded from the final designation in Washington because these lands have existing HCPs that address bull trout conservation needs. The result is that designated bull trout critical habitat that is located outside of federal lands is not a continuous designation but is comprised of thousands of discontiguous segments.

The bull trout stream miles summarized in Tables 39, 40, 43, 44, and 47 include all designated critical habitat within the action area, as well as areas excluded from the final critical habitat designation. In general, bull trout streams located on federal lands are designated as critical habitat, and in most areas, designated critical habitat is located upstream from WDNR HCP-covered lands, and is not affected by HCP-covered activities. Bull trout streams on other ownerships in general are located downstream from WDNR HCP-covered lands and may be affected indirectly by HCP-covered activities. These downstream areas include both designated critical habitat segments in non-forested areas and non-designated segments located on private or tribal forest lands.

In this analysis, we considered all effects arising from changes in sediment inputs and turbidity, water temperature and water quality downstream of HCP lands within designated critical habitat for bull trout. As explained in the description of the Action Area, we estimated effects may occur within one mile downstream of HCP-covered lands as we consider this to be the distance over which effects from HCP-covered activities are likely to be detectable (e.g., short-term increases in turbidity from culvert installations, etc.). In total, we estimated there is 34 miles of bull trout spawning and rearing habitat and 200 miles of bull trout FMO habitat located within one mile downstream of HCP-covered lands for a total of 234 stream miles of potential critical habitat. Most of these stream miles are excluded from critical habitat because they occur on other private forest lands covered under the Washington Forest Practices HCP. There are a few locations in the action area where designated critical habitat on federal lands is located downstream of the HCP-covered lands. Based on the potential for designated critical habitat to be located downstream of HCP-covered lands, we evaluated the general effects of ongoing HCP implementation to the primary constituent elements of bull trout critical habitat.

16.2.1 Primary Constituent Elements

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. Effects analyses for bull trout critical habitat evaluate how a proposed action will affect the capability of the PCEs to support the life-history needs of the species and provide for its conservation (75 FR 63943). There are nine PCEs of bull trout critical habitat listed in the final rule that address the specific habitat requirements essential for bull trout conservation. The nine PCEs relate to (1) water quality; (2) migration habitat; (3) food availability; (4) instream habitat; (5) water temperature; (6) substrate characteristics; (7) stream flow; (8) water quantity; and (9) nonnative species (75 FR 63931).

PCE 1: Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia.

None of the effects of ongoing HCP implementation are expected to significantly alter water quality and quantity associated with springs, seeps, groundwater sources, and subsurface water connectivity within designated critical habitat areas. This conclusion is based on the rationale that no designated critical habitat is located on WDNR-HCP covered lands, and the HCP required RMZs provide a high level of protection for stream banks, springs, wetlands, etc. Actions that may affect PCE 1 resources such as road construction or road reconstruction are expected to occur in locations that would not measurably affect this resource. Therefore, effects to PCE 1 are considered insignificant.

PCE 2: Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers.

Culvert installations and replacements follow the requirements in the WAC 222-24 Road Construction and Maintenance and the Forest Practices Board Manual, which ensures that all crossing structures are designed to allow passage for all life stages of salmonids. WDNR has replaced hundreds of fish passage barrier culverts under RMAPs, improving migration habitat for fish throughout the action area. These fish passage barrier removals have primarily occurred outside of designated critical habitat areas. We expect long-term improvements to physical migration barriers in tributary streams will contribute to the overall productivity of designated bull trout critical habitat with long-term benefits resulting from fish passage enhancement. Therefore, the effects to PCE 2 are considered beneficial.

PCE 3: An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.

HCP implementation on the covered lands can result in downstream effects to aquatic habitat through increased fine sediment deposition in the spawning and rearing habitat for salmon and other native fish species that provide a prey base for bull trout. As described in the effects to bull trout, stream crossings are conduits for direct sediment input to streams, and culvert installations and replacements result in short-term turbidity plumes and long-term increases in fine sediments in stream substrates for up to 0.5 miles downstream from the stream crossing, including areas that provide spawning habitat for other salmonids that provide prey resources for bull trout. The effect is reduced spawning success and productivity in the affected areas. There are a few instances where designated bull trout critical habitat on federal lands is located downstream from HCP-covered lands that have the potential for exposure to these effects. Therefore, we conclude effects to PCE 3 resources are adverse at intermittent, site-specific scales. However, because these effects are likely to be limited to few site-specific locations representing a small fraction of the designated critical habitat, these effects will be immeasurable to at the scale of critical habitat subunits (e.g., specific watersheds such as the Hoh River subunit).

PCE 4: Complex river, stream, lake, reservoir, and marine shoreline aquatic environments, and processes that establish and maintain these aquatic environments, with features such as large *wood, side channels, pools, undercut banks and unembedded substrates, to provide a variety of depths, gradients, velocities, and structure.*

The RMZ buffers for streams provided by the HCP provide a high level of riparian area function for maintaining and restoring stream bank stability and recruitment of large wood on all fish-bearing waters. Therefore, the effects to PCE 4 resources located in designated critical habitat areas downstream from the HCP-covered lands are beneficial.

PCE 5: Water temperatures ranging from 2 to 15 °C (36 to 59 °F), with adequate thermal refugia available for temperatures at the upper end of this range. Specific temperatures within this range will vary depending on bull trout life-history stage and form; geography; elevation; diurnal and seasonal variation; shading, such as that provided by riparian habitat; streamflow; and local groundwater influence.

As described in the *Effects to Stream Temperature*, timber harvest along Type 5 streams without RMZ buffers can result in increases in stream temperature at a highly localized scale. If these effects occur immediately upstream from designated critical habitat located on National Forest lands, there could be a slight increase in temperature within critical habitat segments. These effects would be highly localized to specific sites and are likely to subside relatively quickly as forests regenerate in the harvested areas. Therefore, we conclude effects to PCE 5 are adverse at site-specific scales but are immeasurable at the scale of critical habitat subunit.

PCE 6: In spawning and rearing areas, substrate of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount of fine sediment, generally ranging in size from silt to coarse sand, embedded in larger substrates, is characteristic of these conditions. The size and amounts of fine sediment suitable to bull trout will likely vary from system to system.

HCP covered activities include road construction, timber haul, timber harvest, and culvert replacements that are likely to increase levels of fine sediment into streams, including spawning and rearing habitat. Substrate scouring and sediment deposition from stream crossings and culvert replacements will directly degrade bull trout spawning habitat and spawning and rearing sites for a downstream distance of 0.5 miles. There are a few instances where designated bull trout critical habitat on federal lands is located downstream from HCP-covered lands that have the potential for exposure to these effects. Therefore, we conclude effects to PCE 6 resources are adverse at intermittent, site-specific scales. However, because these effects are likely to be limited to few site-specific locations representing a small fraction of the designated critical habitat, these effects will be immeasurable to at the scale of critical habitat subunits (e.g., specific watersheds such as the Queets River subunit).

PCE 7: A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, minimal flow departure from a natural hydrograph.

Timber harvest on the HCP-covered lands will result in both increases and decreases in forest evapotranspiration rates which can affect both peak flows and summer base flows. HCP-covered timber harvest will, in some limited circumstances, result in increased peak flows that may affect critical habitat located downstream of the HCP-covered lands. These effects are likely to be sporadic, and widely dispersed in spatial extent due to the dispersed nature of WDNR timber harvest patterns in any given decade. The effect to critical habitat is increased risk or frequency of stream scouring events associated with winter peak flow events which can impact bull trout spawning substrates (PCE 6). Local reductions in forest evapotranspiration can also result in short-term increases in summer base flows, resulting in increased wetted channel width during summer months that increases available habitat area for aquatic life which can be a beneficial effect.

HCP-effects to base flows are estimated to be more extensive and long-lasting than peak flow effects. Over 50 percent of the HCP-covered lands within the bull trout watersheds are likely to be maintained in young-forest plantations, which have high rates of evapotranspiration, resulting in significant reductions in summer base flows (up to 50 percent) in headwater streams, relative to summer base flows originating from watersheds with old-growth forest. These effects are long-lasting (50 years or more). There are a few instances where designated bull trout critical habitat on federal lands is located downstream from HCP-covered lands that have the potential for exposure to these effects. The effects to bull trout critical habitat include reduced water quantity (PCE 8) to support summer rearing habitat for bull trout and bull trout prey species (PCE 3). Therefore, we conclude the effects to PCE 7 are adverse effects. The magnitude of these effects in terms of total reductions in summer base flows and reduced wetted stream area for bull trout are unquantifiable at this time due to the complex nature of this effect. Because almost all of the designated critical habitat associated with bull trout spawning and rearing is located on federal lands upstream from the HCP-covered lands, we expect the base flow effects to aquatic habitat on federal lands are limited.

PCE 8: Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.

As described above (PCE 7), we expect HCP-covered actions will affect water quantity through increases (peak flows) and decreases (base flows), and will temporarily affect water quality through road construction, culvert installations, and potentially forest herbicide applications. will temporarily degrade water quality in the action area. There are a few instances where designated bull trout critical habitat on federal lands is located downstream from HCP-covered lands that have the potential for exposure to these effects. The proposed action is not expected to create permanent adverse effects to water quality; however, short-term adverse effects will be anticipated and will likely be measurable in some instances. Project related turbidity plumes depend on activity and duration and may occur more than once depending on stream flow. Therefore, we conclude effects to PCE 8 resources are adverse at intermittent, site-specific scales. However, because these effects are likely to be limited to few site-specific locations representing a small fraction of the designated critical habitat, these effects will be immeasurable to at the scale of critical habitat subunits.

PCE 9: Sufficiently low levels of occurrence of nonnative predatory (e.g., lake trout, walleye, northern pike, smallmouth bass); interbreeding (e.g., brook trout); or competing (e.g., brown trout) species that, if present, are adequately temporally and spatially isolated from bull trout.

Potential effects associated with this PCE are discountable, because none of the proposed actions would result in changes to nonnative fish species presence or distribution within the action area.

16.2.2 Summary of the Effects to Bull Trout Critical Habitat

In the preceding section, we determined that ongoing HCP implementation will result in adverse effects to designated bull trout critical habitat due to the localized degradation of PCE's (3) food availability; (5) water temperature; (6) substrate characteristics; (7) stream flow; (8) water quality and quantity.

Water quality and aquatic habitat conditions within designated bull trout critical habitat are all influenced by upstream watershed conditions and riparian processes. There are a few instances where designated bull trout critical habitat on federal lands is located downstream from the HCP-covered lands that have the potential for exposure to these effects. All bull trout habitat located on federal lands is designated as critical habitat, while all forested lands located outside of federals lands are not designated as critical habitat, because these areas were excluded from the final critical habitat designation.

In the bull trout watersheds with HCP-covered lands there is a total of 951 miles of bull trout spawning and rearing habitat. Of this, 669 miles (70 percent) are located on federal lands and designated as critical habitat. The remaining 30 percent of bull trout spawning and rearing habitat occur on non-federal lands is managed under existing HCPs: 5 percent on the WDNR HCP-covered lands (43 miles), and 238 miles on other private lands managed under the Washington Forest practices HCP, or other authorized HCPs that cover bull trout (25 percent). As described above, there are limited areas where forest management on the covered lands is likely to result in downstream effects to designated critical habitat on federal lands. However, these effects are limited in scope, and are indistinguishable from the effects forest management on adjacent private lands. In the case of designated critical habitat on federal lands, almost all of the designated areas (>95 percent) are located upstream of the HCP-covered lands and are not affected by ongoing HCP implementation. Downstream effects to designated critical habitat FMO areas located in the lower reaches of the watersheds are immeasurable because these areas are generally located further than 1 mile downstream from the HCP-covered lands, and the habitat conditions reflect the condition of the adjacent upland uses (e.g., agriculture, urban development).

HCP implementation will result in habitat degradation and in beneficial effects to designated bull trout critical habitat in some localized areas. The magnitude of these effects is limited in scale and dispersed within the affected subbasins. Because WDNR HCP riparian conservation strategies are effective at minimizing the majority of land-management effects to aquatic habitats, we conclude that the ongoing effects of HCP implementation will not measurably affect the conservation role of critical habitat to support viable bull trout core area populations at the scale of any of the affected critical habitat subunits (e.g., individual core areas and shared FMO watersheds) within the Coastal Recovery Unit.

17 CUMULATIVE EFFECTS: Bull Trout and Designated Bull Trout Critical Habitat

Cumulative effects include the effects of future state, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this Opinion. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Within and adjacent to the administrative boundary of the HCP there are interspersed tracts of nonfederal land. Land uses that are reasonably certain to occur on these lands include timber harvest, agriculture and development. The USFWS anticipates that such nonfederal actions on those lands may affect bull trout and its critical habitat.

<u>Forest Practices</u>

Much of the adjacent nonfederal lands in the action area are used for timber production. These activities have been addressed under existing HCPs and tribal forest-management plans and previously analyzed under Section 7 of the ESA. Those plans include the Washington Forest Practices Rules (RCW 76.09, WAC 222). The effects to bull trout and bull trout critical habitat from forest management under the Washington Forest Practices Act contain minimum no-cut buffers along fish-bearing streams, and long-term requirements for road systems management to minimize effects to listed fish. The USFWS completed formal consultation on the Washington State Forest Practices Rules in 2006 and anticipated that there would be significant adverse effects to bull trout and bull trout critical habitat from forest practices activities but concluded that these effects are not likely to jeopardize the continued existence of bull trout, or adversely modify designated bull trout critical habitat (USFWS 2006, pp. 783, 809). Because these effects have already been addressed through section 7 consultation, they are not considered cumulative effects.

<u>Fisheries Management</u>

Bull trout in the action area are susceptible to incidental bycatch and mortality associated with recreational, commercial, and subsistence fisheries. Although Washington sport-fishing regulations prohibit the retention of bull trout in most rivers and streams, retention of adult bull trout is permitted in the Lower Skagit River (WDFW 2023, p.40). Bull trout are known to be incidentally caught in recreational sport-fisheries. While there is considerable information in the literature regarding catch-and-release mortality for trout, we currently have no information regarding the extent that recreational fisheries may be affecting bull trout populations.

Bull trout are also susceptible to incidental mortality associated with gill-net fisheries that target salmon and steelhead at the mouths of the Hoh, Queets, and Quinault Rivers (Brenkman and Corbett 2005, p. 1080). Currently there is no monitoring of bull trout bycatch in the gill-net fisheries. The extent and seasonal variation of mortality remains unknown in each river, but it is believed to be a significant contributor to mortality of bull trout in several Olympic Peninsula rivers (USFWS 2004, p. 105). In 2002, biologists obtained 105 adult bull trout specimens incidentally captured in gill-net fisheries occurring between January and June 2002 in the Hoh River (Brenkman and Corbett 2007, p.3). These bull trout, ranging in size from 287 to 760 mm

(11 to 30 inches) with an average size of 580 mm (23 inches), were aged 3 to 7 years old (Brenkman and Corbett 2007, p.5). Because migratory bull trout can migrate between marine and freshwater habitats multiple times in their lives, they are vulnerable to bycatch in coastal gill-net fisheries (Brenkman and Corbett 2005, pp. 1079-1080; 2007, p.10).

Bull trout populations are highly vulnerable to over-fishing, and over-exploitation can lead to significant population declines (Johnston et al. 2007, p.114). Both recreational and Tribal salmon and steelhead fisheries are likely affecting bull trout populations in all bull trout core areas within the action area that support recreational or commercial fisheries for salmon and steelhead. Other fisheries management activities that have both long-term historical and current impacts on bull trout populations include fish stocking, hatchery operations, and, indirectly, other fisheries management that affects the bull trout prey base (e.g., reduction in salmon populations) (USFWS 2004, p. 102). The magnitude of the effects of both recreational and tribal fisheries on bull trout in the action area are unknown. Understanding the impact of fisheries to bull trout populations is an important research need (USFWS 2004, pp. 102-106, Brenkman and Corbett 2007, p. 10).

The available evidence indicates that the cumulative effects associated with ongoing fisheries management likely affect all bull trout populations within the action area to some degree. However, we currently have no information regarding the magnitude of these effects relative to overall population sizes or trends within the action area or the Coastal Recovery Unit for bull trout.

18 INTEGRATION AND SYNTHESIS OF EFFECTS: Bull Trout and Designated Bull Trout Critical Habitat

The Integration and Synthesis section is the final step in assessing the risk posed to species and critical habitat as a result of implementing the federal action. In this section, we add the effects of the action and the cumulative effects to the status of the species and critical habitat, and the environmental baseline, to formulate our biological opinion as to whether the proposed action is likely to: (1) appreciably reduce the likelihood of both survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution; or (2) result in the destruction or adverse modification of critical habitat.

Summary of the Status and Conservation Needs of Bull Trout

Based on our most recent status review (USFWS 2014, p. iv), historic habitat loss and fragmentation, interaction with nonnative species, and fish passage issues are widely regarded as the most significant threat factors affecting bull trout. The order of those threats and their potential synergistic effects vary greatly by core area and among local populations (USFWS 2014, p. iv). The primary strategy for the recovery of bull trout is to conserve bull trout so that they are geographically widespread across representative habitats and demographically stable in six recovery units; and to effectively manage and ameliorate the primary threats at the core area scale such that bull trout are not likely to become endangered in the foreseeable future (USFWS 2014, p. v).

The WDNR HCP is located in the Olympic Peninsula, Puget Sound, and the Lower Columbia River geographical regions, which are located in the Coastal Recovery Unit. The Coastal Recovery Unit encompasses 21 bull trout core areas located in western Washington and western Oregon and includes the only core areas that currently support anadromous local populations (USFWS 2014, p. 37). The primary threats identified in the draft Recovery Plan for the Olympic Peninsula, Puget Sound, and the Lower Columbia River regions (in consideration of present and future climate change) are upland and riparian land management, legacy impacts from past timber harvest and roads, and fisheries bycatch (USFWS 2014, p. 83).

The environmental baseline indicates that bull trout have a limited distribution in coastal Washington (relative to other salmonid species), and abundance is generally low to moderate within core areas of the Olympic Peninsula region, the Columbia River region, and Coastal-Puget Sound region with some exceptions, and productivity is highly variable across core areas. Fragmentation and reduced distribution of the migratory life history form is generally more prevalent within core areas in the Columbia River region than within core areas in the Coastal-Puget Sound region. Baseline habitat conditions are generally poorer in spawning and rearing habitats of core areas within the Washington portion of the Columbia River region compared to the Coastal-Puget Sound region. At the core area scale, numerous historical and ongoing factors continue to limit the potential for population recovery within many of the core areas across the three regions; however, there are several core areas with substantial bull trout habitat within relatively protected areas (e.g., Wilderness Areas and National Parks). In some core areas, habitat is largely protected (e.g., Wilderness Areas) and the presence of non-native fish species (i.e., brook trout) may be the only significant factor of concern.

Distribution of Bull Trout on the HCP-covered Lands

The WDNR state lands HCP covers approximately 1.91 million acres located within the range of the northern spotted owl in Washington. Bull trout are a covered species under the HCP, but only in the westside planning units and on the OESF. The HCP covered lands in western Washington include over 1.58 million acres. The distribution of bull trout on the HCP-covered lands is limited to specific watersheds. About 47 percent (~750,000 acres) of the HCP covered lands in the westside areas (including OESF) occur in bull trout watersheds.

Bull trout habitat use within the HCP-covered lands is associated with spawning and rearing habitat (43 stream miles), and foraging, migration, and overwintering habitat (93 miles). These miles are distributed across a total of 14 bull trout core areas, and 14 shared bull trout FMO watersheds. The distribution of bull trout within the HCP covered lands is limited to a relatively small percentage of the total stream miles within these occupied watersheds. There are over 13,300 miles of streams (all stream types) on the HCP-covered lands in the bull trout watersheds. Of these, approximately 2,776 miles are fish-bearing streams. There are 136 miles of known, occupied bull trout rivers and streams on the HCP-covered lands in these watersheds, which represents only about 5 percent of the total fish-bearing streams in the bull trout watersheds (Table 58).

Table 58. Summary of lands, roads, and streams in bull trout watersheds on the HCP covered lands by HCP planning unit.

HCP Planning Unit	Total westside WDNR HCP lands - 2023 (acres)	Average annual timber harvest (2013-2022) (acres)	Roads on HCP-covered lands (2022 inventory) (miles)	WDNR HCP lands in bull trout watersheds (acres)	Percent of total westside WDNR HCP lands located in bull trout watersheds	All streams on HCP covered lands in bull trout watersheds (Types 1-5) (miles)	Fish-bearing streams on HCP-covered lands in bull trout watersheds (Types 1-3) (miles)	Bull trout streams on HCP-covered lands (miles)	Percent of fish-bearing streams on HCP covered lands occupied by bull trout
Columbia	288,442	3,585	1,283	60,443	21%	1,017	152	1	1%
North Puget	457,256	3,040	1,485	430,790	94%	7,988	1,368	77	6%
South Coast	260,716	2,989	1,765	21,858	8%	236	115	1	1%
South Puget	178,130	1,306	1,365	38,444	22%	611	133	1	1%
Straits	127,919	1,337	922	32,297	25%	468	124	7	6%
OESF	273,053	2,269	1,837	170,081	62%	3,024	884	47	5%
Totals	**1,585,516**	**14,526**	**8,657**	**753,913**	**48%**	**13,344**	**2,776**	**136**	5%
Percentages	100% of lands	1% of lands	100% or roads	48% of HCP lands	48% of HCP lands	100% of streams	21% of all streams		5% of fish bearing streams

<u>Summary of Ongoing HCP-Covered Activities</u>

Under the HCP, the WDNR manages approximately half of the HCP-covered lands in the westside areas (including OESF) for timber production, and the other half of the HCP covered lands are deferred from regeneration timber harvesting, and are maintained for various conservation purposes, including riparian and wetland buffers, special habitat features, marbled murrelet conservation areas, spotted owl habitat areas, Natural Area Preserves, and various other deferrals. In the westside areas (including the OESF), WDNR implements various timber harvest treatments on about 14,500 acres per year, which represents a timber harvest rate of less than 1 percent of the total HCP-covered lands per year on average. Harvest types vary, but on average, about 72 percent (11,400 acres per year) are variable retention harvest treatments, while 28 percent (4,500 acres per year) are commercial thinning treatments. Commercial thinning is commonly used to achieve habitat restoration purposes including treatments in riparian buffers. WDNR implements riparian thinning treatments on about 300 acres per year on average, representing less than 1 percent of the estimated riparian buffers on the HCP-covered lands per year. There are a total of 5,738 miles of roads on the HCP-covered lands located within bull trout watersheds. WDNR roads include 4,931 miles within bull trout core areas and 807 miles of roads located within bull trout shared FMO watersheds. Across all bull trout watersheds combined road densities average 4.9 mi/mi^2 in core areas and 4.7 mi/mi^2 in shared FMO watersheds.

The HCP riparian conservation strategies apply a system of variable-width riparian buffers based on stream typing that provide protection to stream banks, large wood recruitment and stream temperature regulation along most of the stream network, including all fish-bearing streams. The riparian conservation strategy was developed to maintain and restore the ecological functions of riparian forests, provide large wood to streams, and support hydrologic connectivity of wetlands. The conservation strategies applied in the HCP, have substantially reduced the scope and magnitude of adverse effects to aquatic habitats compared to historic forest practices. Despite, this, we still anticipate adverse effects to fish and aquatic habitats will result from HCP-covered activities associated with timber harvest, road construction, and road use.

Summary of Effects to Bull Trout and Designated Bull Trout Critical Habitat

In the preceding sections, we described how HCP-covered forest management is likely to result in increased summer maximum stream temperatures; increases in peak flows, decreases in summer base flows, increased soil erosion and sediment loading in streams from timber harvest and forest roads; and degradation of water quality associated with temperature, turbidity, and to a lesser extent, chemical contaminants. These effects are intermittent and often seasonal in nature (e.g., summer water temperatures), but cumulatively degrade the quality of bull trout habitat within the action area. In some areas, migratory bull trout are likely to experience sublethal effects in the form of physiological stress and reduced growth rates, and reduced abundance of prey, which can affect the long-term survival and reproductive capability of affected individuals. In other areas, bull trout eggs, alevins, and age 0-fry will be subject to indirect mortality due to substrate scouring effects and reduced oxygen uptake associated with increased fine sediments in spawning areas. Bull trout spawning habitat is degraded by stream adjacent roads, and by culvert installations for distances up to 0.5 mile downstream from stream crossings due to a reduction in spawning gravel quality.

We anticipate that adverse effects to bull trout will occur at limited locations, and infrequently, over the remainder of the initial 70-year term of the HCP (2067). We do not anticipate that all bull trout associated with the 136 miles of occupied bull trout stream miles on the HCP-covered lands will be affected, but rather an unknown, and likely small percentage of the total bull trout associated with these stream miles will be affected in any given year based on site specific environmental circumstances. Adverse effects to bull trout and bull trout habitat within the HCP-covered lands (and affected areas downstream of covered lands) are not attributable to any single habitat indicator, specific timber harvest unit, or individual road segment. It is the additive and synergistic effects of all forest management activities at the scale of subwatersheds that leads to the degradation of fish habitat and reduced productivity for native fishes, including bull trout. The additive effects of ongoing forest management (timber harvest, high road densities, hundreds of road stream-crossings, etc.), coupled with the projected impacts of climate change lead us to the conclusion that adverse effects to bull trout have occurred, and will continue to occur on the HCP-covered lands, but these effects are limited, and nearly unquantifiable in terms of the impacts to bull trout numbers and reproduction. Removal of fish passage barriers is beneficial for species distribution.

The HCP riparian conservation strategies and contemporary forest road standards provide a high level of riparian function and aquatic habitat protection. The interior core RMZ buffers provided along all fish-bearings streams are effective at maintaining large wood resources, temperature regulation, and sediment retention. WDNR has replaced hundreds of fish passage barriers and will continue to do so as additional barriers are identified. Restoring passage provides substantial benefits to habitat connectivity and productivity for bull trout and other salmonids. The long-term beneficial effects associated with restoring fish passage within WDNR watersheds outweighs the short-term adverse effects in the form of elevated turbidity and sediment deposition at these sites. Additionally, restoration thinning in the RMZ's is expected to improve long-term riparian functions by promoting the growth of large conifer trees, providing a future quality and quantity of large wood, retaining stand diversity, and by creating downed wood in the RMZ. The long-term beneficial effects associated with restoration treatments in the RMZs outweighs the limited short-term adverse effects associated with these actions.

HCP implementation will result in habitat degradation and in beneficial effects to designated bull trout critical habitat in some localized areas. The magnitude of these effects is limited in scale and dispersed within the affected subbasins. Because WDNR HCP riparian conservation strategies are effective at minimizing the majority of land-management effects to aquatic habitats, we conclude that the ongoing effects of HCP implementation will not measurably affect the conservation role of critical habitat to support viable bull trout core area populations at the scale of any of the affected critical habitat subunits (e.g., individual core areas and shared FMO watersheds) within the Coastal Recovery Unit.

Summary of Effects to Bull Trout Numbers, Reproduction, and Distribution

Bull trout are limited to select streams and rivers within the occupied watersheds. A relatively minor amount of the known, occupied bull trout habitat (rivers and streams) within the Coastal Recovery units is located on the HCP-covered lands (5 percent). The HCP-covered lands contain approximately 5 percent of the total available bull trout SR habitat, and 5 percent of the available bull trout FMO habitat located within the Coastal Recovery unit core areas that overlap with HCP-covered lands. Over 70 percent of available spawning and rearing areas for bull trout in the affected core areas is located on federal lands and is not affected by the HCP. On the Olympic Peninsula, over 90 percent of spawning habitat is located on federal lands, primarily within Olympic National Park.

Population viability analysis has been applied to assess the long-term persistence of bull trout populations (Rieman and Mclntyre 1993, Post et al. 2003, Staples et al. 2005). Sensitivity analyses in these models have pointed to the importance of survival of older age classes to population persistence. Post et al. (2003) found that populations of migratory bull trout may be highly susceptible to declines from increased mortality of larger, older fish due to angling. Bull trout generally do not attain first maturity until at least 5 years of age. Thus, in bull trout populations, survival of older juveniles and adults appears to be a critical factor influencing population persistence (Dunham et al. 2008, p.544). The effects to adult bull trout from ongoing HCP implementation are limited to sublethal effects. None of the effects of HCP-covered actions will result in direct mortality of adult bull trout.

The population viability analyses have provided important perspectives on the dynamics of individual populations of bull trout. Within the context of a stream network, connectivity among populations (dispersal) and access between habitats used for spawning and foraging are critical for sustaining populations. Bull trout populations within core areas exhibit complex dynamics and structuring that represent a composite of different metapopulation, landscape, and historical processes (Dunham et al. 2008, p.544). Studies of large-scale patterns of habitat or "patch" occupancy by bull trout show that local population persistence in stream networks is strongly tied to patch size (stream or watershed size), connectivity, and habitat quality (Dunham and Rieman 1999). The importance of habitat size and connectivity to the persistence of bull trout is supported by several lines of evidence that examine temporal processes driving these patterns (e.g., dispersal, demographic variation, and environmental variability) (Dunham et al. 2008, p.544).

Populations that have the potential to exchange individuals through dispersal are much more likely to persist than populations that are totally isolated (Rieman and McIntyre 1993, p. 16). Radio-telemetry studies have demonstrated that migratory bull trout in coastal core areas seasonally use habitat in multiple drainages, including waters in neighboring core areas (Brenkman and Corbett 2005, p. 1078). Most of the bull trout core areas in the Olympic and Puget Sound regions have a high level of connectivity and are likely resilient to minor disturbance-related habitat perturbations. None of the effects of HCP-covered actions will result in reduced habitat area or habitat connectivity within or between local populations, core areas, and shared FMO areas.

Although we anticipate adverse effects to individual bull trout and designated bull trout critical habitat will occur from implementation of the HCP, none of the effects of continued HCP implementation are expected to result in measurable reductions in the bull trout numbers, distribution, or reproduction. Therefore, we conclude that the effects of the action, considering the cumulative effects, will not measurably reduce bull trout distribution, numbers, or reproduction in any of the affected core areas, the Coastal Recovery Unit, or within the listed range of the species. The HCP riparian conservation strategies will lead to the long-term restoration and recovery of bull trout habitat that was degraded by the effects of over a century of historical forest practices that did not provide for the protection of aquatic and riparian habitat.

19 CONCLUSION: Bull Trout and Designated Bull Trout Critical Habitat

After reviewing the current status of bull trout and designated bull trout critical habitat, the environmental baseline for the action area, the ongoing effects of the HCP, and the cumulative effects, it is the USFWS's Opinion that continued implementation of the HCP is not likely to jeopardize the continued existence of the bull trout and is not likely to destroy or adversely modify designated critical habitat.

20 INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. *Harm* is defined by the USFWS as an act which actually kills or injures wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering (50 CFR 17.3). *Harass* is defined by the USFWS as an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering (50 CFR 17.3). Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The 1997 Washington State Department of Natural Resources' Habitat Conservation Plan (HCP), as amended, and its associated documents clearly identify anticipated impacts to affected species likely to result from the taking and the measures that are necessary and appropriate to minimize those impacts. All conservation measures described in the HCP, together with the terms and conditions described in the associated Implementation Agreement, and any section 10(a)(1)(B) permit or permits issued with respect to the proposed HCP, are hereby incorporated by reference within this Incidental Take Statement as reasonable and prudent measures and terms and conditions pursuant to 50 CFR §402.14(i). Such terms and conditions are non-discretionary. The amount or extent of incidental take anticipated under the WDNR HCP, associated reporting requirements, and provisions for disposition of dead or injured animals, are as described in the HCP and its accompanying section10(a)(1)(B) permits.

Direct take of bull trout that may occur as a result of research and fish capture and handling activities including the use of seines, dipnets, block nets, electrofishing or other methods used to capture bull trout will require WDNR to apply for a separate 10(a)(1)(A) permit with the USFWS and is not a covered under this incidental take statement.

21 AMOUNT OR EXTENT OF TAKE

21.1 Spotted Owl

In the accompanying Opinion, we estimated that continued implementation of the HCP over the next 43 years has the potential to result in the loss of up to 93,000 acres of spotted owl nesting / roosting habitat, dispersed across a large landscape that encompasses over 1.9 million acres of HCP-covered lands. The rate of habitat loss is expected to occur gradually, at an average rate of approximately 2,160 acres per year. The spotted owl population in Washington has declined to approximately 5 percent of the population levels that were present at the beginning of the HCP in

1997. The decline in the population is because of competition with barred owls and is not a result of HCP implementation.
As of 2023, we estimated that up to 17 spotted owls pairs are associated with the HCP covered lands. Of these, we estimate that up to 6 pairs (34 percent) will be incidentally taken as a result of HCP-covered timber harvest and related activities within the next decade. The form of the take is harm from significant habitat modification that will impair essential behaviors of breeding, feeding, and sheltering for individuals taken. Because spotted owl populations are rapidly declining, it is unlikely that any spotted owls remaining in Washington within 10 years will be incidentally taken, because these individuals will likely only occur on federal lands, or potentially within areas managed to control barred owls.

In our review of the incidental take permit issued to WDNR for the HCP, we conclude that the amount and extent of incidental take permitted in 1997 (up to 200 pairs) has not been exceeded, and we are reasonably certain this level of incidental take will not be exceeded over the remaining term of the HCP. We conclude that the original incidental take permit issued to WDNR does not require amendment or re-issuance.

Rationale for Habitat Surrogate

The USFWS anticipates incidental take of individual spotted owls will be difficult to detect because occupancy of historic spotted owl territories in the action area has declined, and the presence of barred owls has likely displaced spotted owls from most historic territories. However, pursuant to 50 CFR 402.14(i)(1)(i), a habitat surrogate can be used to express the anticipated level of take in an Incidental Take Statement, provided three criteria are met: (1) measuring take impacts to a listed species is not practical; (2) a link is established between the effects of the action on the surrogate and take of the listed species; and (3) a clear standard is set for determining when the level of anticipated take based on the surrogate has been exceeded.

The following discussion presents the USFWS's analysis and findings with respect to the three regulatory criteria for use of a habitat surrogate in this ITS to express the anticipated level of take likely to be caused by the proposed action:

1) *Measuring take impacts to individual spotted owls is not practical*. To measure take of individual spotted owls would require capturing, tagging, and radio-tracking of individual spotted owls in the action area prior to, during, and after implementation of HCP-covered activities. Such an undertaking is outside the scope of the HCP, is not practicable to implement, and would pose additional risk of harm to spotted owls through capture and handling of individuals.

(2) *A link is established between the effects of the action on suitable spotted owl habitat and take of spotted owls*. In the accompanying Opinion, we have provided a detailed analysis of how the habitat effects are reasonably certain to significantly impair essential spotted owl behavior patterns, including breeding, feeding, or sheltering.

(3) *A clear standard is set for determining when the level of anticipated take based on the surrogate has been exceeded*. Due to the long-term nature of this HCP, we rely on commitments

of the 1997 HCP to determine the standard by which to determine when the level of anticipated take has been exceeded. Specifically, the HCP, as amended, establishes NRF management areas that encompass approximately 224,600 acres, and dispersal management areas (including specific Desired Future Condition designations within the Klickitat planning unit) that encompass approximately 174,300 acres of WDNR-managed lands. In addition to the designated NRF and dispersal management areas, the HCP includes conservation objectives for the maintenance and restoration of spotted owl habitat in the OESF, and additional provisions for designation of nesting habitat patches within NRF management areas, etc. Take will be exceeded, if WDNR disposes of HCP-covered lands within NRF or dispersal management areas without mitigation (replacement acres). If the HCP is modified such that the area covered by the provisions of the spotted owl conservation strategy is reduced, the level of take anticipated in this ITS will be exceeded, triggering reinitiation of formal consultation under section 7 of the ESA.

21.2 Bull Trout

Continued implementation of the HCP over the next 43 years will result in incidental take of bull trout in the form of harm due to significant habitat modification effects from HCP-covered activities, including riparian timber harvest, stream-adjacent forest roads, and stream crossings, which affect all bull trout life-history stages. On average, approximately 1 percent of the total HCP-covered lands are subject to timber harvesting per year, including up to 1 percent of interior core riparian buffers may be subject to timber harvesting per year. These levels may vary slightly from year to year, but over any 10-year period the total area subject to timber harvest is expected to average 1 percent of the total HCP-covered lands per year within the westside units and the OESF. Summaries of annual timber harvest are readily available in the HCP annual reports. Incidental take will occur at limited locations within 43 miles of spawning and rearing streams, and within 93 miles of foraging, migration, and overwintering streams located on the HCP-covered lands (136 miles total). Estimates of incidental take account for the continued implementation of the HCP conservation measures, as amended, or modified. Because bull trout are fish living in streams and rivers, the likelihood of discovering an individual death or injury attributable to the covered activities is unlikely.

We anticipate that incidental take of bull trout will occur at limited locations, and infrequently, over the remainder of the initial 70-year term of the HCP (until 2067). We do not anticipate that all bull trout associated with the 136 miles of occupied bull trout stream miles on the HCP-covered lands will be subject to incidental take, but rather an unknown, and likely small percentage of the total number of bull trout associated with these stream miles will be affected in any given year based on site specific environmental circumstances. The HCP riparian conservation strategies greatly minimize the potential for temperature and sediment-related effects from timber-harvest activities, and the erosion-control measures for forest roads effectively minimize direct sediment delivery to bull trout streams via roads and stream crossings under most circumstances.

In our review of the incidental take permit for bull trout issued to WDNR for the HCP, we conclude that the amount and extent of incidental take permitted in 1998 (501 miles of estimated bull trout streams, and forest management within 1 percent interior-core riparian buffers –

approximately 3,300 acres per year) has not been exceeded, and we are reasonably certain this level of incidental take will not be exceeded over the remaining term of the HCP.

We conclude that the original incidental take permit issued to WDNR does not require amendment or re-issuance.

Rationale for Habitat Surrogate

We anticipate incidental take of individual will be difficult to detect. However, pursuant to 50 CFR 402.14(i)(1)(i), a habitat surrogate can be used to express the anticipated level of take in an Incidental Take Statement, provided three criteria are met: (1) measuring take impacts to a listed species is not practical; (2) a link is established between the effects of the action on the surrogate and take of the listed species; and (3) a clear standard is set for determining when the level of anticipated take based on the surrogate has been exceeded.

The following discussion presents the USFWS's analysis and findings with respect to the three regulatory criteria for use of a habitat surrogate in this ITS to express the anticipated level of take likely to be caused by the action:

1) *Measuring take impacts to individual bull trout is not practical*. Measuring incidental take of bull trout across the action area is not practical. To measure take of bull trout from habitat-related effects (e.g., reduced spawning success due to increased fine sediments) would require intensive before and after controlled experiments to monitor both physical and biological factors linked to bull trout egg survival rates. Such an undertaking is outside the scope of the HCP, is not practicable to implement, and would pose additional risk of harm through capture and handling of individual fish.

(2) *A link is established between the effects of the action on aquatic habitat and take of bull trout*. In the accompanying Opinion, we have provided a detailed analysis of how effects to aquatic habitat are reasonably certain to significantly disrupt normal bull trout behavior patterns, including foraging, spawning, and rearing.

(3) *A clear standard is set for determining when the level of anticipated take based on the surrogate has been exceeded*. Due to the long-term nature of this HCP, we rely on commitments of the 1997 HCP, as amended, to determine the standards by which the level of anticipated take has been exceeded. If future HCP amendments or modifications result in changes that reduce HCP conservation measures for riparian and aquatic habitats, those changes shall be evaluated to determine if the amount or extent of incidental take has been exceeded. Because WDNR has an active land acquisition and disposition program, it is possible that the total area of HCP-covered lands within bull trout watersheds may increase through acquisitions or decrease through dispositions. Incidental take may be exceeded if there is a greater than or equal to a 10 percent increase (through acquisitions) or decrease (through dispositions) in known occupied bull trout habitat located on HCP-covered lands. We chose the 10 percent value as index for the relative proportion of bull trout habitat within the Coastal Recovery Unit on the HCP covered lands. Changes in ownership of 10 percent or more may result in effects that have not been previously

considered. Such changes shall be evaluated to determine if the amount or extent of incidental take has been exceeded, using the best available science.

22 EFFECT OF THE TAKE

In the accompanying Opinion, the USFWS determined that this level of anticipated take is not likely to result in jeopardy to spotted owl and bull trout, or destruction or adverse modification of designated critical habitat for these species.

23 REASONABLE AND PRUDENT MEASURES AND TERMS AND CONDITIONS

The conservation measures negotiated in cooperation with the USFWS and included as part of the 1997 HCP, as amended, constitute all of the reasonable measures necessary to minimize the impacts of incidental take. On that basis, no Reasonable and Prudent Measures except for monitoring and reporting requirements are included in this Incidental Take Statement.

WDNR's reporting obligations in the 1997 HCP, as amended, are not changed or modified by this Incidental Take Statement. Section 17.2, "Notification and Annual Review of Land Transactions," and Section 20.0, "Reporting and Inspections," of the Implementation Agreement (IA); and Section V, "Plan Implementation," of the 1997 HCP describe WDNR's reporting obligations under the 1997 HCP.

24 CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The USFWS should establish quarterly meetings to coordinate with WDNR to implement the following conservation recommendations:

a) The HCP required development of a Headwaters Conservation Strategy for westside areas outside the Olympic Experimental State Forest (OESF) (WDNR 1997, p. IV-59). The USFWS should work with WDNR to develop and finalize a Headwaters Conservation Strategy by 2026.

b) The HCP (p. IV.62) requires completion of a comprehensive landscaped-based road network management process commonly called the Comprehensive Road Network Management Plan (CRNMP), which is both a component of the Riparian Strategy as well as a component of strategies for unlisted species. The USFWS should work with WDNR to complete a CRNMP within 2 years.

c) The HCP and the Implementation Agreement anticipate the development of a monitoring and adaptive management program to assess the effectiveness of exterior wind buffers and to make adjustments based on that monitoring, where appropriate (WDNR, 1997, p.

IV.73). A formal monitoring and adaptive management program for windthrow has yet to be developed and implemented. The USFWS should work with WDNR to develop a windthrow monitoring and adaptive management program to evaluate the effectiveness of current procedures to maintain functional riparian buffers within the next year.

d) In the event that the USFWS decides to implement a barred owl management strategy in Washington, the USFWS should work with WDNR to facilitate barred owl management on or adjacent to WDNR HCP lands.

e) If the USFWS has information indicating current occupancy of a spotted owl activity center, that information should be shared with WDNR to facilitate protection of habitat within the core-area spotted owl management circle around the occupied activity center until such time as 1): the area can be managed for barred owls, or 2), the area is determined to be unoccupied by spotted owls.

25 REINITIATION NOTICE

As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and 1) the amount or extent of incidental take is exceeded; 2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this Opinion; 3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this Opinion; or 4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

26 LITERATURE CITED

Anthony, R.G., E.D. Forsman, A.B. Franklin, D.R. Anderson, K.P. Burnham, et al. 2006. Status and trends in demography of northern spotted owls, 1985-2003. Wildlife Monograph No. 163.

Ardren, W.R., P.W. DeHaan, C.T. Smith, E.B. Taylor, R. Leary, C.C. Kozfkay, L. Godfrey, M. Diggs, W. Fredenberg, and J. Chan. 2011. Genetic structure, evolutionary history, and conservation units of bull trout in the coterminous United States. Transactions of the American Fisheries Society 140:506-525. 22 pp.

Bakun, A. 1990. Global climate change and intensification of coastal ocean upwelling. Science 247:198.

Bart J. and E. Forsman. 1992. Dependence of northern spotted owls (*Strix occidentalis caurina*) on old-growth forests in the western USA. Biological Conservation 1992:95-100.

Bash, J., C. Berman, and S. Bolton. 2001. Effects of turbidity and suspended solids on salmonids. Center for Streamside Studies, University of Washington, Seattle, Washington. November 2001. 78 pp.

Battin, J., M.W. Wiley, M.H. Ruckelshaus, R.N. Palmer, E. Korb, K.K. Bartz, and H. Imaki. 2007. Projected impacts of climate change on salmon habitat restoration. Proceedings of the National Academy of Sciences 104(16):6720-6725. 6 pp.

Baxter, C.V. and F.R. Hauer. 2000. Geomorphology, hyporheic exchange, and selection of spawning habitat by bull trout (*Salvelinus confluentus*). Canadian Journal of Fisheries and Aquatic Sciences 57(7):1470-1481.

Bean, J., A. Wilcox, W. Woessner, and C. Muhlfeld. 2014. Multiscale hydrogeomorphic influences on bull trout (*Salvelinus confluentus*). Canada Journal of Fisheries and Aquatic Science 72:514.

Benda, L., M.A. Hassan, M. Church, and C.L. May. 2005. Geomorphology of steepland headwaters: The transition from hillslopes to channels. Journal of the American Water Resources Association 41(4):835-851.

Bigley, R. E., and S. W. Hull. 1993. Recognizing wetlands and wetland indicator plants on forest lands. Washington Department of Natural Resources, Forest Land Management Division, Olympia. Contribution 500. 77 pp.

Bilby, R.E. and J.W. Ward. 1991. Characteristics and function of large woody debris in streams draining old-growth, clear cut, and second-growth forests in southwestern Washington. Canadian Journal of Fisheries and Aquatic Sciences 48(12):2499-2508.

Bingham, B.B., and B.R. Noon. 1997. Mitigation of habitat “take”: Application to habitat conservation planning. Conservation Biology 11(1):127-138.

Bisson, P.A., B.E. Rieman, C. Luce, P.F. Hessburg, D.C. Lee, J.L. Kershner, G.H. Reeves, and R.E. Gresswell. 2003. Fire and aquatic ecosystems of the western USA: Current knowledge and key questions. Forest Ecology and Management 178:213–29.

Bisson, P.A., R.E. Bilby, M.D. Bryant, C.A. Dolloff, G.B. Grette, R.A. House, M.L. Murphy, K.V. Koski, and J.R. Sedell. 1987. Large woody debris in forested streams in the Pacific Northwest: past, present, and future. Pages 143-190 in Salo, E.O., and T.W. Cundy (eds.). Streamside management: Forestry and fishery interactions. University of Washington, Seattle, Washington. Institute of Forest Resources Contribution No. 57.

BMSL (Battelle Marine Sciences Laboratory), Pentec Environmental, Striplin Environmental Associates, Shapiro Associates, Inc., and King County Department of Natural Resources. 2001. Reconnaissance assessment of the state of the nearshore ecosystem: eastern shore of central Puget Sound, including Vashon and Maury Islands (WRIA 8 and 9). Prepared for King County Department of Natural Resources, Seattle, Washington.

Bograd, S.J., I. Schroeder, N. Sarkar, X. Qiu, W.J. Sydeman, and F.B. Schwing. 2009. Phenology of coastal upwelling in the California Current. Geophysical Research Letters 36: L01602.

Bond, N.A., M.F. Cronin, H. Freeland, and N. Mantua. 2015. Causes and impacts of the 2014 warm anomaly in the NE Pacific. Geophysical Research Letters 42:3414–3420.

Boyd, W.D., C.S. Guy, T.B. Horton, and S.A. Leathe. 2010. Effects of catch-and-release angling on salmonids at elevated water temperatures. North American Journal of Fisheries Management 30(4):898-907.

Brenkman, S.J. 1998. Factors influencing spawning migration of bull trout (*Salvelinus confluentus*) in the North Fork Skokomish River, Olympic National Park, Washington. Master’s Thesis, Oregon State University, Corvallis.

Brenkman, S.J. and S.C. Corbett. 2005. Extent of anadromy in bull trout and implications for conservation of a threatened species. North American Journal of Fisheries Management 25: 1073–1081.

Brenkman, S.J. and S.C. Corbett. 2007. Use of otolith chemistry and radiotelemetry to determine age-specific migratory patterns of anadromous bull trout in the Hoh River, Washington. Transactions of the American Fisheries Society 136: 1-11.

Buchanan, D.V., M.L. Hanson, and R.M. Hooton. 1997. Status of Oregon’s bull trout. Oregon Department of Fish and Wildlife. 168 pp.

Buchanan, D.V. and S.V. Gregory. 1997. Development of water temperature standards to protect and restore habitat for bull trout and other cold water species in Oregon. Friends of the Bull Trout conference proceedings. Edited by: W.C. Mackay, M.K. Brewin, and M. Monita, pp. 119-126.

Bumbaco, K.A., M.H. Rogers, L.W. O'Neill, D.J. Hoekema, and C.L. Raymond. 2022. 2021 Pacific Northwest Water Year Impacts Assessment. A collaboration between the Office of the Washington State Climatologist, Climate Impacts Group, Oregon State Climatologist, Idaho Department of Water Resources, and NOAA National Integrated Drought Information System.

Burns, J.W. 1971. The carrying capacity for juvenile salmonids in some northern California streams. California Fish and Game 57(1): 44–57.

Burt, K., D. Hamoutene, G. Mabrouk, C. Lang, T. Puestow, D. Drover, R. Losier, and F. Page. 2012. Environmental conditions and occurrence of hypoxia within production cages of Atlantic salmon on the south coast of Newfoundland. Aquaculture Research 43:607-620.

Bylhouwer, B., D. Ianson, and K. Kohfeld. 2013. Changes in the onset and intensity of wind-driven upwelling and downwelling along the North American Pacific coast. Journal of Geophysical Research: Oceans 118(5):2565-2580.

Byrne, R.H., S. Mecking, R.A. Feely, and X. Liu. 2010. Direct observations of basin-wide acidification of the North Pacific Ocean. Geophysical Research Letters 37:L0261.

Cairns, J., D.S. Cherry. and K.L. Dickson, 1975. Temperatures selected and avoided by fish at various acclimation temperatures. Journal of the Fisheries Research Board of Canada 32(4):485-491.

Cederholm, C.J.; Reid, L.M.; Salo, E.O. 1981. Cumulative effects of logging road sediment on salmonid populations of the Clearwater River, Jefferson County, Washington. In: Proceedings: Conference on salmon spawning gravel: a renewable resource in the Pacific Northwest? Report 19. Pullman, WA: Washington State University, Water Research Center: 38–74.

Cederholm, C.J. and L.M. Reid. 1987. Impact of forest management on coho salmon (*Oncoryhynchus kisutch*) populations of the Clearwater River, Washington: a project summary. Pages 373-398 in Salo, E.O., and T.W. Cundy (eds.). Streamside management: forestry and fishery interactions. University of Washington Institute of Forest Resources, Contribution 57.

Chan, F., A.B. Boehm, J.A. Barth, E.A. Chornesky, A.G. Dickson, R.A. Feely, B. Hales, T.M. Hill, G. Hofmann, D. Ianson, T. Klinger, J. Largier, J. Newton, T.F. Pedersen, G.N. Somero, M. Sutula, W.W. Wakefield, G.G. Waldbusser, S.B. Weisberg, S.B., and E.A. Whiteman. 2016. The West Coast Ocean Acidification and Hypoxia Science Panel: Major Findings, Recommendations, and Actions. California Ocean Science Trust, Oakland, California, USA. April 2016.

Chapman, D.W. 1988. Critical review of variable used to define effects of fines in redds of large salmonids. Transactions of the American Fisheries Society 117:1-21.

Chen, J., J.F. Franklin, and T.A. Spies. 1992. Vegetation responses to edge environments in old-growth Douglas-fir forests. Ecological Applications, 2(4) pp. 387-396.

Chen, J., J.F. Franklin, and T.A. Spies. 1993. Contrasting microclimates among clearcut, edge, and interior old-growth Douglas-fir forest. Agriculture and Forest Meteorology, 63 (1993) pp. 219-237.

Chen, J., J.F. Franklin, and T.A. Spies. 1995. Growing-season microclimate gradients from clearcut edges into old-growth Douglas-fir forests. Ecological Applications, 5(1):74-86.

Coble., A.A., H. Barnard, E. Du, S. Johnson, J. Jones, et al. 2020. Long-term hydrological response to forest harvest during seasonal low flow: Potential implications for current forest practices. Science of the Total Environment 730 (2020) 138926.

Davenport, K. 2018. Impacts of temperature on life history traits of invasive Eastern Brook Trout (*Salvelinus fontinalis*). Masters. Eastern Washington University, Cheney, Washington. 61 pp.

Davis, R.J., B. Hollen, J. Hobson, J.E. Gower, and D. Keenum. 2016. Northwest Forest Plan—the first 20 years (1994–2013): status and trends of northern spotted owl habitats. Gen. Tech. Rep. PNW-GTR-929. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 54 pp.

Davis, R.J., Z. Yang, A. Yost, C. Belongie, W. Cohen. 2017. The normal fire environment – modeling environmental suitability for large forest fires using past, present, and future climate normal. Forest Ecology and Management 390 (2017) 173-186.

Davis, R. J., D.B. Lesmeister, Z. Yang, B. Hollen, B. Tuerler, J. Hobson, J. Guetterman, and A. Stratton. 2022. Northwest Forest Plan—the first 25 years (1994–2018): status and trends of northern spotted owl habitats. Gen. Tech. Rep. PNW-GTR-1003. Portland, Oregon: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 38 p. https://doi.org/10.2737/PNW-GTR-1003.

Delaney, D.K., T.G. Grubb, P. Beier, L.L. Pater, and M.H. Reiser. 1999. Effects of helicopter noise on Mexican spotted owls. Journal of Wildlife Management 63:60-76.

Delaney, D.K., and T.G. Grubb. 2003. Effects of off-highway vehicles on northern spotted owls: 2002 results. A report to the State of California Department of Parks and Recreation, Off-Highway Motor Vehicle Recreation Division under Contract No. 439129-0-0055. USDA Forest Service Rocky Mountain Research Station. May 2003. 38 pp.

Diller, L.V., K.A. Hamm, D.A. Early, D.W. Lamphear, K.M. Dugger, C.B. Yackulic, C.J. Schwarz, P.C. Carlson, and T.L. McDonald. 2016. Demographic response of northern spotted owls to barred owl removal. The Journal of Wildlife Management 80:691–707.

Dube, K., W. Megahan, and M. McCalmon. 2004. Washington road surface erosion model. Prepared for State of Washington Department of Natural Resources, February 20, 2004.

Dubé, K., A. Shelly, J. Black, and K. Kuzis. 2010. Washington Road Sub-basin Scale Effectiveness Monitoring First Sampling Event (2006-2008) Report. Cooperative Monitoring, Evaluation and Research Report CMER 02-801. Washington Department of Natural Resources. Olympia, Washington.

Dugger, K.M., F. Wagner, R.G. Anthony, and G.S. Olson. 2005. The relationship between habitat characteristics and demographic performance of northern spotted owls in southern Oregon. The Condor 107:863-878.

Dugger, K.M., R.G. Anthony, and S. Andrews. 2011. Transient dynamics of invasive competition: Barred Owls, Spotted Owls, habitat and the demons of competition present. Ecological Applications (7):2459-68.

Dugger, K.M., E.D. Forsman, A.B. Franklin, R.J. Davis, G.C. White, C.J. Schwarz, et al. 2016. The effects of habitat, climate, and barred owls on long-term demography of northern spotted owls. The Condor 118:57–116.

Dunham, J.B. and B.E. Rieman. 1999. Metapopulation structure of bull trout: influence of physical, biotic, and geometrical landscape characteristics. Ecological Applications 9(2):642-655.

Dunham, J., B. Rieman, and G. Chandler. 2003. Influences of temperature and environmental variables on the distribution of bull trout within streams at the southern margin of its range. North American Journal of Fisheries Management 23:894-905.

Dunham, J., C. Baxter, K. Fausch, W. Fredenberg, and 9 others. 2008. Evolution, ecology, and conservation of Dolly Varden, white-spotted char, and bull trout. Fisheries, 33:11, 537-550.

Eby, L.A., O. Helmy, L.M. Holsinger, and M.K. Young. 2014. Evidence of climate- induced range contractions in bull trout *Salvelinus confluentus* in a Rocky Mountain watershed, U.S.A. PLoS ONE 9(6): e98812. doi:10.1371/journal.pone.0098812.

Everest, F.H., R.L. Beschta, J.C. Scrivener, K.V. Koski, J.R. Sedell, and C.J. Cederholm. 1987. Fine sediment and salmonid production: a paradox. Pages 98-142 in E.O. Salo and T.W. Cundy (eds.). Streamside management: forestry and fishery interactions. University of Washington Institute of Forest Resources, Contribution 57.

Everest, F.H., and G.H. Reeves. 2007. Riparian and aquatic habitats of the Pacific Northwest and southeast Alaska: ecology, management history, and potential management strategies. Gen. Tech. Rep. PNW-GTR-692. Portland, Oregon: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 130 pp.

Fairchild, J.F., A.L. Allert, K.P. Feltz, K.J. Nelson, and J.A. Valle. 2007. A comparative aquatic risk assessment of rainbow trout (*Onchorynchus mykiss*) and the threatened bull trout (*Salvelinus confluentus*) exposed to common forest-use herbicides. U.S. Geological Survey. Unpublished agency report on file at the Western Washington Fish and Wildlife Office, Lacey, Washington.

Fairchild, J.F., A. Allert, L.S. Sappington, K.J. Nelson, and J. Valle. 2008. Using accelerated life testing procedures to compare the relative sensitivity of rainbow trout and the federally listed threatened bull trout to three commonly used rangeland herbicides (picloram, 2,4-D, and clopyralid). Environmental Toxicology and Chemistry 27(3):623-630.

Falke, J.A., R.L. Flitcroft, J.B. Dunham, K.M. McNyset, P.F. Hessburg, and G.H. Reeves. 2015. Climate change and vulnerability of bull trout (*Salvelinus confluentus*) in a fire-prone landscape. Canadian Journal of Fisheries and Aquatic Sciences 72:304-318.

Farrell, A.P., A.K. Gamperl, and I.K. Birtwell. 1998. Prolonged swimming, recovery and repeat swimming performance of mature sockeye salmon *Onchorhynchus nerka* exposed to moderate hypoxia and pentachlorophenol. Journal of Experimental Biology 201:2183-2193.

Feely, R.A., C.L. Sabine, J.M. Hernandez-Ayon, D. Ianson, and B. Hales. 2008. Evidence for upwelling of corrosive "acidified" water onto the continental shelf. Science 320(5882):1490-1492.

Feely, R.A., S.C. Doney, and S.R. Cooley. 2009. Ocean acidification: present conditions and future changes in a high-CO2 world. Oceanography 22(4):36-47

Foltz, R.B., K.A. Yanosek, and T.M. Brown. 2008. Sediment concentration and turbidity changes during culvert removals. Journal of Environmental Management, 87(3):329-40. doi.org/10.1016/j.jenvman.2007.01.047

Foltz, R.B., B. Westfall, and B. Kopyscianski. 2013. Turbidity changes during culvert to bridge upgrades at Carmen Creek, Idaho. Res. Note RMRS-RN-54. Fort Collins, Colorado: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 12 pp.

Foreman, M.G.G., B. Pal, and W.J. Merryfield. 2011. Trends in upwelling and downwelling winds along the British Columbia shelf. Journal of Geophysical Research: Oceans 116:C10023.

Forsman, E.D., E.C. Meslow, and H.M. Wight, 1984. Distribution and biology of the spotted owl in Oregon. Wildlife Monographs, 87:1-64.

Forsman, E.D., R.G. Anthony, J.A. Reid, P.J. Loschl, S.G. Sovern, M. Taylor, B.L. Biswell, A. Ellingson, E.C. Meslow, G.S. Miller, K.A. Swindle, J.A. Thrailkill, F.F. Wagner, and D.E. Seaman. 2002. Natal and breeding dispersal of northern spotted owls. Wildlife Monographs, No. 149. 35 pp.

Forsman, E.D., T.J. Kaminiski, 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. Journal of Raptor Research 39(4):365-377.

Franklin, A.B., D.R. Anderson, R.J. Gutierrez, and K.P. Burnham. 2000. Climate, habitat quality, and fitness in northern spotted owl populations in northwestern California. Ecological Monographs 70:539–590.

Franklin, A.B., K.M. Dugger, D.B. Lesmeister, R.J. Davis, J.D. Wiens, G.C. White, J.D. Nichols, et al. 2021. Range-wide declines of northern spotted owl populations in the Pacific Northwest: A meta-analysis. Biological Conservation 259:109168.

Fraley, J.J. and B.B. Shepard. 1989. Life history, ecology and population status of migratory bull trout (*Salvelinus confluentus*) in the Flathead Lake and River System, Montana. Northwest Science 63(4):133-143.

Gaines, W.L., P.F. Hessburg, G.H. Aplet, P. Henson, S.J. Prichard, et al. 2022. Climate change and forest management on federal lands in the Pacific Northwest, USA: Managing for dynamic landscapes. Forest Ecology and Management. 504:119794.

Gamperl, A.K., A.E. Todgham, W.S. Parkhouse, R. Dill, and A.P. Farrell. 2001. Recovery of trout myocardial function following anoxia: preconditioning in a non-mammalian model. American Journal of Physiology—Regulatory, Integrative and Comparative Physiology 281: R1755-R-1763

Glenn, E.M., D.B. Lesmeister, R.J. Davis, B. Hollen, and A. Poopatanapong. 2017. Estimating density of a territorial species in a dynamic landscape. Landscape Ecology 32:563-579.

Glenn, E.M., R.G. Anthony, and E.D. Forsman. 2010. Population trends in northern spotted owls: associations with climate in the Pacific Northwest. Biological Conservation. 143(11):2543-2552.

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. The Journal of Wildlife Management 75(6):1279-1294; 2011; DOI: 10.1002/jwmg.177.

Gomi, T., R.D. Moore, and M.A. Hassan. 2005. Suspended sediment dynamics of small forest streams of the Pacific Northwest. Journal of the American Water Resources Association 41:877-98.

Gomi, T. R.D. Moore, and A.S. Dhakal. 2006. Headwater stream temperature response to clear-cut harvesting with different riparian treatments, coastal British Columbia, Canada. Water Resources Research, Vol. 42, W08437.

Goode, J.R., J.M. Buffington, D. Tonina, D.J. Isaak, R.F. Thurow, S. Wenger, D. Nagel, C. Luce, D. Tetzlaff, and C. Soulsby. 2013. Potential effects of climate change on streambed scour and risks to salmonid survival in snow-dominated mountain basins. Hydrological Processes 27(5):750-765.

Grant, G.E., S.L. Lewis, F.J. Swanson, J.H. Cissel, and J.J. McDonnell. 2008. Effects of forest practices on peak flows and consequent channel response: a state-of-science report for western Oregon and Washington. General Technical Report PNW-GTR-760. Pacific Northwest Research Station, Forest Service, USDA, Portland, Oregon, May, 2008, 76 pp.

Gremel, S. 2005. Factors controlling distribution and demography of Northern Spotted Owls in a reserved landscape. A thesis submitted in partial fulfillment for a Master of Science degree. University of Washington.

Gremel, S. 2018. Spotted owl monitoring in Olympic National Park: 1992-2018. Unpublished agency report. National Park Service, Port Angeles, Washington. 20 pp.

Grizzel, J.D. and N. Wolff. 1998. Occurrence of windthrow in forest buffer strips and its effect on small streams in northwest Washington. Northwest Science 72(3):214-23.

Gronsdahl, S., Moore, R.D., Rosenfeld, J., McCleary, R., Winkler, R., 2019. Effects of forestry on summertime low flows and physical fish habitat in snowmelt-dominant headwater catchments of the Pacific Northwest. Hydrol. Process. 33 (25), 3152–3168.

Gucinski, H., M.J. Furniss, R.R. Ziemar, and M.H. Brookes. 2001. Forest roads: A synthesis of scientific information. Forest Service, USDA, June 14, 2000, 117 pp.

Gutiérrez, R.J., M. Cody, S. Courtney, and A.B. Franklin. 2007. The invasion of barred owls and its potential effect on the spotted owl: a conservation conundrum. Biological Invasions (2007) 9:181-196.

Halofsky, J.E., D.L. Peterson, K.A. O'Halloran, and C. Hawkins Hoffman, eds. 2011. Adapting to climate change at Olympic National Forest and Olympic National Park. Gen. Tech. Rep. PNW-GTR-844. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, Oregon, 130 pp.

Halofsky, J.S. and D.C. Donato. 2023. Assessing the efficacy of a large-scale habitat conservation plan in western Washington, USA. Draft manuscript for publication. December 2023.

Halofsky, J.S., D.C. Donato, P.H. Singleton, D.J. Churchill, G.W. Meigs, W.L. Gaines, J.T. Kane, V.R. Kane, and D. Munzing. 2023. Integrating landscape history, climate, and fire to reconcile species conservation and ecosystem resilience in a fire-prone landscape. Draft manuscript for publication, and associated GIS data, December 2023.

Halofsky, J.S., D.R. Conklin, D.C. Donato, J.E. Halofsky, and J.B. Kim. 2018. Climate change, wildfire, and vegetation shifts in a high-inertia forest landscape: Western Washington, USA. PLoS One 13(12): e0209490.

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. The Condor 109:750-768.

Hamlet, A.F., P.W. Mote, M.P. Clark, and D.P. Lettenmaier. 2007. Twentieth-century trends in runoff, evapotranspiration, and soil moisture in the western United States. Journal of Climate 20(8): 1468-1486.

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. i-116. 126 pp.

Hari, R.E., D.M. Livingstone, R. Siber, P. Burkhardt-Holm, and H. Guttinger. 2006. Consequences of climatic change for water temperature and brown trout populations in alpine rivers and streams. Global Change Biology 12:10–26. 17 pp.

Hassan, M.A., M. Church, T.E. Lisle, F. Brardinoni, L. Benda, and G.E. Grant. 2005. Sediment transport and channel morphology of small, forested streams. Journal of the American Water Resources Association 41(4):853-876.

Hayward, L.S., A.E. Bowles, J.C. Ha, and S.K. Wasser. 2011. Impacts of acute and long-term vehicle exposure on physiology and reproductive success of the northern spotted owl. Ecosphere 2(6) 20 pp.

Hessburg, P.F. and J.K. Agee. 2003. An environmental narrative of inland northwest United States forests, 1800–2000. Forest Ecology and Management 178(2003):23–59.

Howell, P.J., J.B. Dunham, and P.M. Sankovich. 2010. Relationships between water temperatures and upstream migration, cold water refuge use, and spawning of adult bull trout from the Lostine River, Oregon. Ecology of Freshwater Fish 19:96-106.

Hudson, J.M., J. Doyle, J. Lamperth, R. Al-Chokhachy, G. Robertson, and T. Wadsworth. 2019. Lewis River bull trout: A synthesis of known information. April 4, 2019, report. 53 pp.

Ikeda, K., R. Rasmussen, C. Liu, A. Newman, F. Chen, M. Barlage, E. Gutmann, J. Dudhia, A. Dai, C. Luce, and K. Musselman. 2021. Snowfall and snowpack in the Western U.S. as captured by convection permitting climate simulations: Current climate and pseudo global warming future climate. Climate Dynamics 57: 2191-2215.

IPCC (Intergovernmental Panel on Climate Change). 2014a. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

IPCC. 2014b. Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, New York, 1132 pp.

IPCC. 2018. Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. In Press.

IPCC. 2019. IPCC Special report on the ocean and cryosphere in a changing climate. Porter, H.O., D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, M. Nicolai, A. Okem, J. Petzold, B. Rama, and N. Weyer, eds. Final government draft version. Available at https://www.ipcc.ch/srocc/home/.

ISAB (Independent Scientific Advisory Board). 2007. Climate change impacts on Columbia River basin fish and wildlife. ISAB 2007-2. Portland, Oregon. 146 pp.

Isaak, D.J., C.H. Luce, B.E. Rieman, D.E. Nagel, E.E. Peterson, D.L. Horan, S. Parkes, and G.L. Chandler. 2010. Effects of climate change and wildfire on stream temperatures and salmonid thermal habitat in a mountain river network. Ecological Applications 20(5):1350-1371.

Isaak, D.J., S. Wollrab, D. Horan, and G. Chandler. 2011. Climate change effects on stream and river temperatures across the Northwest from 1980-2009 and implications for salmonid fishes. Climatic Change 113:499-524.

Isaak, D.J., M.K. Young, D.E. Nagel, D.L. Horan, and M.C. Groce. 2015. The cold-water climate shield: delineating refugia for preserving salmonid fishes through the 21st century. Global Change Biology, DOI:10.1111/gcb.12879.

Isaak, D.J., M.K. Young, C.H. Luce, S.W. Hosteltler, S.J. Wenger, E.E. Pererson, J.M. Ver Hoef, M.C. Groce, D.L. Horan, and D.E. Nagel. 2016. Slow climate velocities of mountain streams portend their role as refugia for cold-water biodiversity. Proceedings of the National Academy of Sciences 113(16):4374-4379.

Isaak, D.J., M.K. Young, D.L. Horan, D. Nagel, M.K. Schwartz, and K.S. McKelvey. 2022. Do metapopulations and management matter for relict headwater bull trout populations in a warming climate? Ecological Applications. 2022; e2594.

Isaak D.J. and C.H. Luce. 2023. Elevation-dependent warming of streams in mountainous regions: implications for temperature modeling and headwater climate refugia. Canadian Water Resources Journal 48(2): 167-188.

Isaak, D.J. and M.K. Young. 2023. Cold-water habitats, climate refugia, and their utility for conserving salmonid fishes. Canadian Journal of Fisheries and Aquatic Sciences 80:1187-1206.

Janisch, J.E., S.M. Wondzell, W.J. Ehringer. 2012. Headwater stream temperature: Interpreting response after logging, with and without riparian buffers, Washington, USA. Forest Ecology and Management 270 (2012) 302-313.

Jenkins, J.M.A, D.B. Lesmeister, E.D. Forsman, K.M. Dugger, S.H. Ackers, et al. 2021. Conspecific and congeneric interactions shape increasing rates of breeding dispersal of northern spotted owls. Ecological Applications 31(7) 2021, e02398

Jenkins, J.M.A., D.B. Lesmeister, J.D. Wiens, J.T. Kane, V.R. Kane, and J. Verschuyl. 2019. Three- dimensional partitioning of resources by congeneric forest predators with recent sympatry. Scientific Reports (2019) 9:6036.

Johnson, S.L., and J.A. Jones. 2000. Stream temperature responses to forest harvest and debris flows in western Cascades, Oregon. Canadian Journal of Fisheries and Aquatic Sciences 57:1-10.

Keppeler, E.T. 1998. The summer flow and water yield response to timber harvest. Pages 35-43 in Ziemer, R.R. (tech. coord.). Proceedings of the conference on coastal watersheds: the Caspar Creek story. May 6, 1998, Ukiah, California. General Technical Report PSW GTR-168. Albany, California: Pacific Southwest Research Station, U.S. Department of Agriculture Forest Service.

King, J. E. 1966. Site index curves for Douglas-fir in the Pacific Northwest. Weyerhaeuser Company, Forestry Research Center, Centralia, WA.

Kraemer, C. 1994. Some observations on the life history and behavior of the native char, Dolly Varden (*Salvelinus malma*) and bull trout (*Salvelinus confluentus*) of the North Puget Sound Region. Draft. Washington Department of Wildlife.

Lachance, S., M. Dube, R. Dostie, and P. Berube. 2008. Temporal and spatial quantification of fine-sediment accumulation downstream of culverts in brook trout habitat. Transactions of the American Fisheries Society 137:1826-38.

Lagler, K.F., J.E. Bardach, R.R. Miller, and D.R. M. Passino. 1977. Ichthyology. John Wiley & Sons, Inc., New York, New York. 506 pp.

Lanquaye, C.O. 2003. Empirical modelling of windthrow risk and hazard mapping using Geographic Information Systems. Master of Science Thesis. University of British Columbia, Vancouver, British Columbia. 141 pp.

Leary, R.F., F.W. Allendorf, and S.H. Forbes. 1993. Conservation genetics of bull trout in the Columbia and Klamath River drainages. Conservation Biology 7:856-865.

Leising, A.W., I.D. Schroeder, S.J. Bograd, J. Abell, R. Durazo, G. Gaxiola-Castro, E.P. Bjorkstedt, J. Field, K. Sakuma, R. Robertson, et al. 2015. State of the California Current 2014–15: Impacts of the Warm-Water "Blob." CalCOFI Reports 56:31–68.

LeMoine, M.T., L.A. Eby, C.G. Clancy, L.G. Nyce, M.J. Jakober, and D.J. Isaak. 2020. Landscape resistance mediates native fish species distribution shifts and vulnerability to climate change in riverscapes. Global Change Biology, 26(10):5492-5508.

Lesmeister, D.B., J.M.A. Jenkins, Z.J. Ruff, et al. 2022. Passive acoustic monitoring within the Northwest Forest Plan area: 2021 Annual Report. USDA Forest Service Pacific Northwest Research Station and USDI National Park Service Pacific West Region. February 2022. 30 pp.

Lesmeister, D.B., M.S. Pruett, D. Kelso, and K. Williamson. 2019. Demographic characteristics of northern spotted owls (*Strix occidentalis caurina*) in the Olympic National Forest, Washington 1987 – 2018. USDA Forest Service Pacific Northwest Research Station, Corvalis, OR. January 2019. 15 pp.

Lesmeister, D.B., R.J. Davis, P.H. Singleton, and J.D. Wiens. 2018. Northern spotted owl habitat and populations: Status and threats. Chapter 4 *in:* Spies, T.A.; Stine, P.A.; Gravenmier, R.; Long, J.W.; Reilly, M.J., tech. coords. 2018. Synthesis of science to inform land management within the Northwest Forest Plan area. Gen. Tech. Rep. PNW-GTR-966. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 1020 p. 3 vol.

Lewis, J.C., S.R. Mori, E.T. Keppeler, and R.R. Ziemer. 2001. Impacts of logging on storm peak flows, flow volumes and suspended sediment loads in Caspar Creek, California. Pages 85-125 in Wigmosta, M.S. and S.J. Burges (eds.). Land use and Watersheds: Human influences on hydrology and geomorphology in urban and forest areas. Water Science and Application Vol 2, American Geophysical Union, Washington, D.C.

Littell, J.S., E.E. Oneil, D. McKenzie, J.A. Hicke, J.A. Lutz, R.A. Norheim, and M.M. Elsner. 2010. Forest ecosystems, disturbance, and climatic change in Washington State, USA. Climatic Change 102:129-158.

Long, B.A. 1987. Recruitment and abundance of large woody debris in an Oregon Coastal stream system. Master's Thesis, Oregon State University, Corvallis, Oregon.

Mangan, A.O., T. Chestnut, J.C. Vogeler, I.K. Breckheimer, W.M. King, K. Bagnall, and K.M. Dugger. 2019. Barred owls reduce occupancy and breeding propensity of northern spotted owls in a Washington old-growth forest. The Condor: Ornithological Applications 121(3):1-20.

Martens, K.D., D.C. Donato, J.S. Halofsky, W.D. Devine, and T.V. Minkova. 2020. Linking instream wood recruitment to adjacent forest development in landscapes driven by stand-replacing disturbances: a conceptual model to inform riparian and stream management. Environmental Reviews. 28(4): 517-527.

Martens, K.D., W.D. Devine, T.V. Minkova, and A.D. Foster. 2019. Stream conditions after 18 years of passive riparian restoration in small fish-bearing watersheds. Environmental Management. 63(5): 673-690.

Mauger, G.S. and J.M. Vogel. 2020. PSP Climate Literature Review: A tailored review of climate change science to inform recovery. Report prepared for the Puget Sound Partnership. Climate Impacts Group, University of Washington. 55 pp.

MBTSG (Montana Bull Trout Scientific Group). 1998. The relationship between land management activities and habitat requirements of bull trout. Prepared for Montana Bull Trout Restoration Team. Helena, Montana. 86 pp.

McDade, M.H., F.J. Swanson, W.A. McKee, J.F. Franklin, and J. Van Sickle. 1990. Source distances for coarse woody debris entering small streams in western Oregon and Washington. Canadian Journal of Forest Research 20:326-330.

McHenry, M. 2003. Lower Elwha S'Klallmam Tribe. 2003. 1996 Little River temperature data. As cited on p. 43 of USFWS 2004, Draft Recovery Plan for the Coastal-Puget Sound Distinct Population Segment of Bull trout (*Salvelinus confluentus*). Volume II (of II): Olympic Peninsula Management Unit. Portland, Oregon. 277 + xvi pp.

McPhail, J.D., and C. Murray. 1979. The early life history of Dolly Varden (*Salvelinus malma*) in the upper Arrow Lakes. Report to the British Columbia Hydro and Power Authority and Kootenai Department of Fish and Wildlife. University of British Columbia, Department of Zoology and Institute of Animal Resources, Vancouver, British Columbia.

McPhail, J.D., and J.S. Baxter. 1996. A review of bull trout (*Salvelinus confluentus*) life-history and habitat use in relation to compensation and improvement opportunities. Department of Zoology, University of British Columbia, Fisheries Management Report Number 104, Vancouver, BC. 31 pp.

Miller, G.S., R.J. Small, and E.C. Meslow. 1997. Habitat selection by spotted owls during natal dispersal in western Oregon. Journal of Wildlife Management 61(1):140-150.

Miller, M.P., S.M. Haig, E.D. Forsman, R.G. Anthony, L. Diller, K.M. Dugger, A.B. Franklin, T.L. Fleming, S. Gremel, D.B. Lesmeister, M. Higley, D.R. Herter, and S.G. Sovern. 2018. Variation in inbreeding rates across the range of northern spotted owls (*Strix occidentalis caurina*): insights from over 30 years of monitoring data. Auk 135:821-833.

Mobbs, M.W., and B.C. Jones. 1995. Quinault Indian Nation - Riparian management zone project report. Quinault Department of Natural Resources, Division of Environmental Protection. Taholah, Washington. 50 pp.

Mochnacz, N.J., M.K. Taylor, M.F. Docker, and D.J. Isaak. 2022. An ecothermal paradox: bull trout populations diverge in response to thermal landscapes across a broad latitudinal gradient. Environmental Biology of Fishes. https://doi.org/10.1007/s10641-022-01339-0.

Moore, R.D., D.L. Spittlehouse, and A. Story. 2005. Riparian microclimate and stream temperature response to forest harvesting: a review. Journal of the American Water Resources Association 41(4):813-834.

Moore, R.D. and S.M. Wondzell. 2005. Physical hydrology and the effects of forest harvesting in the Pacific Northwest: A review. Journal of the American Water Resources Association 41(4):763-784.

Mote, P.W., E.A. Parson, A.F. Hamlet, W.S. Keeton, D. Lettenmaier, et al. 2003. Preparing for climatic change: the water, salmon, and forests of the Pacific Northwest. Climatic Change 61, no. 1-2: 45-88.

Mote, P.W. and E.P. Salathé, Jr. 2010. Future climate in the Pacific Northwest. Climatic Change. 102:29–50.

Munzing, D. 2007. Habitat Conservation Plan for State Trust Lands 2006 Implementation Monitoring Report. October 2007. Washington State Department of Natural Resources, October 2007. 36 pp.

Murphy, M.L. 1995. Forestry impacts on freshwater habitat of anadromous salmonids in the Pacific Northwest and Alaska–requirements for protection and restoration. National Oceanographic and Atmospheric Administration (NOAA) Coastal Ocean Program Decision Analysis Series No. 7. NOAA Coastal Ocean Office, Silver Spring, Maryland. 156 pp.

NCASI (National Council for Air and Stream Improvement). 2010. Spotted owl and barred owl resource selection in southwestern Washington. Progress Report. L. Irwin, D. Rock. S. Rock. February 2010. 12 pp. Unpublished report to the U.S. Fish and Wildlife Service.

Newcombe, C.P. and D.D. MacDonald. 1991. Effects of suspended sediments on aquatic ecosystems. North American Journal of Fisheries Management 11(1):72-82.

NIFC (National Interagency Fire Center). 2023. National Interagency Fire Center Open Data Site - Federal interagency wildland fire maps. Data set: Interagency Fire Perimeter History All Years View. Available online at: https://data-nifc.opendata.arcgis.com

NMFS (National Marine Fisheries Service). 1997. Intra-Service Endangered Species Act Section 7 Conference Report, Unlisted Species Analysis, and Section 10 Findings for the Washington State Department of Natural Resources Habitat Conservation Plan. 41 pp.

NMFS. 2016. California Current Integrated Ecosystem Assessment (CCIEA) State of the California Current Report, California Current Integrated Ecosystem Assessment Team. 20 pp.

NMFS. 2019. New marine heatwave emerges off west coast, resembles “the Blob.” Available at https://www.fisheries.noaa.gov/feature-story/new-marine-heatwave-emerges-west-coast-resembles-blob.

Nowacki, G.J. and M.G. Kramer. 1998. The effects of wind disturbance on temperate rain forest structure and dynamics of southeast Alaska. USDA Forest Service Pacific Northwest Research Station. General Technical Report. PNW-GTR-421. 25 pp.

OFCO (Olympic Forest Coalition) et al. 2018. Olympic Forest Coalition and Conservation Northwest. Sixty-Day Notice of Intent to Sue, ESA § 11, 16 U.S.C. § 1540, on failure to consult on the 2017 Olympic Experimental State Forest Land Plan and failure to reinitiate consultation on the Washington DNR Trust Lands Habitat Conservation Plain. January 5, 2018. 21 pages + attachments.

OFCO. 2022. Olympic Forest Coalition, Plaintiff, v. The U.S. Fish and Wildlife Service; Martha Williams, in her capacity as Director of the United States Fish and Wildlife Service, Defendants. Case 3:22-cv-05549, filed 07/29/2022 in the United States District Court Western District of Washington at Tacoma. 26 pages + attachments.

OFCO. 2023. OFCO Riparian Buffer Data Analysis. C. Copass and M. Golde. Unpublished draft report submitted to USFWS, Lacey, Washington. June 2023. 22 pp + photos.

OFCO. 2023a. OFCO State lands monitoring work – project summary and report. C. Copass, G. Wade, M. Golde. Unpublished draft report submitted to USFWS, Lacey, Washington. December, 2023.

Ogg, L. 2003. Fisheries Biologist, U. S. Forest Service. June 5, 2003, email to Shelley Spalding, U.S. Fish and Wildlife Service. Subject: Water temperature for Satsop River and Brown Creek. Cited as L. Ogg, pers. comm. 2003c on p. 43 of USFWS. 2004. Draft Recovery Plan for the Coastal-Puget Sound Distinct Population Segment of Bull trout (*Salvelinus confluentus*). Volume II (of II): Olympic Peninsula Management Unit. Portland, Oregon. 277 + xvi pp.

Olson, G.S., E.M. Glenn, R.G. Anthony, E.D. Forsman, J.A. Reid, P.J. Loschl, and W.J. Ripple. 2004. Modeling demographic performance of northern spotted owls relative to forest habitat in Oregon. Journal of Wildlife Management 68(4):1039-1053.

Ou, M., T.J. Hamilton, J. Eom, E.M. Lyall, J. Gallup, A. Jiang, J. Lee, D.A. Close, S.-S. Yun, and C.J. Brauner. 2015. Responses of pink salmon to CO2-induced aquatic acidification. Nature Climate Change 5(10):950-955.

Patra, R.W., J.C. Chapman, R.P. Lim, P.C. Gehrke, and R.M. Sunderam. 2015. Interactions between water temperature and contaminant toxicity to freshwater fish. Environmental Toxicology and Chemistry 34:1809-1817.

Perry, T.D., Jones, J.A., 2017. Summer streamflow deficits from regenerating Douglas-fir forest in the Pacific Northwest, USA. Ecohydrology 10 (2), e1790.

Pollock, M.M., T.J. Beechie, M. Liermann, and R.E. Bigley. 2009. Stream temperature relationships to forest harvest in western Washington. Journal of the American Water Resources Association 45(1):141-156.

Post, J.R., C. Mushens, A. Paul, and M. Sullivan. 2003. Assessment of alternative harvest regulations for sustaining recreational fisheries: Model development and application to bull trout. North American Journal of Fisheries Management 23:22-34.

Potyondy, J. P. and T. W. Geier. 2011. Watershed Condition Classification Technical Guide FS-978. U. S. Department of Agriculture, Forest Service, Washington D.C.

Pratt, K.L. 1992. A review of bull trout life history. Pages 5-9 In P.J. Howell, and D.V. Buchanan, eds. Proceedings of the Gearhart Mountain bull trout workshop, Oregon Chapter of the American Fisheries Society, Corvallis, Oregon. 80 pp.

PSEMP (Puget Sound Ecosystem Monitoring Program) Marine Waters Workgroup. 2016. Puget Sound marine waters: 2015 overview. S. K. Moore, R. Wold, K. Stark, J. Bos, P. Williams, K. Dzinbal, C. Krembs and J. Newton (Eds). Available: www.psp.wa.gov/PSEMP/PSmarinewatersoverview.php.

PSEMP Marine Waters Workgroup. 2017. Puget Sound marine waters: 2016 overview. S. K. Moore, R. Wold, K. Stark, J. Bos, P. Williams, N. Hamel, A. Edwards, C. Krembs, and J. Newton (Eds). Available: www.psp.wa.gov/PSmarinewatersoverview.php.

PSP (Puget Sound Partnership). 2013. 2013 State of the Sound: a biennial report on the recovery of Puget Sound. Tacoma, Washington. 177 pp

PSP. 2014. The 2014/2015 Action Agenda for Puget Sound. Tacoma, Washington. Available at http://www.psp.wa.gov/action_agenda_center.php

PSWQAT (Puget Sound Water Quality Action Team). 2000. 2000 Puget Sound update. Seventh report of the Puget Sound ambient monitoring program. Olympia, Washington.

Quigley, T.M. and S.J. Arbelbide, tech. eds. 1997. An assessment of ecosystem components in the Interior Columbia Basin and portions of the Klamath and Great Basins: volume III. Gen. Tech. Rep. PNW-GTR-405. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 4 vol. 13 pp.

Rahel, F.J., and J.D. Olden. 2008. Assessing the effects of climate change on aquatic invasive species. Conservation Biology 22(3):521-533.

Raphael, M.G., S.K. Nelson, P. Swedeen, M. Ostwald, K. Flotlin, S. Desimone, S. Horton, P. Harrison, D. Prenzlow Escene, and W. Jaross. 2008. Recommendations and supporting analysis of conservation opportunities for the marbled murrelet long-term conservation strategy. Washington State Department of Natural Resources, Olympia, WA.

Rashin, E., C. Clishe, A. Loch, and J. Bell. 1999. Effectiveness of forest road and timber harvest best management practices with respect to sediment-related water quality impacts. Publication no. 99-317. Washington State Department of Ecology, Olympia, Washington.

Rashin, E.B., C.J. Clishe, A.T. Loch, and J.M. Bell. 2006. Effectiveness of timber harvest practices for controlling sediment related water quality impacts. Journal of the American Water Resources Association 42 (5): 1307-1327.

Ratliff, D.E. and P.J. Howell. 1992. The status of bull trout populations in Oregon. Pages 10-17 in: P.J. Howell and D.V. Buchanan (eds). Proceedings of the Gearhart Mountain bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis. 8 pp.

Reeves, G.H., K.M. Burnett, and E.V. McGarry. 2003. Sources of large wood in the main stem of a fourth-order watershed in coastal Oregon. Canadian Journal of Forest Research 33(8): 1352-1362.

Rehnberg, B.G., B. Jonasson, and C.B. Schreck. 1985. Olfactory sensitivity during parr and smolt developmental stages in coho salmon. Transactions of the American Fisheries Society 114:732-736.

Reid, L.M. and T. Dunne. 1984. Sediment production from forest road surfaces. Water Resources Research 20(11):1753-61.

Riche, O., S.C. Johannessen, and R.W. Macdonald. 2014. Why timing matters in a coastal sea: trends, variability and tipping points in the Strait of Georgia, Canada. Journal of Marine Systems 131:36-53.

Riedel, J.L., S. Wilson, W. Baccus, M. Larrabee, T.J. Fudge, and A. Fountain. 2015. Glacier status and contribution to streamflow in the Olympic Mountains, Washington. Journal of Glaciology 61: 8-16.

Rieman, B.E. and J.D. McIntyre. 1993. Demographic and habitat requirements of bull trout *Salvelinus confluentus*. General Technical Report INT-GTR- 302. U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, Utah. 42 pp.

Rieman, B.E., D.C. Lee, and R.F. Thurow. 1997. Distribution, status and likely future trends of Bull trout within the Columbia River and Klamath River basins. North American Journal of Fisheries Management 17:1111-1125. 48 pp.

Rieman, B.E., and G.L. Chandler. 1999. Empirical evaluation temperature effects on bull trout distribution in the Northwest. Final Report to U.S. Environmental Protection Agency, Boise, Idaho.

Rieman, B.E., J.T. Peterson, and D.E. Myers. 2006. Have brook trout (*Salvelinus fontinalis*) displaced bull trout (*Salvelinus confluentus*) along longitudinal gradients in central Idaho streams? Canadian Journal of Fish and Aquatic Sciences 63:63-78.

Rieman, B.E., D. Isaak, S. Adams, D. Horan, D. Nagel, C. Luce, and D. Myers. 2007. Anticipated climate warming effects on bull trout habitats and populations across the Interior Columbia River Basin. Transactions of the American Fisheries Society. 136:1552-1565. 16 pp.

Roberts, S.D., C.A. Harrington, and K.R. Buermeyer. 2007. Does variable-density thinning increase wind damage in conifer stands on the Olympic peninsula? Western Journal of Applied Forestry. 22 (4):285-296 pp.

Rockweit, J.T., J.M. Jenkins, J.E. Hines, J. Nichols, K.M. Dugger, et al. 2017. Range-wide sources of variation in reproductive rates of northern spotted owls. Ecological Applications 33(1):e2726.

Rossi, A. 2021. Rainier spotted owl demography study area – 2021 annual report. Raedeke Associates, Inc. November 2016. Seattle, WA. 30 pp. Unpublished report.

Ryan, R., M. Maiolie, K. Yallaly, C. Lawson, and J. Fredericks. 2014. Panhandle Region 2013 Fishery Management Annual Report. Idaho Fish and Game, Coeur d'Alene. (Bull Trout – B1306).

Rykken, J.J., S.S. Chan, and A.R. Moldenke. 2007. Headwater riparian microclimate patterns under alternative forest management treatments. Forest Science 53 (2) 270:280.

Saffel, P.D. and D.L. Scarnecchia. 1995. Habitat use by juvenile bull trout in belt-series geology watersheds of Northern Idaho. Northwest Science 69:4.

Salathe, E.P., L.R. Leung, Y. Qian, and Y. Zhang. 2010. Regional climate model projections for the state of Washington. Climatic Change 102 (1-2):51-75.

Sauter, S.T., J. McMillan, and J. Dunham. 2001. Issue paper 1: salmonid behavior and water temperature. U.S. Environmental Protection Agency, Region 10 Temperature Water Quality Criteria Guidance Development Project, EPA-910-D-01-001. 36 pp.

Schill, D.J. 1992. River and stream investigations. Job Performance Report, Project F-73-R-13. Idaho Department of Fish and Game, Boise, Idaho. 66 pp.

Schisler, G.J. and E.P. Bergersen. 1996. Postrelease hooking mortality of rainbow trout caught on scented artificial bait. North American Journal of Fisheries Management 16:570–578.

Segura, C., K.D. Bladon, J.A. Hatten, J.A. Jones, V.C. Hale, and G.G. Ice. 2020. Long-term effects of forest harvesting on summer low flow deficits in the Coast Range of Oregon. Journal of Hydrology 585 (2020) 124749.

Selong, J.H., T.E. McMahon, A.V. Zale, and F.T. Barrows. 2001. Effect of temperature on growth and survival of bull trout, with application of an improved method for determining thermal tolerances in fishes. Transactions of the American Fisheries Society 130:1026-1037.

Sexauer, H.M. and P.W. James. 1993. A survey of the habitat use by juvenile and pre-spawning adult bull trout, *Salvelinus confluentus*, in four streams in the Wenatchee National Forest. Ellensburg, Washington, Central Washington University.

Shellberg, J.G., S.M Bolton, and D.R. Montgomery. 2010. Hydrogeomorphic effects on bedload scour in bull char (*Salvelinus confluentus*) spawning habitat, western Washington, USA. Canadian Journal of Fisheries and Aquatic Sciences 72(4): 626-640.

Shirk, A., H. Morgan, M. Krosby, C. Raymond, G.S. Mauger, and L. Helbrecht. 2021. Preparing Washington Department of Fish and Wildlife for a changing climate: assessing risks and opportunities for action. A collaboration of the Washington Department of Fish and Wildlife and University of Washington Climate Impacts Group. 67 pp.

Shuter, B.J., and Meisner, J.D. 1992. Tools for assessing the impact of climate change on freshwater fish populations. GeoJournal 28(1):7-20. 22 pp.

Siirila-Woodburn, E.R., A.M. Rhoades, B.J. Hatchett, L.S. Huning, J. Szinai, C. Tague, P.S. Nico, D.R. Feldman, A.D. Jones, W.D. Collins, and L. Kaatz. 2021. A low-to-no snow future and its impacts on water resources in the western United States. Nature Reviews, Earth and Environmental 2: 800-819.

Singleton, P., 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(2):285-294.

Sinton, D.S., J.A., Jones, J.L. Ohmann, and F.J. Swanson. 2000. Windthrow disturbance, forest composition, and structure in the Bull Run basin, Oregon. Ecology 81(9): pp. 2539-2556.

Somero, G.N., J.M. Beers, F. Chan, T.M. Hill, T. Klinger, and S.Y Litvin. 2016. What changes in the carbonate system, oxygen, and temperature portend for the northeastern Pacific Ocean: a physiological perspective. Bioscience 66:14-26.

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. The Journal of Wildlife Management 78:1436–1443.

Spruell P., A.R. Hemmingsen, P.J. Howell, N. Kanda1 and F.W. Allendorf. 2003. Conservation genetics of bull trout: Geographic distribution of variation at microsatellite loci. Conservation Genetics 4: 17–29. 14 pp.

Strathers, R.J., T.P. Rollerson, and S.J. Mitchell. 1994. Windthrow handbook for British Columbia forests. British Columbia Ministry of Forests. Research Program Working Paper 9401. 32 pp.

Staples, D.E., M.L. Taper, and B.B. Shepard. 2005. Risk-based viable population monitoring. Conservation Biology Vol. 9, No. 6 pp. 1908-1916.

Swanberg, T. 1997. Movements of and habitat use by fluvial bull trout in the Blackfoot River, Montana. Transactions of the American Fisheries Society. 126:735-746.

Sweeney, B.W. and J.D. Newbold. 2014. Streamside forest buffer width needed to protect stream water quality, habitat, and organisms: a literature review. Journal of the American Water Resources Association 50(3): 560-584.

Sydeman, W.J., M. García-Reyes, D.S. Schoeman, R.R. Rykaczewski, S.A. Thompson, B.A. Black, and S.J. Bograd. 2014. Climate change and wind intensification in coastal upwelling ecosystems. Science 345(6192):77-80.

Taboada, F.G., C.A. Stock, S.M. Griffies, J. Dunne, J.G. John, R.J. Small, and H. Tsujino. 2019. Surface winds from atmospheric reanalysis lead to contrasting forcing and coastal upwelling patterns. Ocean Modelling 133:79-111.

Tang, S.M. 1995. The influence of forest clearcutting patterns on the potential for debris flows and wind damage. Ph.D. Dissertation, University of Washington, Seattle, 151 pp.

Tempel, D.J. and R.J. Gutierrez. 2003. Fecal corticosterone levels in California spotted owls exposed to low-intensity chainsaw sound. Wildlife Society Bulletin 31(3):698-702.

Tempel, D.J. and R.J. Gutierrez. 2004. Factors related to fecal corticosterone levels in California spotted owls: Implications for assessing chronic stress. Conservation Biology 18(2):538-547.

Tennant, L.B., R.E. Gresswell, C.S. Guy, and M.H. Meeuwig. 2016. Spawning and rearing behavior of Bull Trout in a headwater lake ecosystem. Environmental Biology of Fishes 99:117–131.

Thomas, G. 1992. Status of bull trout in Montana. Report prepared for Montana Department of Fish, Wildlife and Parks, Helena, Montana. 108 pp.

Tierney, K.B., P.S. Ross, H.E. Jarrard, K.R. Delaney, and C.J. Kennedy. 2006. Changes in juvenile coho salmon electro-olfactogram during and after short-term exposure to current use pesticides. Environmental Toxicology and Chemistry 25(10): 2809-2817.

U.S. Air Force. 2012. Biological assessment in support of reinitiation of consultation for the German Air Force Beddown (USFWS Consultation no. 2-22-96-F-334, May 8, 1998) and the realistic bombing training initiative (USFWS Consultation no. 2-22-98-I-124, April 12, 2000) in the Southwest (NM, TX, AZ). 878 pp.

USDA and USDI (U.S. Department of Agriculture and U.S. Department of the Interior). 1994a. Standards and Guidelines for Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl. 153 pp.

USDA and USDI (U.S. Department of Agriculture and U.S. Department of the Interior). 1994b. Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl. 78 pp.

USDI (U.S. Department of Interior), U.S. Department of Commerce, and Washington Department of Natural Resources. 1995. Draft Environmental Impact Statement, Habitat Conservation Plan. Issued March 22, 1996. Olympia, Washington.

USDI (U.S. Department of lnterior), U.S. Department of Commerce, and Washington Department of Natural Resources. 1996. Final Environmental Impact Statement, Habitat Conservation Plan. October 25, 1996. Olympia, Washington.

USFS (U.S. Forest Service). 2005. Final Environmental Impact Statement and Record of Decision for the Pacific Northwest Invasive Plant Program – preventing and managing invasive plants. R6-NR FHP-PR-02-05. April 2005. Record of Decision document signed October 2005. USDA Forest Service. Pacific Northwest Region, Portland, Oregon.

USFS. 2022. Confronting the wildfire crisis. A strategy for protecting communities and improving resilience in America's forests. U.S.D.A. Forest Service. FS-1187a. January 2022. 47 pp.

USFS. 2023. Northern spotted owl nesting/roosting forest maps and trend viewer. Online Earth Engine Application hosted by USDA Forest Service, Northwest Forest Plan monitoring program. https://r06-nwfp.projects.earthengine.app/view/nwfp-nso-cts-mspa-trend-view

USFWS (U.S. Fish and Wildlife Service). 1990. Procedures leading to Endangered Species Act compliance for the northern spotted owl. U.S. Fish and Wildlife Service, Region 1, Portland, Oregon. 15 pp.

USFWS. 1992. Draft final recovery plan for the northern spotted owl. U.S. Fish and Wildlife Service. 2 Volumes. Portland, Oregon. 662 pp.

USFWS. 1993. Biological parameters related to take for the northern spotted owl (updates information presented in Table 2 in USFWS 1990). December 29, 1993. U.S. Fish and Wildlife Service, Region 1, Portland, Oregon. 1 p.

USFWS. 1997a. Intra-Service Concurrence Memorandum and Biological Opinion on the Proposed Issuance of an Incidental Take Permit (PRT- 812521) for Northern Spotted Owls, Marbled Murrelets, Gray Wolves, Grizzly Bears, Bald Eagles, Peregrine Falcons, Aleutian Canada Geese, Columbian White-tailed Deer, and Oregon Silverspot Butterflies, and the Approval of the Implementation Agreement for the Washington State Department of Natural Resources Habitat Conservation Plan (FWS Reference: 1-3-96-FW-594; X-Reference: 1-3-9-HCP-013) January 27, 1997. Washington Fish and Wildlife Office, Olympia WA. 151 pp.

USFWS. 1997b. Intra-Service Conference Report on the Proposed Issuance of an Incidental Take Permit (PRT 812521) and the Approval of the Implementation Agreement for the Washington State Department of Natural Resources Habitat Conservation Plan (FWS Reference 1-3-96-FW-594; X-Reference 1-3-9-HCP-013) Conference Report for proposed *Castilleja levisecta* (golden paintbrush), and candidates species: bull trout (*Salvelinus confluentus*), spotted frogs (*Rana pretiosa complex*) and *Sidalcea oregana* var. *calva* (Oregon checkermallow). January 29, 1997. Washington Fish and Wildlife Office, Olympia WA. 29 pp.

USFWS. 1997c. Findings and recommendations on issuance of an Incidental Take Permit for threatened and endangered species on lands managed by the Washington State Department of Natural Resources (DNR) Habitat Conservation Plan and Implementation Agreement for listed and unlisted species submitted in support of DNR's Application (PRT 812521). January 30, 1997. U.S. Fish and Wildlife Service, North Pacific Coast Ecoregion, Portland, OR. 22 pp + appendices.

USFWS. 1998a. Reinitiation of the Biological Opinion and Conference Opinion on the Amendment of an Incidental Take Permit (PRT-812521) for the Washington State Department of Natural Resources' Habitat Conservation Plan to Include Bull Trout (*Salvelinus confluentus*) on the Permit (FWS Reference: 1-3-96-FW-594; X-Reference 1-3-9- HCP-013) December 18, 1998. Washington Fish and Wildlife Office, Olympia WA. 74 pp.

USFWS. 1998b. Determination of threatened status for the Klamath River and Columbia River distinct population segments of bull trout. Federal Register Vol. 63 31647-31674. 28 pp.

USFWS. 1999. A framework to assist in making Endangered Species Act determinations of effect for individual or grouped actions at the bull trout subpopulation watershed scale. U.S. Fish and Wildlife Service, Washington Fish and Wildlife Office, Lacey, Washinton. June 1999. 52 pp.

USFWS. 2004. Draft Recovery Plan for the Coastal-Puget Sound Distinct Population Segment of Bull Trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Portland, Oregon. 297 pp.

USFWS. 2006. Biological Opinion for the Issuance of a Section 10(a)(1)(B) Incidental Take Permit to the State of Washington for the Forest Practices Habitat Conservation Plan. USFWS Reference No. 1-3-06-FWI-0301. Western Washington Fish and Wildlife Office, Lacey, Washington, May 16, 2006. 1152 pp.

USFWS. 2008. Bull trout (*Salvelinus confluentus*) 5-year review: summary and evaluation. Portland, Oregon. 55 pp.

USFWS. 2010a. Revised designation of critical habitat for bull trout in the coterminous United States. Federal Register Vol 75, No. 200. 63898-64070.

USFWS. 2010b. Biological effects of sediment on bull trout and their habitat – Guidance for evaluating effects. Prepared by Jim Muck, Washington Fish and Wildlife Office, Lacey, Washington. July 10, 2010, 57 pp.

USFWS. 2010c. Bull trout critical habitat justification: Rationale for why habitat is essential, and documentation of occupancy. U.S. Fish and Wildlife Service, Idaho Fish and Wildlife Office, Boise, Idaho. Pacific Region, Portland, Oregon. September 2010. 1035 pp.

USFWS. 2011. Revised recovery plan for the northern spotted owl (*Strix occidentalis caurina*). U.S. Fish and Wildlife Service, Portland, Oregon. xvi + 258 pp.

USFWS. 2012. Endangered and Threatened Wildlife and Plants; Revised Designation of Critical Habitat for the Northern Spotted Owl (FR 77(233): 1876-72068).

USFWS. 2015a. Recovery plan for the coterminous United States population of bull trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Portland, Oregon. xii + 179 pp.

USFWS. 2015b. Coastal recovery unit implementation plan for bull trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Lacey, Washington, and Portland, Oregon. 155 pp.

USFWS. 2015c. Bull Trout 5-Year Review, Short Form Summary. Idaho Fish and Wildlife Office, Boise, Idaho. 55 pp.

USFWS. 2019. Biological Opinion on the Washington State Department of Natural Resources Marbled Murrelet Long-term Conservation Strategy Amendment to the 1997 Habitat Conservation Plan. Reference No. 01EWFW00-20190F-1650, 1-3-96-FW-594. Washington Fish and Wildlife Office, Lacey, Washington, 250 pp.

USFWS. 2020. Biological opinion for programmatic forest management activities on the Olympic National Forest, June 15, 2020, to June 15, 2030. USFWS Reference No.: 13410-2009-F-0388-R001. U.S. Fish and Wildlife Service, Washington Fish and Wildlife Office, Lacey, WA. 341 pp. + appendices.

USFWS. 2021. Endangered and Threatened Wildlife and Plants; Revised Designation of Critical Habitat for the Northern Spotted Owl (FR 86(215): 62606-62666).

USFWS. 2023. Draft Environmental Impact Statement for the Barred Owl Management Strategy. U.S. Fish and Wildlife Service, U.S. Department of the Interior, Portland, Oregon. November 2023. 264 pp.

USFWS and NMFS (U.S. Fish and Wildlife Service and National Marine Fisheries Service). 1998. Final Endangered Species Act Consultation Handbook, Procedures for Conducting Section 7 Consultation and Conferences. March 1998. 315 pp.

USFWS and NMFS (U.S. Fish and Wildlife Service and National Marine Fisheries Service). 2016. Confirmation that the Forest Land Plan for the Olympic Experimental State Forest is consistent with the State Trust Lands Habitat Conservation Plan. Lacey, Washington, 1p.

USFWS (U.S. Fish and Wildlife Service), National Marine Fisheries Services, Environmental Protection Agency, Washington State Department of Natural Resources, Washington State Department of Fish and Wildlife, Washington State Department of Ecology, Colville Confederated Tribes, Washington State Association of Counties, Washington Forest Protection Association, and Washington Farm Forestry Association. 1999. Forests and Fish Report. Presented to the Forest Practices Board, Washington, 182 pp.

USFWS and ODFW (U.S. Fish and Wildlife Service and Oregon Department of Fish and Wildlife). 2011. Clackamas River bull trout reintroduction: implementation, monitoring, and evaluation plan. Oregon Fish and Wildlife Office, Portland, Oregon.

USFWS and WDNR (U.S. Fish and Wildlife Service and Washington State Department of Natural Resources). 2019. Final Environmental Impact Statement for a Long-Term Conservation Strategy for the Marbled Murrelet. Department of Natural Resources Forest Resources Division, Olympia, Washington, 428 pp.

USGCRP (United States Global Change Research Program). 2017. Climate science special report: fourth national climate assessment, volume I. U.S. Global Change Research Program, Washington, DC. 477 pp.

Wald, A.R. 2009. High flows for fish and wildlife in Washington. Report of Investigations in Instream Flow. State of Washington Department of Fish and Wildlife. Washington State Department of Printing. Olympia, Washington. 30 pp.

WDFW (Washington Department of Fish and Wildlife), FishPro Inc., and Beak Consultants. 1997. Grandy Creek trout hatchery biological assessment. March 1997. Olympia, Washington.

WDFW. 2023. Washington sport fishing rules. Effective July 1, 2023 – June 30, 2024. Washington Department of Fish and Wildlife, Olympia WA. 147 pp.

WDNR (Washington State Department of Natural Resources). 1987. Timber/Fish/Wildlife Agreement, a better future in our woods and streams, final report. 59 pp.

WDNR. 1992. Forest resource plan: policy plan, final. Department of Natural Resources, Forest Land Management Division, Olympia, 53 pp.

WDNR. 1997. Final Habitat Conservation Plan. Washington Department of Natural Resources. Olympia, Washington. 209 pp. + appendices.

WDNR. 1998. Final (Merged) Environmental Impact Statement, Habitat Conservation Plan. Department of Natural Resources, Olympia, Washington, 1340 pp.

WDNR. 1999. Procedure PR 14-004-120. Management activities within spotted owl nest patches, circles, designated nesting, roosting, and foraging and dispersal management areas. Washington Department of Natural Resources. Olympia, Washington. 4 pp.

WDNR. 2004a. Administrative Amendment to the northern spotted owl conservation strategy for the Klickitat HCP Planning Unit. Washington Department of Natural Resources, Olympia, Washington. 96 pp.

WDNR. 2004b. Habitat conservation plan 5-year comprehensive review. May 2004. Washington Department of Natural Resources, Olympia, Washington. 121 pp.

WDNR. 2005. Final Forest Practices Habitat Conservation Plan. Department of Natural Resources Forest Resources Division, Olympic, Washington, 1107 pp.

WDNR. 2005a. Habitat Conservation Plan for State Trust Lands, 2005 Implementation Monitoring Report. Washington Department of Natural Resources Land Management Division, Ecosystem Services Section, Olympia, Washington, 40 pp.

WDNR. 2006a. Policy for Sustainable Forests. Washington Department of Natural Resources. Olympia, Washington. December 2006. 40 pp + appendices.

WDNR. 2006b. Implementation Procedures for the Habitat Conservation Plan Riparian Forest Restoration Strategy for Westside Planning Units excluding the Olympic Experimental State Forest. Department of Natural Resources Scientific Support Section, Olympia, Washington, 98 pp.

WDNR. 2007a. Habitat Conservation Plan for State Trust Lands, 2006 Implementation Monitoring Report. Land Management Division, Ecosystem Services Section, Olympia, Washington, 42 pp.

WDNR. 2007b. Northern spotted owl surveys on DNR-managed lands in southwest Washington. Final Report. USFWS Agreement # 13410-6-J023. Prepared by T. Minkova. Washington Department of Natural Resources. Olympia, Washington. 30 pp.

WDNR. 2008. Habitat Conservation Plan for State Trust Lands 2007 Implementation Monitoring Report. Prepared by D. Munzing. July 2008. Washington Department of Natural Resources. Olympia, Washington. 46 pp.

WDNR. 2008a. Habitat Conservation Plan for State Trust Lands. 2008 Annual Report. Published November 2008. Prepared by Washington State Department of Natural Resources Forest Resources Division, Olympia, Washington. 144 pp.

WDNR. 2009. Amendment to the northern spotted owl dispersal management strategy in the South Puget Planning Unit of the Washington Department of Natural Resources State Trust Lands Habitat Conservation Plan. Department of Natural Resources Forest Resources Division, Olympia, Washington, 12 pp.

WDNR. 2010a. Northern spotted owl surveys in the Olympic Experimental State Forest. Washington Department of Natural Resources. Olympia, Washington. 2 pp.

WDNR. 2010b. South Puget HCP Planning Unit Forest Land Plan. Final Environmental Impact Statement. Washington Department of Natural Resources, Olympia, Washington. 233 pp.

WDNR. 2013. Habitat Conservation Plan for State Trust Lands, 2012 Implementation Monitoring Report. Land Management Division, Ecosystem Services Section, Olympia, Washington, 34 pp.

WDNR. 2015. State Trust Lands Habitat Conservation Plan 2014 Annual Report for Fiscal Year 2014. Published April 2015. Prepared by Washington State Department of Natural Resources Forest Resources Division, Olympia, Washington, 108 pp.

WDNR. 2016a. Olympic Experimental State Forest Habitat Conservation Plan (HCP) Planning Unit Forest Land Plan. Department of Natural Resources Forest Resources Division, Olympia, Washington, 171 pp.

WDNR. 2016b. Olympic Experimental State Forest HCP Planning Unit Forest Land Plan. Final Environmental Impact Statement. Washington Department of Natural Resources, Olympia, WA. 381 pp + appendices.

WDNR. 2016c. State Trust Lands Habitat Conservation Plan 2015 Annual Report for Fiscal Year 2015. Published April 2016. Prepared by Washington State Department of Natural Resources Forest Resources Division, Olympia, Washington, 86 pp.

WDNR. 2017. State Trust Lands Habitat Conservation Plan 2016 Annual Report for Fiscal Year 2016. Published May 2017. Prepared by Washington State Department of Natural Resources Forest Resources Division, Olympia, Washington, 112 pp.

WDNR. 2018. State Trust Lands Habitat Conservation Plan 2017 Annual Report for Fiscal Year 2017. Published April 2018. Prepared by Washington State Department of Natural Resources Forest Resources Division, Olympia, Washington, 112 pp.

WDNR. 2019a. Final Environmental Impact Statement for Alternatives for the Establishment of a Sustainable Harvest Level for Forested State Trust Lands in Western Washington. October 2019. Washington Department of Natural Resources, Olympia, Washington. 170 pp.

WDNR. 2019b. State Trust Lands Habitat Conservation Plan 2018 Annual Report for Fiscal Year 2018. Published May 2019. Prepared by Washington State Department of Natural Resources Forest Resources Division, Olympia, Washington, 96 pp.

WDNR. 2019c. Final State Trust Lands Habitat Conservation Plan Amendment Marbled Murrelet Long-term Conservation Strategy. Department of Natural Resources Forest Resources Division, Olympia, Washington, 286 pp.

WDNR. 2020a. State Trust Lands Habitat Conservation Plan 2019 Annual Report for Fiscal Year 2019. Published July 2020. Prepared by Washington State Department of Natural Resources Forest Resources Division, Olympia, Washington, 94 pp.

WDNR. 2020b. Forest health assessment and treatment framework (RCW 76.06.200). Washington Department of Natural Resources, Olympia, Washington. 78 pp + appendices.

WDNR. 2021a. State Trust Lands Habitat Conservation Plan Annual Report for Fiscal Year 2020. Published September 2021. Prepared by Washington State Department of Natural Resources Forest Resources Division, Olympia, Washington, 88 pp.

WDNR. 2021b. Minor amendment in allocation of spotted owl dispersal management areas within the Ahtanum State Forest. November 17, 2021. Washington Department of Natural Resources. Olympia, Washington. 8 pp.

WDNR. 2022a. State Trust Lands Habitat Conservation Plan Annual Report for Fiscal Year 2021. Published November 2022. Prepared by Washington State Department of Natural Resources Forest Resources Division, Olympia, Washington, 103 pp.

WDNR. 2022b. Status and trends monitoring of riparian and aquatic habitat in the Olympic Experimental State Forest: 2013-2020 results. Prepared by: Devine, W.D., Minkova, T., Martens, K.D., Keck, J., Foster, A.D. 2022. Washington State Department of Natural Resources, Forest Resources Division, Olympia, WA. 133 pp + Appendices.

WDNR. 2023a. State Trust Lands Habitat Conservation Plan Annual Report for Fiscal Year 2022. Prepared by Washington State Department of Natural Resources Forest Resources Division, March 2023. Olympia, Washington, 103 pp.

WDNR. 2023b. Minutes - Board of Natural Resources Meeting. December 5, 2023, and presentation by Duane Emmons, regarding the proposed Eastside Sustainable Harvest calculation and the 1999 NSO Procedure to Eastern Washington Revision. Washington Department of Natural Resources, Olympia, Washington.

WDNR. 2023c. State Trust Lands Implementation Monitoring Report: Implementation of the Riparian Forest Restoration Strategy (RFRS). Washington State Department of Natural Resources Forest Resources Division, October 2023. Olympia, Washington. 15 pp.

WDNR. 2024. T3 Watershed Experiment in the Olympic Experimental State Forest: 2016-2023 Implementation Report. Prepared by: Minkova, T.V., Devine, W.D., Martens, K.D. Washington State Department of Natural Resources, Forest Resources Division, Olympia, Washington. 66 pp.

WDNR et al. 2006. Settlement Agreement from Washington Environmental Council et al. v. Sutherland et al. (King County Superior Court No. 04-2-26461-8SEA, dismissed April 7, 2006. Settlement agreement regarding WDNR management of spotted owl habitat within spotted owl management circles.

WDNR and USFWS (Washington Department of Natural Resources and U.S. Fish and Wildlife Service. 2019. Final Environmental Impact Statement for a Long-Term Conservation Strategy for the Marbled Murrelet. September 2019. Washington Department of Natural Resources and U.S. Fish and Wildlife Service. Olympia, Washington. https://www.dnr.wa.gov/mmltcs

Wasser, S.K., K. Bevis, G. King, and E. Hanson. 1997. Noninvasive physiological measures of disturbance in the northern spotted owl. Conservation Biology 11(4):1019-1022.

Wasser, S.K. and K.E. Hunt. 2005. Noninvasive measures of reproductive function and disturbance in the barred owl, great horned owl, and northern spotted owl. Annals of the New York Academy of Sciences 1046:109-137.

Wemple, B.C., J.A. Jones, and G.E. Grant. 1996. Channel Network Extension by Logging Roads in Two Basins, Western Cascades, Oregon. Water Resources Bulletin. 32(6): 1195-1207.

Wenger, S.J., D.J. Isaak, J.B. Dunham, K.D. Fausch, C.H. Luce, H.M. Neville, B.E. Rieman, M.K. Young, D.E. Nagel, D.L. Horan, and G.L. Chandler. 2011. Role of climate change and invasive species in structuring trout distributions in the interior Columbia River Basin, USA. Canadian Journal of Fisheries and Aquatic Sciences 68:988-1008.

Westerling, A. L., H. Hidalgo, D.R. Cayan, and T. Swetnam. 2006: Warming and Earlier Spring Increases Western US Forest Wildfire Activity, Science, 313:940-943.

WFPB (Washington Forest Practices Board). 1993a. Forest Practices Board Manual. Washington State Department of Natural Resources. 457 pp. Available online at: https://www.dnr.wa.gov/about/boards-and-councils/forest-practices-board/rules-and-guidelines/forest-practices-board-manual

WFPB (Washington Forest Practices Board). 2001. Washington forest practices: rules-WAC 222 (including emergency rules). Board manual (watershed manual not included), Forest Practices Act, RCW 76.09. Washington Forest Practices Board, Olympia, Washington.

Whitesel, T.A., J. Brostrom, T. Cummings, J. Delavergne, W. Fredenberg, H. Schaller, P. Wilson, and G. Zydlewski. 2004. Bull trout recovery planning: a review of the science associated with population structure and size. Science team report no. 2004-01, U.S. Fish and Wildlife Service, Portland, Oregon. 68 pp.

Whitmore, C.M., C.E. Warren, and P. Doudoroff. 1960. Avoidance reactions of salmonid and centrarchid fishes to low oxygen concentrations. Transactions of the American Fisheries Society 89(1):17-26.

Wiley, K. N., 1978. Site Index Tables for Western Hemlock in the Pacific Northwest, Weyerhaeuser Forestry Paper 17. Weyerhaeuser Company, Forestry Research Center, Centralia, Washington. 28 pp.

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. Wildlife Monographs No. 185. 50 pp.

Wiens, J.D., K.M. Dugger, K.E. Lewicki, and D.C. Simon. 2017. Effects of experimental removal of barred owls on population demography of northern spotted owls in Washington and Oregon—2016 progress report: U.S. Geological Survey Open-File Report 2017-1040, 23 pp.

Wiens, J.D., K.M. Dugger, J M. Higley, D.B. Lesmeister, A.B. Franklin, K.A. Hamm, et al. 2021. Invader removal triggers competitive release in a threatened avian predator. Proceedings of the National Academy of Sciences 118: e2102859118.

Williams, C.R., A.H. Dittman, P. McElhany, D.S. Busch, M.T. Maher, T.K. Bammler, J.W. MacDonald, and E.P. Gallagher. 2019. Elevated CO2 impairs olfactory-mediated neural and behavioral responses and gene expression in ocean-phase coho salmon (*Onchorhynchus kisutch*). Global Change Biology 25:963-977.

Wilson, T.M., and E.D. Forsman. 2013. Thinning effects on spotted owl prey and other forest-dwelling small mammals. *In*: Anderson, Paul D.; Ronnenberg, Kathryn L., eds. Density management for the 21st century: west side story. General Technical Report PNW-GTR-880. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, pp. 79–90.

Wright, B. 2015. National Park Service, Mount Rainier National Park, Ashford, Washington.RE: glacial outburst floods. Email message to Jeffrey Chan, Fish Biologist, Washington Fish and Wildlife Office, U.S. Fish and Wildlife Service, Lacey, Washington. March 16, 2015.

WSCC (Washington State Conservation Commission). 1999. Salmon habitat limiting factors report for the Puyallup River basin (Water Resource Inventory Area 10). Olympia, Washington.

van Rooyen, J.C., J.M. Malt, and D.B. Lank. 2011. Relating microclimate to epiphyte availability: Edge effects on nesting habitat availability for the marbled murrelet. Northwest Science, 85(4): pp. 549-561.

Yackulic, C.B., L.L. Bailey, K.M. Dugger, R.J. Davis, A.B. Franklin, E.D. Forsman, S.H. Ackers, L.S. Andrews, L.V. Diller, S.A. Gremel, K.A. Hamm, D.R. Herter, J.M. Higley, R.B. Horn, C. McCafferty, J.A. Reid, J.T. Rockweit, and S.G. Sovern. 2019. The past and future roles of competition and habitat in the range-wide occupancy dynamics of Northern Spotted Owls. Ecological Applications 29: e01861.

APPENDICES

Endangered Species Act - Section 7 Consultation
Intra-Service

BIOLOGICAL OPINION

U.S. Fish and Wildlife Service Reference:
2023-0004491

March 2024

Effects of Continued Implementation of the Incidental Take Permit
for the
Washington State Trust Lands Habitat Conservation Plan
(PRT-812521)

APPENDIX A

USFWS Correspondence with the Washington Department of Natural Resources regarding the 1997 State Trust Lands Habitat Conservation Plan

A. USFWS Correspondence to WDNR (dated 01/11/2024) regarding clarifications for implementation for the OESF Forest Land Plan

B. USFWS Correspondence to WDNR (dated 01/11/2024) regarding timeline extensions for HCP strategy and plan development.

C. WDNR Correspondence to USFWS (dated 03/01/2024) regarding timeline extensions for HCP strategy and plan development.

United States Department of the Interior

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Ms. Crump:

Subject: Clarifications for Implementation of the OESF Forest Land Plan

This purpose of this letter is to provide clarification for certain elements of the Riparian Conservation Strategy included in the 2016 Olympic Experimental State Forest Land Plan.

In 1997, both the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) (together, "the Services") approved the Habitat Conservation Plan (HCP) for Washington State Department of Natural Resources (WDNR) State Trust Lands (WDNR 1997). In August 2016, WDNR completed the *Final Environmental Impact Statement for the Olympic Experimental State Forest HCP Planning Unit Forest Land Plan* (FEIS) (WDNR 2016a). Following this, in September 2016, the WDNR completed the *Olympic Experimental State Forest Habitat Conservation Plan Planning Unit Forest Land Plan* (OESF Plan) (WDNR 2016b). The Services did not submit formal written comments on the 2016 FEIS. The Services did provide a short letter in 2016 stating the OESF Plan is consistent with the HCP. However, after further review of the OESF documents (WDNR 2016a and 2016b), we note several OESF Plan elements that appear to be inconsistent with the HCP. Therefore, we request clarification of how WDNR is implementing the OESF Plan regarding the elements identified below.

Clarifications for OESF Headwater Stream Protections

The HCP continues to govern the treatment of headwater streams on the OESF. On page 3-27, the OESF Plan states that: "DNR does not apply an interior-core buffer to Type 5 streams on stable ground." This statement is inconsistent with the HCP. The HCP specifies that "A separate protocol is warranted for Type 5 channels because of the abundance and variety of intermittent streams found on the western Olympic Peninsula. Management objectives in the Experimental Forest are to protect all Type 5 streams that cross unstable ground and occupy stable ground but have identifiable channels with evidence of water discharge or material transport" (HCP, pp. IV.111-112). The HCP directs WDNR to evaluate Type 5, 9, and unknown streams for bed and bank formation as well as slope stability. Because the OESF Plan omits explicit acknowledgment of this process, the protections applied to Type 5 streams on stable ground are not specified. We acknowledge that the OESF Plan requires a 30-foot Equipment Limitation Zone on all Type 5 streams (WDNR 2016b, p. 3-29). We request clarification that the HCP requirements for Type 5 stream channel evaluation and protections continue to apply.

<u>Clarifications for Riparian Conservation Strategy Objectives</u>

The HCP objectives for the OESF Plan riparian strategy require the WDNR to both "to maintain and aid restoration" of riparian functions. In contrast, the OESF Plan and associated FEIS repeatedly use the phrase "to maintain <u>or</u> aid restoration" (emphasis added) regarding objectives for the OESF Plan riparian strategy, thereby implying that the goal is to maintain or aid in restoration but not both.

In addition to the above, the objectives stated in the HCP are broader than the objectives stated in the OESF Plan. The objectives of the OESF Plan (pp. 3-22 - 3-23) focus on riparian functions associated with wood, shade, peak flows, and windthrow. The objectives in the HCP (IV.107) include these elements as well as channel and floodplain integrity, sediment regimes, and water quality and quantity.

We request clarification that the riparian conservation goals and objectives stated in the HCP for the OESF Plan remain unchanged, and the use of the term "to maintain or aid restoration" is merely a semantic issue rather than a proposed change in HCP objectives for the riparian strategy.

<u>Clarifications Regarding Other Activities within Interior-Core Buffers</u>

The OESF Plan (pp. 3-32 - 3-33) lists other management activities within interior-core buffers, which appear to be inconsistent with the HCP. Examples include the following:

- *Pre-commercial and commercial thinning.* The OESF Plan (p. 3-32) states that "Thinning may occur up to the last row of trees adjacent to typed waters…" However, for timber harvest, the HCP (IV.59) directs that no timber harvest will occur within the first 25 feet from the outer margin of the 100-year floodplain.
- *Application of herbicides.* The OESF Plan (p. 3-33) lists application of herbicides in interior-core buffers "in accordance with WAC 222-38-020 *Handling, Storage, and Application of Pesticides*…" However, the HCP (IV.132) directs that herbicide release is excluded from interior-core buffers.
- *Applying Interior-core Buffers to Type 5 Streams.* The OESF Plan (p. 3-35) states that "Thinning and regeneration harvest is allowed in the interior-core buffer of Type 5 streams." While the HCP does not specify a width for interior-core buffers for Type 5 streams, the HCP indicates that timber harvest within interior-core buffers would generally be limited to restoration, thinning, and research (HCP, pp. IV.131 – IV. 132).

We request confirmation that, notwithstanding the text of the OESF Plan above, the direction provided in the HCP regarding these activities governs.

Application of Allotted Acres

The OESF Plan (pp. 3-29 – 3-32) includes a general description for placement of regeneration harvest within interior-core buffers [“default width buffers”] and refers to these potential areas as “allotted acres.” The HCP indicates that timber harvest within the original function-based interior-core buffers would generally be limited to restoration, thinning, and research (HCP, pp. IV.131 – IV. 132). The OESF Plan addressed an implementation issue by converting the “anticipated average buffer widths” in the HCP (p. IV. 123) to a default buffer width (OESF Plan, p. 3-27). Regeneration harvest of allotted acres is limited, and “must be placed at least 25 feet from the outer edge of 100-year floodplain” (OESF Plan p. 3-31). The allotted acres that may be utilized as described in the OESF Plan would be located within the default buffer width but would be located outside the original function-based interior-core buffers as described in the HCP (pp. IV. 109 - IV.12). We request your confirmation that the limitations for regeneration harvest anticipated in the HCP regarding function-based interior-core buffers continue to apply.

Widths of Exterior Wind Buffers

The HCP (p. IV.123) specifies that Type 1 through Type 3 streams would receive 150-foot exterior wind buffers and Type 4 streams would receive 50-foot exterior buffers as a starting hypothesis. The HCP also specifies that Type 5 streams (when receiving an interior buffer) would receive 50-foot exterior buffers. The HCP anticipates potential adjustments to exterior wind buffer widths (p. IV.73): “The wind buffer specifications of this HCP should be considered interim. The width of the wind buffer may change as research concerning windthrow in managed forests, especially that conducted in the Olympic Experimental Forest State, finds means of minimizing windthrow.”

Adjustments to exterior buffer widths are included in the OESF Plan (p. 3-35). The OESF Plan applies an 80-foot exterior wind buffer for all stream types where indicated through windthrow risk modelling and field assessment. With this letter the Service acknowledges that adjustments in exterior wind buffer widths and application were anticipated in the HCP.

Summary

With this letter, we request clarification and confirmation that the HCP strategies for OESF Headwater Streams, OESF Plan Riparian Goals and Objectives, and Other Activities continue to apply. We appreciate your assistance in understanding and resolving any related issues. If you have any questions about this letter or our shared responsibilities under the HCP, please contact Bill Vogel (bill_vogel@fws.gov) or Vince Harke (vince_harke@fws.gov).

Sincerely,

SONJA KOKOS

Digitally signed by SONJA KOKOS
Date: 2024.01.11 16:37:16 -08'00'

for Brad Thompson, State Supervisor
Washington Fish and Wildlife Office

cc:

WDNR, Olympia, WA, (A. Estep,)
WAGO, Olympia, WA, (P. Ferester)
USFWS/RO, Portland, OR (K. Freund, C. Simes)
NMFS, Portland, OR (K. Kratz)
DOI/SOL, Portland, OR (J. Bernstein)
DOJ, Washington, DC (T. Mayhall)
DOJ, Portland, OR (C. Howell)

Literature Cited

WDNR (Washington State Department of Natural Resources). 1997. Final habitat conservation plan. Washington State Department of Natural Resources. September 1997. Olympia, WA. 209 pp. + appendices.

WDNR. 2016a. Final Environmental Impact Statement for the Olympic Experimental State Forest HCP Planning Unit Forest Land Plan. Washington State Department of Natural Resources. Olympia, WA. August 2016. 381 pp.

WDNR. 2016b. Olympic Experimental State Forest Habitat Conservation Plan (HCP) Planning Unit Forest Land Plan. Washington State Department of Natural Resources. Olympia, WA. September 2016. 171 pp.

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Ms. Crump:

Subject: Timeline Extensions for HCP Strategy and Plan Development

The U.S. Fish and Wildlife Service (USFWS) is reviewing the status of the Washington State Department of Natural Resources (WDNR) implementation of the 1997 State Lands Habitat Conservation Plan (HCP) (WDNR 1997). We have detected several processes and documents that remain incomplete. We seek WDNR's written commitment to complete these HCP requirements within the reasonable time frames setout below.

Headwaters Conservation Strategy

The HCP required development of a Headwaters Conservation Strategy (HCS) for westside areas outside the Olympic Experimental State Forest (OESF) by 2007. The USFWS is aware of the 2008 draft HCS; however, the HCS development has stalled. We request WDNR's commitment to update the draft 2008 HCS with currently available information, and to finalize the HCS within 2-years.

Comprehensive Road Network Management Plan

The HCP (p. IV.62) requires completion of a comprehensive landscaped-based road network management process commonly called the Comprehensive Road Network Management Plan (CRNMP), which is both a component of the Riparian Strategy as well as a component of strategies for unlisted species. In the 1998 Final (Merged) EIS (Volume 2, Page 3-201) the WDNR and the Services stated that "The lack of current information regarding roads has led the Services and WDNR to an agreement whereby a road-management plan would be developed in the first decade of the HCP which will address road location, construction, and maintenance standards, as well as landscape-level road issues such as density of open and closed roads." It is likely that many aspects of an acceptable CRNMP are already contained in and are currently being implemented through WDNR's Road Management and Abandonment Plans, the Forest Practices Rules, and other WDNR plans and policies. A potentially acceptable CRNMP could summarize and incorporate those documents. Those aspects of an acceptable CRNMP not addressed in existing road-management documents would need to be developed. These likely include, without limitation, construction standards, ensuring new roads are only constructed when necessary, seasonal closures, and road densities. We request WDNR's commitment to complete the CRNMP within 2 years.

Procedures for Salvage Harvest

The OESF Plan (WDNR 2016; p. 2-20) anticipates the development of salvage harvest tasks and procedures. The HCP requires discussion with the USFWS' of such tasks and procedures to ensure consistency with the HCP (pp. IV 10 and IV 22). The USFWS understands that the tasks and procedures are complete and are being implemented. The USFWS requests the WDNR's commitment to submit the tasks and procedures to USFWS for review and concurrence by March 1, 2024.

Windthrow Monitoring and Adaptive Management Plan

The HCP (p. IV.73) anticipated that the width of exterior wind buffers may change and noted that monitoring the success of wind buffers in maintaining the ecological integrity of the riparian buffers will be an important element of the HCP. As described in the 2016 OESF Plan, WDNR has developed a windthrow risk model for use in the OESF (p.3-34). The windthrow risk model is designed to both predict where buffers are needed and to plan harvest units (size, location, shape) that reduce or eliminate the need for wind buffers.

The HCP and the Implementation Agreement anticipate development of a monitoring and adaptive management program to assess the effectiveness of exterior wind buffers and to make adjustments based on that monitoring, where appropriate (HCP, p. IV.73; Implementing Agreement at §24.5(h)). A formal monitoring and adaptive management program for windthrow has yet to be developed and implemented. Components of a wind risk model monitoring and adaptive management program could include, but are not limited to, the following:

- Prioritization of sites with situations where windthrow is most likely.
- Consideration of some retrospective analysis.
- Identification of windthrow levels that represent acceptable components of natural processes as opposed to unacceptable infringement of riparian and aquatic functions.
- Differentiation of chronic and episodic windthrow.
- Identification of additional factors beyond the model that contribute to prediction of windthrow.
- Acknowledgement of continued use of adaptive management into the future.

The USFWS is prepared to provide technical assistance to the WDNR on these and related matters. We request confirmation that WDNR will develop a wind risk model monitoring and adaptive management program within 1 year.

Closing

We appreciate your assistance in completing these outstanding tasks. To this end, we recommend establishing regularly scheduled meetings between our agencies to help ensure that outstanding work meets HCP requirements.

If you have any questions about this letter or our shared responsibilities under the HCP, please contact Bill Vogel (bill_vogel@fws.gov) or Vince Harke (vince_harke@fws.gov). We would appreciate your written concurrence with this letter.

Sincerely,

SONJA KOKOS

Digitally signed by SONJA KOKOS
Date: 2024.01.11 16:31:30 -08'00'

for Brad Thompson, State Supervisor
Washington Fish and Wildlife Office

cc:

WDNR, Olympia, WA, (A. Estep,)
WAGO, Olympia, WA (P. Ferester)
NMFS, Portland, OR (K. Kratz)
USFWS/RO, Portland, OR (K. Freund, C. Simes)
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DOJ, Portland, OR (C. Howell)

Literature Cited

WDNR. 1998. Final (Merged) Environmental Impact Statement for the Washington State Department of Natural Resources Habitat Conservation Plan: 2 Volumes. October 1998. Olympia, WA. 1340 pp

WDNR. 1997. Final Habitat Conservation Plan. Washington State Department of Natural Resources. September 1997. Olympia, WA. 209 pp. + appendices.

WDNR. 2016. Olympic Experimental State Forest Habitat Conservation Plan (HCP) Planning Unit Forest Land Plan. Washington State Department of Natural Resources. September 2016. Olympia, WA. 171 pp.

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March 01, 2024

Subject: Timeline Extensions for HCP Strategy and Plan Development

Mr. Thompson,
Thank you for your letter signed January 11, 2024, regarding timeline extensions for the Washington Department of Natural Resources (WDNR) Trust Lands Habitat Conservation Plan (HCP) strategy and plan development. WDNR is committed to completing these efforts as specified below.

Headwaters Conservation Strategy
WDNR shared a draft Headwaters Conservation Strategy (HCS) with the U.S. Fish and Wildlife Service (USFWS) in 2008 which was subsequently delayed. WDNR will update the draft 2008 HSC with currently available information and strive to finalize the HCS with USFWS within two years. WDNR will keep USFWS apprised of our progress and any delays.

Comprehensive Road Network Management Plan
The HCP requires completing a comprehensive landscape-based road network management process called the Comprehensive Road Network Management Plan (CRNMP). WDNR will complete the CRNMP and submit to USFWS within two years.

Procedures for Salvage Harvest
The salvage of damaged timber in the five west-side Western Washington planning units is addressed in the HCP on page IV.10. The HCP recognizes that WDNR's conservation commitments may, in some cases, be inconsistent with the Washington State Legislature's express statutory direction to "determine if the salvage of damaged valuable materials is in the best interests of the trust for which the land is held" , and if so, to "proceed to offer the valuable material for sale." RCW 79.01.795, recodified at RCW 79.15.220. When WDNR determines that a proposed salvage harvest may conflict with conservation commitments, the HCP requires that WDNR discuss the potential conflict with USFWS and, if needed, "identify additional mitigation that would allow the necessary activities to go forward." The HCP does not address the salvage of damaged timber in the Olympic Experimental State Forest (OESF). HCP IV.E. Nevertheless, table IV.15 acknowledges that some salvage harvest would occur in the OESF.

WDNR has developed and implemented a procedure for salvage harvest after natural disturbance events within the OESF, as contemplated by the OESF Plan (p 2-20). Please find enclosed, PR14-004-520, *Response to Natural Disturbances in the OESF HCP Planning Unit*, which we are providing as a courtesy. We will be happy to discuss the procedure's implementation with the USFWS, yet note that the HCP did not contemplate or provide for USFWS concurrence in DNR's internal staff directives on this topic.

Windthrow Monitoring and Adaptive Management Plan
WDNR will develop and submit a formal wind risk model monitoring and adaptive management program, to the USFWS, within one year.

WDNR appreciates working with the USFWS in the continuing implementation of the HCP. WDNR will continue to meet with the USFWS regularly.

Sincerely,

DocuSigned by:
J. Cameron Crump
43AC844EC3904A3...

Cameron Crump
Forest Resources Division Manager
Washington Department of Natural Resources

Cc:

USFWS, Lacey, WA (V. Harke)
USFWS, Lacey, WA (B. Vogel)
NMFS, Portland, OR (K. Kratz)
USFWS/RO, Portland, OR (K. Freund, C. Simes)
DOI/SOL, Portland, OR (J. Bernstein)
DOJ, Washington, DC (T. Mayhall)
DOJ, Portland, OR (C. Howell)
WDNR, Olympia, WA, (A. Estep, T. Welker)
WAGO, Olympia, WA (P. Ferester, T. Moulton)

Enclosure:
Procedure 14-004-520 Natural Disturbance OESF

Response to Natural Disturbances in the Olympic Experimental State Forest (OESF) Habitat Conservation Plan (HCP) Planning Unit

Date: June 2017

Application: All HCP-covered lands within the OESF HCP planning unit

DISCUSSION

Natural disturbance events include wind, fire, insect outbreak, and disease epidemic. Of these, the most prevalent in the OESF is wind due to the alignment of major river valleys with prevailing wind directions, fully saturated soils during the winter months, and edge effects associated with harvest openings adjacent to mature timber stands (DNR 1997, p. IV. 106).

Wind can blow trees down or damage them. Damaged trees appropriate for salvage are those that have lost all or most of their canopy but have enough bole remaining to make a saw log.

This procedure addresses salvage of down or damaged trees in marbled murrelet habitat, northern spotted owl habitat, riparian management zones, and wetland management zones (DNR does not salvage in a floodplain or a non-forested wetland). For all salvage operations, follow DNR's catastrophic loss policy in the *Policy for Sustainable Forests*, RCW 79.15.210, RCW 79.15.220, and Chapter 296-54-WAC, which addresses worker safety.

The size of the riparian management zone depends on the associated stream type; refer to PR 14-004-160 *Riparian Management in the Olympic Experimental State Forest (OESF) Habitat Conservation Plan (HCP) Planning Unit.* The size of the wetland management zone depends on the size and type of wetland; refer to PR 14-004-500, *Wetlands Management in the OSEF HCP Planning Unit.*

ACTION BY FOREST RESOURCES DIVISION (division)

Annually update and provide current maps and databases of marbled murrelet and northern spotted owl habitat to the Olympic Region.

ACTION BY OLYMPIC REGION

Safety regulations pre-empt all other requirements; address them first to maintain worker safety. All green tree and snag retention are subject to the safety standards of the Department of Labor and Industries (Chapter 296-54-WAC). Design the salvage harvest to avoid jeopardizing forest worker safety once on-the-ground activity commences.

1. Using the most current maps and databases, determine if the natural disturbance is in marbled murrelet or northern spotted owl habitat and/or a riparian or wetland management zone.

2. If the area of natural disturbance is not in any of the areas listed in action item 1 (above), evaluate whether salvage meets the stand's management objectives and if warranted, proceed with salvage.

3. If the area of natural disturbance is located in marbled murrelet habitat:

    a. If the marbled murrelet long-term conservation strategy (LTCS) has not been completed and approved, continue to follow the "Memorandum for Marbled Murrelet Management within the Olympic Experimental State Forest" dated March 7, 2013 and consult with the HCP and Scientific Consultation Section prior to conducting any salvage harvest.

    b. If the marbled murrelet LTCS has been completed and approved, assure compliance with the LTCS and consult with the HCP and Scientific Consultation Section.

4. If the area of natural disturbance is within northern spotted owl habitat:

    a. Determine whether the 2006 Settlement Agreement (PR 14-001-030) is still in effect.

        i. If the Settlement Agreement is still in effect, follow the existing *Interim Direction for Addressing Blowdown in Northern Spotted Owl Habitat (Westside)*.

        ii. If the Settlement Agreement is no longer in effect, consult with the appropriate specialist(s) to determine whether the area still contains the elements needed to function as northern spotted owl habitat. Refer to Procedure PR 14-004-510 *Northern Spotted Owl Habitat Management in the Olympic Experimental State Forest (OESF) Habitat Conservation Plan (HCP) Planning Unit* for northern spotted owl habitat definitions.

    b. If the area still meets the habitat definitions and would continue to meet the definition following salvage, conduct the salvage. Document habitat status in the Planning and Tracking (P&T) or Land Resource Manager (LRM) database.

    c. If the area still meets the habitat definitions and salvage would cause it to become non-habitat, mitigate to maintain habitat status or do not salvage.

    d. If the area no longer meets the habitat definitions, notify the HCP and Scientific Consultation Section so that habitat maps can be updated and conduct salvage.

5. If the area of natural disturbance is within a riparian management zone:

    a. Determine the number of allotted acres available within the Type 3 watershed, if any.

b. Notify the HCP and Scientific Consultation Section if the watershed does not have allotted acres or the number of acres of salvage exceeds the allotted acres currently available in the Type 3 watershed. The HCP and Scientific Consultation Section will, depending on the scale of the disturbance, notify the Federal Services (US Fish and Wildlife Service and NOAA Fisheries) about the salvage.

c. Conduct the salvage.

d. If, in consultation with region specialists, it is determined that the area of natural disturbance within a riparian management zone is on a scale that would impair the function of the riparian management zone, communicate with the HCP and Scientific Consultation Section so that they can notify the Federal Services.

e. When salvage harvesting within a riparian management zone, consult with the appropriate specialist(s) to retain as much riparian function as possible. Do not remove trees that are entirely within 25 feet of the outer edge of the 100-year floodplain. If a tree originating from outside of 25 feet from the outer edge of the floodplain extends into this area, remove the entire tree if this can be done without damaging the bed or bank of the stream. Trees originating from inside of 25 feet from the outer edge of the floodplain will be cut at the 25-foot mark and the portion within this area will be left. If salvaging in a watershed without allotted acres, or if the area to be salvaged is larger than the allotted acres, maintain as many standing trees and snags as is safe to do so to retain and promote riparian function.

6. If the area of natural disturbance is in a wetland management zone:

   a. If the area of natural disturbance is associated with a non-forested wetland, establish a 50-foot no harvest buffer measured from the wetland's edge (refer to Procedure PR 14-004-500 *Wetlands Management in the Olympic Experimental State Forest (OESF) Habitat Conservation Plan (HCP) Planning Unit*). Conduct salvage in the portion of the wetland management zone outside of the 50-foot no-harvest buffer. If trees originating from outside the buffer extend into the no-harvest buffer, remove the entire tree if this can be done without affecting wetland function. If trees originating from inside the buffer extend outside the no-harvest buffer, remove only the portion that is outside the no-harvest buffer.

   b. When salvage harvesting in a forested wetland, a forested wetland management zone, or a wetland management zone for a non-forested wetland, remove only down or damaged trees and maintain a stand that is wind firm and has a minimum basal area of 120 square feet per acre if remaining stand conditions allow.

7. If the area of natural disturbance is located within a unique habitat or habitat for unlisted species of concern, develop a mitigation plan in consultation with the HCP and Scientific Consultation Section prior to salvage harvesting. Refer to Table 1 for a list of unique habitats and habitat for unlisted species of concern.

Table 1. Unique Habitats and Unlisted Species of Concern.

Habitat Type	Associated Procedure (PR) or Policy (PO)
Unique Habitats	
Structurally complex forests	PR 14-004-046
Talus fields	PR 14-004-170
Forest stand cohorts	PR 14-006-090
Old-growth timber	PR 14-004-045
Mineral Springs	PR 14-004-230
Cliffs	PR 14-004-190
Caves	PR 14-004-180
Balds	PR 14-004-220
Habitat for Unlisted Species of Concern	
Pileated woodpecker nests	PR 14-004-290
Vaux's swifts nests and night roosts	PR 14-004-300
Pacific fisher dens	PR 14-004-280
Northern goshawk nests west of the Cascades	PR 14-004-260
Myotis bat communal roosts and maternal colonies	PR 14-004-310
Harlequin duck nests	PR 14-004-250
Common loon nests	PR 14-004-240
Wildlife habitat	PO 14-009
Taylor's checkerspot butterfly habitat	Procedure pending

Exceptions

For exceptions to this procedure, obtain approval from the region manager in consultation with the Forest Resources division manager.

APPROVED BY: [signature] Date: 6/9/17

Andrew Hayes
Forest Resources Division Manager

APPENDIX B – Northern Spotted Owl Habitat Definitions

The following habitat types and definitions of northern spotted owl habitat are used in the Washington Department of Natural Resources (WDNR) state lands habitat conservation plan (HCP).

West Cascades and Olympic Experimental State Forest (OESF).

Habitat Type	Habitat Attributes
High Quality Nesting Habitat (West Cascades & OESF)	• At least 31 trees per acre are greater than or equal to 21 inches dbh with at least 15 trees, of those 31 trees, per acre greater than or equal to 31 inches dbh. • At least three trees from the above group of 31 trees have broken tops • At least 12 snags per acre larger than 21 inches dbh • A minimum of 70 percent canopy closure • A minimum of 5 percent ground cover of large woody debris
Type A Habitat (West Cascades & OESF)	• A multi-layered, multispecies canopy dominated by large (30 inches dbh or greater) overstory trees (typically 15-75 trees per acre) • Greater than 70 percent3 canopy closure • A high incidence of large trees with various deformities such as large cavities, broken tops, and dwarf mistletoe infection • More than two large snags per acre, 30 inches dbh or larger • Large accumulations of fallen trees and other woody debris on the ground
Type B Habitat (West Cascades & OESF)	• Few canopy layers, multispecies canopy dominated by large (greater than 20 inches dbh) overstory trees (typically 75-100 trees per acre, but can be fewer if larger trees are present) • Greater than 70 percent canopy closure • Some large trees with various deformities • Large (greater than 20 inches dbh) snags present • Accumulations of fallen trees and other woody debris on the ground
Old Forest Habitat (OESF)	Old forest habitat is an aggregation of Type A, Type B, high-quality nesting, and other mapped old-forest stands in the OESF.
Notes: High quality nesting habitat, Type A, and Type B habitat are counted as "nesting habitat" in HCP designated NRF management areas in the West Cascades planning units. In the OESF these habitat types are counted as "old forest habitat." *Sources: WDNR 1997, p. IV.11 – IV.12, WDNR 2016, p. 3-191*	

West Cascades and Olympic Experimental State Forest (OESF).

Habitat Type	Habitat Attributes
Sub-Mature Habitat (West Cascades & OESF)	• Forest community dominated by conifers, or in mixed conifer/hardwood forest, the community is composed of at least 30 percent conifers (measured as stems per acre dominant, co-dominant, and intermediate trees) • At least 70 percent canopy closure • Tree density of between 115 and 280 trees greater than 4 inches dbh • per acre • Dominant and co-dominant trees at least 85 feet tall • At least three snags or cavity trees per acre that are at least 20 inches dbh • A minimum of 5 percent ground cover of large down woody debris
Young Forest Marginal Habitat (OESF)	• Forest community dominated by conifers, or in mixed conifer/hardwood forest, the community is composed of at least 30 percent conifers (measured as stems per acre dominant, co-dominant, and intermediate trees) • At least 70 percent canopy closure • Tree density of between 115 and 280 trees greater than 4 inches dbh per acre • Dominant and co-dominant trees at least 85 feet tall • At least two snags or cavity trees per acre that are at least 20 inches dbh or equal to 10 percent of the ground covered with 4 inch diameter or larger wood with 25 to 60 percent shrub cover.
Dispersal Habitat (West Cascades – except South Puget Planning Unit)	• Canopy cover of at least 70 percent • Quadratic mean diameter of 11 inches dbh for 100 largest trees per acre in a stand • Top height of at least 85 feet (Top height is the average height of the 40 largest diameter trees per acre.) • At least four trees per acre from the largest size class retained for future snag and cavity tree recruitment.
Next-best Stands	• Within spotted owl management units that are below the habitat threshold, next-best stands are considered non-habitat, but are predicted to attain the structural characteristics that define northern spotted owl habitat either through passive or active management relatively sooner than other non-habitat stands. Next best stands count towards the target amount of suitable habitat, but are still considered non-habitat. Remaining stands not identified as habitat or next best are available for the full range of silvicultural activities (WDNR 2023, p. B-4).
Notes: In the OESF, sub-mature habitat and young forest marginal habitat are counted as “young forest” or “structural” habitat that supports spotted owl foraging. High-quality, Type A, Type B, and sub-mature habitats can also be counted as dispersal habitat. *Sources: WDNR 1997, p. IV.11 – IV.12, WDNR 2016, p. 3-191*	

East Cascades.

Habitat Type	Habitat Attributes
Type A Habitat (East Cascades)	• Multi-layered, multi-species canopy dominated by overstory trees that exceed 20 inches dbh (typically 35-100 trees per acre) • At least 75 percent canopy closure • Some dominant trees have mistletoe brooms, cavities, or broken tops • Three snags per acre greater than or equal to 20 inches dbh • Down woody debris that is greater than or equal to 20 inches dbh plus accumulations of other woody debris
Sub-Mature Habitat (East Cascades)	• Forest community composed of at least 40 percent Douglas fir or grand fir • Canopy closure of at least 70 percent • Tree density of between 110 and 260 trees per acre • Either tree height or vertical diversity (one characteristic but not both needs to be present): dominant and co-dominant trees at least 90 feet tall, or, two or more canopy layers with numerous intermediate trees and low perches • Either snags/cavity trees or mistletoe infection (one characteristic but not both needs to be present): Three or more snags or cavity trees per acre that are equal to or greater than 20 inches dbh, or; a moderate to high infection of mistletoe. • Five percent ground cover of dead and down wood averaged over a stand
Near-NRF Klickitat Planning Unit	• Mature forest condition in each vegetation series but lacking a component, such as canopy closure, top height or snags, with respect to existing HCP NRF definitions. An expectation of the near-NRF definition is that this missing component will be created within 30 years.
Dispersal Habitat (East Cascades)	• At least 50 percent canopy closure • Overstory tree density of at least 40 trees per acre that are at least 11 inches dbh • Top height of at least 60 feet • Retention of four green trees per acre from the largest size class present for recruitment of snags and cavity trees
Desired Future Condition (DFC) Klickitat Planning Unit	• The desired future condition represents a sustainable, realistic forest structure that could be expected for a properly managed vegetation series at a stand age of 60 years. DFC dispersal habitat applies the East Cascades dispersal habitat definition. Only vegetation series capable of sustaining dispersal habitat counted towards dispersal
Notes: Type A and sub-mature habitats are counted as "nesting habitat" in HCP designated NRF management areas in the East Cascades planning units. *Sources: WDNR 1997, p. IV.22 – IV.23, WDNR 2004, p. G-1*	

South Puget Dispersal Landscapes.

Habitat Type	Habitat Attributes
South Puget Movement Habitat	• Canopy closure of at least 70 percent • Quadratic mean diameter of 11 inches dbh for 100 largest trees per acre in a stand • Top height of at least 85 feet • Forest community dominated by conifers with at least 30 percent conifer (measured as stems per acre dominant, co-dominant, and intermediate trees) • Tree density no more than 280 trees per acre greater than or equal to 3.5 inches dbh • At least four trees per acre from the largest size class retained for future snag and cavity tree recruitment.
Movement, Roosting, and Foraging (MoRF) (South Puget Planning Unit)	• Forest community dominated by conifers with at least 30 percent conifer (measured as stems per acre dominant, co-dominant, and intermediate trees) • Canopy closure of at least 70 percent • Tree density between 115 and 280 280 trees per acre greater than or equal to 3.5 inches dbh • Dominant and co-dominant trees at least 85 feet tall • At least five percent coverage of down woody debris • At least 3 snags or cavity trees per acre that are least 15 inches dbh • At least two canopy layers
The desired future condition for the South Puget dispersal areas is that each spotted owl management unit (SOMU) is to provide 35 percent of the landscape in MoRF habitat, and an additional 15 percent in South Puget movement habitat. *Source: WDNR 2010, pp. 30-31*	

References

WDNR. 1997. Final Habitat Conservation Plan. Washington Department of Natural Resources. Olympia, WA. 209 pp. + appendices.

WDNR. 2004. Administrative Amendment to the northern spotted owl conservation strategy for the Klickitat HCP Planning Unit. April, 2004. Washington Department of Natural Resources, Olympia, WA. 96 pp.

WDNR. 2010. South Puget HCP Planning Unit Forest Land Plan. Final Environmental Impact Statement. January, 2010. Washington Department of Natural Resources, Olympia, WA. 233 pp.

WDNR. 2016. Olympic Experimental State Forest HCP Planning Unit Forest Land Plan. Final Environmental Impact Statement. Washington Department of Natural Resources, Olympia, WA. 381 pp + appendices.

Appendix C. Maps of WDNR HCP Lands

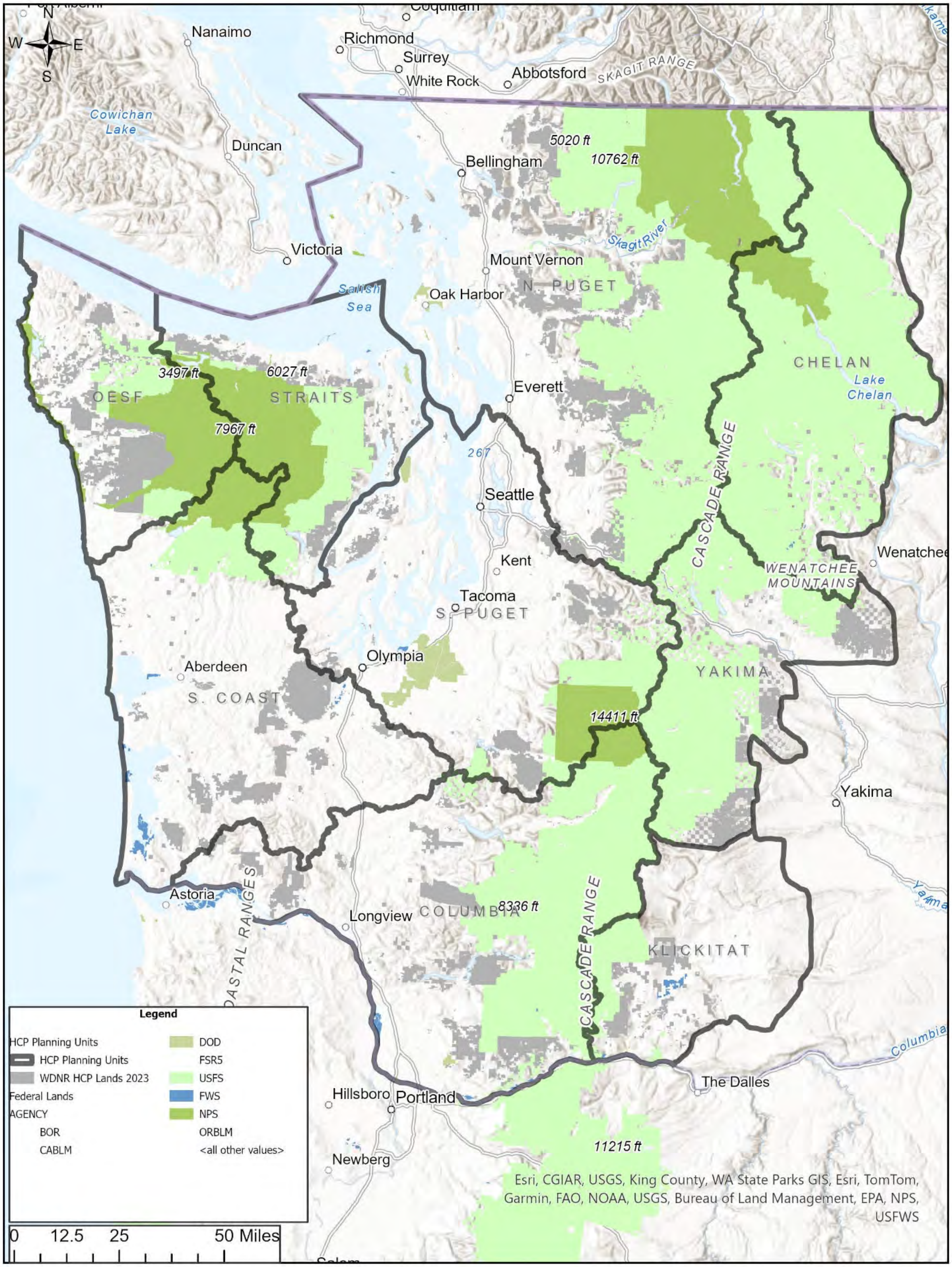


Figure 1. WDNR Habitat Conservation Plan (HCP) lands (dark grey) and HCP Planning Units.

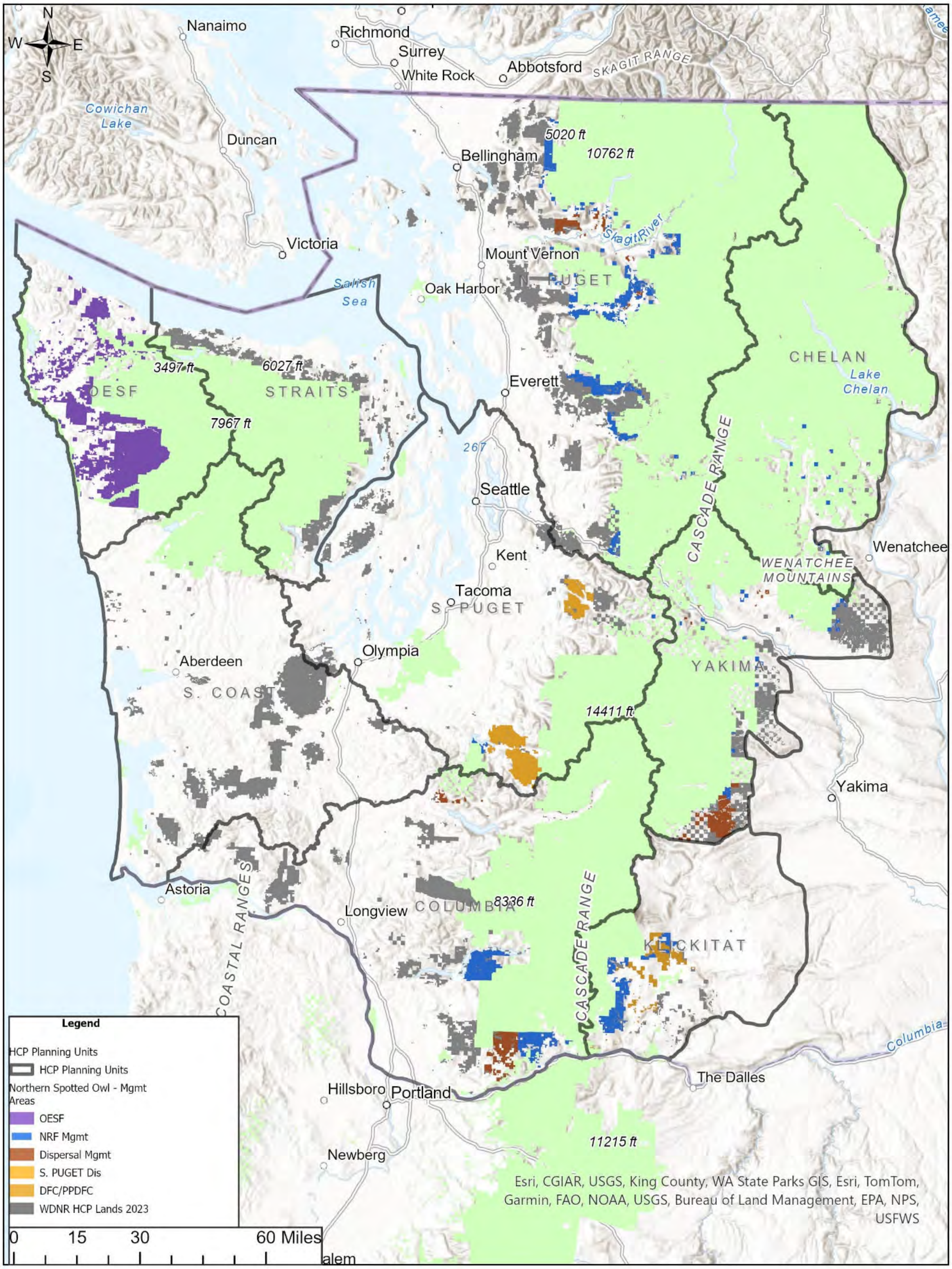


Figure 2. WDNR HCP-designated spotted owl management areas.

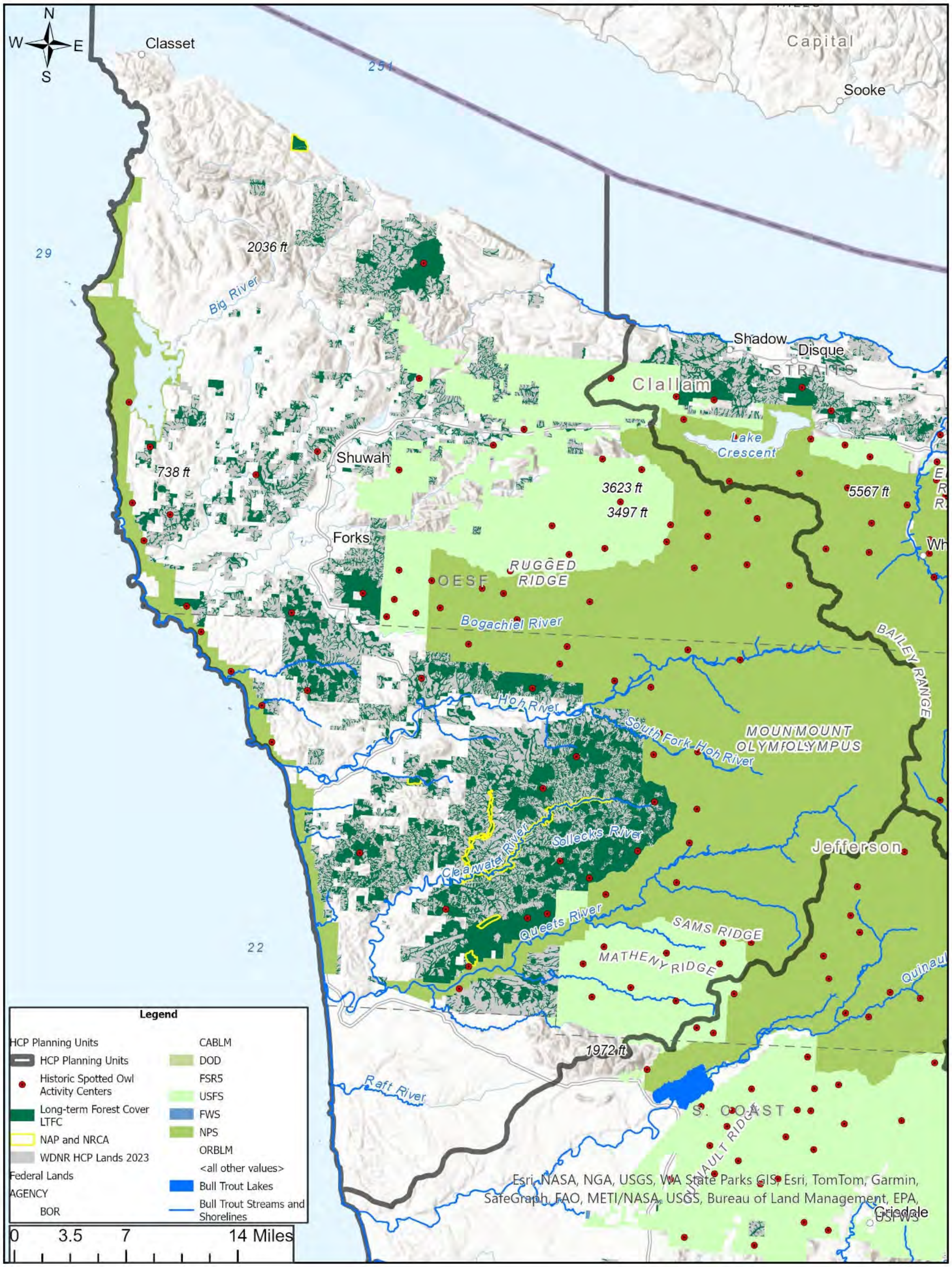


Figure 3. Olympic Experimental State Forest (OESF) and mapped long-term forest cover (LTFC).

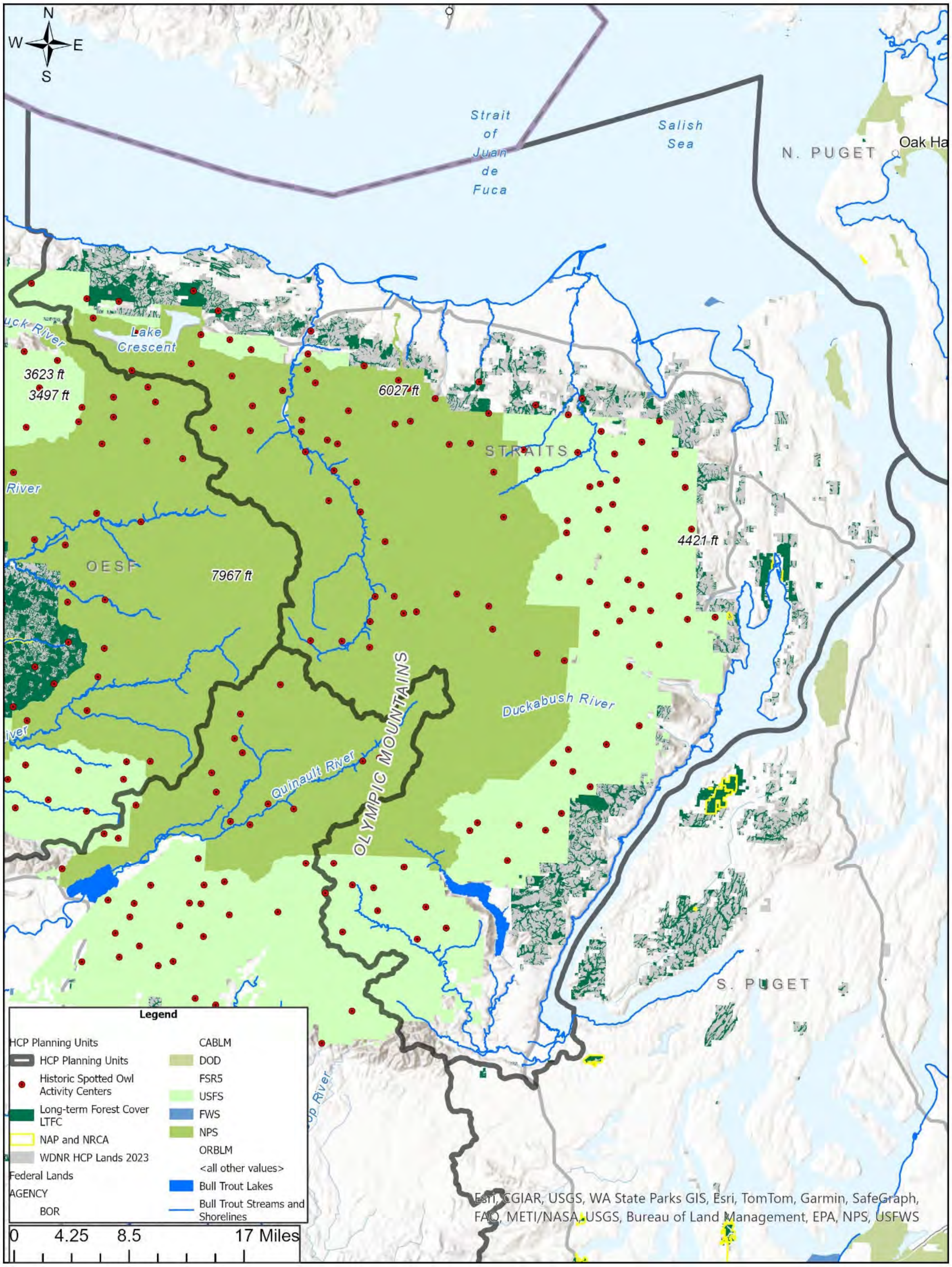


Figure 4. Straits HCP Planning Unit and mapped LTFC.

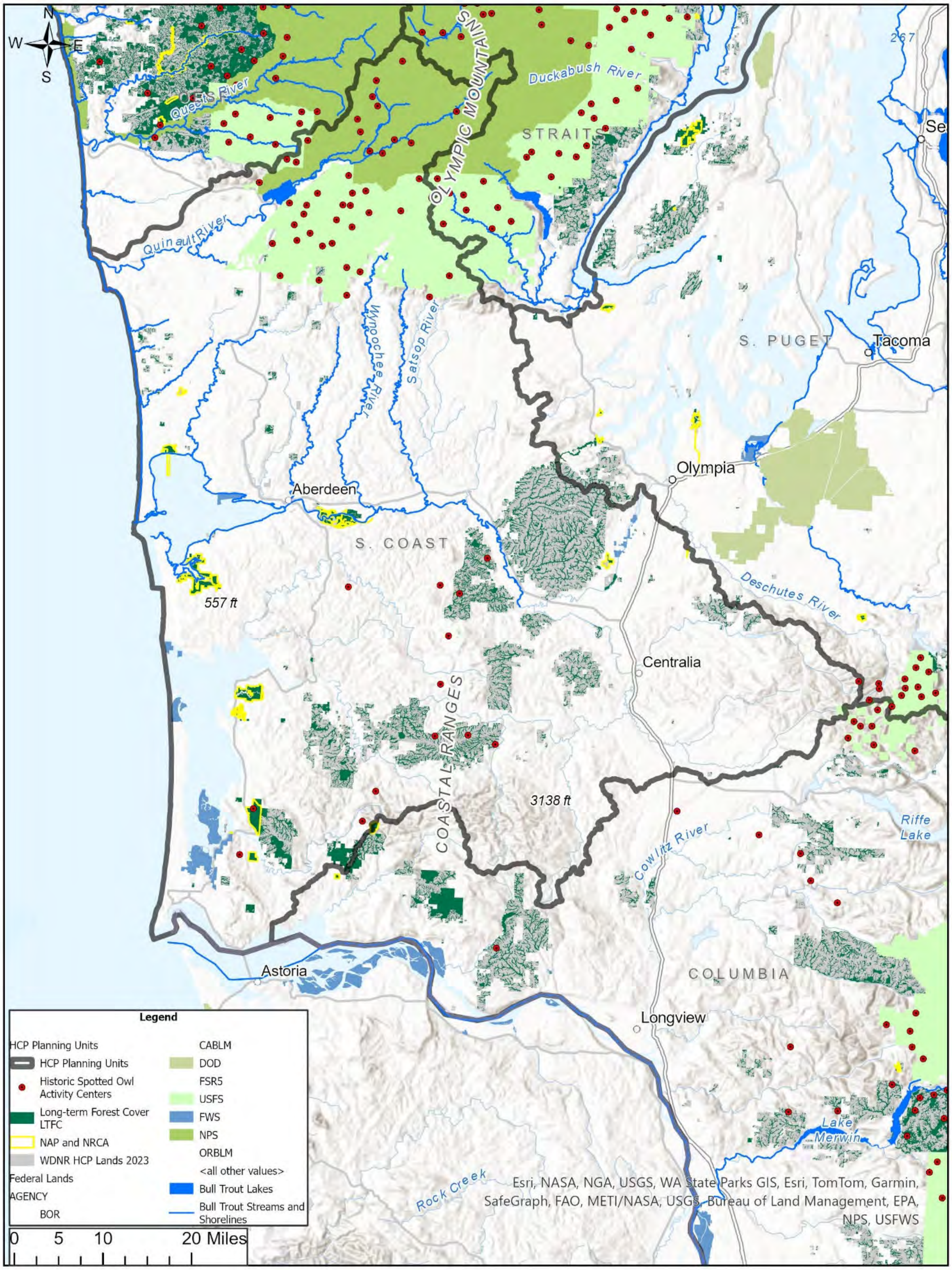


Figure 5. South Coast HCP Planning Unit and mapped LTFC.

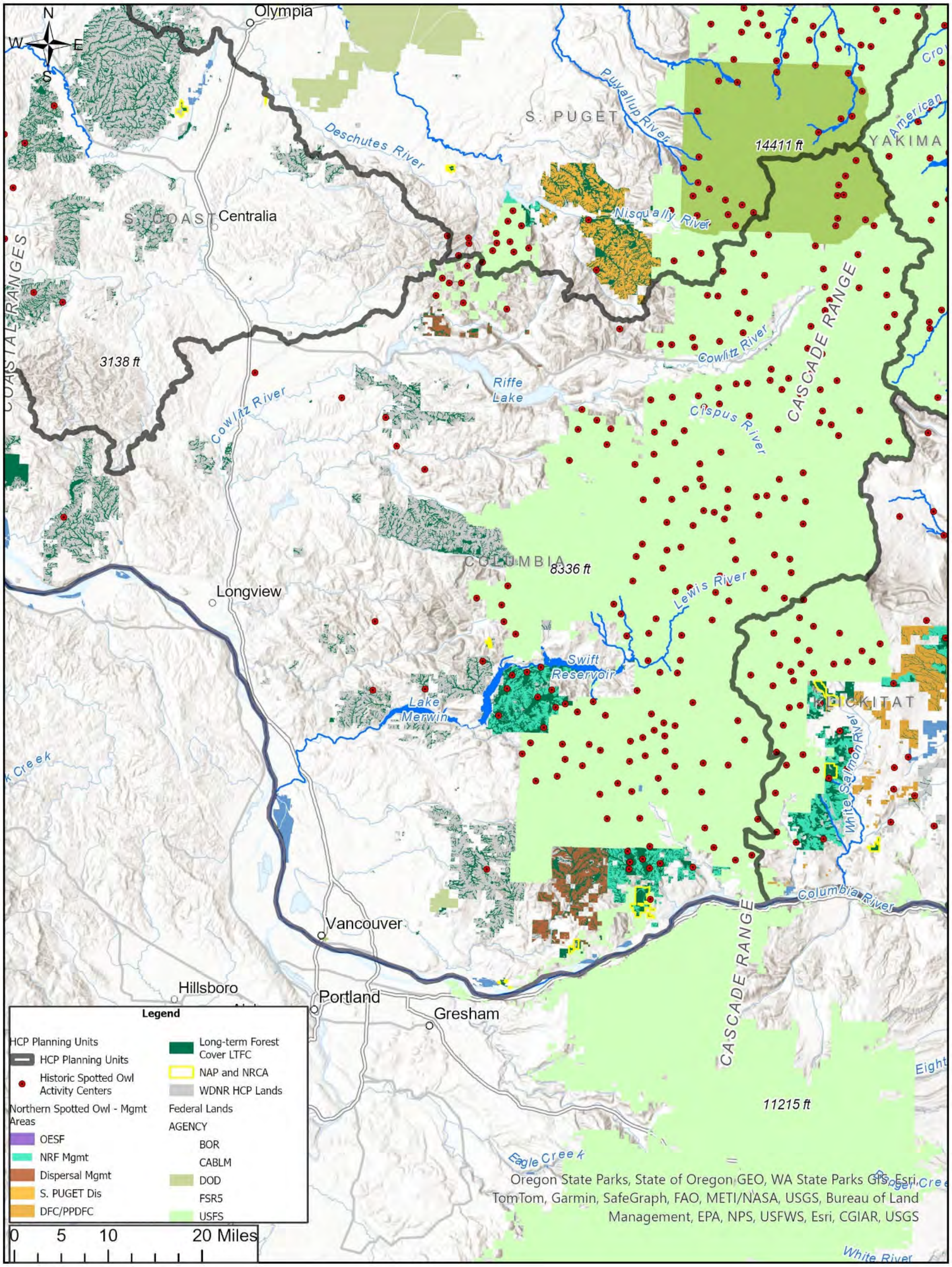


Figure 6. Columbia HCP Planning Unit and mapped LTFC.

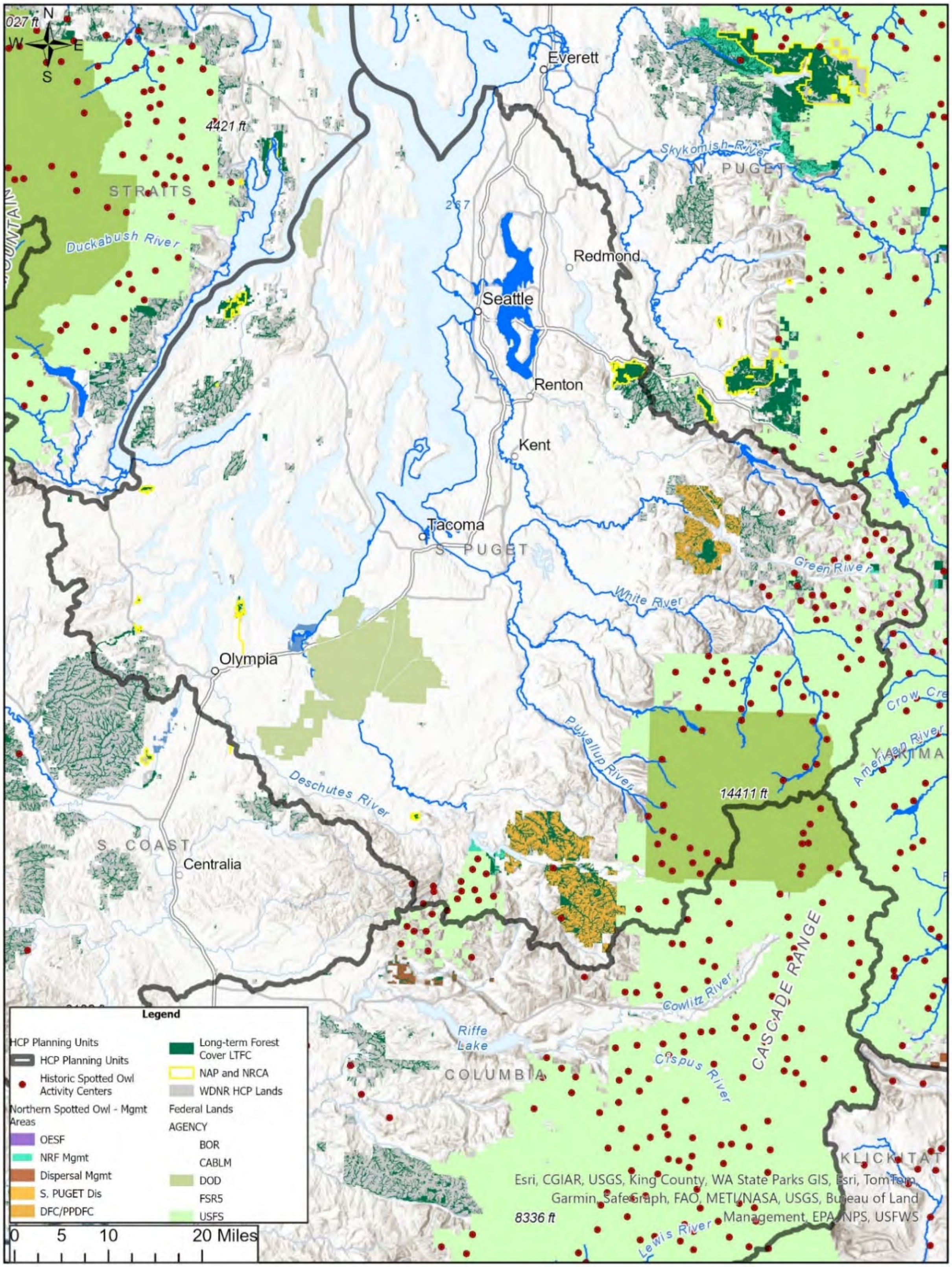


Figure 7. South Puget HCP Planning Unit and mapped LTFC.

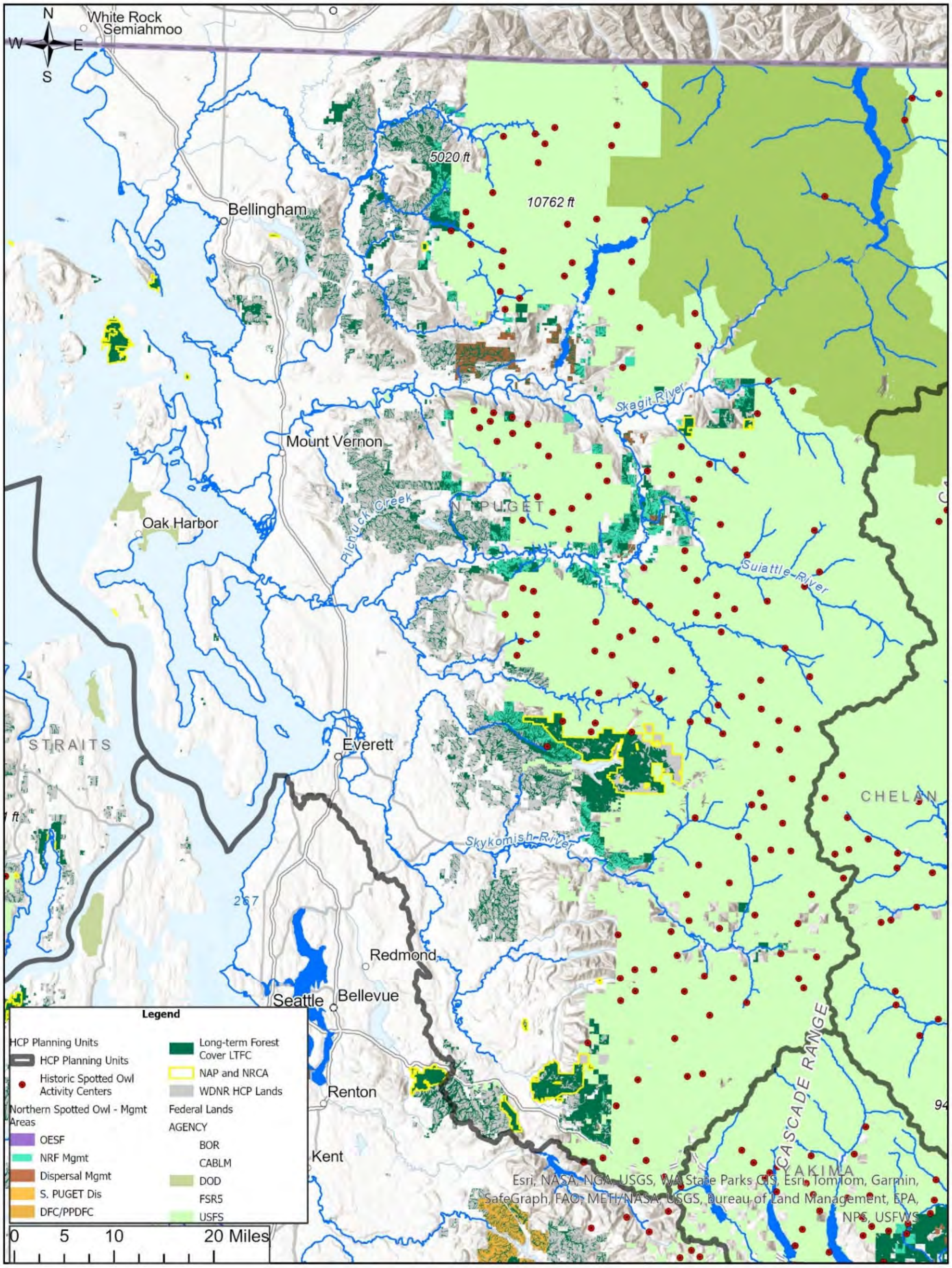


Figure 8. North Puget HCP Planning Unit and mapped LTFC.

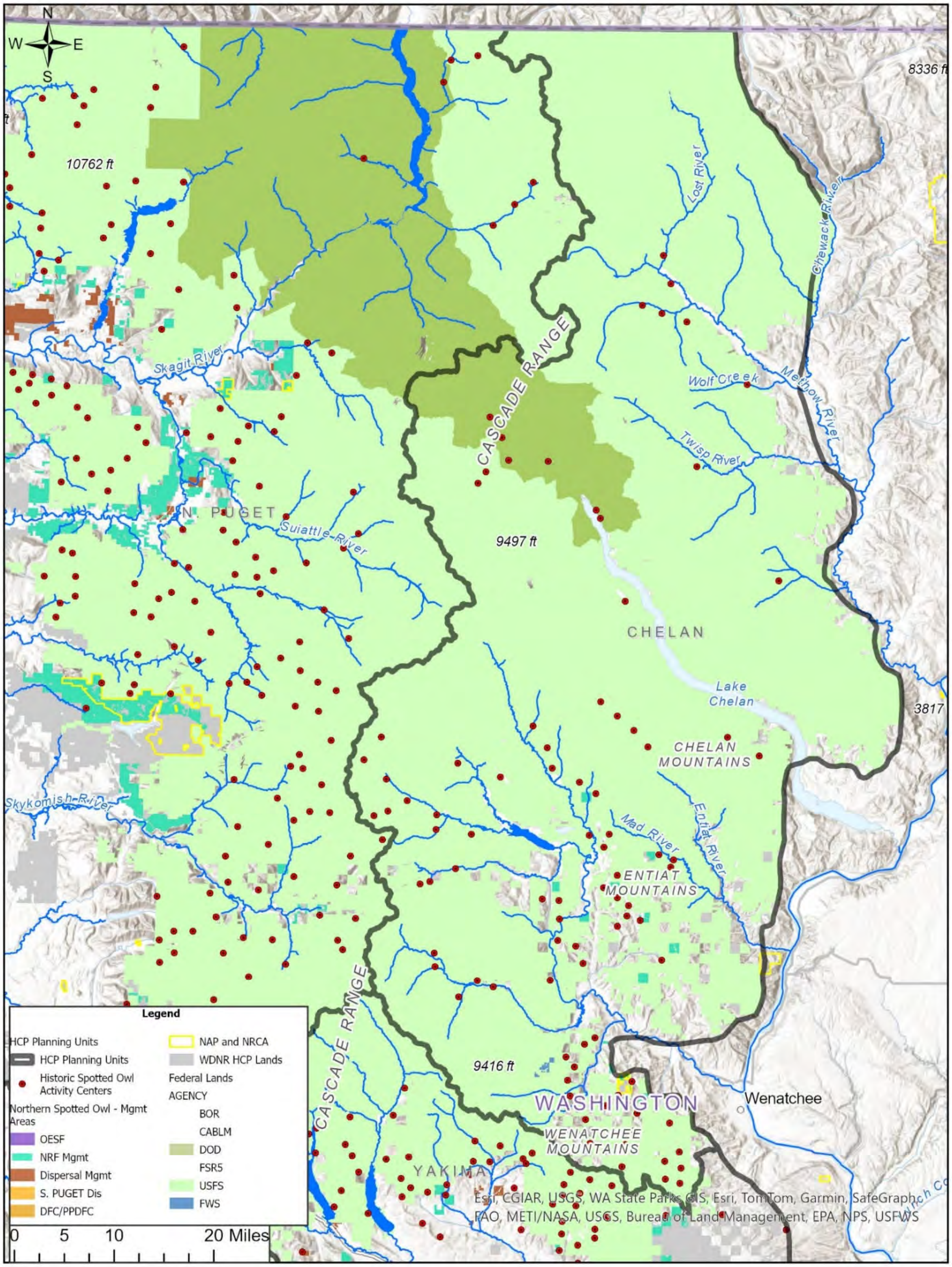


Figure 9. Chelan HCP Planning Unit.

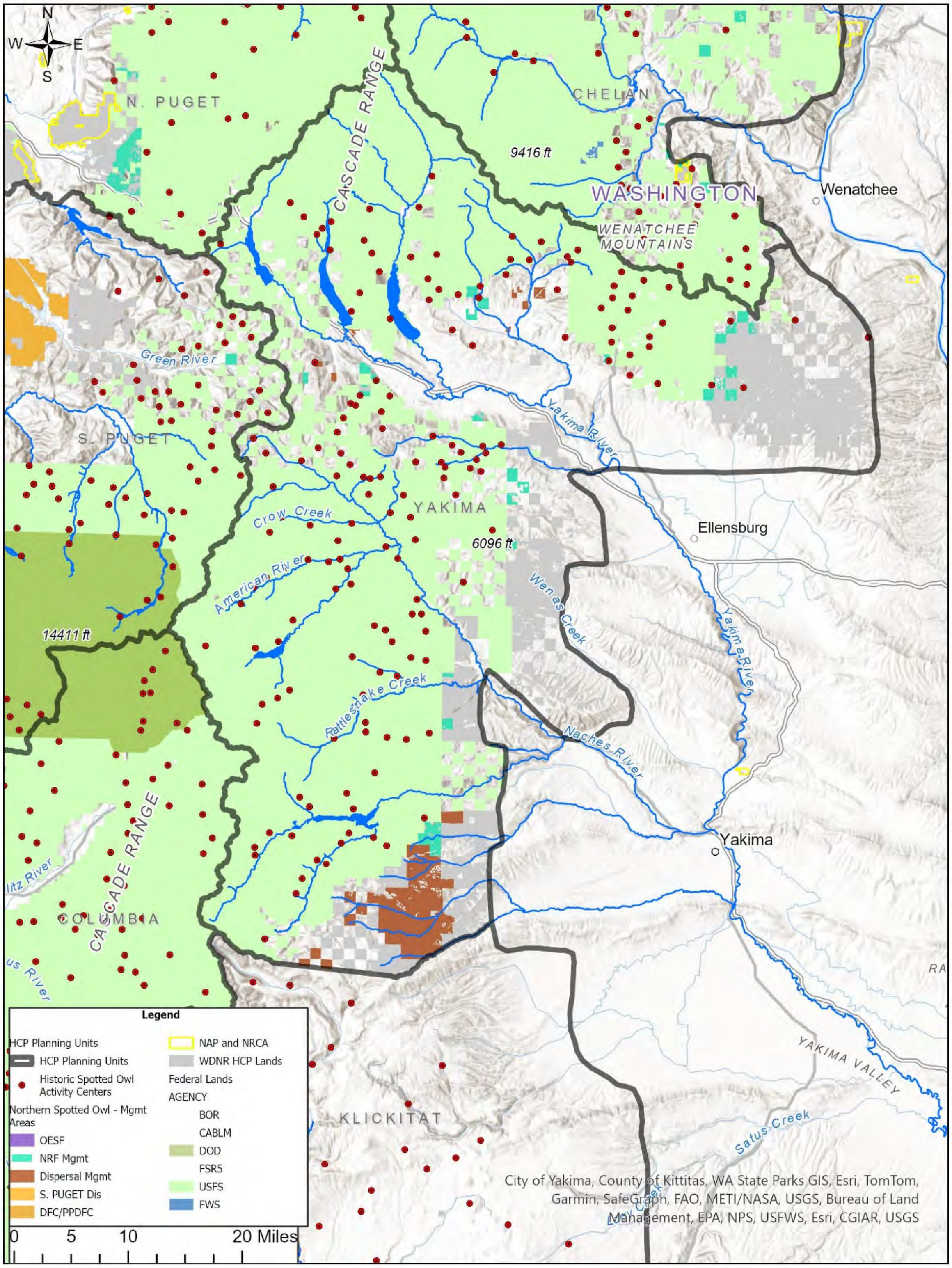


Figure 10. Yakima HCP Planning Unit.

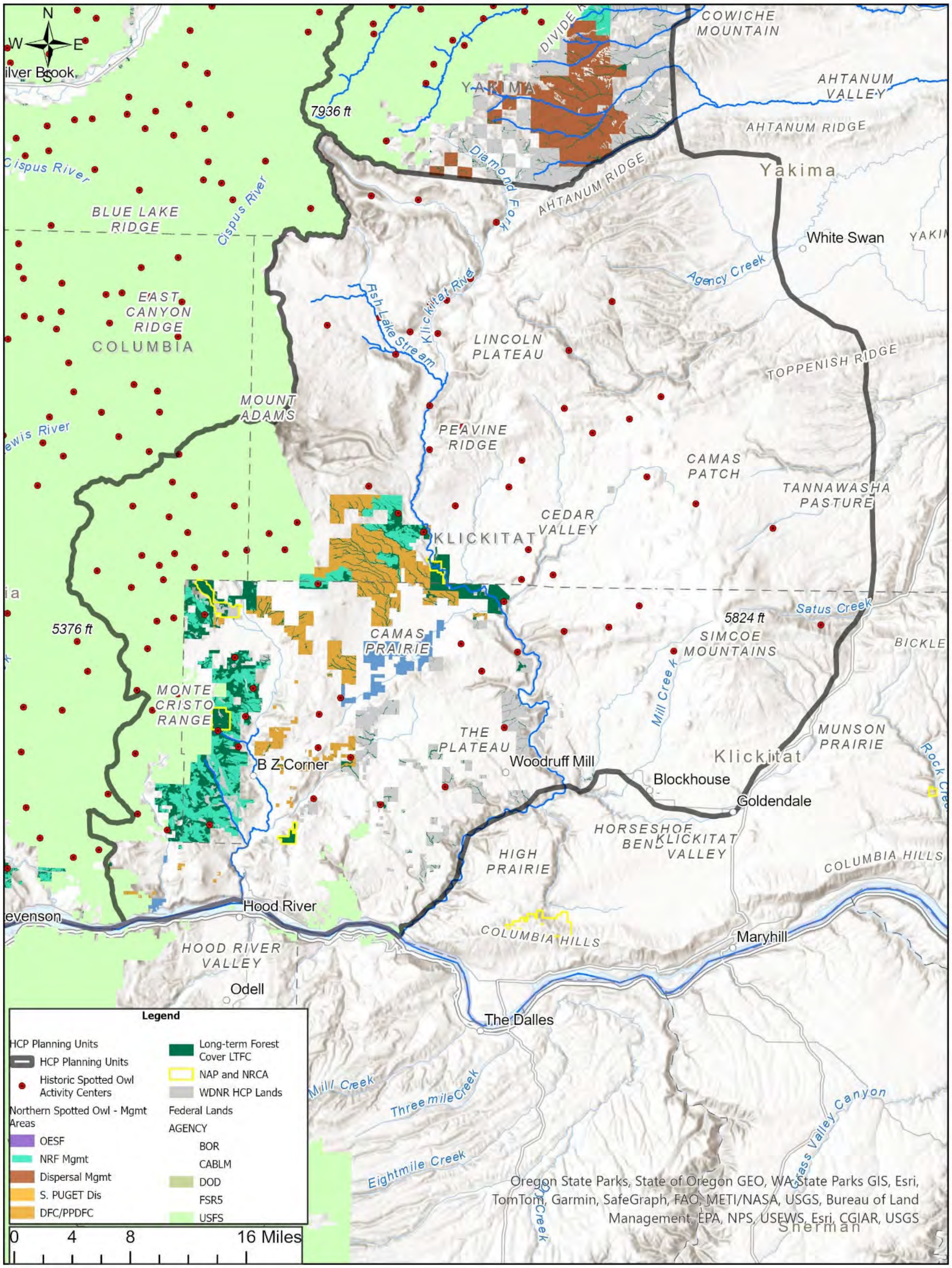


Figure 11. Klickitat HCP Planning Unit.

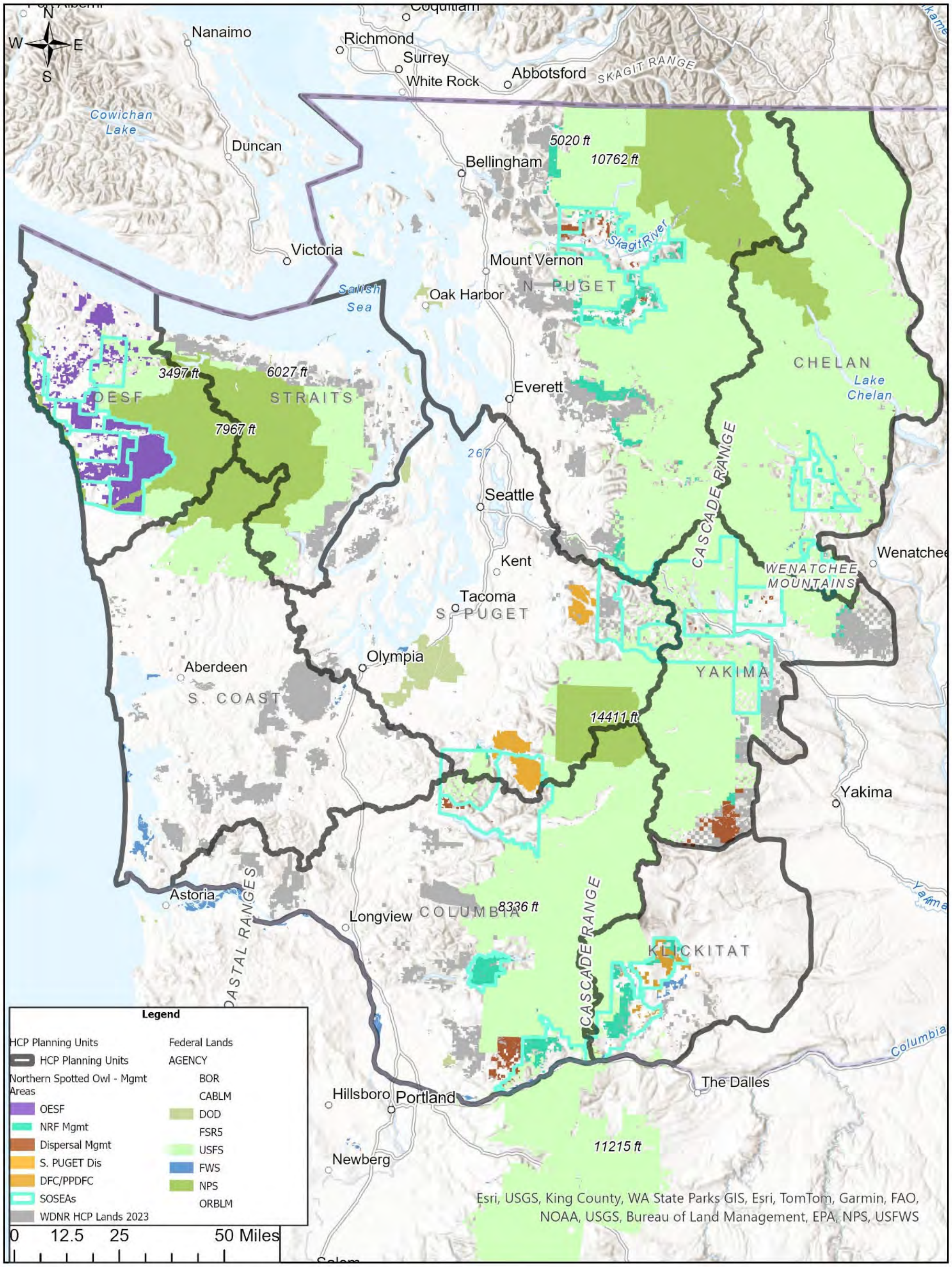


Figure 12. HCP designated spotted owl management and Spotted Owl Special Emphasis Areas (SOSEAs).

APPENDIX D

STATUS of the SPECIES

for

Northern Spotted Owl

and its

Critical Habitat

Produced by

U.S. Fish and Wildlife Service

February 2023

Table of Contents

Executive Summary

The northern spotted owl has declined across large portions of its range since the time of listing in 1990. The biggest threats are 1) loss of habitat due to timber harvest or severe wildfire 2) and competition with non-native barred owls (*Strix varia*). The most severe declines are occurring in the northern portion of the species range where barred owls have been established for the longest period of time. The current rate of decline raises concerns about the long-term persistence of the northern spotted owl throughout the Pacific Northwest.

Northern spotted owls rely on older forested habitats because such forests contain the structures and characteristics required for nesting, roosting, and foraging. The northern spotted owl was listed as threatened throughout its range “due to loss and adverse modification of northern spotted owl habitat as a result of timber harvesting and exacerbated by catastrophic events such as fire, volcanic eruption, and wind storms” (Service 1990a, p. 26114). Loss of northern spotted owl habitat on Federal lands since the 1990s due to timber harvest has been reduced on Federal lands over the past two decades under the Northwest Forest Plan (NWFP or the Plan). Wildfire is currently the primary cause of habitat loss on Federal lands, and the rate and severity of wildfire in portions of the range of the northern spotted owl are expected to increase in the future under projected climate change scenarios. Northern spotted owl habitat on private lands has continued to decline since the time of listing and has declined at a higher rate than on Federal lands; thus, Federal and State lands will continue to provide the majority of habitat for northern spotted owls for the foreseeable future. With the exception of some areas in northern California, northern spotted owls are unlikely to persist in areas without Federal lands.

The most recent estimated 5.3 percent annual rate of decline of the northern spotted owl rangewide (Franklin et al., p. 11) indicates that this species is rapidly declining and that its extinction risk has increased since the time of listing. Spotted owl populations in long-term study areas have declined from 30 to over 80 percent since the early 1990s. If this rate of decline continues, the species will likely become extirpation in the northern portion of its range in the near future as this is where population declines have been greatest (over 60 percent) (Franklin et al. 2021, p. 12). The most recent rangewide northern spotted owl demographic study indicated that barred owls are currently the factor with the largest negative impact on northern spotted owls (Franklin et al 2021, entire).

On November 10, 2021, the USFWS issued a final rule that took effect on December 10, 2021, which revised the total area of designated critical habitat for the spotted owl. Approximately 204,294 acres of critical habitat located in Oregon were excluded, while the total area of critical habitat in Washington and California remained unchanged (86 FR 62606 [November 10, 2021]). Critical habitat for the spotted owl now includes approximately 9,373,676 acres in 11 units and 60 subunits in California, Oregon, and Washington (86 FR 62606:62641 [November 10, 2021]). Our GIS data on current total area of designated critical habitat vary slightly (9,372,892 acres) from the total number of acres published in the Federal Register (a difference of 784 acres). We used the Albers Equal Area Conic (EPSG:5070) projection.

Legal Status

The northern spotted owl (*Strix occidentalis caurina*) was listed as threatened on June 26, 1990 due to widespread loss and adverse modification of suitable habitat across the species' entire range and the inadequacy of existing regulatory mechanisms to conserve the owl (Service 1990a, p. 26114). Listing priority numbers are assigned on a scale of 1C (highest) to 18 (lowest). The "C" reflects conflict with development, construction, or other economic activity (Service 1983, p. 43104). The northern spotted owl was originally listed with a recovery priority number of 3C, but that number was changed to 6C in 2004 during the 5-year review of the species (Service 2004, p. 55). This number reflects a high degree of threat, a low potential for recovery, and the owl's taxonomic status as a subspecies (Service 1983, p. 51895). In 2012, the U.S. Fish and Wildlife Service (Service) was petitioned to uplist the northern spotted owl from threatened to endangered status under the Endangered Species Act. In April 2015, the Service determined that petition presented substantial information indicating that the listing may be warranted due to a number of listing factors (Service 2015, pp. 19259-19263). An assessment of the species status in the most recent 5-year review documented the declining status of the northern spotted owl (Service 2019, entire). After this review, the Service concluded on December 15, 2020 that changing the status of the northern spotted owl from threatened to endangered was warranted but precluded by higher priority actions to amend the Lists of Endangered and Threatened Wildlife and Plants (Service 2020, pp. 81144-81152).

Life History

Taxonomy

The northern spotted owl is one of three subspecies of spotted owls currently recognized by the American Ornithologists' Union. The taxonomic separation of these three subspecies is supported by genetic (Barrowclough and Gutiérrez 1990, pp.741-742; Barrowclough et al. 1999, p. 928; Haig et al. 2004, p. 1354; Funk et al. 2008, pp. 1-11), morphological (Gutiérrez et al. 1995, p. 2), and biogeographic information (Barrowclough and Gutiérrez 1990, p.741-742). Studies analyzing mitochondrial DNA sequences (Haig et al. 2004, p. 1354; Chi et al. 2004, p. 3; Barrowclough et al. 2005, p. 1117) and microsatellites (Henke et al., unpubl. data, p. 15) confirmed the validity of the current subspecies designations for northern and California spotted owls. The narrow hybrid zone between these two subspecies, which is located in the southern Cascades and northern Sierra Nevada, appears to be stable (Barrowclough et al. 2005, p. 1116), although bi-directional hybridization and dispersal between the subspecies occurs (Funk et al. 2008, pp. 1-11) The distribution of the Mexican subspecies (*S. o. lucida*) is separate from those of the northern and California (*S. o. occidentalis*) subspecies (Gutiérrez et al. 1995, p.2). However, Funk et al. (2008, pp. 1-11) discovered intro-regression of Mexican spotted owls into the northernmost parts of the northern spotted owl populations in Washington, indicating some long-distance dispersal of Mexican spotted owls into the northern spotted owl range. Hybridization of northern spotted owls with barred owls (*Strix varia*) has been recorded (Hamer et al. 1994, pp. 487-491; Dark et al. 1998, pp. 50-56; Kelly 2001, pp. 33-34, 38; Kelly and Forsman 2004, pp. 807-809; Funk et al. 2008, pp. 161-171; Wiens 2012, p. 1).

Physical Description

The northern spotted owl is a medium-sized owl and is the largest of the three subspecies of spotted owls (Gutiérrez et al. 1995, p. 2). It is approximately 46 to 48 centimeters (18 inches to 19 inches) long and the sexes are dimorphic, with males averaging about 13 percent smaller than females. The mean mass of 971 males taken during 1,108 captures was 580.4 grams (1.28 pounds) (out of a range 430.0 to 690.0 grams) (0.95 pound to 1.52 pounds), and the mean mass of 874 females taken during 1,016 captures was 664.5 grams (1.46 pounds) (out of a range 490.0 to 885.0 grams) (1.1 pounds to 1.95 pounds) (Loschl, P. and E. Forsman pers. comm. 2006 cited in Service 2011b, p. A-1). The northern spotted owl is dark brown with a barred tail and white spots on its head and breast, and it has dark brown eyes surrounded by prominent facial disks. Four age classes can be distinguished on the basis of plumage characteristics (Forsman 1981; Moen et al. 1991, p. 493). The northern spotted owl superficially resembles the barred owl, a species with which it occasionally hybridizes (Kelly and Forsman 2004, p. 807). Hybrids exhibit physical and vocal characteristics of both species (Hamer et al. 1994, p. 488).

Current and Historical Range

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

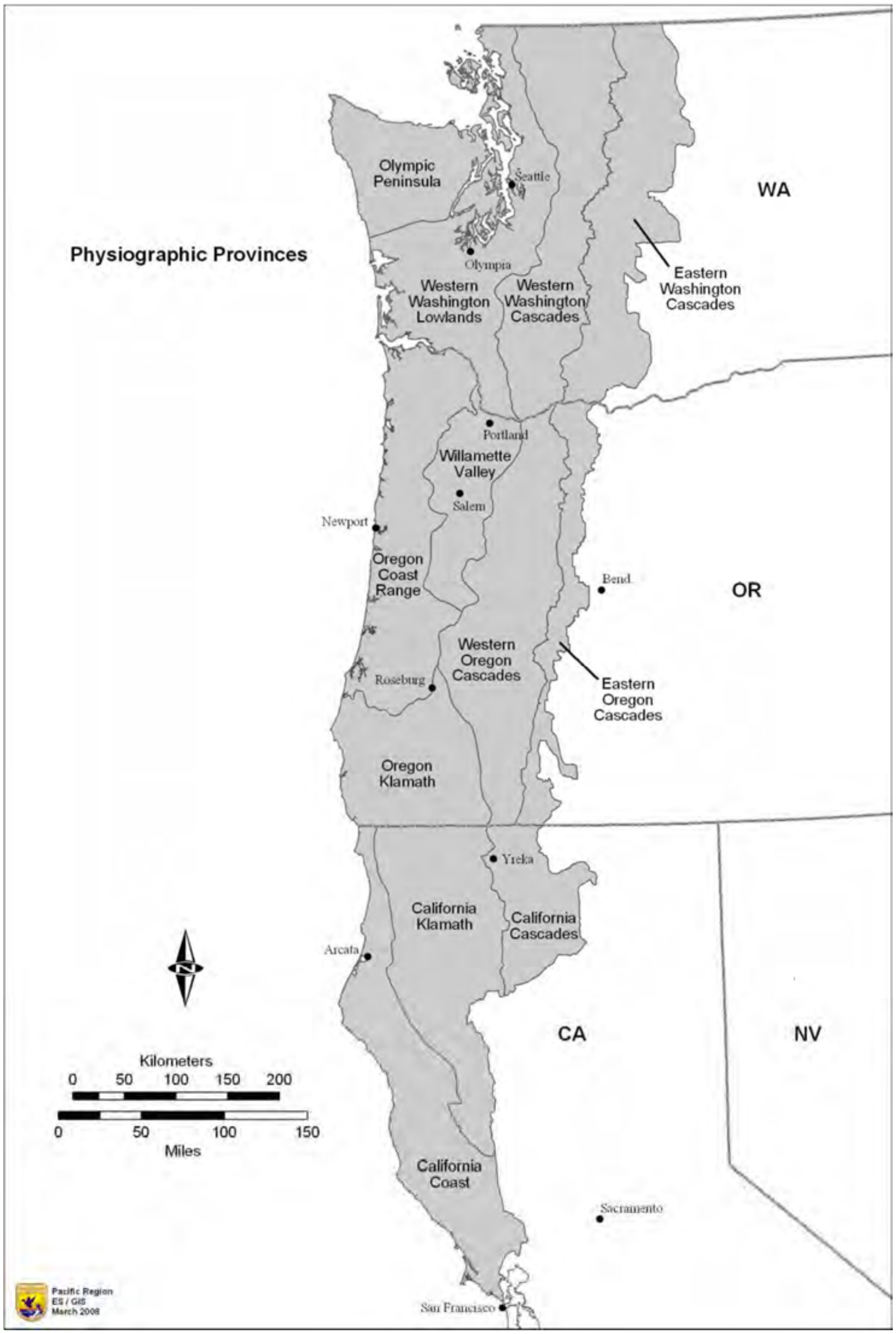
- Four provinces in Washington: Eastern Washington Cascades, Olympic Peninsula, Western Washington Cascades, Western Washington Lowlands
- Five provinces in Oregon: Oregon Coast Range, Willamette Valley, Western Oregon Cascades, Eastern Oregon Cascades, Oregon Klamath
- Three provinces in California: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

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

Behavior

Northern spotted owls are primarily nocturnal (Forsman et al. 1984, pp. 51-52) and spend virtually their entire lives beneath the forest canopy (Courtney et al. 2004, p. 2-5). They are adapted to maneuverability beneath the forest canopy rather than strong, sustained flight (Gutiérrez et al. 1995, p. 9). They forage between dusk and dawn and sleep during the day with peak activity occurring during the two hours after sunset and the two hours prior to sunrise

Figure A-1. Physiographic Provinces within the range of the northern spotted owl in the United States (from Service 2011b, A-3)



(Gutiérrez et al. 1995, p. 5; Delaney et al. 1999, p. 44). They will sometimes take advantage of vulnerable prey near their roosts during the day (Layman 1991, pp. 138-140; Sovern et al. 1994, p. 202).

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

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

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

Habitat Relationships

Home Range and Core Areas

Northern spotted owls are territorial raptors that range widely in search of prey but are 'anchored' during the breeding season to a nest site (central-place forager). Evaluations of northern spotted owl habitat are usually conducted at two spatial scales; the home range and core areas. The home range is the "area traversed by the individual in its normal activities of food gathering, mating, and caring for young" (Burt 1943:351, cited in Service 2009).

Home-range sizes vary geographically, generally increasing from south to north, which is likely a response to differences in habitat quality (Service 1990a, p. 26117). Estimates of median size of their annual home range (the area traversed by an individual or pair during their normal activities (Thomas and Raphael 1993, pp. IX-15) vary by province and range from 2,955 acres in the Oregon Cascades (Thomas et al. 1990, p. 194) to 14,211 acres on the Olympic Peninsula (Service 1994, p. 3). Zabel et al. (1995, p. 436) showed that these provincial home ranges are larger where flying squirrels are the predominant prey and smaller where wood rats are the predominant prey. Home ranges of adjacent pairs overlap (Forsman et al. 1984, p. 22; Solis and Gutiérrez 1990, p. 746), suggesting that the defended area is smaller than the area used for foraging.

Within home ranges, areas receiving concentrated use, typically surrounding the nest site and favored foraging areas, are called core areas. Results from Bingham and Noon (1997) showed that northern spotted owls typically used 20-21 percent of their home range as core use area habitat, which generally included 60-70 percent of the sites within their home range used during the breeding season. As central place foragers, nesting northern spotted owls are likely very sensitive to activities that occur within their core use areas and especially their nest patches (Swindle et al. 1997, Miller 1989, and Meyer et al. 1998). Zabel et al. (2003, abstract, p. 1033) found the best-fitting model for northern spotted owl occupancy predictions in northwest California was at the 200-ha (500 acre) scale.

Some studies have found that northern spotted owls use smaller home ranges during the breeding season and often dramatically increase their home range size during fall and winter (Forsman et al. 1984, pp. 21-22; Sisco 1990, p. iii). In Southern Oregon, one study found that home range and core areas remained essentially the same between seasons, concluding that perhaps this was due to the quality of available habitat (Schilling et al. 2013).

The habitat composition, specifically sufficient amounts of nesting, roosting and foraging habitat (N, R, and F), within cores and annual home ranges has been found to be directly correlated with demographic responses such as occupancy, reproductive success, survival, and fitness. For example, Franklin et al. (2000) found that the proportion of good habitat was around 60 percent to lesser quality habitat for owl core use areas in northwest California. Bart (1995) found that core areas should contain 30-50 percent mature and old growth forest. When northern spotted owl home ranges have less than 40 to 60 percent nesting/roosting/foraging (NRF), they were more likely to have lower occupancy and fitness (Thomas et al.,1990; Bart and Forsman 1992; Bart 1995; Dugger et al. 2005; and Olson et al. 2005). Northern spotted owl survival has been found to be negatively correlated with forest fragmentation (Schilling et al. 2013).

The probability of occupancy is increased when core areas contain a range of habitat conditions suitable for use by northern spotted owls, and the survival and fitness of northern spotted owls is positively correlated with larger patch sizes or proportion of older forests (Franklin et al. 2000, Dugger et al. 2005, Service 2009). The Service notes that "the strongest type of information relevant to the evaluation of take relates the fitness of [northern spotted owls] to characteristics of their habitat" (Service 2009). Although differences exist in natural stand characteristics that influence home range size, habitat loss and forest fragmentation effectively reduce habitat quality in the home range. A reduction in the amount of suitable habitat reduces spotted owl abundance and nesting success (Bart and Forsman 1992, pp. 98-99; Bart 1995, p. 944).

Habitat Use and Selection

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

Northern spotted owls generally rely on older forested habitats because such forests contain the structures and characteristics required for nesting, roosting, and foraging. Features that support nesting and roosting typically include a moderate to high canopy closure (60 to 80 percent); a multi-layered, multi-species canopy with large overstory trees (with diameter at breast height [dbh] of greater than 30 inches); a high incidence of large trees with various deformities (large cavities, broken tops, mistletoe infections, and other evidence of decadence); large snags; large accumulations of fallen trees and other woody debris on the ground; and sufficient open space below the canopy for northern spotted owls to fly (Thomas et al. 1990, p. 19). Weathers et al. 2001, (p. 686) found the northern spotted owl association with structurally complex habitats containing high canopy closure was in part due to their intolerance of high temperatures. Complex vertically structured habitat such as mature and old-growth forests habitats contain sufficient cover to provides protection from predators (Franklin et al. 2000, p. 578-579).

Northern spotted owls nest almost exclusively in trees. Nest sites are found in forests having complex structure dominated by large diameter trees and high canopy closure (Forsman et al. 1984, p. 30; Hershey et al. 1998, p. 1402, LaHaye et al. 1997, p. 46-48). Even in forests that have been previously logged, spotted owls select forests having a structure (i.e., larger trees, greater canopy closure) different than forests generally available to them (Folliard 1993, p. 40; Buchanan et al. 1995, p. 304-305; Hershey et al. 1998, p. 1406-1407). Similarly, roost sites selected by spotted owls have more complex vegetation structure than forests generally available to them (Barrows and Barrows 1978, p. 2-3; Forsman et al. 1984, pp. 29-30; Solis and Gutiérrez 1990, pp. 742-743, 747).

Foraging habitat, which provides a food supply for northern spotted owl survival and reproduction, is the most variable of all habitats used by territorial northern spotted owls (Thomas et al. 1990; Service 2011b, p. G-2). Northern spotted owls select old forests for foraging in greater proportion than their availability at the landscape scale (Carey et al. 1992, pp. 236-237; Carey and Peeler 1995, p. 235; Forsman et al. 2004, pp. 372-373), but will forage in younger stands with high prey densities and access to prey (Carey et al. 1992, p. 247; Rosenberg and Anthony 1992, p. 165; Thome et al. 1999, pp. 56-57). Glenn et al. (2004, p. 48) found that northern spotted owls had larger home ranges in areas with less old-growth and mature forest, although the population was not self-sustaining during the study period (Franklin et al. 1999 in Glenn et al. 2004, p. 46).

Foraging activity is positively associated with tree height diversity (North et al. 1999, p. 524), canopy closure and woody debris (Irwin et al. 2000, p. 180; Courtney et al. 2004, pp. 5-15), snag volume, density of snags greater than 20 in (50 cm) dbh (North et al. 1999, p. 524; Irwin et al. 2000, pp. 179-180; Courtney et al. 2004, pp. 5-15), density of trees greater than or equal to 31 in (80 cm) dbh (North et al. 1999, p. 524), volume of woody debris (Irwin et al. 2000, pp. 179-180), and young forests with some structural characteristics of old forests (Carey et al.1992, pp. 245-

247; Irwin et al. 2000, pp. 178-179). Habitat use is influenced by prey availability. Ward (1990, p. 62) found that spotted owls foraged in areas where the occurrence of prey was more predictable within older forests and near ecotones of old forest and brush seral stages. The availability or abundance of prey can in turn influence reproductive success (Rosenburg et al. 2003, pp. 1720-1723).

Dispersal habitat is essential to maintaining stable populations by filling territorial vacancies when resident northern spotted owls die or leave their territories, and to providing adequate gene flow across the range of the species. While dispersal habitat may include younger and less diverse forest stands than foraging habitat, such as even-aged, pole-sized stands, at a minimum it consists of stands with adequate tree size and canopy closure to provide protection from avian predators and at least minimal roosting and foraging opportunities (Service 2011b, p. G-1). Northern spotted owls have been found to disperse through highly fragmented forest landscapes (Forsman et al., 2002; p. 22). However, in a study of the natal dispersal of northern spotted owls, Sovern and others (2015, pp. 257-260) found the majority of roosts were in forested habitats with at least some large (>50 cm or about 19 inches dbh) trees and they selected stands with high canopy cover (>70 percent) at the landscape scale. These authors suggested the concept of 'dispersal' habitat as a lower quality type of habitat may be inappropriate.

Geographic Variability

In redwood forests and mixed conifer-hardwood forests along the coast of northwestern California, spotted owls occur in both old growth forests and younger forest stands, particularly in areas where hardwoods provide a multi-layered structure at an early age (Thomas et al. 1990, p. 158; Diller and Thome 1999, p. 275). In the southern portion of their range, where woodrats are a major component of their diet, northern spotted owls are more likely to use a variety of stands, including younger stands, brushy openings in older stands, and edges between forest types in response to higher prey density in some of these areas (Forsman et al. 1984, pp. 24-29).

In the Coast Ranges, Western Oregon and Washington Cascades, and the Olympic Peninsula, radio-marked spotted owls selected for old-growth and mature forests for foraging and roosting and used young forests less than predicted based on availability (Forsman et al. 1984, pp. 24-25; Carey et al. 1990, pp. 14-15; Thomas et al. 1990; Irwin et al. 2000, p. 41; Herter et al. 2002, p. 441; Forsman et al. 2005, pp. 372-373).

In mixed conifer forests in the eastern Cascades in Washington, 27 percent of nest sites were in old-growth forests, 57 percent were in the understory reinitiation phase of stand development, and 17 percent were in the stem exclusion phase (Buchanan et al. 1995, p. 304). In eastern Washington, spotted owl nest sites were found to have canopies of dominant and/or codominant and intermediate trees that were farther aboveground, more 35-60-cm (14-24 in)-dbh Douglas-fir, greater basal area of Douglas-fir trees, more 61-84-cm (24-33.5 in) dbh ponderosa pine trees, more live tree basal and more basal area of Class IV snags (broken snags with no branches and little bark).

The availability and distribution of habitats are important considerations. Landscape-level analyses in portions of Oregon Coast and California Klamath provinces suggest that a mosaic of late-successional habitat interspersed with other seral conditions may benefit spotted owls more than large, homogeneous expanses of older forests (Zabel et al. 2003, p. 1038; Franklin et al. 2000, pp. 573-579; Meyer et al. 1998, p. 43). Olson et al. (2004, pp. 1049-1050) infer that while mid-seral and late-seral forests are important to spotted owls, in the central Oregon Coast Range a mixture of these forest types with younger forest and non-forest may be best for spotted owl survival and reproduction in their study area.

In a large-scale demography modeling study, Forsman et al. (2011, pp. 1-2) found a positive correlation between the amount of suitable habitat and recruitment of young. The most recent rangewide population meta-analysis (Franklin et al. 2021, pp. 13, 18) found that increased amounts of northern spotted owl habitat decreased site extirpation, and in most areas increased site colonization, even when barred owls were present. Yackulic and others (2019, pp. 4-6) found that the influence of habitat availability on population extirpation was similar in magnitude to the influence of barred owls.

Reproductive Biology

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

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

Dispersal Biology

Natal dispersal of northern spotted owls typically occurs in September and October with a few individuals dispersing in November and December (Miller et al. 1997; Forsman et al. 2002, p.

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

There is little evidence that small openings in forest habitat influence the dispersal of northern spotted owls, but large, non-forested valleys such as the Willamette Valley apparently are barriers to both natal and breeding dispersal (Forsman et al. 2002, p. 22). The degree to which water bodies, such as the Columbia River and Puget Sound, function as barriers to dispersal is unclear, although radio telemetry data indicate that northern spotted owls move around large water bodies rather than cross them (Forsman et al. 2002, p. 22). Analysis of the genetic structure of northern spotted owl populations suggests that gene flow may have been adequate between the Olympic Mountains and the Washington Cascades, and between the Olympic Mountains and the Oregon Coast Range in the late 1990s (Haig et al. 2001, p. 35).

Breeding dispersal occurs among a small proportion of adult northern spotted owls; these movements were more frequent among females and unmated individuals (Forsman et al. 2002, pp. 20-21). Breeding dispersal distances were shorter than natal dispersal distances and also are apparently random in direction (Forsman et al. 2002, pp. 21-22). In California spotted owls, a similar subspecies, the probability for dispersal was higher in younger owls, single owls, paired owls that lost mates, owls at low quality sites, and owls that failed to reproduce in the preceding year (Blakesley et al. 2006, p.77). Both males and females dispersed at near equal distances (Blakesley et al. 2006, p. 76). Owls that dispersed tended to improve their territory quality, with 72% of dispersal movements to a territory of higher quality than the original territory (Blakesley et al. 2006, p. 77).

Dispersal can also be described as having two phases: transience and colonization (Courtney et al 2004, p. 5-13). Dispersal success is likely highest in mature and old growth forest stands where there is more likely to be adequate cover and food supply (Service 2012a, p. 14086). Transient dispersers use a wider variety of forest conditions for movements than colonizing dispersers, who require habitats resembling nesting/roosting and foraging habitats used by breeding birds (Miller et al 1997, p. 144; Courtney et al 2004, p. 5-13; Service 2012a, p. 14086).

Food Habits

Northern spotted owls are mostly nocturnal, although they also forage opportunistically during the day (Forsman et al. 1984, p. 51; 2004, pp. 222-223; Sovern et al. 1994, p. 202). The composition of the northern spotted owl's diet varies geographically and by forest type.

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

Other prey species such as the red tree vole (*Arborimus longicaudus),* red-backed voles (*Clethrionomys gapperi),* mice, rabbits and hares, birds, and insects) may be seasonally or locally important (reviewed by Courtney et al. 2004, pp. 4-27). For example, Rosenberg et al. (2003, p. 1720) showed a strong correlation between annual reproductive success of northern spotted owls (number of young per territory) and abundance of deer mice (*Peromyscus maniculatus*) ($r^2 = 0.68$), despite the fact they only made up 1.6±0.5 percent of the biomass consumed. However, it is unclear if the causative factor behind this correlation was prey abundance or a synergistic response to weather (Rosenberg et al. 2003, p. 1723). Ward (1990, p. 55) also noted that mice were more abundant in areas selected for foraging by owls. Nonetheless, northern spotted owls deliver larger prey to the nest and eat smaller food items to reduce foraging energy costs; therefore, the importance of smaller prey items, like *Peromyscus*, in the northern spotted owl diet should not be underestimated (Forsman et al. 2001, p. 148; 2004, pp. 218-219).

Population Dynamics

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

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

A variety of factors may regulate northern spotted owl population levels. These factors may be density-dependent (e.g., habitat quality, habitat abundance) or density-independent (e.g., climate). Interactions may occur among factors. For example, as habitat quality decreases, density-independent factors may have more influence on survival and reproduction, which tends to increase variation in the rate of growth (Franklin et al. 2000, pp. 581-582). Specifically, weather could have increased negative effects on northern spotted owl fitness for those owls occurring in relatively lower quality habitat (Franklin et al. 2000, pp. 581-582). A consequence of this pattern is that at some point, lower habitat quality may cause the population to be unregulated (have negative growth) and decline to extinction (Franklin et al. 2000, p. 583, Yackulic et al. 2019, pp. 4-6).

Competition with barred owls is an important stressor of northern spotted owl populations. The presence of barred owls decreases northern spotted owl fecundity, survival, and recruitment, as well as occupancy, colonization, and increases territorial extinction (Franklin et al. 2021, pp. 9-13). Older research also established barred owl influences on site occupancy, site extirpation, and colonization (Olson et al. 2005, pp. 930-931). In the older research, northern spotted owl site occupancy was mostly stable through time, but in more recent research, site occupancy has declined at all study areas (Franklin et al. 2021, p. 17; Olson et al. 2005, pp. 930-931). The older research also found that per-visit detection probabilities were lower than expected and were highly variable among years and study areas (Olson et al. 2005, pp. 930-931). The most recent analysis of occupancy, colonization, and extirpation of northern spotted owl territories also accounts for varying detection probabilities (Franklin et al. 2021, p. 7).

Even while accounting for the effects of competition with barred owls, habitat availability and climatic patterns also appear to influence survival, occupancy, recruitment, and, to a lesser extent, fecundity (Dugger et al. 2016, entire). Occupancy, colonization, and extirpation of northern spotted owl territories are all influenced by the amount of habitat present, and territory extinction is also related to climate factors (Franklin et al. 2021, pp. 13, 16, 18). Habitat availability also influences the likelihood of northern spotted owl population persistence, and this effect is similar in magnitude to the effect of competition with barred owls (Yackulic et al. 2019, p. 4).

Northern spotted owl populations are declining across the range. Between 1995 and 2017, the Northwest California study area showed the lowest rate of decline, around two percent per year; the Hoopa study area, also in northwestern California, showed a similar rate of decline from 1995 through 2012, prior to the implementation of barred owl control there (Franklin et al. 2021, pp. 11-13). The highest rates of decline, around 9 percent per year from 1995 through 2017, have been observed in Washington at the Cle Elum and Olympic study areas (Franklin et al. 2021, pp. 11-13). Considering only study areas without barred owl removal, the estimated rangewide mean rate of population change was -5.3 percent per year from 1995 through 2017 (Franklin et al. 2021, p. 12). By 2017, northern spotted owl populations in study areas without barred owl removal were, at best, 50 percent of their size in 1995 (for the Northwest California study area), and at worse, more than 80 percent smaller than in 1995, for the Cle Elum and Olympic study areas (Franklin et al. 2021, p. 12). For more details on current status, see section on Population Trends below.

Threats

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

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

The Service conducted a 5-year review of the northern spotted owl in 2004 (Service 2004), for which the Service prepared a scientific evaluation of the status of the northern spotted owl (Courtney et al. 2004). Some of the key threats identified in 2004 were catastrophic wildfire, barred owls, and the legacy of past harvest (Courtney and Gutiérrez 2004, pp.11.7-8). The 2011 Revised Recovery Plan for the Northern Spotted Owl emphasizes that habitat loss and barred owls the main threats to northern spotted owl recovery (Service 2011b, Appendix A), and that effects of high severity wildfires pose concern for habitat conservation in some portions of the range (Davis et al. 2016, p. 38).

The most recent 5-year review, completed in 2019, concludes that competition with barred owls is likely now driving population declines across the range, that habitat loss has slowed but remains a threat, and that climate change is expected to drive increases in habitat loss due to fire (Service 2019, pp. 3-4). Even more recent scientific information, published since 2019, continues to confirm the severity of the threats from barred owls, lack of habitat, and the effects of increasingly severe fire (e.g., Franklin et al. 2021, pp. 9-19; Jones et al. 2021, pp. 5-6).

Barred Owls (Strix varia)

Barred owls currently appear to be the primary threat to northern spotted owls. Having expanded along the coast as far south as Marin County, California and in the Sierra Nevada, as far south as the Greenhorn Mountains in northern Kern County, California (Gutiérrez et al. 2004, pp. 7-12 to 7-13; Steger et al. 2006, p. 226, Long and Wolf 2019, p. 1283), the barred owl's range now completely overlaps that of the northern spotted owl. Evidence that barred owls are occurring in higher densities than northern spotted owls in many parts of the range (3 to 8 barred owl territories/northern spotted owl; Hamer et al. 2007; Singleton et al. 2010; Wiens et al. 2011, 2014), now including the portion of the northern spotted owl range within California (Diller et al. 2016, Dugger et al. 2016). In a recent study, the highest densities found were in the Oregon Coast Range, with up to 20 barred owls per northern spotted owl territory reported (Wiens et al. 2017, p. 12).

The two species of owls share similar habitats and are likely competing for food resources (Hamer et al. 2001, p. 226, Gutiérrez et al. 2007, p. 187; Livezey and Fleming 2007, p. 319, Wiens et al., 2014, pp. 24 and 33, Holm et al. 2016, Long and Wolf 2019, Irwin et al. 2020). Hamer found a strong diet overlap (76 percent) between northern spotted and barred owl diets (pp. 221, 226). Barred owl diets are more diverse than northern spotted owl diets and include species associated with riparian and other moist habitats (e.g., fish, invertebrates, frogs, and crayfish), along with more terrestrial and diurnal species (Smith et al. 1983; Hamer et al. 2001; Gronau 2005; Wiens et al., 2014, p. 24). Even though barred owls may be taking northern spotted owls' primary prey only as a generalist, northern spotted owls may be affected by a sufficient reduction in the density of these prey items due to barred owls, leading to a depletion of prey to the extent that the northern spotted owl cannot find an adequate amount of food to sustain maintenance or reproduction (Gutiérrez et al. 2007, p. 187; Livezey and Fleming 2007, p. 319). These impacts are likely to have direct and indirect effects on ecosystem processes (Holm et al. 2016, p. 618)

In addition to competition for prey, barred owls are competing for habitats (Hamer et al. 1989, p. 55; Dunbar et al. 1991, p. 467; Herter and Hicks 2000, p. 285; Pearson and Livezey 2003, p. 274; Wiens et al., 2014, pp. 24 and 33). Barred owls were initially thought to be more closely associated with early successional forests than northern spotted owls, based on studies conducted on the west slope of the Cascades in Washington (Hamer et al 1989, p. 34; Iverson 1993, p.39). However, more recent studies conducted in the Pacific Northwest show that barred owls frequently use mature and old-growth forests (Pearson and Livezey 2003, p. 270; Gremel 2005, Schmidt 2006, p. 1; Singleton et al. 2010, pp. 290-292).

In the fire prone forests of eastern Washington, a telemetry study conducted on barred and northern spotted owls showed that barred owl home ranges were located on lower slopes or valley bottoms, in closed canopy, mature, Douglas-fir forest, while northern spotted owl sites were located on mid-elevation areas with southern or western exposure, characterized by closed canopy, mature, ponderosa pine or Douglas-fir forest (Singleton et al. 2005, p. 1). Several other studies in western Washington have similarly shown that when barred owls are present, northern spotted owl habitat use shifts upslope and into areas with steeper slopes and more marginal habitat (Gremel et al. 2005, p. 17; Mangan et al. 2019, p. 10; Pearson and Livezey 2003, p. 274, Irwin et al. 2020). The most recent rangewide meta-analysis indicated that barred owl colonization of northern spotted owl territories was more likely in lower-elevation territories in most study areas (Franklin et al. 2021, pp. 13, 18).

In addition to resource competition, barred owls have been documented to physically attack northern spotted owls (Pearson and Livezey 2003, p. 274), and circumstantial evidence strongly indicated that a barred owl killed a northern spotted owl (Leskiw and Gutiérrez 1998, p. 226).

A consensus in the literature documents the negative influence barred owls are having on northern spotted owl site occupancy, fecundity, reproduction, apparent survival, and detectability, and that data indicates that over the last 26 years, they are contributing to declines in northern spotted owl populations (Olson et al. 2005, p. 924; Forsman et al. 2011, pp. 69-70), Dugger et al. 2011, pp. 2463-2467; Dugger et al. 2016, pp. 70-96); Franklin et al. 2021, entire). As barred owls have expanded, the occupancy of historical northern spotted owl territories is declining (Franklin et al. 2021, p. 17). Even 20 years ago, site occupancy of northern spotted owls in Washington and Oregon was significantly lower ($p < 0.001$) after barred owls were detected within 0.8 kilometer (0.5 miles) of the territory center but was "only marginally lower" ($p = 0.06$) if barred owls were located more than 0.8 kilometer (0.5 miles) from the northern spotted owl territory center (Kelly et al. 2003, p. 51). Pearson and Livezey (2003, p. 271) found that there were significantly more barred owl site-centers in unoccupied northern spotted owl circles than occupied northern spotted owl circles (centered on historical northern spotted owl site-centers) with radii of 0.8 kilometer (0.5 miles) ($p = 0.001$), 1.6 kilometer (1 mile) ($p = 0.049$), and 2.9 kilometer (1.8 miles) ($p = 0.005$) in Gifford Pinchot National Forest. In Olympic National Park, Gremel (2005, p. 11) found a significant decline ($p = 0.01$) in northern spotted owl pair occupancy at sites where barred owls had been detected, while pair occupancy remained stable at northern spotted owl sites without barred owls. Olson et al. (2005, p. 928) found that the annual probability that a northern spotted owl territory would be occupied by a pair of northern spotted owls after barred owls were detected at the site declined by 5 percent in the HJ Andrews study area, 12 percent in the Coast Range study area, and 15 percent in the Tyee study area. In contrast, Bailey et al. (2009, p. 2983), when using a two-species occupancy model, showed no evidence that barred owls excluded northern spotted owls from territories in Oregon. More recently, results from a barred owl and northern spotted owl radio-telemetry study in Washington reported two northern spotted owls fleeing their territories and traveling six and 15 miles, believed to be as a result of frequent direct encounters with barred owls; both northern spotted owls were subsequently found dead (Irwin et al. 2010, p. 3-4). Preliminary findings from an ongoing barred owl experimental control/treatment study, northern spotted owl pair occupancy was low, has declined in control sites; while (with the exception of one year in one study area), the occupancy by barred owls has increased (Wiens et al. 2017, tables 1 and 2). Authors also report that the probability of use by barred owls within 500-acre hexagons (1,235 acres) in the Oregon Coast Ranges study area was high in the two years of the study in the control area (>0.920) (p. 16).

Numerous studies suggest that barred owls are negatively affecting northern spotted owl survival and reproduction. Anthony et al. (2006, p. 32) found significant evidence for negative effects of barred owls on apparent survival of northern spotted owls in two of 14 study areas (Olympic and Wenatchee). They attributed the equivocal results for most of their study areas to the coarse nature of their barred owl covariate. Dugger et al. (2011, pp. 2463-2467) described synergistic effects associated with territory composition and presence of barred owls; some northern spotted owl pairs retained their territories and continued to survive and successfully reproduce during their study even when barred owls were present, but the effects of reduced old growth forest in the core habitat areas were compounded when barred owls were present - extinction rates of northern spotted owl territories nearly tripled when barred owls were detected. Yackulic and others documented similar findings; the effects of interspecific competition were likely to negatively affect northern spotted owls, both through its immediate effects on local extinction and by indirectly lowering colonization (Yackulic et al., 2014, pp. 271-273).

Most recently, apparent survival, recruitment, and territory colonization and extinction rates were the key vital rates associated with barred owl presence in northern spotted owl populations (Franklin et al. 2021, pp. 9-18). Franklin et al. (2021, p. 19) suggested that without barred owl management, near-term extirpation of northern spotted owls is likely in portions of the range, and the small populations that may remain in other parts of the range will be highly vulnerable to extirpation due to wildfire or other stressors, resulting in eventual extinction. Dugger et al. (2016) found that the removal of barred owls in the Green Diamond study area in northern California had rapid, positive effects on northern spotted owl survival and rates of population change. The meta-analysis of the larger, multi-year barred owl removal experiment (Wiens et al. 2021, entire) in five study areas across the range demonstrated that removal of invasive barred owls had a strong, positive effect on survival of native northern spotted owls, and subsequently reduced long-term population declines. Barred owl removal had a positive, but weaker, effect on recruitment of northern spotted owls, which was likely a consequence of consistently depressed reproduction of northern spotted owls (and diminished availability of new recruits) during the later years of the study. Removal of barred owls also influenced the dispersal dynamics of resident northern spotted owls in at least two study areas where NSO from territories without barred owl removal had an increased estimated probability of movement to territories in treatment areas where barred owls had been removed. Both studies suggest that, along with habitat conservation and management, barred owl removal may be able to slow or reverse northern spotted owl population declines on at least a localized scale (Diller et al. 2016, Wiens et al. 2021).

Olson et al. (2004, p. 1048) found that the presence of barred owls had a significant negative effect on the reproduction of northern spotted owls in the central Coast Range of Oregon (in the Roseburg study area). The conclusion that barred owls had no significant effect on the reproduction of northern spotted owls in one study (Iverson 2004, p. 89) was unfounded because of small sample sizes (Livezey 2005, p. 102). It is likely that all of the above analyses underestimated the effects of barred owls on the reproduction of northern spotted owls because northern spotted owls often cannot be relocated after they are displaced by barred owls (Forsman, E. pers. comm. 2006, cited in Service 2011b, p. B-11). Anthony et al. (2006, p. 32) found significant evidence for negative effects of barred owls on apparent survival of northern spotted owls in two of 14 study areas (Olympic and Wenatchee). They attributed the equivocal results for most of their study areas to the coarse nature of their barred owl covariate. Dugger et al. (2011, pp. 2463-2467) confirmed the synergistic effects of barred owls and territory habitat characteristics on extirpation and colonization rates of territories by northern spotted owls. Extirpation rates of northern spotted owl territories nearly tripled when barred owls were detected (Dugger et al. 2011, p. 2464).

Monitoring and management of northern spotted owls has become more complicated due to their possible reduced detectability when barred owls are present (Kelly et al. 2003, pp. 51-52; Courtney et al. 2004, p. 7-16 ; Olson et al. 2005, p. 929; Crozier et al. 2006, p.766-767). Evidence that northern spotted owls were responding less frequently during surveys led the Service and its many research partners to update the northern spotted owl survey protocol (Service 2012b) and develop a survey protocol using autonomous recording units (Service 2021, entire). The recent changes to the northern spotted owl survey protocol were based on the probability of detecting northern spotted owls when barred owls are present (See Service Memorandum, revised January 9, 2012, "Northern Spotted Owl Survey Protocol" and attached "Protocol for Surveying Proposed Management Activities That May Impact Northern Spotted Owls" for guidance and methodology).

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

There is no evidence that the increasing trend in barred owls has stabilized in any portion of the northern spotted owl's range in the western United States, and "there are no grounds for optimistic views suggesting that barred owl impacts on northern spotted owls have been already fully realized" (Gutiérrez et al. 2004, pp. 7-38). To date, this situation does not appear to have changed.

The most recent meta-analysis of 26 years of survey and capture-recapture data at 11 study areas across the range of the northern spotted owl (Franklin et al. 2021, entire) indicated barred owl presence on northern spotted owl territories was the primary factor negatively affecting apparent survival, fecundity and recruitment, increasing territorial extirpation, decreasing territorial colonization of northern spotted owls, and ultimately, continued rates of population decline. In addition to lowering northern spotted owl survival and reproduction, competition with barred owl appears to impair the ability of younger northern spotted owls to acquire breeding territories (Franklin et al. 2021, p. 18).

The rate of decline of northern spotted owl populations in control areas where barred owl removal did not occur by the end of the barred owl removal experiment was severe (approximately 12 percent per year), indicating an increasingly high risk of northern spotted owl populations to local extirpations without barred owl control (Wiens et al. 2021 p. 7). Results of the barred owl control experiments across the range indicated that persistence and recovery of northern spotted owl populations are possible with active control of the barred owl threat, at least over the short term, in managed areas (Wiens et al. 2021, p. 7). However, recovery of northern spotted owls will also require short and long-term availability of older forests and suitable northern spotted owl habitat on the landscape (Wiens et al. 2021, p. 7, Franklin et al. 2021, p.18).

Wildfire

At the time of listing there was recognition that large-scale wildfire posed a threat to the northern spotted owl and its habitat (Service 1990a, p. 26183). Large scale wildfire is now recognized as the primary source of habitat loss on federal lands; there have been significant losses of nesting/roosting habitats since 2005, particularly in the reserved land allocations of the Klamath Province and parts of the Oregon Cascades (Davis et al. 2011, pp. 43-48; Davis et al. 2016, tables 5 and 7). Table A-2 below also summarizes habitat lost from natural disturbances, the majority of which has resulted from high severity fires. The NWFP recognized wildfire as an inherent part of managing northern spotted owl habitat in certain portions of the range. The distribution and size of reserve blocks as part of the NWFP design may help mitigate the risks associated with large-scale fire (Lint 2005, p. 77).

Wildfire is often considered a primary threat to spotted owls because of its potential to alter habitat rapidly (Bond et al. 2009, p. 1116) and is a major cause of habitat loss on Federal lands (Courtney et al. 2004, executive summary; Davis et al. 2011, pp. 43-48; Davis et al. 2016, tables 5 and 7). A recent systematic review and meta-analysis of 21 studies, including studies of all three spotted owl subspecies, concluded that most demographic effects of mixed-severity fire are insignificant (Lee 2018, p. 15), but the authors of several of the included studies have outlined problems with the ecological foundations, statistical methods, and conclusions of the analysis, and counter that stand-replacing fire can threaten spotted owls (Jones et al. 2020a, entire).

In some parts of the range, nesting/roosting habitat is associated with a lower likelihood of high-severity fire, as compared with unsuitable forest cover types (Lesmeister et al. 2019, pp. 12-15). Studies indicate that the effects of wildfire on spotted owls and their habitat are variable, depending on fire intensity, severity, and size. Within the fire-adapted forests of the spotted owl's range, spotted owls likely have adapted to withstand fires of variable sizes and severities (Eyes et al. 2017, p. 384). However, current indications are that hotter, drier summers due to climate change will likely result in larger, more intense fires than historically occurred (Service 2011, pp. III-6).

Mixed and lower severity fires may have little or even beneficial effects to spotted owls (Bond et al. 2002, p. 1025-1026; Jones et al. 2016, 304); but large, high severity fires have been found to cause reduced survival and occupancy (Jones et al. 2016). Site fidelity can influence spotted owl use of burned areas that were previously suitable (Clark 2007; Bond et al. 2009; Lee et al. 2012), and high severity fires can result in population sinks when northern spotted owls return to burned territories (Rockweit et al. 2017, p. 1574). In two telemetry studies, California spotted owls avoided large high-severity burned patches, especially those larger than 115 ha (284 ac), a size similar to the maximum historical high-severity patch size of that region (Jones et al. 2020b, pp. 1208; Kramer et al. 2021, p. 7).

One year following the extensive King Fire in the Sierra Nevada Mountains, Jones and others (2016) documented strong negative California spotted owl population impacts, with declines in occupancy and reproduction associated with severely burned sites; the probability of site extirpation in that study was seven times higher one year after the fire where more than 50 percent of the site (approximately 0.7 mile radius area) burned at high severity (75–100 percent canopy mortality) (p. 303-304). In southwest Oregon, lower occupancy and survival rates of northern spotted owl were found in burned areas compared to unburned, but the results were confounded by prior management and post-fire harvest (Clark 2007, Clark et al. 2011, Clark et al. 2013).

Available data on the direct mortality of spotted owls from fire is limited. In one study, mortality was assumed to have occurred at one site, and northern spotted owls were present at only one of the six sites 1 year after a fire (Gaines et al. 1997, p. 126). In 1994, two wildfires burned in the Yakama Indian Reservation in Washington's eastern Cascades, northern spotted owls were observed using areas that burned at low and medium intensities, although the amount of home ranges burned was not quantified (King et al. 1998, pp. 2-3). No direct mortality of northern spotted owls was observed, even though thick smoke covered several northern spotted owl site-centers for a week.

Additional impacts to northern spotted owls related to wildfire include forest management that occurs after fires. Post-fire salvage logging typically occurs on the majority of private timberlands, but also occurs on Federal lands to a smaller degree. This type of harvest can directly impact habitat potentially occupied by northern spotted owls and can negatively influence ecological processes, which can impair the long-term development of northern spotted owl habitat (reviewed in Service 2011b, p. III-48). Action agencies, working with the Service, are attempting to influence fire severity by designing projects to reduce fire-suppressed vegetation and mimic the effects of historical fire regimes. The effects of this type of management are uncertain and highly debated in the literature (Courtney et al. 2004, pp. 12-11, Omi and Martenson 2002, pp. 19-27; Irwin et al. 2004, p. 21; Spies et al. 2006 p. 359-361; Hanson et al. 2009, pp. 1316-1319; Spies et al. 2009, pp. 331-332; Ager et al. 2012, p. 282; Odion et al. 2014a pp. 10-12, Spies et al. 2012, pp. 10-12; Odion et al. 2014b, pp. 46-49; Gaines et al. 2010, Baker 2015, entire; Baker 2017, entire; Gallagher et al. 2018, pp. 10-13).

West Nile Virus (WNV)

At this time, no avian diseases, including West Nile virus (WNV), are significantly affecting northern spotted owls; Recovery Action 17 recommends monitoring for such diseases as needed (Service 2011, p. III-5).

Sudden Oak Death

Sudden oak death was not listed as particular threat at the time of listing but was recognized as a potential threat to the northern spotted owl after it was discovered in Oregon (Courtney et al. 2004, USDI Fish and Wildlife 2011). Because of the coastal influence on this pathogen, sudden oak death is not likely to be of consequence rangewide but could compound existing stressors in coastal provinces of the northern spotted owl range.

This disease is caused by the fungus-like pathogen, *Phytopthora ramorum* that was recently introduced from Europe and is rapidly spreading as it is capable of infecting over 100 species of trees and shrubs (APHIS 2011, in Peterson et al. 2015, p. 937). The disease has been found in several different forest types and at elevations from sea level to over 800 m and is now known to extend over 650 km from south of Big Sur, California to Curry County, Oregon (Rizzo and Garbelotto 2003, p. 198). In some areas it has reached epidemic proportions in oak (Quercus spp.) and tanoak (*Lithocarpus densiflorus*) forests along approximately 300 kilometers (186 miles) of the central and northern California coast (Rizzo et al. 2002, p. 733). Near Brookings, Oregon it has killed tanoak and caused dieback of closely associated wild rhododendron (*Rhododendron* spp.) and evergreen huckleberry (*Vaccinium ovatum*) (Goheen et al. 2002, p. 441), common components of northern spotted owl habitat. Despite treatments of infected sites that remove all infected trees and shrubs as well as those occurring within a 300-foot buffer, occurrences of infected sites have increased since 2001 (Peterson et al. 2015, p. 937). The majority of infected sites in Oregon are concentrated in the Chetco River drainage, but it has been located as far north as Cape Sebastian (Peterson et al. 2015, p. 238). The spores from this pathogen are transmitted through the coastal fog and rain or through contaminated surfaces. During a study completed between 2001 and 2003 in California, one-third to one-half of the hikers present in the study area carried infected soil on their shoes (Davidson et al. 2005, p. 587), creating the potential for rapid spread of the disease. Sudden oak death poses a threat of uncertain proportion because of its potential impact on forest dynamics and alteration of key prey and northern spotted owl habitat components (e.g., hardwood trees, forest structure and nest tree mortality); especially in the southern portion of the northern spotted owl's range (Courtney et al. 2004, pp. 6-26 through 6-27, 11-8). Eradication treatments themselves have the potential to remove habitat at the stand level as all hardwoods and shrubs identified as carriers are removed.

Inbreeding Depression, Genetic Isolation, and Reduced Genetic Diversity

Inbreeding and other genetic problems due to small population sizes were not considered an imminent threat to the northern spotted owl at the time of listing. Earlier studies showed no indication of reduced genetic variation and past bottlenecks in Washington, Oregon, or California (Barrowclough et al. 1999, p. 922; Haig et al. 2004, p. 36). A more recent study however, reported a significant bottleneck influence in the Washington Cascades, an area known to be experiencing a significant population decline, and that other areas with significant population bottlenecks were correlated with declines in population growth rate (Funk et al. 2010, as reviewed in Haig et al. 2016, p. 187). Recently, evidence has emerged that inbreeding depression (reduced fitness resulting from mating of close relatives) in is affecting northern spotted owls, though it is not clear whether or to what extent inbreeding depression may be exacerbating current population declines (Miller et al. 2018, pp. 827, 829, 831). Northern spotted owls known to have closely-related parents, such as full-sibling pairs, were much less likely to be observed producing offspring themselves (6.8 percent), as compared with owls without closely-related parents (27.2 percent of which were observed to produce offspring), indicating a large reduction in fitness. Rates of inbreeding were highest in the Washington Cascades (12.3 percent), intermediate on the Olympic Peninsula (5.3 percent), and low in Oregon (0.6 percent) and California (1.2 percent) (Miller et al. 2018, p. 826).

The circumstantial case for increasing risk of inbreeding depression, genetic isolation, and reduced genetic diversity also has become stronger in the northern portion of the range. In Washington demography study areas, current effective population sizes are on average fewer than 20 individuals (Gremel 2015, pp. 4–5; Herter 2016, p. 8; Lesmeister et al. 2017, pp. 3 and 12; Lesmeister and Pruett 2017, pp. 3, 7-8). Populations of this size are highly susceptible to loss of genetic variation and fitness due to genetic drift and other factors (Frankham 1996, entire; Frankham et al. 2014, entire). Canadian populations may be even more adversely affected by issues related to small population size including inbreeding depression, genetic isolation, and reduced genetic diversity (Courtney et al. 2004, pp. 11-9). A 2004 study (Harestad et al. 2004, p. 13) indicates that the Canadian breeding population was estimated to be less than 33 pairs and annual population decline may be as high as 35 percent. In 2007, a recommendation was made by the Spotted Owl Population Enhancement Team to remove northern spotted owls from the wild in British Columbia (Service 2012a, p. 14078). This recommendation resulted in the eventual capture of the remaining 16 wild northern spotted owls in British Columbia for a captive breeding program (Service 2012a, p. 14078). Low and persistently declining populations throughout the northern portion of the species range (see “Population Trends” below) may be at increased risk of losing genetic diversity.

Hybridization of northern spotted owls with California spotted owls, Mexican spotted owls, and barred owls has been confirmed through genetic research (Funk et al. 2008, p. 1; Hamer et al. 1994, p. 487; Gutiérrez et al. 1995, p. 3; Dark et al. 1998, p. 50; Kelly 2001, pp. 33-35).

Climate Change

Global climate change has the potential to produce entirely new environmental conditions, making predictions about future ecological consequences a more daunting challenge. Recent forecasts indicate that climate change will have long-term and variable impacts on forest habitat at local and regional scales. Locally, this could involve shifts in tree species composition that influence habitat suitability. Frey et al. (2016, pp. 1, 6) concluded that old-growth will provide some buffer from impacts of regional warming and/or slow the rate at which some species relying on old-growth must adapt, based on their modeling of the fine-scale spatial distribution, under-canopy air temperatures in mountainous terrain of central Oregon. Similarly, Lesmeister et al. (2019, p. 16) concluded that older forest can serve as a buffer to climate change and associated increases in wildfire, as these areas have the highest probability of persisting through fire events even in weather conditions associated with high fire activity. Regionally, there could be losses of habitat availability caused by advances or retreats of entire vegetative communities, and perhaps prey communities as well. Effects of climate change, including fire and pest incidence, will not only affect currently suitable habitat for the northern spotted owl, but they will also likely alter or interrupt forest growth and development processes (Karl et al. 2008, pp. 15 and 18; Dale et al. 2001, entire; Yospin et al. 2015, entire) that influence forest turnover rates and the emergence of suitable habitat attributes in new locations. These changes are predicted to be driven by changes in patterns of temperature and precipitation that are projected to occur under climate change scenarios (Mote et al. 2014, entire).

Glenn et al. (2010, p.2551) noted that the potential consequences of global climate change on Pacific Northwest forests remain somewhat unclear, though there is potential for changes in forest composition and disturbance patterns that could affect northern spotted owl populations. Most models predict warmer, wetter winters and hotter, drier summers for the Pacific Northwest in the first half of the 21st century (Mote et al., 2008, Mote et al. 2014, p. 489). This may result in a change in species composition or reduction in the acreage of existing low-elevation forests. The general predicted trend in North American forests is declining occupancy by conifers and displacement by hardwoods. Both the frequency and intensity of wildfires and insect outbreaks are expected to increase over the next century in the Pacific Northwest (Littell et al. 2010, p.

130). One of the largest projected effects on Pacific Northwest forests is likely to come from an increase in fire frequency, duration, and severity. Westerling et al. (2006, pp. 940-941) analyzed wildfires and found that since the mid-1980s, wildfire frequency in western forests has nearly quadrupled compared to the average of the period from 1970-1986. The total area burned is more than 6.5 times the previous level and the average length of the fire season during 1987-2003 was 78 days longer compared to 1978-1986 (Westerling et al. 2006, p. 941). The area burned annually by wildfires in the Pacific Northwest is expected to double or triple by the 2080s (Littell et al. 2010, p. 140). Wildfires are now the primary cause of northern spotted owl habitat loss on Federal lands, with about 703,700 acres of nesting/roosting habitat loss attributed to wildfires from 1993 to 2017 (Davis et al. 2022, p. 29).

In its review of the status of the northern spotted owl in California (CDFW 2016, p. 153-155), the California Department of Fish and Wildlife (CDFW) evaluated the possible effects of climate change upon northern spotted owl and the forested habitats on which it depends. In general, CDFW (2016, p. 153-155) determined that climate change is occurring within the northern spotted owl's entire range, including California, with many climate projections forecasting steady changes in the future. They reported that climate change studies predict future conditions that may negatively impact northern spotted owls, such as wet and cold springs, more frequent and severe summer heat waves, decreased fog along the coast, shifts in forest species composition, and increased frequency of severe wildfire events. However, CDFW (2016, p. 153-155) also reported that in some instances predicted future conditions, such as increased frequency of low to moderate severity fires and expansion of suitable owl habitat forest types, may be favorable to the northern spotted owl in the long-term. They further reported that in California, current rates of temperature and precipitation change predict hotter and drier conditions in some areas of the northern spotted owl's range, and wetter colder conditions in other areas of the range. They looked at past precipitation and temperature trends and reported that drying trends across most of the northern spotted owl's range in California, coupled with warmer winters and cooler summers in the interior and cooler winters and warmer summers along the coast, may play a role in both owl and prey population dynamics. CDFW (2016, p. 153-155) recommended that further research is necessary to understand how climate change may be affecting northern spotted owls in California and throughout its range.

Potential changes in temperature and precipitation have important implications for northern spotted owl reproduction and survival. Wet, cold weather during the winter or nesting season, particularly the early nesting season, has been shown to negatively affect northern spotted owl reproduction (Olson et al. 2004, p. 1039, Dugger et al. 2005, p. 863), survival (Franklin et al. 2000 pp. 576-577, Olson et al. 2004, p. 1039, Glenn et al. 2011, p. 1279), and recruitment (Glenn et al. 2010, pp.2446-2547). Cold, wet weather may reduce reproduction and/or survival during the breeding season due to declines or decreased activity in small mammal populations so that less food is available during reproduction when metabolic demands are high (Glenn et al. 2011, pp. 1288-1289). Cold, wet nesting seasons may increase the mortality of nestlings due to chilling and reduce the number of young fledged per pair per year (Franklin et al. 2000, p.557, Glenn et al. 2011, p. 1286). The relationships between northern spotted owl populations and climate are complex and variable, but more recent study such as the one from Dugger and others (2016, page 98) suggests that survival increased when winters were warmer and drier. This may become a factor in population numbers in the future; given climate change predictions for the

Pacific Northwest include warmer, wetter winters.

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

Various types of changes in climate can have direct or indirect effects on species. These effects may be positive, neutral, or negative and they may change over time, depending on the species and other relevant considerations, such as the effects of interactions of climate with other variables (e.g., habitat fragmentation) (IPCC 2007, pp. 8–14, 18–19).

While a change in forest composition or extent is likely as a result of climate change, the rate of that change is uncertain. In forests with long-lived dominant tree species, mature individuals can survive these stresses, so direct effects of climate on forest composition and structure would most likely occur over a longer time scale (100 to 500 years) in some areas than disturbances such as wildfire or insect outbreaks (25 to 100 years) (McKenzie et al. 2009). The presence of high-quality habitat may buffer the negative effects of cold, wet, springs and winters on survival of northern spotted owls as well as ameliorate the effects of heat. This habitat might help maintain a stable prey base, thereby reducing the cost of foraging during the breeding season when energetic needs are high (Franklin et al. 2000).

Although the scientific literature has explored the link between climate change and the invasion by barred owls, changing climate alone is unlikely to have caused the invasion (Livezey 2009). In general, climate change can increase the success of introduced or invasive species in colonizing new territory. Invasive animal species are more likely to be generalists, such as the barred owl, than specialists, such as the northern spotted owl, and adapt more successfully to a new climate than natives.

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

Exposure to Toxicants

Toxicants were not identified as a threat when the northern spotted owl was listed, but a growing body of information suggests exposure to anti-coagulant rodenticides, fertilizers, other contaminants, as well as other factors associated with marijuana cultivation represent a growing concern for northern spotted owls. Recent accounts show that the scope and scale of exposure from illegal cultivation is increasing on federal and non-federal ownerships; these threats extend northern spotted owls and many other wildlife species and the resources they depend upon (Thompson et al. 2013, entire, Gabriel et al. 2013, entire; Wengert et al. 2015, p. 8; CDFW 2016 pp. 176-177, CEPA 2017b, p.1; Gabriel et al. 2018, entire; Higley et al. 2017 (abstracts). Known grow sites have been found to intersect with both subspecies of spotted owl ranges throughout

California. On Forest Service lands in 2014, more than 620,000 marijuana plants on about 1,500 ac (607 ha) were removed from 167 different sites; about 90 percent of which were in California (US Senate press release 2015). Over 600 trespass grow sites were reported on mixed California ownerships in 2010 (Wengert et al. 2015, p. 8). Increases in mortalities from and exposure to pesticides in fishers in the Sierras and Northern California indicate that toxicants from marijuana cultivation suggest increasing trends (Gabriel et al. 2015, pp. 5-8, 14).

Illegal cultivation is a serious issue in the Klamath Physiographic Province, an area recognized as an important area for northern spotted owl populations (Schumaker et al. 2014). In Southwestern Oregon in Jackson and Josephine Counties alone, a multi-agency Drug Task force reported a total of 100 illegal marijuana cultivation sites containing approximately 294,090 plants between 2005-2014 (Caruthers, R. pers. comm. 2017). Many of these sites were located within known northern spotted owl home ranges, cores, or nest stands (Clayton, D. pers. comm. 2017).

Known exposure and recent data on impacts to barred owls suggest serious implications for northern spotted owls. In Hoopa Tribal lands in northwestern California, of 176 barred owls tested for exposure to anticoagulant rodenticides (ARs), 65 percent tested positive for one or more second generation ARs; many of these were collected from known northern spotted owl home ranges (Higley et al. 2017). In a separate study in northwestern California, seven out of ten northern spotted owls (70 percent) and 34 of 80 barred owls (40 percent) tested positive for ARs (Gabriel et al. 2018, pp. 5-6). At experimental barred owl removal areas in Oregon and Washington, 19 of 40 (48 percent) of tested barred owl carcasses, as well as one of two opportunistically-obtained northern spotted owl carcasses, showed evidence of exposure to ARs (Wiens et al. 2019, p. 4). Most exposures in Oregon and Washington were at trace levels, and AR toxicosis could not be confirmed in any of the tested owls. These exposures in Oregon and Washington could not be definitively attributed to legal rodenticide applications or to illicit marijuana cultivation (Wiens et al. 2019, p. 6).

<u>*Disturbance*</u>

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

The effect of noise on birds is extremely difficult to determine due to the inability of most studies to quantify one or more of the following variables: 1) timing of the disturbance in relation to nesting chronology; 2) type, frequency, and proximity of human disturbance; 3) clutch size; 4) health of individual birds; 5) food supply; and 6) outcome of previous interactions between birds and humans (Knight and Skagan 1988, pp. 355-358). Additional factors that confound the issue of disturbance include the individual bird's tolerance level, ambient sound levels, physical parameters of sound, and how it reacts with topographic characteristics and vegetation, and differences in how species perceive noise. Information specific to behavioral responses of spotted owls to disturbance is limited, research indicates that recreational activity can cause Mexican spotted owls (*S. o. lucida*) to vacate otherwise suitable habitat (Swarthout and Steidl 2001, p. 314) and helicopter overflights can reduce prey delivery rates to nests (Delaney et al. 1999, p. 70). Additional effects from disturbance, including altered foraging behavior and decreases in nest attendance and reproductive success, have been reported for other raptors (White and Thurow 1985, p. 14; Andersen et al. 1989, p. 296; McGarigal et al. 1991, p. 5).

Although it has not been conclusively demonstrated, it is anticipated that nesting spotted owls may be disturbed by heat and smoke as a result of burning activities during the breeding season.

Conservation Needs of the Northern Spotted Owl

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

Habitat-specific Needs

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

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

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

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

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

Habitat-independent Needs

1. A coordinated research and adaptive management effort to better understand and manage

competitive interactions between spotted and barred owls; and

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

Conservation Strategy to Address Habitat Loss and Fragmentation

Since 1990, various efforts have addressed the conservation needs of the northern spotted owl and attempted to formulate conservation strategies based upon these needs. These efforts began with the ISC's Conservation Strategy (Thomas et al. 1990); they continued with the designation of critical habitat (Service 1992b), the Draft Recovery Plan (Service 1992a), and the Scientific Analysis Team report (Thomas et al. 1993), report of the Forest Ecosystem Management Assessment Team (Thomas and Raphael 1993); and they culminated with the NWFP (USFS and BLM 1994a). Recently, the management strategy for portions of Bureau of Land Management lands in Oregon (2.5 million acres) was modified and is no longer following all measures described in the NWFP (BLM 2016a, entire and BLM 2016b, entire). In comparison to the NWFP land use allocations, the Late-Successional Reserve (LSR) designs of the revised Resource Management Plans (RMPs) make similar contributions to the development and spacing of the large habitat blocks needed for northern spotted owl conservation. The RMPs includes approximately 177,000 more acres (71,629 ha) of LSR and Riparian Reserves than in the NWFP. These land use allocations represent 36 and 27 percent of the RMP lands, respectively, and will be managed for the retention and development of large trees and complex forests across the RMP landscape (Service 2016, Table 1, p. 9). Two additional key provisions differ from previous strategies, including a mitigation that the BLM would participate in, cooperate with, and provide support for an interagency program for barred owl management to implement Recovery Action 30 when the Service determines the best manner in which barred owl management can contribute to the recovery of the northern spotted owl. Also, timber sales that would cause the incidental take of northern spotted owls from timber harvest would not be authorized until implementation of a barred owl management program has begun (BLM 2016a, p 19 and BLM 2016b, p. 19). Overall fundamentals of these large-scale conservation strategies have been based upon the reserve design principles first articulated in the ISC's report, which are summarized as follows:

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

Federal Contribution to Recovery

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

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

The Forest Ecosystem Management Assessment Team and the NWFP predicted, based on expert opinion, that the northern spotted owl population would decline in the Matrix land use allocation over time, while the population would stabilize and eventually increase within LSRs as habitat conditions improved over the next 50 to 100 years (Thomas and Raphael 1993, p. II-31; USFS and BLM 1994a, 1994b, p. 3&4-229). The results of the first decade of monitoring, Lint (2005, p. 18) did not yield conclusions whether implementation of the NWFP would reverse the northern spotted owl's declining population trend because not enough time had passed to provide the necessary measure of certainty. However, the results from the first decade of monitoring did not provide any reason to depart from the objective of habitat maintenance and restoration as described in the NWFP (Lint 2005, p. 18; Noon and Blakesley 2006, p. 288). Other stressors that occur in suitable habitat, such as the range expansion of the barred owl (already in action) and infection with WNV (which may or may not occur) may complicate the conservation of the northern spotted owl. Recent reports about the status of the northern spotted owl offer few management recommendations to deal with these emerging threats. However, Franklin and others (2021, p. 18) suggest that maintaining northern spotted owl habitat, even where it is currently unoccupied, will be helpful in allowing for recolonization by northern spotted owls if barred owl populations can be reduced, and in allowing for connectivity among areas still occupied by northern spotted owls.

Recovery Plan

On June 28, 2011, the Service published the Revised Recovery Plan for the Northern Spotted

Owl (Service 2011b). The recovery plan identifies threats from competition with barred owls, ongoing loss of northern spotted owl habitat as a result of timber harvest, loss or modification of northern spotted owl habitat from uncharacteristic wildfire, and loss of amount and distribution of northern spotted owl habitat as a result of past activities and disturbances (Service 2011b, p. II-2 and Appendix A). To address these threats, the current recovery strategy identifies five main steps: 1) development of a rangewide habitat modeling framework; 2) barred owl management; 3) monitoring and research; 4) adaptive management; and 5) habitat conservation and active forest restoration (Service 2011b, p. II-2). The recovery plan lists recovery actions that address each of these items, some of which were retained from the 2008 recovery plan (Service 2008). The Managed Owl Conservation Areas and Conservation Support Areas recommended in the 2008 recovery plan are not a part of the recovery strategy outlined in the Revised Recovery Plan. The Service completed a rangewide, multi-step habitat modeling process to help evaluate and inform management decisions and critical habitat development (Service 2011b, Appendix C).

The Revised Recovery Plan recommended implementing a robust monitoring and research program for the northern spotted owl. The recovery plan encourages these efforts by laying out the following primary elements to evaluate progress toward meeting recovery criteria: monitoring northern spotted owl population trends, comprehensive barred owl research and monitoring, continued habitat monitoring; inventory of northern spotted owl distribution, and; explicit consideration for climate change mitigation goals consistent with recovery actions (Service 2011b, p. II-5). The Revised Recovery Plan also strongly encourages land managers to be aggressive in the implementation of recovery actions, including strategies that include active forest management. In other words, land managers should not be so conservative that, to avoid risk, they forego actions that are necessary to conserve the forest ecosystems that are necessary to the long-term conservation of the northern spotted owl. But they should also not be so aggressive that they subject northern spotted owls and their habitat to treatments where the long-term benefits do not clearly outweigh the short-term risks. Finding the appropriate balance to this dichotomy will remain an ongoing challenge for all who are engaged in northern spotted owl conservation (Service 2011b, p. II-12). The Revised Recovery Plan estimates that recovery of the northern spotted owl could be achieved in approximately 30 years (Service 2011b, p. II-3). The Revised Recovery Plan and the critical habitat designation build on the NWFP and recommends continued implementation of the NWFP and its standards and guides (Service 2011b, p. I-1).

<u>Northern Spotted Owl Recovery Units</u>

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

The 2011 Revised Recovery Plan for the Northern Spotted Owl (Service 2011b) contains 14 recovery actions that specifically address northern spotted owl habitat loss and degradation. Two actions of primary importance are recovery actions 10 and 32:

- Recovery Action 10: Conserve northern spotted owl sites and high value northern spotted owl habitat to provide additional demographic support to the northern spotted owl population. This action addresses both nesting/roosting and foraging habitat.
- Recovery Action 32: Because northern spotted owl recovery requires well distributed, older and more structurally complex multi-layered conifer forests on Federal and non-Federal lands across its range, land managers should work with the Service to maintain and restore such habitat while allowing for other threats, such as fire and insects, to be addressed by restoration management actions. These high-quality northern spotted owl habitat stands are characterized as having large diameter trees, high amounts of canopy cover, and decadence components such as broken-topped live trees, mistletoe, cavities, large snags, and fallen trees. This action addresses nesting/roosting habitat.

Recovery actions 10 and 32 are implemented on reserved areas by the USFS and BLM through the NWFP and the Resource Management Plans (RMPs); these two regulatory actions are discussed in more detail in Section 6. The large reserve network created under the NWFP and RMPs facilitates implementation of recovery actions 10 and 32 by protection of current nesting/roosting and foraging habitat, protection of northern spotted owl nest sites, and allowing for recruitment of new northern spotted owl habitat. Through the section 7 consultation process, the Service reviews the management activities implemented under the NWFP and RMPs and provides technical assistance to the USFS and BLM in making activities within or outside of reserves consistent with recovery actions 10 and 32 to the extent consistent with other land management priorities. Nesting/roosting and foraging habitat associated with both recovery actions 10 and 32 may decrease in local areas, but over the larger area and time, habitat that is associated with these recovery actions is increasing and will continue to increase under both the NWFP and RMPs.

Conservation Efforts on Non-Federal Lands

Non-Federal lands contributed 3,149,700 ac (1,274,638 ha) to the total 12,103,700 ac (4,898,193 ha) of nesting/roosting habitat available for breeding northern spotted owls in 2012 (Davis et al. 2016, pp. 21-22). There are portions of the range where habitat on Federal lands is lacking or of low quality, or where there is little Federal ownership; State and private lands may be important to provide demographic support (pair or cluster protection) and habitat connectivity for northern spotted owl in key areas such as southwestern Washington, northwestern Oregon (potentially including parts of the Tillamook and Clatsop State Forests), and northeastern California (Service 2011b, p. III-51). Timber harvest on State and private lands in Washington, Oregon, and California is regulated by each State's forest practice rules. The level of northern spotted owl conservation included in each State's regulations varies. Furthermore, while recovery efforts for the northern spotted owl are primarily focused on Federal land, Recovery action 14 in the 2011 Revised Recovery Plan centered on seeking partnership with non-Federal landowners to supplement Federal conservation efforts, including voluntary actions like Habitat Conservation Plans (HCPs) and Safe Harbor Agreements (SHAs). There are a total of 21 current conservation plans in these states, including 7 HCPs and 3 SHAs located in Washington, 2 HCPs and 5 SHAs in Oregon, and 2 HCPs and one SHA in California, with an additional SHA occurring in both Washington and Oregon.

U.S. Fish and Wildlife Habitat Conservation Plans and Safe Harbor Agreements

The purpose of the HCP and SHA process is to provide for the conservation of endangered and threatened species while at the same time authorizing the incidental take of those species. HCPs are required as part of an application for an incidental take permit. They describe the anticipated effects of the proposed taking; how those impacts will be minimized and mitigated; and how the HCP is to be funded among other things. The Secretary must issue the permit if statutory issuance criteria are met, including that the applicant will minimize and mitigate the effects of the taking to the maximum extent practicable, the taking will not jeopardize the continued existence of the species, and funding to implement the plan is assured. 16 U.S.C. 1539(a)(2)(B). In developing HCPs, people applying for incidental take permits describe measures designed to minimize and mitigate the effects of their actions and receive formal assurances from the Service that if they fulfill the conditions of the HCP, the Service will not require any additional or different management activities by the participants without their consent. SHAs are voluntary agreements between non-Federal property owners and the Service; in exchange for actions that contribute to the recovery of listed species on non-Federal lands, participating property owners may return the enrolled property to the baseline conditions that existed at the beginning of the SHA. Incidental Take Permits that result from both HCPs and SHAs are intended to allow non-Federal entities to undertake actions that incidentally "take" species protected under the Act.

HCPs are not required to have a net benefit and SHAs are designed to have a temporary net gain for northern spotted owls. Under these plans, timber harvest has continued, resulting in the loss of nesting/roosting, foraging, and dispersal habitat. We do not currently have an analysis of habitat loss on lands without conservation plans compared to habitat loss on lands covered by HCPs and SHAs. Although the HCPs do not provide a net conservation benefit to northern spotted owl, they provide mitigation for habitat loss or slow down habitat loss through the required conservation measures. SHAs do provide a net conservation benefit to the northern spotted owl, and both conservation plans eliminate uncertainty with respect to landowners' actions in northern spotted owl habitat and provide the Service an opportunity to provide technical assistance to landowners in the development of conservation measures included in the agreements. Therefore, in this context, both HCPs and SHAs have contributed to the overall conservation of northern spotted owls.

In Washington, there are seven northern spotted owl-related HCPs currently in effect covering 2 million ac (80,9371 ha) of non-Federal lands, one of which covers Washington Department of Natural Resources (DNR) lands. These HCPs still allow timber harvest but are designed to retain some nesting habitat and or connectivity over the next few decades. There are four northern spotted owl-related SHAs in Washington, with one including some lands in Oregon.

The primary intent of SHAs is to maintain or create potential northern spotted owl habitat. In addition, there is a long-term habitat management agreement covering 13,000 ac (5,261 ha) in which authorization of take was provided through an incidental take statement (section 7) associated with a Federal land exchange (Service 2011b, p. A-15). While timber harvest and habitat loss continue on lands covered by these agreements, the plans retain some nesting/roosting habitat throughout the area or in strategic locations and provide habitat connectivity. Overall, HCPs, and SHAs in Washington provide some protection to northern spotted owls and their habitat. However, nesting/roosting and foraging habitat continue to decline due to timber harvest on non-Federal lands in Washington.

In Oregon, there are two northern spotted owl-related HCPs currently in effect covering 210,400 ac (85,146 ha) of non-Federal lands. These HCPs still allow timber harvest but are designed to retain some nesting habitat and or connectivity over the next few decades. There are two northern spotted owl-related SHAs occurring in Oregon. One SHA is a Washington SHA that covered some Oregon lands. The other SHA is a programmatic SHA with the Oregon Department of Forestry with 13 landowners with 3,484 acres enrolled. The primary intent of SHAs is to maintain or create potential northern spotted owl habitat. Strategies employed in the programmatic Oregon Department of Forestry SHA include maintaining existing suitable habitat, increasing time between harvests to allow for habitat development, and lightly to moderately thinning younger forest stands that are currently not habitat (to increase tree diameter and stand diversity) (Service 2011b, p. A-16). There are 4 additional SHAs in Oregon related to the Barred Owl Removal Experiment explained below in the barred owl section. While timber harvest and habitat loss continue on lands covered by these HCPs and SHAs in Oregon, the plans retain some nesting/roosting habitat throughout the area or in strategic locations and provide habitat connectivity. Overall, HCPs, and SHAs in Oregon provide some protection to northern spotted owls and their habitat. However, nesting/roosting and foraging habitat continue to decline due to timber harvest on non-Federal lands in Oregon.

In California, there are two northern spotted owl-related HCPs currently in effect covering 211,765 ac (85,698 ha) of non-Federal lands. These HCPs still allow timber harvest but are designed to retain some nesting habitat and or connectivity over the next few decades. There is one northern spotted owl-related SHA in California. The primary intent of SHAs is to maintain or create potential northern spotted owl habitat. While timber harvest and habitat loss continue on lands covered by these agreements, the plans retain some nesting/roosting habitat throughout the area or in strategic locations and provide habitat connectivity. Overall, HCPs, and SHAs in California provide some protection to northern spotted owls and their habitat. However, nesting/roosting and foraging habitat continue to decline due to timber harvest on non-Federal lands in California.

State Forest Practice Rules

The majority of northern spotted owl conservation is expected from Federal lands, but the Service's primary expectations for private lands are for their contributions to demographic support (pair or cluster protection) to Federal lands, or their connectivity with Federal lands. Timber harvest on State and private lands in Washington, Oregon, and California is regulated by each State's forest practice rules. The level of northern spotted owl conservation included in each State's regulations varies. Each State's rules are described below.

Washington

The northern spotted owl was listed as endangered species in Washington State by the Washington Fish and Wildlife Commission in 1988 to prioritize conservation for the subspecies (WDFW 2017). Timber harvest on State and private lands in Washington is guided by a number of State laws and policies, except for Washington Department of Natural Resources (WDNR) lands that are covered by an HCP. The Washington State Environmental Policy Act (SEPA) requires analysis of environmental impacts and consideration of reasonable alternatives for actions proposed by the State. State timber harvest activities must also comply with the State Forest Practices Act (Chapter 76.09 RCW), which regulates all forest management activities in Washington. The management of State trust lands, specifically, is guided by the Forest Resource Plan, which was adopted by the Board of Natural Resources in 1992. Among other things, the policies of the Plan require the Washington DNR analyze and potentially modify the impacts of its activities on watersheds, wildlife habitat, special ecological features, wetlands, and other natural resources to maintain healthy forests for future generations.

In 1996, the State Forest Practices Board adopted rules (Washington Forest Practices Board 1996) that would contribute to conserving the northern spotted owl and its habitats on non-Federal lands. Adoption of the rules was based in part on recommendations from a Science Advisory Group that identified important non-Federal lands and recommended roles for those lands in northern spotted owl conservation (Hanson et al. 1993, pp. 11-15; Buchanan et al. 1994, p. ii). The 1996 rule package was developed by a stakeholder policy group and then reviewed and approved by the Forest Practices Board (Buchanan and Swedeen 2005, p. 9). The 1996 rules identified 10 landscapes, or Spotted Owl Special Emphasis Areas (SOSEAs) where owl protections on non-Federal lands would be emphasized. Protections provided under the State Environmental Policy Act for those portions of owl sites located beyond the boundaries of the SOSEAs were largely eliminated (Buchanan and Swedeen 2005, p. 7). The overarching policy goal of the Washington Forest Practices Rules is to complement the conservation strategy on Federal lands, and so the SOSEAs are adjacent to Federal lands. The SOSEAs are designed to provide a larger landscape for demographic and dispersal support for northern spotted owls with the long-term goal of supporting a viable population of northern spotted owls in Washington.

The Forest Practices Rules for northern spotted owls can be described as containing three basic types of provisions: 1) regulations that apply outside SOSEAs, 2) a circle-based protection scheme for northern spotted owl sites inside SOSEAs (retain all suitable habitat within 0.7 mi (1.1 km) of site center and retain 40 percent of suitable habitat within 1.8 to 2.7 mi (2.9 to 4.3 km) radius of home range), and 3) landscape-level planning options for inside SOSEAs. To avoid disturbance of nesting northern spotted owls inside SOSEAs, the rules also include timing restrictions from March 1 to August 31 within 0.25 miles of a site center for several potentially disruptive activities (e.g., road construction). Forest practices rules outside the SOSEAs are designed to protect the immediate vicinity of northern spotted owl site centers during the nesting season (March 1 to August 31) by restricting harvest within the best 70 ac (28 ha) of habitat around the site center and requiring additional environmental analysis for permitting (of harvesting, road construction, or aerial application of pesticides), but outside the nesting season there are no owl-related protections outside SOSEAs that constrain harvest of suitable northern spotted owl habitat in northern spotted owl management circles (Buchanan and Swedeen 2005,

p. 14).

Within SOSEAs, the rules were intended to maintain the viability of each northern spotted owl site center by establishing that enough suitable habitat should be maintained to protect the viability of owls associated with each northern spotted owl site center, or to provide for the goals established in Spotted Owl Special Emphasis Areas. Due to extensive timber harvest activities in the decades leading up to listing of the northern spotted owl, most northern spotted owl management circles centered on non-Federal lands have far less habitat than the viability threshold identified (see below) when the rule went into effect. Because the rules do not include provisions for restoration of habitat to achieve the viability threshold at northern spotted owl sites these circles remain far below those thresholds. For individual site centers, the habitat considered necessary to maintain viability is as follows: (a) all suitable northern spotted owl habitat within 0.7 mi (1.1 km) of each northern spotted owl site center; (b) at least 5,863 ac (2,373 ha) of suitable northern spotted owl habitat within of 2.7 mi (4.3 km) of a site center in the Hoh-Clearwater Spotted Owl Special Emphasis Area on the western Olympic Peninsula, and (c) at least 2,605 ac (1,054 ha) of suitable northern spotted owl habitat within 1.8 mi (2.9 km) of a site center in all other Spotted Owl Special Emphasis Areas. At all sites within SOSEAs, any proposed harvest of suitable northern spotted owl habitat within a territorial owl circle (status 1, 2, or 3 in the Washington Department of Fish and Wildlife database) would be considered a "Class-IV special" and would trigger State Environmental Policy Act review; such activities would require a Class IV special forest practices permit and an environmental impact statement per the State Environmental Policy Act (Buchanan and Swedeen 2005, p. 15-16).

The Forest Practices Board in Washington has a long-standing relationship with the Service and collaborates extensively on owl conservation. The Service provided extensive technical assistance in the development of the Board's existing owl rules. The Board was recognized in the Revised Recovery Plan for the Northern Spotted Owl (Service 2011b) for its ongoing owl conservation efforts in Recovery Action 18 encouraged to continue to use its existing processes "to identify areas on non-Federal lands in Washington that can make strategic contributions to northern spotted owl conservation over time. The Service encourages timely completion of the Board's efforts and will be available to assist as necessary." The Board convened the Northern Spotted Owl Implementation Team (NSOIT) in 2010 to develop incentives for landowners to achieve conservation goals for northern spotted owls and to identify the temporal and spatial allocation of conservation efforts on non-Federal lands; a draft product is due to be completed in 2017. The NSOIT conducted a pilot project testing different thinning prescriptions in northern spotted owl habitat but the project has since been discontinued. These efforts underway have evolved over years of collaboration and are designed to change the dynamic away from fear and resistance to partnership and participation. The Service has provided and is providing funding to support the work of the NSOIT. Overall, State forest practice rules in Washington provide some protection to northern spotted owls and their habitat. However, nesting/roosting and foraging habitat continue to decline due to timber harvest on non-Federal lands in Washington.

Oregon

The northern spotted owl is listed as a threatened species in Oregon (ODFW 2017). The Oregon Fish and Wildlife Commission's long-term goal for species listed as threatened or endangered under the Oregon Endangered Species Act is to manage the species and their habitats so that the status of the species improves to a point where listing is no longer necessary. Timber harvest on non-Federal lands in Oregon is guided by the Forest Practices Act and Forest Practices Rules (ODF 2014). The Oregon Forest Practices Act restricts timber harvest within 70 ac (28 ha) core areas around sites occupied by an adult pair of northern spotted owls capable of breeding (as determined by recent protocol surveys), but it does not provide for protection of northern spotted owl habitat beyond these areas (ODF 2014, pp. 61-62). In general, no large-scale northern spotted owl habitat protection strategy or mechanism currently exists for non-Federal lands in Oregon.

State forests in particular are managed to achieve "greatest permanent value," considering economics, environmental, and cultural goals. Each State Forest has a Forest Management Plan that seeks to implement these ideals. Ultimately, the State's goal is to produce timber revenue and also provide for a range of habitats across ownerships. Specific policies and procedures have been adopted on State lands to protect and conserve the northern spotted owl and its habitat. The State Forests Division has an extensive survey program across all districts as part of annual harvest planning (approximately $1.4 million spent in 2016) and conducts density surveys on two districts. Division policy directs districts to avoid any harvest activity on State lands which results in less than 40% suitable habitat within the provincial home range of an owl or pair (a 1.2 – 1.5-mi (1.9- 2.4 km) radius circle centered on a nest site or activity center). Division policy also directs districts to avoid any harvest activity which results in less than 500 ac (202 ha) of suitable habitat within a 0.7-mi (1.1 km) radius (1000 ac (405 ha)) of a nest site or activity center. In addition, 30 percent of Oregon State forests must be managed for the development of "complex forest structure" and late-seral tree species, which could provide some level of conservation benefit for a number of wildlife species of concern, including the northern spotted owl (IEc 2012). The locations of these managed lands are based in part on locations of northern spotted owl nest sites. Within these areas, a variety of treatments are employed to promote complex habitat and species diversity. Overall, State forest practice rules in Oregon provide some protection to northern spotted owls and their habitat. However, nesting/roosting and foraging habitat continue to decline due to timber harvest on non-Federal lands in Oregon.

California

The northern spotted owl was listed as an endangered species under the California Endangered Species Act (CESA) in early 2016 (CDFW 2017). The incidental take of state-listed species is prohibited under the California Code of Regulations (783-783.8 and the California Fish and Game Code 2080 (CDFW 2016), unless permitted by an HCP. Forest management and forest practices on private lands in California, including harvesting for forest products or converting land to another use are regulated by the State under Division 4 of the Public Resources Code, and in accordance with the California Forest Practice Rules (CFPR)(California Code of Regulations, (CCR) Title 14, Sections 895-1115; CFPR)(CFPR 2017). The CFPR require surveys for northern spotted owls in nesting/roosting and foraging habitat and restrict timber harvest within 0.7–1.3 mi (1-2 km) of a northern spotted owl activity center. Under this framework, the California Department of Forestry and Fire Protection (CALFIRE) is the designated authority on forest management and forest practices on private lands in California.

All private land timber harvesting in California must be conducted in accordance with a site-specific Timber Harvest Plan (THP, for industrial timberlands) or Nonindustrial Timber

Management Plan (NTMP, for non-industrial private timberland owners) that is submitted by the owner and is subject to administrative approval by the CALFIRE. The THP/NTMP must be prepared by a State-registered professional forester and must contain site-specific details on the quantity of timber involved, where and how it will be harvested, and the steps that will be taken to mitigate potential environmental damage. The THP/NTMP and CALFIRE's review process are recognized as the functional equivalent to the environmental review processes required under the California Environmental Quality Act of 1970 (CEQA). The CFPRs require surveys for northern spotted owls in suitable habitat and to provide protection around activity centers. Under the CFPRs, no THP or NTMP can be approved if it is likely to result in incidental take of federally-listed species, unless the take is authorized by a Federal incidental take permit.

For private timber lands in California not covered by a HCP or SHA, the policy of the State with regard to the northern spotted owl and timber harvest can be characterized as one of "take avoidance," for which the Service (Arcata and Yreka Fish and Wildlife Offices) has recommended measures to avoid take of northern spotted owls, primarily through recommendations for habitat retention, timing of timber operations and survey procedures for northern spotted owls (described briefly below). The Director of CALFIRE is not authorized to approve any proposed THP or NTMP that would result in take of a federally-listed species, including the northern spotted owl, unless that taking is authorized under a Federal Incidental Take Permit (review process is outlined in 14 CCR 919.9 and 919.10). This latter point creates an incentive for private landowners to enter into HCPs or SHAs, or to implement take avoidance measures recommended by the Service.

Prior to 2000, the California Department of Fish and Wildlife (then, California Department of Fish and Game; CDFW) reviewed THPs and NTMPs to ensure that take of northern spotted owls was not likely to occur. From about 2000 until 2010, the Service assumed this role and reviewed THPs and NTMPs (hundreds per year) for northern spotted owl "take avoidance." From 2010, the Service and CALFIRE shared duties for northern spotted owl take avoidance review of THPs and NTMPs. Beginning in 2014, the northern spotted owl was listed as a candidate species for potential listing under the California Endangered Species Act; consequently, in 2014, CDFW began reviewing a small number of THPs and NTMPs annually for northern spotted owl take avoidance. On August 25, 2016, the California Fish and Game Commission recommended that the northern spotted owl be added to the State list of threatened and endangered animals. Regarding timber harvest on private lands in California after 2016, the Service, CALFIRE and CDFW have not formally discussed how the agencies will share reviewing duties for northern spotted owl take avoidance associated with THPs and NTMPs, but recommended habitat retention standards (i.e., Attachments A and B) and survey recommendations remain in effect. California is currently engaged in discussions with the Service addressing northern spotted owl use of post-fire landscapes currently lacking in the California Forest Practice Rules.

For timber harvest activities that occur on non-Federal lands (excluding California State Parks and lands covered under an HCP) within CAL FIRE's Coast Forest District (generally, within the range of the coast redwood), the Service (Arcata Fish and Wildlife Office) provided to CAL FIRE and foresters a document titled, Northern Spotted Owl Take Avoidance Analysis and Guidance for California Coast Forest District ("Attachment A"), dated March 15, 2011. In general, recommended habitat retention guidelines around known active northern spotted owl activity centers in include: (1) delineation of a 100 ac (40 ha) “Core Area” comprised of “nesting/roosting” habitat (defined in Attachment A), in which timber harvest does not occur; (2) retention of at least an additional 100 ac (40 ha) of “nesting/roosting” habitat within 0.7 mi (1.1

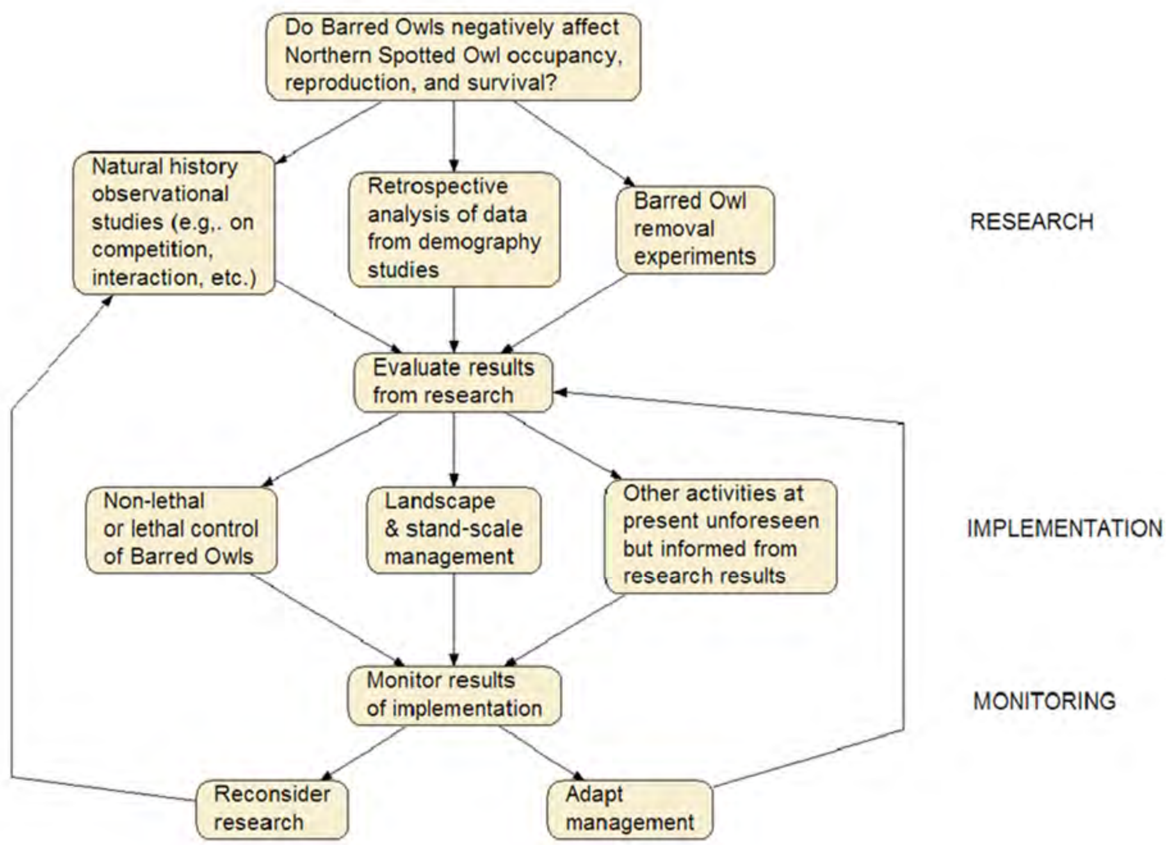
km) of an activity center; and (3) retention of at least 300 ac (121 ha) of “foraging” habitat (defined in Attachment A) within 0.7 mi (1.1 km) of an activity center.

For timber harvest activities that occur on non-Federal lands within CAL FIRE’s Interior Forest District, the Service (Arcata and Yreka Fish and Wildlife Offices) provided to CAL FIRE and foresters a document titled, Attachment B: Take Avoidance Analysis-Interior, dated February 27, 2008. In general, recommended habitat retention guidelines around known active northern spotted owl activity centers in include: (1) no harvest within 1,000 ft (305 m) of an activity center; (2) within 0.5 mi (0.8 km) radius (502 ac (203 ha) of an activity center, retention of four habitat types (as defined in Attachment B), including at least 100 ac (40 ha) “high quality nesting/roosting” habitat, 150 ac (61 ha) of “nesting/roosting” habitat, 100 ac (40 ha) of “foraging” habitat and 50 ac (20 ha) “low-quality foraging habitat”; and (3) between 0.5 mi (0.8 km) and 1.3 mi (2 km) radius circles on an activity center (2896 ac (1172 ha)), retention of greater than 935 ac (378 ha) of habitat, including at least 655 ac (265 ha) foraging habitat and at least 280 ac (113 ha) low-quality foraging habitat. Overall, State forest practice rules in California provide some protection to northern spotted owls and their habitat. However, nesting/roosting and foraging habitat continue to decline due to timber harvest on non-Federal lands in California.

Conservation Measures to Address Barred Owls

The 2011 Revised Recovery Plan for the Northern Spotted Owl contains ten recovery actions specific to addressing the barred owl threat. These include the establishment of protocols to detect barred owls and document barred owl site status and reproduction (Recovery Action 24), and the design and implementation of large-scale control experiments to assess effects of barred owl removal on northern spotted owl site occupancy, reproduction, and survival (Recovery Action 29). The manner in which this set of ten Recovery Actions is expected to contribute to northern spotted owl recovery is presented in Figure A-2.

Figure A-2. Flowchart of barred owl Recovery Actions (Service 2011b, p. III-66, Figure III-1).



Several barred owl recovery actions have been completed, and recovery Action 29 is currently ongoing. The Barred Owl Removal Experiment (Service 2013a and Service 2013b) was developed based on a pilot project at Green Diamond Resources study area that demonstrated barred owl removal had rapid, positive effects on northern spotted owl survival and the rate of population change (Dugger et al. 2016, p. 58). This experiment is currently being implemented under the direction of USGS, the Hoopa Tribe, and APHIS in partnership with the Service. The research program is evaluating the effectiveness of barred owl removal as a potential recovery strategy for northern spotted owls on one study area in Washington, two study areas in Oregon, and one study area in northern California. Barred owl removal was implemented on the California study area in fall/winter 2013-2014, and on the Washington and one of the Oregon study areas in fall/winter 2015-2016. Barred owl removal on the final Oregon study area was initiated in fall of 2016. Removal was scheduled to occur for a minimum of four consecutive years at each study area but could be extended if northern spotted owl population results from the initial removal are not definitive.

Under the BLM RMPs, the BLM will support barred owl management on their lands as informed by the outcome of the Barred Owl Removal Experiment. In the interim, the BLM is avoiding incidental take of northern spotted owls resulting from timber harvest on their lands. This support is intended to mitigate for the adverse effects associated with timber harvest and other resource programs, and result in a net positive impact on the recovery of northern spotted owls (Service 2016, p. 701).

Results from this experiment will provide future management guidance for the recovery of the northern spotted owl. Annual reports on study progress are provided each year, and a final report is anticipated in 2022. While results of this experiment are not yet fully analyzed, removal has resulted in a substantial increase in the apparent survival of northern spotted owls on the Hoopa Reservation in California, the longest running of the study areas in the experiment, improving by nearly 10 percent over the apparent survival for the 5 years prior to the initiation of removal (Carlson et. al. 2019, p 9). On the three study areas in Oregon and Washington, the occupancy of spotted owl sites continues to decline on the control areas where no barred owls are removed but appears to have stabilized or increased slightly on the treatment areas where barred owls are removed. However, the number of spotted owls on these areas is very low. Statistical analysis has not been completed on these areas yet (Wiens et. al. 2019, pp 12-13).

Safe Harbor Agreements in Oregon for Barred Owl Experiment

There are currently four SHAs specific to the Service's ongoing Barred Owl Removal Experiment in Oregon. The SHAs were limited to areas managed by landowners that were willing to work with the Service to provide access for survey and removal of barred owls on their lands within the study areas. Agreements were established with Roseburg Resources Company, Oxbow I LLC, Weyerhaeuser Company, and Oregon Department of Forestry to facilitate successful completion of this research project. The Barred Owl Removal Experiment implements Recovery Action 29 of the 2011 Revised Recovery Plan for the Northern Spotted Owl (Service 2011b, p. III-65). The Barred Owl Removal Experiment is being implemented on two study areas in Oregon, one in the Oregon Coast Ranges west of Eugene, Oregon, and one in the forest lands around Canyonville, Oregon. While the experiment is focused on Federal lands, the landscapes involved in the study areas include significant interspersed private and state lands. In the Oregon Coast Ranges study area, this includes lands owned by Roseburg Resources Company and Oxbow Timber I, LLC (SHA covers 9,400 ac (3,804 ha) of land total, 308 ac (125 ha) of currently unoccupied northern spotted owl habitat for which an incidental take permit was issued); Weyerhaeuser Company (SHA covers 1,072 ac (434 ha) total, 817 ac (331 ha) of currently unoccupied northern spotted owl habitat for which an incidental take permit was issued), and lands managed by Oregon Department of Forestry (SHA covers 20,000 ac (8,093 ha) total, 3,345 ac (1,354 ha) of currently unoccupied northern spotted owl habitat for which an incidental take permit was issued). In the Union/Myrtle (Klamath) study area in southern Oregon, this includes lands owned by Roseburg Resources Company (SHA covers 45,100 ac (18,251 ha) of land total, 7,080 ac (2865 ha) of currently unoccupied northern spotted owl habitat for which an incidental take permit was issued). Access to these non-Federal lands is important to the effective and efficient completion of the experiment.

Through these four SHAs, Roseburg Resources Company, Oxbow I LLC, Weyerhaeuser Company, and Oregon Department of Forestry will contribute to the conservation of the northern spotted owl by allowing the researchers to survey for barred owls on their lands throughout the Study Area and remove barred owls from their lands within the removal portion of the experiment. The section 10 permit issued to them as part of the SHA provides these landowners with short-term incidental take authorization through habitat modification for northern spotted owls that may return to non-baseline northern spotted owl sites (unoccupied by resident northern spotted owls for the three years prior to the initiation of removal on the area) after the removal of barred owls. However, this information and access is crucial to efficient and effective implementation of this experiment. Information from this experiment is critical to the development of a long-term management strategy to address the barred owl threat to the northern spotted owl.

Rangewide Environmental Baseline

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

Habitat Trends

The Service has used information provided by the USFS, BLM, and National Park Service to update the habitat baseline conditions by tracking relative habitat changes over time on Federal lands for northern spotted owls on several occasions, since the northern spotted owl was listed in 1990 (USFS and BLM 1994b, Service 2001, Lint 2005, Davis et al. 2011, Davis et al. 2016). These NWFP monitoring reports assess the status and trends of northern spotted owl habitat across 22.1 million acres of federally administered forest lands in addition to 23.8 million acres of nonfederal forest lands within the range in the United States. The estimate of 7.4 million acres used for the NWFP in 1994 (USFS and BLM 1994b) was believed to be representative of the general amount of northern spotted owl habitat on NWFP lands at that time. These periodic rangewide evaluations of northern spotted owl habitat (Lint 2005, Davis et al. 2011, Davis et al. 2016) are used to determine if the rate of change to northern spotted owl habitat has been consistent with changes in amount of habitat anticipated under the NWFP and described in the Final Supplemental Environmental Impact Statement (FSEIS; USFS and USDI 1994b). Each analysis has used more up-to-date and higher quality data than the previous analyses and new analytical methods have been incorporated over time. While this improved the overall quality of the information provided, it also means that individual reports should not be compared directly without fully understanding the processes used to develop the results.

Trends for suitable habitat are largely declining rangewide, with rates of loss varying by province and land allocation. Approximately 9,089,700 acres of northern spotted owl nesting/roosting habitat existed on Federal lands and 3,436,000 acres existed on non-federal lands at the beginning of the NWFP in 1994/1996 Davis and others (2016, pp.23-24). Two decades into the NWFP, Davis and others (2016, tables 6 and 7, pp. 21-22) reported a gross loss of about 650,200 acres of nesting/roosting habitat, representing about 7.2 percent of what was present in 1994/1996. Most of the losses (73 percent) occurred within the federally reserved LUAs, or a loss of about 7.5 percent of the habitat reserved by the NWFP; the majority of these losses were due to high severity fires within the Klamath Physiographic Provinces.

Most of the gains occurred in the moister physiographic provinces (e.g., Coast Ranges and Western Cascades) however, there was also a large gain (13.5 percent) in the Oregon Eastern Cascades. Authors noted that habitat recruitment estimates have a higher level of uncertainty than estimates of habitat loss, for reasons detailed in the NWFP 15-year monitoring report (Davis et al. 2011, pgs. 48 and 49). Although the spatial resolution of this rangewide habitat map currently makes it unsuitable for tracking habitat effects at the scale of individual projects, the Service has evaluated the map for use in tracking provincial and rangewide habitat trends and now considers these data as the best available information on the distribution and abundance of extant northern spotted owl habitat within its range as of 2012 for Oregon and Washington, and California, when the base imagery was collected. The Service also considers habitat effects that are documented through the section 7 consultation process since 1994. The analytical framework of these consultations focuses on the reserve and connectivity goals established by the NWFP land-use allocations (USFS and BLM 1994a), with effects expressed in terms of changes in suitable northern spotted owl habitat within those land-use allocations.

In February 2013, the Service adopted the 2006/07 satellite imagery data on northern spotted owl habitat as the new rangewide habitat baseline for Federal lands, effectively resetting the timeframe for establishing changes in the distribution and abundance of northern spotted owl habitat. These data were refreshed in May of 2017 to reflect the 2012 remotely-sensed layer utilized in Davis et al., 2016. A new analysis based on the 2017 imagery has been published in 2022.

According to this 2022 report, estimates in nesting and roosting habitat have increased from 8.89 million acres in 1993 to 9.15 million acres in 2017 on the Northwest Forest Plan Federal lands, which is an overall net gain of about 3 percent (Davis et al. 2022, abstract, p. 29). However, while some nesting and roosting habitat was gained due to succession, 1.05 million acres on federal land were also lost, and this is equal to an 11.8 percent loss since 1993 (Davis et al. 2022, p. 29). The largest sources of loss between 1993 and 2017 were mainly from wildfire (703,700 acres or 7.9 percent loss) and timber harvest (257,700 acres or 2.9 percent loss) (Davis et al. 2022, abstract).

Across all lands (Federal and non-federal), nesting and roosting habitat increased from approximately 12.37 million acres to 12.63 million acres, which is a net gain of about 2.1 percent from 1993 to 2017 (Davis et al. 2022, p. 32). This gain was due to succession; however, 2.93 million acres of nesting/roosting habitat were also lost, which is equal to a 23.7 percent loss since 1993. The largest sources of loss during this period were from wildfire (785,700 acres or 6.3 percent loss) and timber harvest (2.05 million acres or 16.6 percent loss) (Davis et al. 2022, p. 32). While wildfire was the primary cause of habitat loss on Federal lands, timber harvest was the primary cause of habitat loss on non-federal lands (Davis et al. 2022, pp. 29-32).

Service’s Consultation Database

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

Rangewide Consultation Effects: 1994 to April 14, 2021

Between 1994 and April 14, 2021, the Service has consulted on the proposed removal/downgrade of approximately 241,782 acres of federal nesting/roosting habitats (Table A-1) or about 2.7 percent of the 9.09 million acres of northern spotted owl nesting/roosting habitat estimated by Davis et al. (2016, p. 21) to have occurred on Federal lands in 1994. These changes in suitable northern spotted owl habitat are consistent with the expectations for implementation of the NWFP, which anticipated a rate of habitat harvested at 2.5 percent per decade (USFS and BLM 1994a).

The Service also tracks habitat changes on non-NWFP lands through consultations including long-term Habitat Conservation Plans, Safe Harbor Agreements, or Tribal Forest Management Plans. Consultations conducted since 1994 have documented the eventual combined reduction of about 523,079 acres of habitat on non-NWFP lands. Most of the losses on non-NWFP lands have yet to be realized because they are part of long-term management plans.

In 2017, the Service updated the nesting /roosting habitat baseline which impacts are evaluated against, based on the 2012 habitat layer documented in Davis et al. (2016, p. 21) which is the most current evaluation of northern spotted owl habitat. The acre values for the Service's 2012 baseline in Table A-2 varies slightly from the acre values in Davis et al. (2016, p. 21), with the total acre variation being 0.09 percent. Davis et al. (2016, p. 21) rounded to the nearest 100 acres, but this does not explain all the variation. In 2016, the BLM in Oregon changed their land use allocations. Therefore, the 2012 base habitat layer was divided by different land use allocations representing reserves and non-reserved lands than was used to produce Davis et al. (2016, p. 21). Due to raster data (2012 habitat layer) overlaid on polygons (land use allocations representing reserves and non-reserved lands) there is some error in the identification of acres. The use of a different polygon layer, than used for the Davis et al. (2016, p. 21) land use allocations, resulted in different physiographic province reserves and non-reserved lands habitat acres. The combination of errors is extremely small and is still the best available information to use. This highlights that this data is to be used at a landscape level and may not be appropriate at the finer local scale. Since 2012, the acres reported as removed/downgraded are summarized by origin and by province (Table A-2).

Table A-1: Northern Spotted Owl Take/Effect Reports Table A - Rangewide summary of effects to northern spotted owl nesting/roosting habitat[1] (acres) documented through ESA section 7 consultations or technical assistance reports; 1994 to present (December 27, 2021).

Old Table

Land Ownership	Consulted On Habitat Changes[2]		Other Habitat Changes[3]	
	Removed/ Downgraded	Maintained/ Improved	Removed/ Downgraded	Maintained/ Improved
USFS, BLM, and NPS	330,865	687,106	739,165	169,769
Bureau of Indian Affairs / Tribes	116,446	28,893	3,954	0
Habitat Conservation Plans/Safe Harbor Agreements	340,301	14,545	0	0
Other Federal, State, County, Private Lands	68,813	28,447	3,822	0
Total Changes	**856,425**	**758,991**	**746,941**	**169,769**

Latest Table A- numbers are a little different

Land Ownership	Consulted On Habitat Changes[2]		Other Habitat Changes[3]	
	Removed/ Downgraded	Maintained/ Improved	Removed/ Downgraded	Maintained/ Improved
USFS, BLM, and NPS	330,876	687,106	739,261	169,925
Bureau of Indian Affairs / Tribes	116,446	28,893	3,954	0
Habitat Conservation Plans/Safe Harbor Agreements	340,301	14,545	0	0
Other Federal, State, County, Private Lands	68,813	28,447	3,822	0
Total Changes	**856,436**	**758,991**	**747,037**	**169,925**

Notes:

1. Northern spotted owl suitable habitat includes nesting/roosting habitat, and foraging habitat. Nesting/roosting habitat supports all life-history functions for spotted owls including foraging, and is sometimes referred to as nesting, roosting, and foraging habitat (NRF). Foraging-only habitat is a separate category that can include more open and fragmented forests and does not provide structures for nesting/roosting. Habitat effects summarized in this table are all classified as impacts to nesting/roosting habitats. Impacts to foraging-only habitat are tracked separately.
2. Includes effects documented through ESA section 7 consultations for the period from 1994 to 6/26/2001 (Service 2001) and all subsequent effects reported in the USFWS Tracking and Integrated Logging System - Northern Spotted Owl Consultation Effects Database (web application and database).
3. Includes effects to northern spotted owl nesting/roosting habitat documented through technical assistance reports resulting from wildfires and other natural causes, private timber harvest, and/or land exchanges not associated with ESA section 7 consultations.

Table A-2. Northern Spotted Owl Take/Effect Reports Table B - Summary of northern spotted owl nesting/roosting[1] habitat (acres) removed or downgraded as documented through ESA section 7 consultations on Federal lands. Environmental baseline and summary of effects by state, province, and land use function from 2012 to present (December 27, 2021).

Old Table

State	Physiographic Province[2]	Evaluation Baseline (2012)[3]			Nesting/Roosting Habitat Removed/Downgraded[4]							% Provincial Baseline Affected	% Range-wide Effects
					Land Management Effects			Habitat Loss from Natural Events					
		NR Acres in Reserves	NR Acres in Non-Reserves	Total NR Acres	Reserves[5]	Non-Reserves[6]	Total	Reserves	Non-Reserves	Total	Total NR removed/ downgraded		
WA	Eastern Cascades	554,786	224,876	779,662	2,504	55	2,559	123,967	0	123,967	126,526	16.23	21.37
	Olympic Peninsula	714,555	23,084	737,639	1	0	1	0	0	0	1	0.00	0.00
	Western Cascades	957,314	212,325	1,169,639	15	188	203	4,320	0	4,320	4,523	0.39	0.76
	Western Lowlands	12,964	3	12,967	0	0	0	0	0	0	0	0.00	0.00
OR	Cascades East	206,719	133,080	339,799	1,251	8,808	10,059	3,305	1,981	5,286	15,345	4.52	2.59
	Cascades West	1,425,026	949,045	2,374,071	4,569	11,250	15,819	25,804	78,979	104,783	120,602	5.08	20.37
	Coast Range	468,575	38,898	507,473	2,594	2,177	4,771	0	0	0	4,771	0.94	0.81
	Klamath Mountains	706,840	227,726	934,566	9,462	80,958	90,420	47,865	44,880	92,745	183,165	19.60	30.94
	Willamette Valley	3,688	3,938	7,626	0	0	0	0	28,438	28,438	28,438	372.91	4.80
CA	Cascades	120,067	89,316	209,383	0	174	174	0	0	0	174	0.08	0.03
	Coast	113,857	9,999	123,856	0	0	0	0	3,073	3,073	3,073	2.48	0.52
	Klamath	1,143,050	622,027	1,765,077	387	727	1,114	33,333	70,967	104,300	105,414	5.97	17.81
	Total	**6,427,441**	**2,534,317**	**8,961,758**	**20,783**	**104,337**	**125,120**	**238,594**	**228,318**	**466,912**	**592,032**	**6.61**	**100.00**

Latest Table B- numbers are a little different

State	Physiographic Province[2]	Evaluation Baseline (2012)[3]			Nesting/Roosting Habitat Removed/Downgraded[4]							% Provincial Baseline Affected	% Range-wide Effects
					Land Management Effects			Habitat Loss from Natural Events					
		NR Acres in Reserves	NR Acres in Non-Reserves	Total NR Acres	Reserves[5]	Non-Reserves[6]	Total	Reserves	Non-Reserves	Total	Total NR removed/ downgraded		
WA	Eastern Cascades	554,786	224,876	779,662	2,504	55	2,559	123,967	0	123,967	126,526	16.23	21.37
	Olympic Peninsula	714,555	23,084	737,639	1	0	1	0	0	0	1	0.00	0.00
	Western Cascades	957,314	212,325	1,169,639	15	188	203	4,320	0	4,320	4,523	0.39	0.76
	Western Lowlands	12,964	3	12,967	0	0	0	0	0	0	0	0.00	0.00
OR	Cascades East	206,719	133,080	339,799	1,251	8,808	10,059	3,305	1,981	5,286	15,345	4.52	2.59
	Cascades West	1,425,026	949,045	2,374,071	4,569	11,250	15,819	25,804	78,979	104,783	120,602	5.08	20.37
	Coast Range	468,575	38,898	507,473	2,594	2,177	4,771	0	0	0	4,771	0.94	0.81
	Klamath Mountains	706,840	227,726	934,566	9,462	80,958	90,420	47,891	44,880	92,771	183,191	19.60	30.94
	Willamette Valley	3,688	3,938	7,626	0	0	0	0	28,438	28,438	28,438	372.91	4.80
CA	Cascades	120,067	89,316	209,383	0	174	174	0	0	0	174	0.08	0.03
	Coast	113,857	9,999	123,856	0	0	0	0	3,073	3,073	3,073	2.48	0.52
	Klamath	1,143,050	622,027	1,765,077	387	727	1,114	33,333	70,967	104,300	105,414	5.97	17.80
	Total	**6,427,441**	**2,534,317**	**8,961,758**	**20,783**	**104,337**	**125,120**	**238,620**	**228,318**	**466,938**	**592,058**	**6.61**	**99.99**

Notes:

1. Northern spotted owl suitable habitat includes nesting/roosting habitat, and foraging habitat. Nesting/roosting habitat supports all life-history functions for northern spotted owls including foraging, and is sometimes referred to as nesting, roosting, and foraging habitat (NRF). Foraging-only habitat is a separate category that can include more open and fragmented forests and does not provide structures for nesting/roosting. Habitat effects summarized in this table are all classified as impacts to nesting/roosting habitat. Impacts to foraging-only habitat are tracked separately.
2. Defined in the Revised Recovery Plan for the Northern Spotted Owl (Service 2011) as Recovery Units as depicted on page A-3.
3. Northern spotted owl nesting/roosting (NR) habitat on Federal lands (includes USFS, BLM, NPS, DoD, Service) based on GIS data developed for the Northwest Forest Plan 20-year monitoring report for northern spotted owl habitat as reported by Davis et al. 2016 (PNW-GTR-929). Nesting/roosting habitat acres are approximate values based on 2012 satellite imagery. Values reported here may vary slightly from values reported in PNW-GTR-929.
4. Estimated nesting/roosting habitat removed or downgraded from land management (e.g., timber sales) or natural events (e.g., wildfires) as documented through section 7 consultation or technical assistance. Effects reported here include acres removed or downgraded from 2012 to present.
5. Reserve land use allocations intended to provide northern spotted owl demographic support include Late-Successional Reserves identified in the Northwest Forest Plan on National Forests, designated Wilderness, and other Congressionally-reserved lands. Reserves on BLM lands in western Oregon managed under the 2016 revised Land and Resource Management Plans include Late-Successional Reserves, Congressionally-reserved lands, National Landscape Conservation System lands, and some District Designated Reserves (e.g., Areas of Critical Environmental Concern).
6. Non-reserve lands intended to provide northern spotted owl dispersal connectivity between reserves include USFS and BLM designations for timber production (matrix and harvest land base designations), Adaptive Management Areas, and other non-reserved land use designations.

Recently, the Service modified the database input to account for effects to the habitats that could be used as foraging, but that lack the age or structural characteristics of habitats used for nesting and roosting (NR). This distinction may not be made in all consultations. These data represent effects as reported in individual consultations and likely do not represent the entirety of impacts to foraging habitat within critical habitat since 2012. For many projects, affected foraging likely is captured within the “NR” acres as foraging habitat was lumped into “nesting/roosting/foraging habitat” at the time of consultation. Table A-3 summarizes the acres of foraging habitat removed or downgraded.

Table A-3. Northern Spotted Owl Take/Effect Reports Table B2 - Summary of northern spotted owl foraging habitat[1] (acres) removed or downgraded as documented through ESA section 7 consultations on Federal lands. Summary of effects by state, province, and land use function from 2012 to present (December 27, 2021).

State	Physiographic Province[2]	Foraging Habitat Removed/Downgraded[3]						
		Land Management Effects			Habitat Loss from Natural Events			
		Reserves[4]	Non-Reserves[5]	Total	Reserves	Non-Reserves	Total	Total Foraging Habitat removed/ downgraded
WA	Eastern Cascades	0	0	0	0	0	0	0
	Olympic Peninsula	0	0	0	0	0	0	0
	Western Cascades	0	10	10	0	0	0	10
	Western Lowlands	0	0	0	0	0	0	0
OR	Cascades East	124	2,738	2,862	0	124	124	2,986
	Cascades West	263	1,746	2,009	0	0	0	2,009
	Coast Range	24	2,050	2,074	0	0	0	2,074
	Klamath Mountains	242	6,867	7,109	0	0	0	7,109
	Willamette Valley	0	0	0	0	0	0	0
CA	Cascades	571	248	819	0	0	0	819
	Coast	0	1	1	0	8,036	8,036	8,037
	Klamath	1,454	655	2,109	15,521	16,122	31,643	33,752
	Total	**2,678**	**14,315**	**16,993**	**15,521**	**24,282**	**39,803**	**56,796**

Notes:

1. Northern spotted owl suitable habitat includes nesting/roosting habitat, and foraging habitat. Nesting/roosting habitat supports all life-history functions for northern spotted owls including foraging, and is sometimes referred to as nesting, roosting, and foraging habitat (NRF). Foraging-only habitat is a separate category that can include more open and fragmented forests and does not provide structures for nesting/roosting. Habitat effects summarized in this table are all classified as impacts to nesting/roosting habitat. Impacts to foraging-only habitat are tracked separately.
2. Defined in the Revised Recovery Plan for the Northern Spotted Owl (Service 2011) as Recovery Units as depicted on page A-3.
3. Northern spotted owl nesting/roosting (NR) habitat on Federal lands (includes USFS, BLM, NPS, DoD, Service) based on GIS data developed for the Northwest Forest Plan 20-year monitoring report for northern spotted owl habitat as reported by Davis et al. 2016 (PNW-GTR-929). Nesting/roosting habitat acres are approximate values based on 2012 satellite imagery. Values reported here may vary slightly from values reported in PNW-GTR-929. Estimated nesting/roosting habitat removed or downgraded from land management (e.g., timber sales) or natural events (e.g., wildfires) as documented through section 7 consultation or technical assistance. Effects reported here include acres removed or downgraded from 2012 to present.
4. Reserve land use allocations intended to provide northern spotted owl demographic support include Late-Successional Reserves identified in the Northwest Forest Plan on National Forests, designated Wilderness, and other Congressionally-reserved lands. Reserves on BLM lands in western Oregon managed under the 2016 revised Land and Resource Management Plans include Late-Successional Reserves, Congressionally-

reserved lands, National Landscape Conservation System lands, and some District Designated Reserves (e.g., Areas of Critical Environmental Concern).

5. Non-reserve lands intended to provide northern spotted owl dispersal connectivity between reserves include USFS and BLM designations for timber production (matrix and harvest land base designations), Adaptive Management Areas, and other non-reserved land use designations.

Other Past Habitat Trend Assessments

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

Moeur et al. 2005 estimated an increase of approximately 1.25 to 1.5 million acres of medium and large older forest (greater than 20 inches dbh, single and multi-storied canopies) on Federal lands in the NWFP area between 1994 and 2003. The increase occurred primarily in the lower end of the diameter range for older forest. In the greater than 30-inch dbh size class, the net area increased by only an estimated 102,000 to 127,000 acres (Moeur et al. 2005). The estimates were based on change-detection layers for losses due to harvest and fire and re-measured inventory plot data for increases due to ingrowth. Transition into and out of medium and large older forest over the 10-year period was extrapolated from inventory plot data on a subpopulation of Forest Service land types and applied to all Federal lands. Because size class and general canopy layer descriptions do not necessarily account for the complex forest structure often associated with northern spotted owl habitat, the significance of these acres to northern spotted owl conservation remains unknown.

Population Trends

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

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

Because the existing survey coverage and effort are insufficient to produce reliable rangewide estimates of population size, demographic data are used to evaluate trends in northern spotted owl populations. Analysis of demographic data can provide an estimate of the finite rate of population change (λ), which provides information on the direction and magnitude of population change. A λ of 1.0 indicates a stationary population, meaning the population is neither increasing nor decreasing. A λ of less than 1.0 indicates a decreasing population, and a λ of greater than 1.0 indicates a growing population. Demographic data, derived from studies initiated as early as 1985, have been analyzed periodically to estimate trends in the populations of the northern spotted owl (Anderson and Burnham 1992; Burnham et al. 1994; Forsman et al. 1996; Anthony et al. 2006; Forsman et al. 2011; Dugger et al. 2016; Franklin et al. 2021).

The most recent meta-analysis (Franklin et al. 2021) found continued declines in virtually all demographic parameters evaluated (Table A-4). Estimates of annual rates of population change, occupancy rates, and realized population change showed continuing declines across the range, and the annual rate of decline has increased in most areas, including southern Oregon and northern California. Populations in all study areas are declining, including those study areas that had been relatively stable in earlier analyses (Franklin et al. 2021, pp. 12-13). Notably, the rate of realized population change for northern spotted owls in demographic study areas in Washington, as well as the Coast Range and Klamath study areas in Oregon, showed declines of 75 percent or more between 1995 and 2017. Other Oregon study areas showed declines of over 60 percent over the same time period. In California, declines ranged from more than 60 percent over the same time period, to 30 percent at Hoopa between 1995 and 2013, to exclude the period when barred owl removal was conducted at Hoopa (Franklin et al. 2021, p. 13). These findings indicate that these populations are declining over time and the rate of decline is increasing. The probability of occupancy has declined in all three states over the past two decades (Franklin et al. 2021, p. 17). The lowest recent occupancy rates were observed in Washington study areas, as well as the Coast Range and Tyee study areas in Oregon, where 2017 occupancy rates were below 25 percent. The other Oregon study areas had 2017 occupancy rates of approximately 25 percent. In California, 2017 occupancy rates were between 25 and 50 percent; 2017 data were not given for Hoopa, which was between 50 and 75 percent occupied in 2013.

Current estimates of the rangewide northern spotted owl population are not available. Two methods of estimating populations have previously been described - records of known sites and population modeling. There is no central database containing all known site information, but the number of known sites was documented in 1995 in a Federal Register notice (Service 1995, p. 9495). Population modeling was conducted for the 2012 critical habitat designation, and further research has been conducted using the same population modeling framework. We can also combine each of these methods of population estimation with information from the most recent demographic meta-analysis to update these earlier estimates.

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

Estimated populations were modeled during the 2012 critical habitat designation which projected a steady-state rangewide population size of roughly 3,000 female northern spotted owls. Note that this steady-state population estimate was not meant to be a measure of actual population size, but rather an estimate of landscape capacity, given the amount of suitable habitat (modelled based on 2006 satellite imagery) and competition with barred owls. Steady-state population estimates varied regionally from low in the north, especially the northwest (e.g., far fewer than 100 female northern spotted owls in the North Coast Olympics and West Cascades North modeling regions), to high in parts of southern Oregon and northern California (e.g., between around 400 and 750 females each in the Inner California Coast, Klamath East, Klamath West, Redwood Coast, and West Cascades South modeling regions) (Dunk et al., 2012, p. 64). These estimates likely over-represent the numbers of females as this modeling effort does not reflect the effects of habitat loss since 2006, or of increasing encounter rates with barred owls in the southern portion of the range.

Additionally, the actual number of currently occupied northern spotted owl locations across the range is unknown because many areas remain un-surveyed (Service 2011a, p. A-2) and many historical sites are no longer occupied because northern spotted owls have been displaced by barred owls, timber harvest, or severe fires. However, displaced northern spotted owls may survive in new territories or as floaters, and so may still be present in the population. Other factors such as impacts of anticoagulant rodenticides have likely negatively affected localized northern spotted owl populations (Gabriel et al. 2018, p. 6). Another unmeasured factor might include the possibility that some new sites have been established due to reduced timber harvest on Federal lands since 1994. At 10 long-term study areas where local northern spotted owl populations have been tracked since 1995 or before, without barred owl management, the average annual rate of population change from 1995 through 2017 was -5.3 percent (Franklin et al. 2021, p. 13). This rate of decline has not been consistent throughout the entire 22-year period, but rather, it was shallower in the earlier years and has become steeper in recent years. In 2016, the annual rate of change for 1985 through 2013 was estimated to be -3.8 percent, and in 2011, the annual rate of change for 1990 through 2006 was estimated to be -2.9 percent (Dugger et al. 2016, p. 70; Forsman et al. 2011, p. 65).

If we simplistically assume that all 5,431 sites known in 1994 were occupied in 1995, and that site occupancy has decreased proportionally to the rate of population change, we would expect that approximately 1,318 (calculated as 5,431 *0.947^26) of these sites would remain occupied in 2021. More realistically, it is likely that some of these sites were unoccupied in 1995, but also that some number of other sites were occupied in 1995 but remained unknown due to lack of survey. Furthermore, the rate of decline in site occupancy may have outpaced the decline in the population, as barred owls have displaced northern spotted owls, increasing the proportion of floaters in the population. Because these realistic considerations include some sources of overestimation and other sources of underestimation, all of unknown magnitude, it is not clear whether this might be an overestimate or an underestimate of the number of currently occupied sites.

Similarly, if we simplistically assume that 3,074 females were present in the rangewide population in 2006, as estimated for the steady-state population in the critical habitat modeling exercise, and that the number of females has declined by 5.3 percent per year since then, we would expect that 1,358 (calculated as 3,074*0.947^15) females would be present in the 2021 rangewide population. More realistically, it is not clear how well the steady-state population estimates approximated the actual 2006 northern spotted owl population, and the rate of population change between 2006 and 2021 has likely been steeper than -5.3.

Based on both of these adjustments to earlier estimates of the number of sites and females in the population, we hypothesize that there are likely 3,000 or fewer individuals present in the rangewide population as of 2021.

Table A-4. Summary of most recent northern spotted owl population trends from in demographic study areas in Washington, Oregon, and California 1985-2017 (Derived from Franklin et al. 2021, pp. 10-18).

Study Area	Apparent Survival	Territory Colonization	Territory Extirpation	Occupancy Rates	Population Trend	Mean Lambda [a]	% 1995 Pop Size in 2017
Washington							
CLE	Declining	Declining	Increasing	Declining	Declining	0.91	<20%
RAI	Declining	Declining	Increasing	Declining	Declining	0.94	25%
OLY	Declining	Declining	Increasing	Declining	Declining	0.91	<20%
Oregon							
COA	Declining	Declining	Increasing	Declining	Declining	0.92	<25%
HJA	Declining	Declining	Increasing	Declining	Declining	0.96	<40%
TYE	Declining	Not significant	Increasing	Declining	Declining	0.96	<40%
KLA	Declining	Declining	Increasing	Declining	Declining	0.93	<25%
CAS	Declining	Declining	Increasing	Declining	Declining	0.96	<40%
California							
NWC	Declining	Not significant	Increasing	Declining	Declining	0.98	50%
HUP[b]	Declining	Not significant	Increasing	Declining	Declining	0.98	70%
GDR[c]	Declining	Not significant	Increasing	Declining	Declining	0.94	<40%

[a] Approximate estimates from Franklin et al. 2021, pp. 11-12 and Figure 7; lambda estimates not listed by study area.

[b] Trends calculated only through 2012, prior to commencement of barred owl removal

[c] Data used for occupancy modeling in the GDR study area excluded treatment areas after Barred Owl removals began in 2009.

In the northern-most portion of the range in British Columbia, few northern spotted owls are remaining. Chutter et al. (2004, p. v) suggested immediate action was required to improve the likelihood of recovering the northern spotted owl population in British Columbia. In 2007, personnel in British Columbia captured and brought into captivity the remaining 16 known wild northern spotted owls (Service 2011b, p. A-6). Prior to initiating the captive-breeding program, the population of northern spotted owls in Canada was declining by as much as 10.4 percent per year (Chutter et al. 2004, p. v). As of 2016, this program included 17 northern spotted owls, eight of which were born in captivity (British Columbia 2017, p. 1). The program is targeted to produce annually up to 20 captive-born owls ready for release back into the wild until the population reaches 200. In summer 2022, three spotted owls born and raised through this breeding program were released for the first time into the wild (gov.bc.ca; nsobreedingprogram.com). The amount of previous interaction between northern spotted owls in Canada and the United States is unknown.

Northern spotted owl Critical Habitat

Legal Status

The final rule designating critical habitat for the northern spotted owl was published on December 4, 2012 (Service 2012a) and became effective on January 3, 2013. On November 10, 2021, the USFWS issued a final rule that took effect on December 10, 2021, which revised the total area of designated critical habitat for the spotted owl. Approximately 204,294 acres of critical habitat located in Oregon were excluded, while the total area of critical habitat in Washington and California remained unchanged (86 FR 62606 [November 10, 2021]). Critical habitat for the spotted owl now includes approximately 9,373,676 acres in 11 units and 60 subunits in California, Oregon, and Washington (86 FR 62606:62641 [November 10, 2021]). Our GIS data on current total area of designated critical habitat vary slightly (9,372,892 acres) from the total number of acres published in the Federal Register (a difference of 784 acres). We used the Albers Equal Area Conic (EPSG:5070) projection.

Designation of critical habitat serves to identify those lands that are necessary for the conservation and recovery of the listed species. In this case, the Service's primary objective in designating critical habitat was to identify capable and existing essential northern spotted owl habitat and highlight specific areas where management of the northern spotted owl and its habitat should be given highest priority. The expectation of critical habitat is to ameliorate habitat-based threats. The recovery of the northern spotted owl requires habitat conservation in concert with the implementation of recovery actions that address other, non-habitat-based threats to the species, including the barred owl (Service 2012a, p. 71879). The conservation role of northern spotted owl critical habitat is to "adequately support the life-history needs of the species to the extent that well-distributed and inter-connected northern spotted owl nesting populations are likely to persist within properly functioning ecosystems at the critical habitat unit and range-wide scales" (Service 2012a, p. 71938). The specific conservation roles of the subunits included in the action area are described below in the Environmental Baseline.

Physical or Biological Features and Primary Constituent Elements

When designating critical habitat, the Service considers "the physical or biological features [PBFs] essential to the conservation of the species and which may require special management considerations or protection" (50 CFR §424.12; Service 2012a, p. 71897). "These include but are not limited to: (1) space for individual and population growth and for normal behavior; (2) food, water, air, light, minerals, or other nutritional or physiological requirements; (3) cover or shelter; (4) sites for breeding, reproduction, or rearing (or development) of offspring; and (5) habitats that are protected from disturbance or are representative of the historical, geographical, and ecological distributions of a species" (Service 2012a, p. 71897). The final critical habitat rule states that "for the northern spotted owl, the physical or biological features essential to the conservation of the species are forested areas that are used or likely to be used for nesting, roosting, foraging, or dispersing" (Service 2012a, p. 71897). The final critical habitat rule for the northern spotted owl provides an in-depth discussion of the PBFs, which may be referenced for further detail (Service 2012a, pp. 71897-71906).

The final rule for critical habitat defines the primary constituent elements (PCEs) as the specific elements of the PBFs that are considered essential to the conservation of the northern spotted owl and are those elements that make areas suitable as nesting, roosting, foraging, and dispersal habitat (Service 2012a, p. 71904). In 2016, the Service returned to the use of statutory reference of PBFs rather than PCEs when evaluating and discussing the availability and function of, as well as the effects to the attributes of critical habitat in the adverse modification analysis (Service and USDC NOAA 2016, p. 2716). References to PCE here are to be consistent with cited critical habitat rule. The PCEs should be arranged spatially such that it is favorable to the persistence of populations, survival and reproductive success of resident pairs, and survival of dispersing individuals until they are able to recruit into a breeding population (Service 2012a, p. 71904). Within areas essential for the conservation and recovery of the northern spotted owl, the Service has determined that the PCEs are:

1: Forest types that may be in early-, mid-, or late-seral stages and that support the northern spotted owl across its geographic range;
2: Habitat that provides for nesting and roosting;
3: Habitat that provides for foraging;
4: Habitat to support the transience and colonization phases of dispersal, which in all cases would optimally be composed of nesting, roosting, or foraging habitat (PCEs 2 or 3), but which may also be composed of other forest types that occur between larger blocks of nesting, roosting, or foraging habitat (Service 2012, pp. 72051-72052).

Some critical habitat subunits may contain all of the PBFs and support multiple life history requirements of the northern spotted owl, while some subunits may contain only those PBFs necessary to support the species' particular use of that habitat. All of the areas designated as critical habitat, however, do contain PCE 1, forest type. As described in the final rule, PCE 1 always occurs in concert with at least one other PCE (PCE 2, 3, or 4; Service 2012a, p. 72051). Northern spotted owl critical habitat does not include meadows, grasslands, oak woodlands, aspen woodlands, or manmade structures and the land upon which they are located (Service 2012a, p. 71918).

PCE 1: Forest Types

The primary forest types that support the northern spotted owl are: Sitka spruce, western hemlock, mixed conifer, mixed evergreen, grand fir, Pacific silver fir, Douglas-fir, white fir, Shasta red fir, redwood/Douglas-fir, and moister ponderosa pine (Service 2012a, p. 72051).

PCE 2: Nesting and Roosting Habitat

Nesting and roosting habitats provide structural features for nesting, protection from adverse weather conditions, and cover to reduce predation risk for adults and young. Unlike foraging habitat, structural conditions of nesting roosting habitats do not vary much across the range. The final rule describes characteristics associated with nesting and roosting habitats sufficient for foraging by territorial pairs, moderate to high canopy cover (60 to over 80 percent), multilayered and multispecies canopies with large overstory trees (20 to 30 inches dbh), basal area greater than 240 square feet per acre, high diversity of tree diameters, high incidence of large live trees with various deformities (e.g., large cavities, broken tops, mistletoe infections, and other evidence of decadence), large snags and large accumulations of woody debris on the ground, and sufficient open space beneath the canopy for flight (Service 2012a, p. 72051). Nesting and roosting habitats also function as foraging and dispersal habitat (Service 2012a, p. 71884).

PCE 3: Foraging Habitat

Foraging habitat varies across the range, depending upon ecological conditions and disturbance regimes that influence vegetation structure and prey species distributions. Across most of the owl's range, nesting and roosting habitat is also foraging habitat, but in some regions (particularly in the southern portion of the range) northern spotted owls may additionally use other habitat types for foraging as well (differences in foraging habitats between ecological provinces are discussed below).

PCE 4: Dispersal Habitat

Northern spotted owl dispersal habitat is habitat that supports the transience and colonization phases of owl dispersal, and in all cases would optimally be composed of nesting, roosting, or foraging habitat (PCE 2 or 3), but which may also be composed of other forest types that occur between larger blocks of northern spotted owl nesting, roosting, or foraging habitat. In cases where nesting, roosting, or foraging habitats are insufficient to provide for dispersing or nonbreeding owls, the specific dispersal PCEs are: habitat supporting transience phase of dispersal (protection from avian predators, minimal foraging opportunities, younger and less diverse forests that provide some roosting structures and foraging opportunities) and habitat supporting the colonization phase of dispersal (nesting, roosting, and foraging habitat but in smaller amounts than needed to support a nesting pair) (Service 2012a, p. 72052).

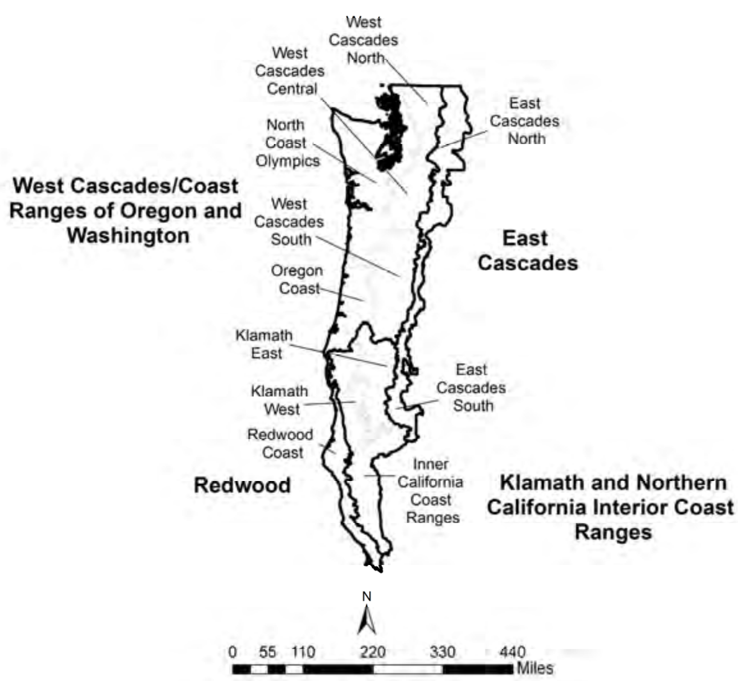
Zones of Habitat Associations used by Northern Spotted Owls

Differences in patterns of habitat associations used by the northern spotted owl across its range suggest four different broad zones of habitat use, which we characterize as the (1) West Cascades/Coast Ranges of Oregon and Washington, (2) East Cascades, (3) Klamath and Northern California Interior Coast Ranges, and (4) Redwood Coast (Figure A-3). We configured these zones based on a qualitative assessment of similarity among ecological conditions and habitat associations within the 11 different regions analyzed during the critical habitat designation process (see Service 2012a). These four zones capture the range in variation of some of the PBFs essential to the conservation of the northern spotted owl. Habitat modeling indicates that vegetation structure has a dominant influence on owl population performance, with habitat pattern and topography also contributing. High canopy cover, high density of large trees, high numbers of sub-canopy vegetation layers, and low to moderate slope positions are all important features. Summarized below are the PBFs for each of these four zones, emphasizing zone-specific features that are distinctive within the context of general patterns that apply across the entire range of the northern spotted owl.

West Cascades/ Coast Ranges of Oregon and Washington

This zone includes five regions west of the Cascade crest in Washington and Oregon (Western Cascades North, Central and South; North Coast Ranges and Olympic Peninsula; and Oregon Coast Ranges; Service 2011b, p. C–13). Climate in this zone is characterized by high rainfall and cool to moderate temperatures. Variation in elevation between valley bottoms and ridges is relatively low in the Coast Ranges, creating conditions favorable for development of contiguous forests. In contrast, the Olympic and Cascade ranges have greater topographic variation with many high-elevation areas supporting permanent snowfields and glaciers. Douglas-fir and western hemlock dominate forests used by northern spotted owls in this zone. Root diseases and wind-throw are important natural disturbance mechanisms that form gaps in forested areas. Flying squirrels (*Glaucomys sabrinus*) are the dominant prey, with voles and mice also representing important items in the northern spotted owl's diet.

Figure A-3. Regions and zones of habitat associations used by northern spotted owls in Washington, Oregon, and California.



Nesting habitat in this zone is mostly limited to areas with large trees with defects such as mistletoe brooms, cavities, or broken tops. The subset of foraging habitat that is not nesting/roosting habitat generally has slightly lower values than nesting habitat for canopy cover, tree size and density, and canopy layering. Prey species (primarily the northern flying squirrel) in this zone are associated with mature to late-successional forests, resulting in small differences between nesting, roosting, and foraging habitats.

East Cascades

This zone includes the Eastern Cascades North and Eastern Cascades South regions (Service 2011b, p. C–13). This zone is characterized by a continental climate (cold, snowy winters and dry summers) and a high frequency of natural disturbance due to fires and outbreaks of forest insects and pathogens. Flying squirrels are the dominant prey species, but the diet of northern spotted owls in this zone also includes relatively large proportions of bushy-tailed woodrats (*Neotoma cinerea*), snowshoe hare (*Lepus americanus*), pika (*Ochotona princeps*), and mice (*Microtus spp*. (Forsman et al. 2001, pp. 144–145).

Our modeling indicates that habitat associations in this zone do not show a pattern of dominant influence by one or a few variables (Service 2011b, Appendix C). Instead, habitat association models for this zone included a large number of variables, each making a relatively modest contribution (20 percent or less) to the predictive ability of the model. The features that were most useful in predicting northern spotted owl habitat quality were vegetation structure and composition, and topography, especially slope position in the north. Other efforts to model habitat associations in this zone have yielded similar results (e.g., Garm et al. 2010, pp. 2048–2050; Loehle et al. 2011, pp. 25–28).

Relative to other portions of the northern spotted owls' range, nesting and roosting habitat in this zone includes relatively younger and smaller trees, likely reflecting the common usage of dwarf mistletoe (*Arceuthobium douglasii*) brooms (dense growths) as nesting platforms (especially in the north). Forest composition that includes high proportions of Douglas-fir is also associated with this nesting structure. Additional foraging habitat in this zone generally resembles nesting and roosting habitat, with reduced canopy cover and tree size, and reduced canopy layering. High prey diversity suggests relatively diverse foraging habitats are used. Topographic position was an important variable, particularly in the north, possibly reflecting competition from barred owls (Singleton et al. 2010, pp. 289, 292). Barred owls, which have been present for over 30 years in the northern portions of this zone, preferentially occupy valley-bottom habitats, possibly compelling northern spotted owls to establish territories on less productive, mid-slope locations (Singleton et al. 2010, pp. 289, 292).

Klamath and Northern California Interior Coast Ranges

This zone includes the Klamath West, Klamath East, and Interior California Coast regions (Service 2011b, p. C–13). This region in southwestern Oregon and northwestern California is characterized by very high climatic and vegetative diversity resulting from steep gradients of elevation, dissected topography, and large differences in moisture from west to east. Summer temperatures are high, and northern spotted owls occur at elevations up to 5,800 feet. The western portions of this zone support a diverse mix of mesic forest communities interspersed with drier forest types. Forests of mixed conifers and evergreen hardwoods are typical of the zone. The eastern portions of this zone have a Mediterranean climate with increased occurrence of ponderosa pine. Douglas-fir/dwarf mistletoe is rarely used for nesting platforms in the western part of the northern spotted owl's range but is commonly used in the east.

The prey base for northern spotted owls in this zone is correspondingly diverse, but dominated by dusky-footed woodrats, bushy-tailed woodrats, and flying squirrels. Northern spotted owls have been well studied in the western Klamath portion of this zone (Forsman et al. 2004, p. 217), but relatively little is known about northern spotted owl habitat use in the eastern portion and the California Interior Coast Range portion of the zone.

Our habitat association models for this zone suggest that vegetation structure and topographic features are nearly equally important in influencing owl population performance, particularly in the Klamath. High canopy cover, high levels of canopy layering, and the presence of very large dominant trees were all important features of nesting and roosting habitat. Compared to other zones, additional foraging habitat for this zone showed greater divergence from nesting habitat, with much lower canopy cover and tree size. Low to intermediate slope positions were strongly favored. In the eastern Klamath, the presence of Douglas-fir was an important compositional variable in our habitat model (Service 2011b, Appendix C).

Redwood Zone

This zone is confined to the northern California coast, and is represented by the Redwood Coast region (Service 2011b, p. C–13). It is characterized by a maritime climate with moderate temperatures and generally mesic conditions. Near the coast, frequent fog delivers consistent moisture during the summer. Terrain is typically low-lying (0 to 3,000 feet). Forest communities are dominated by redwood, Douglas-fir–tanoak (*Lithocarpus densiflorus*) forest, coast live oak (*Quercus agrifolia*), and tanoak series. Dusky footed woodrats are the dominant prey items for northern spotted owls in this zone.

Habitat association models for this zone diverged strongly from models for other zones. Topographic variables (slope position and curvature) had a dominant influence with vegetation structure having a secondary role. Low position on slopes was strongly favored, along with concave landforms.

Several studies of northern spotted owl habitat relationships suggest that stump-sprouting and rapid growth of redwood trees, combined with high availability of woodrats in patchy, intensively managed forests, enables northern spotted owls to occupy a wide range of vegetation conditions within the redwood zone. Rapid growth rates enable young stands to develop structural characteristics typical of older stands in other regions. Thus, relatively small patches of large remnant trees can also provide nesting habitat structure in this zone.

Climate Change and Range-wide Northern spotted owl Critical Habitat

There is growing evidence that recent climate change has impacted a wide range of ecological systems (Stenseth et al. 2002, entire; Walther et al. 2002, entire; Ådahl et al. 2006, entire; Karl et al. 2009, entire; Moritz et al. 2012, entire; Westerling et al. 2011, p. S459; Marlon et al. 2012, p. E541). Climate change, combined with effects from past management practices, is exacerbating changes in forest ecosystem processes and dynamics to a greater degree than originally anticipated under the NWFP. Environmental variation affects all wildlife populations; however, climate change presents new challenges as systems change beyond historical ranges of variability. In some areas, changes in weather and climate may result in major shifts in vegetation communities that can persist in particular regions. (See expanded discussion in environmental baseline section above).

Climate change will present unique challenges to the future of northern spotted owl populations and their habitats. Northern spotted owl distributions (Carroll 2010, entire) and population dynamics (Franklin et al. 2000, entire; Glenn et al. 2010, entire; Glenn et al. 2011a, entire) may be directly influenced by changes in temperature and precipitation. In addition, changes in forest composition and structure as well as prey species distributions and abundance resulting from climate change may impact availability of habitat across the historical range of the subspecies. The *2011 Northern Spotted Owl Revised Recovery Plan* provides a detailed discussion of the possible environmental impacts to the habitat of the northern spotted owl from the projected effects of climate change (Service 2011b, pp. III-5 to III-11).

Because both northern spotted owl population dynamics and forest conditions are likely to be influenced by large-scale changes in climate in the future, we have attempted to account for these influences in our designation of critical habitat by recognizing that forest composition may change beyond the range of historical variation, and that climate changes may have unpredictable consequences for both Pacific Northwest forests and northern spotted owls. Our critical habitat designation also recognizes that forest management practices that promote ecosystem health under changing climate conditions will be important for northern spotted owl conservation.

Current Condition of Range-Wide Critical Habitat

The current condition of critical habitat incorporates the effects of all past human activities and natural events that led to the present-day status of the habitat (Service and NMFS 1998, pg. 4-19). With the revision of northern spotted owl critical habitat, the rangewide condition has been "reset" as of December 4, 2012.

Critical habitat for the spotted owl encompasses over 9.37 million acres in 11 units and 60 subunits in California, Oregon, and Washington. The critical habitat encompasses a broad range of forest types and seral conditions. Much of the suitable nesting and roosting habitat within the critical habitat exists in fragmented patches due to past timber harvest, wildfire, disease, and other disturbances. Based on the spotted owl habitat data developed for the Northwest Forest Plan 25-year monitoring report (Davis et al. 2022), we estimate that in 2022, approximately 46.1 percent of the lands within Critical Habitat Units (CHUs) contained suitable spotted owl nesting/roosting habitat (4.32 million acres), and that 29.0 percent (2.72 million acres) of the total designated critical habitat acres were highly suitable nesting/roosting habitat (Appendix A). Our estimates also indicate that there are 4% (473,763 acres) less nesting/roosting habitat than there were in 2012 (Appendix D). For more details on estimates of spotted owl habitat within critical habitat units, physiographic provinces and subunits, refer to appendices A, B, C and D.

Due to land management actions and natural disturbance events such as fire, windstorms, and insect damage, not all habitat capable lands in a Critical Habitat Unit are likely to be high quality habitat at any one time. However, these lands retain the PBFs necessary to allow for the regrowth of the habitat characteristics required by spotted owls and are essential to achieving the area, quality, and configuration of habitat required for recovery of the owl (77 FR 71877).

Range-wide Critical Habitat Environmental Baseline

For tracking purposes, the USFWS maintains an online database of effects to spotted owl critical habitat, including both the effects of land management actions as well as losses due to natural disturbances documented through section 7 consultations. The USFWS updated the consultation database to reflect the 2012 habitat baseline developed for the NWFP 20-year monitoring report (Davis et al. 2016), and adjusted the habitat estimates to account for changes in land use allocations resulting from the 2016 revised Land and Resource Management Plans for Bureau of Land Management (BLM) managed lands in western Oregon.

Since 2012, the USFWS has consulted on the removal or downgrading of 36,611 acres of nesting/roosting habitat within critical habitat range-wide, which represents a cumulative loss of about 0.75 percent of the available nesting/roosting habitat that existed in 2012 (Table A-5). Most of these impacts originated in the Washington East Cascades, Oregon West Cascades and the Oregon and California Klamath Physiographic Provinces.

Range-wide, about 15,269 acres of habitat loss were associated with natural disturbances as reported through section 7 consultation. However, the USFWS recognizes that this value greatly underestimates the area impacted by wildfires within designated critical habitat, and we rely on other sources of information to evaluate The losses of nesting/roosting habitat in the Oregon Cascades (East and West) and Oregon Klamath Mountain Provinces represent about 69 percent of the range-wide losses, but these totals under-estimate the habitat losses that have occurred due to large wildfires. Habitat losses from wildfires that occurred from 2012 to 2017 within designated critical habitat have been estimated to be as high as 132,000 acres (2.7 percent) (Davis 2017, p. 28). The estimates provided by Davis (2017) were calculated as a cumulative range-wide total that was not analyzed at a level that allows us to account for these losses at the scale of individual provinces or land-use allocations. As reported in Davis et al. (2016, p. 42), wildfire is now the leading cause of habitat loss on Federal lands, far out-weighing habitat losses associated with land-management actions.

Table A-5. Northern Spotted Owl Take/Effect Reports Table D - Designated northern spotted owl critical habitat. Summary of northern spotted owl nesting/roosting[1] habitat (acres) removed or downgraded as documented through ESA section 7 consultations. Summary of effects by state, province, and land use function from 2012 to present (last updated December 20, 2022).

Physiographic Province[2]		Evaluation Baseline		Nesting/Roosting Habitat Removed/Downgraded[5]							% Provincial Baseline Affected	% Range-wide Effects
				Land Management Effects			Habitat Loss from Natural Events			Total NR Acres Removed		
		Total Designated Critical Habitat Acres[3]	Nesting/ Roosting Acres[4]	Reserves[6]	Non-Reserves[7]	Total	Reserves	Non-Reserves	Total			
WA	Eastern Cascades	1,022,960	467,221	1,552	55	1,607	3,895	0	3,895	5,502	1.18	15.03
	Olympic Peninsula	507,165	211,373	1	0	1	0	0	0	1	0.00	0.00
	Western Cascades	1,387,567	606,093	15	185	200	0	0	0	200	0.03	0.55
OR	Cascades East	529,652	187,798	893	4,618	5,511	1,003	195	1,198	6,709	3.57	18.33
	Cascades West	1,965,407	1,255,027	1,830	4,230	6,060	662	617	1,279	7,339	0.58	20.05
	Coast Range	1,151,874	483,846	96	854	950	0	0	0	950	0.20	2.59
	Klamath Mountains	911,681	542,119	2,109	4,068	6,177	2,517	2,727	5,244	11,421	2.11	31.20
CA	Cascades	243,205	97,248	0	114	114	0	0	0	114	0.12	0.31
	Coast	149,044	94,033	0	0	0	0	2,212	2,212	2,212	2.35	6.04
	Klamath	1,708,787	945,505	292	430	722	30	1,411	1,441	2,163	0.23	5.91
	Total	**9,577,342**	**4,890,263**	**6,788**	**14,554**	**21,342**	**8,107**	**7,162**	**15,269**	**36,611**	**0.75**	**100.01**

Notes:

1. Northern spotted owl suitable habitat includes nesting/roosting habitat, and foraging-only habitat. Nesting/roosting habitat supports all life-history functions for northern spotted owls including foraging, and is sometimes referred to as nesting, roosting, and foraging habitat. Foraging-only habitat is a separate category that can include more open and fragmented forests and does not provide structures for nesting/roosting. Habitat effects summarized in this table are all classified as impacts to nesting/roosting habitats. Impacts to foraging-only habitat are tracked separately.
2. Defined in the Revised Recovery Plan for the Northern Spotted Owl (Service 2011a) as Recovery Units as depicted on page A-3.
3. Spotted owl critical habitat as designated December 4, 2012 (77 FR 71876). Total designated critical habitat acres listed here (9,577,342 acres) reflects GIS data for the 2012 final designation. In 2021, the Service issued a revised rule which removed 204,294 acres from CH in Oregon. That revision is not depicted in the totals listed above.
4. Northern spotted owl nesting/roosting (NR) habitat based on GIS data developed for the Northwest Forest Plan 20-year monitoring report by Davis et al. 2016 (PNW-GTR-929). NR habitat acres are approximate values based on 2012 satellite imagery.
5. Estimated nesting/roosting habitat removed or downgraded from land management (e.g., timber sales) or natural events (e.g., wildfires) as documented through section 7 consultation or technical assistance. Effects reported here include acres removed or downgraded from 2012 to present
6. Reserve land use allocations intended to provide northern spotted owl demographic support include Late-Successional Reserves identified in the Northwest Forest Plan on National Forests, designated Wilderness, and other Congressionally-reserved lands. Reserves on BLM lands in western Oregon managed under the 2016 revised Land and Resource Management Plans include Late-Successional Reserves, Congressionally-reserved lands, National Landscape Conservation System lands, and some District Designated Reserves (e.g., Areas of Critical Environmental Concern).

7. Non-reserve lands intended to provide northern spotted owl dispersal connectivity between reserves include USFS and BLM designations for timber production (matrix and harvest land base designations), Adaptive Management Areas, and other non-reserved land use designations.

Recently, the Service modified the ECOS database input to account for effects to the habitats that could be used as foraging, but that lack the age or structural characteristics of habitats used for nesting and roosting. This distinction may not be made in all consultations. These data represent effects as reported in individual consultations and likely do not represent the entirety of impacts to foraging habitat within critical habitat since 2012. For many projects, affected foraging likely is captured within the NR acres as foraging habitat was lumped into “nesting/roosting/foraging habitat” at the time of consultation. Trends to date show that habitat reductions are disproportionally affecting reserved lands, the California Coast, and the Oregon and California Klamath Provinces (Table A-6).

Table A-6. Northern Spotted Owl Take/Effect Reports Table D2 - Designated northern spotted owl critical habitat. Summary of northern spotted owl foraging habitat[1] (acres) removed or downgraded as documented through ESA section 7 consultations. Summary of effects by state, province, and land use function from 2012 to present (last updated December 20, 2022).

Physiographic Province[2]		Total Designated Critical Habitat Acres[3]	Foraging Habitat Removed/Downgraded[4]						
			Land Management Effects			Habitat Loss from Natural Events			Total Foraging Habitat removed/ downgraded
			Reserves[5]	Non-Reserves[6]	Total	Reserves[5]	Non-Reserves[6]	Total	
WA	Eastern Cascades	1,022,960	0	0	0	0	0	0	0
	Olympic Peninsula	507,165	0	0	0	0	0	0	0
	Western Cascades	1,387,567	0	0	0	0	0	0	0
OR	Cascades East	529,652	0	29	29	0	0	0	29
	Cascades West	1,965,407	263	687	950	0	0	0	950
	Coast Range	1,151,874	12	486	498	0	0	0	498
	Klamath Mountains	911,681	242	1,789	2,031	0	0	0	2,031
CA	Cascades	243,205	98	91	189	0	0	0	189
	Coast	149,044	0	1	1	0	4,688	4,688	4,689
	Klamath	1,708,787	1,449	523	1,972	772	133	905	2,877
	Total	**9,577,342**	**2,064**	**3,606**	**5,670**	**772**	**4,821**	**5,593**	**11,263**

Notes:

1. Northern spotted owl suitable habitat includes nesting/roosting habitat, and foraging-only habitat. Nesting/roosting habitat supports all life-history functions for northern spotted owls including foraging, and is sometimes referred to as nesting, roosting, and foraging habitat. Foraging-only habitat is a separate category that can include more open and fragmented forests and does not provide structures for nesting/roosting. Habitat effects summarized in this table are all classified as impacts to foraging-only habitat. Impacts to nesting/roosting habitat are tracked separately. Environmental baseline information for foraging habitat as a separate habitat category is not available at a provincial scale.
2. Defined in the Revised Recovery Plan for the Northern Spotted Owl (Service 2011) as Recovery Units as depicted on page A-3.
3. Spotted owl critical habitat as designated December 4, 2012 (77 FR 71876). Total designated critical habitat acres listed here (9,577,342 acres) reflects GIS data for the 2012 final designation. In 2021, the Service issued a revised rule which removed 204,294 acres from CH in Oregon. That revision is not depicted in the totals listed above.
4. Estimated foraging-only habitat removed or downgraded from land management (e.g., timber sales) or natural events (e.g., wildfires) as documented through ESA section 7 consultations or technical assistance. Effects reported here include acres removed or downgraded from 2012 to present.
5. Reserve land use allocations intended to provide northern spotted owl demographic support include Late-Successional Reserves identified in the Northwest Forest Plan on National Forests, designated Wilderness, and other Congressionally-reserved lands. Reserves on BLM lands in western Oregon managed under the 2016 revised Land and Resource Management Plans include Late-Successional Reserves, Congressionally-reserved lands, National Landscape Conservation System lands, and some District Designated Reserves (e.g., Areas of Critical Environmental Concern).
6. Non-reserve lands intended to provide northern spotted owl dispersal connectivity between reserves include USFS and BLM designations for timber production (matrix and harvest land base designations), Adaptive Management Areas, and other non-reserved land use designations.

Literature Cited

Ådahl, E., P. Lundberg, N. Jonzén et al. 2006. From climate change to population change: the need to consider annual life cycles. Global Change Biology. [Abstract] V. 12(9), pp. 1627-1633.

Ager, A., N. Vaillant, M. Finney, and H. Preisler. 2012. Analyzing wildfire exposure and source-sink relationships on a fire prone forest landscape. Forest Ecology and Management 267 (2012) 271-283.

Anderson, David E. and K.P. Burnham. 1992. Evidence that Northern Spotted Owl populations are declining, Part II. In Service 1992a, Draft Recovery Plan for the northern spotted owl, Appendix C.

Anthony, R.G., and L.S. Andrews. 2004. Summary Report – Winter habitat use by spotted owls on USDI Bureau of Land Management Medford District Lands within the boundaries of the Timbered Rock Fire. Unpublished report, OCWRU, OSU, Corvallis, Oregon. 29 pages.

Anthony, R.G., E.D. Forsman, A.B. Franklin, D.R. Anderson, K.P. Burnham, G.C. White, C.J. Schwarz, J. Nichols, J.E. Hines, G.S. Olson, S.H. Ackers, S. Andrews, B.L. Biswell, P.C. Carlson, L.V. Diller, K.M. Dugger, K.E. Fehring, T.L. Fleming, R.P. Gerhardt, S.A. Gremel, R.J. Gutiérrez, P.J. Happe, D.R. Herter, J.M. Higley, R.B. Horn, L.L. Irwin, P.J. Loschl, J.A. Reid, and S.G. Sovern. 2006. Status and trends in demography of northern spotted owls, 1985-2003. Wildlife Monograph No. 163.

Bailey, L.L., J.A. Reid, E.D. Forsman, and J.D. Nichols. 2009. Modeling co-occurrence of northern spotted and barred owls: accounting for detection probability differences. Biological Conservation. 142: 2983-2989.

Baker, W.L. 2015. Historical Northern spotted owl habitat and old-growth dry forests maintained by mixed-severity wildfires Landscape Ecology (2015) 30:655–666.

Baker, W.L. 2017. Restoring and managing low-severity fire in dry-forest landscapes of the western USA. PLoS ONE 12(2): e0172288. 28 pp.

Barrowclough, G. F. and R. J. Gutiérrez. 1990. Genetic variation and differentiation in the spotted owl. Auk 107:737-744.

Barrowclough, G.F., R.J. Gutiérrez, and J.G. Groth. 1999. Phylogeography of spotted owl (Strix occidentalis) populations based on mitochondrial DNA sequences; gene flow, genetic structure, and a novel biogeographic pattern. Evolution 53(3):919-931.

Barrowclough, G.F., J.G. Groth, and R.J. Gutiérrez. 2005. Genetic structure, introgression and a narrow hybrid zone between northern and California spotted owls (Strix occidentalis). Molecular Ecology 14:1109–1120.

Barrows, C.W., and K. Barrows. 1978. Roost characteristics and behavioral thermoregulation in the spotted owl. Western Birds 9:1-8.

Barrows, C.W. 1981. Roost selection by Spotted Owls: an adaptation to heat stress. Condor 83: 302-309.

Bart, J. 1995. Amount of suitable habitat and viability of northern spotted owls. Conservation Biology 9 (4):943-946.

Bart J. and E. Forsman. 1992. Dependence of northern spotted owls (Strix occidentalis caurina) on old-growth forests in the western USA. Biological Conservation 1992: 95-100.

Bingham, B.B., and B.R. Noon. 1997. Mitigation of habitat "take": Application to habitat conservation planning. Conservation Biology 11 (1):127-138.

Blakesley, J.A., W. LaHaye, J.M.M. Marzluff, B.R. Noon, and S. Courtney. 2004. Scientific evaluation of the status of the northern spotted owl – demography. Chapter 8 In: Courtney, S.P., J.A. Blakesley, R.E. Bigley, M.L. Cody, J.P. Dumbacher, R.C. Fleischer, A.B. Franklin, J.F. Franklin, R.J. Gutiérrez, J.M. Marzluff, L. Sztukowski. *In* 2004. Scientific evaluation of the status of the northern spotted owl. Sustainable Ecosystems Institute. Portland, Oregon. September 2004.

Blakesley, J.A., D. R. Anderson, and B. R. Noon. 2006. Breeding dispersal in the California spotted owl. The Condor, Vol. 108, No. 1:71-81.

BLM (Bureau of Land Management). 2016a. Northwestern & Coastal Oregon Record of Decision and Resource Management Plan. Oregon State Office, Portland, Oregon. i-308. 320 pp. Available online: https://www.blm.gov/or/plans/rmpswesternoregon/feis/

BLM (Bureau of Land Management). 2016b. Southwestern Oregon Record of Decision and Resource Management Plan. Oregon State Office, Portland, Oregon. i-318. 332 pp. Available online: https://www.blm.gov/or/plans/rmpswesternoregon/feis/

Bond, M.L., R.J. Gutierrez, A.B. Franklin, W.S. LaHaye, C.A. May, and M.E. Seamans. 2002. Short-term effects of wildfires on spotted owl survival, site fidelity, mate fidelity, and reproductive success. Wildlife Society Bulletin 30(4):1022-1028.

Bond, M.L., D.E. Lee, R.B. Siegel, and J.P. Ward, Jr. 2009. Habitat use and selection by spotted owls in a postfire landscape. Journal of Wildlife Management 73(7):1116-1124.

Bond, M.L., C. Bradley, and D.E. Lee. 2016. Foraging habitat selection by California spotted owls after Fire. The Journal of Wildlife Management; Vol. 80, Issue 7, pp. 1290–1300.

Buchanan, J.B., L.L. Irwin, and E.L. McCutchen. 1995. Within-stand nest site selection by spotted owls in the eastern Washington Cascades. Journal of Wildlife Management 59:301-310.

Buchanan, J.B. 2004. Managing habitat for dispersing northern spotted owls - are the current management strategies adequate? Wildlife Society Bulletin 32:1333–1345.

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. 84 pp.

Burnham, K.P., D.R. Anderson, and G.C. White. 1994. Estimation of vital rates of the northern spotted owl. Colorado Cooperative Fish and Wildlife Research Unit, Colorado State University, Fort Collins, Colorado, USA.

Burt, W.H. 1943. Territoriality and home range concepts as applied to mammals. Journal of Mammalogy 24:346-352.

British Columbia. 2017. Northern Spotted Owl Recovery & Breeding Program. Website. http://www2.gov.bc.ca/gov/content/environment/plants-animals-ecosystems/species-ecosystems-at-risk/implementation/conservation-projects-partnerships/northern-spotted-owl. Accessed June 1, 2017.

Caffrey, C. 2003. Determining impacts of West Nile Virus on crows and other birds. American Birds (103rd Count) 57:14-21.

Caffrey, C. and C.C. Peterson. 2003. West Nile Virus may not be a conservation issue in northeastern United States. American Birds (103rd Count) 57:14-21.

CFPR (California Forest Practices Rules). 2017. Title 14, California Code of Regulations, Chapters 4, 4.5, and 10. Sacramento, CA. Available online: http://calfire.ca.gov/resource_mgt/downloads/2017%20Forest%20Practice%20Rules%20and%20Act.pdf.

Campbell, N. A. 1990. Biology. The Benjamin/Cummings Publishing Company, Inc. Redwood City, California.

Carey, A.B., J.A. Reid, and S.P. Horton. 1990. Spotted owl home range and habitat use in southern Oregon coast ranges. Journal of Wildlife Management 54:11–17.

Carey, A. B., S. P. Horton, and B. L. Biswell. 1992. Northern spotted owls: influence of prey base and landscape character. Ecological Monographs 62: 223-250.

Carey, A.B. and K.C. Peeler. 1995. Spotted owls: resource and space use in mosaic landscapes. Journal of Raptor Research 29(4):223-229.

Carlson, P.C., J.M. Higley, and A.B. Franklin. 2019. Barred Owl Experimental Removal: Hoopa/Willow Creek Study Area NSO Demographic Report, 11 June 2019. Pp. 1-10.

Carroll, Carlos. 2010. Role of climatic niche models in focal-species-based conservation planning: assessing potential effects of climate change on Northern Spotted Owl in the Pacific. Biological Conservation. Volume 143, Issue 6, June 2010, Pp. 1432–1437.

Carsia, R. V., and S. Harvey. 2000. Adrenals. Chapter 19 in G. C. Whittow, editor. Sturkie's Avian Physiology. Academic Press, San Diego, California.

CEPA (California Environmental Protection Agency). 2017. Cannabis Cultivation Regulatory and Enforcement Unit. Environmental Harm from Cannabis Cultivation. http://www.waterboards.ca.gov/water_issues/programs/enforcement/cannabis_enforcement.shtml. Accessed February 16, 2017. 4 pp.

CDFW (California Department of Fish and Wildlife). 2016. Report to the Fish and Game Commission a status review of the northern spotted owl (Strix occidentalis caurina) in California. Charlton H. Bonham, Director, California Department of Fish and Wildlife, January 27, 2016. i-229. 238 pp.

CDFW (California Department of Fish and Wildlife). 2017. Special Animals List- Natural Diversity Database. Periodic publication. 51 pp. Available online: https://www.wildlife.ca.gov/Conservation/SSC/Mammals

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 (Strix occidentalis caurina) in British Columbia. British Columbia Ministry of Environment, Victoria. 74 pp.

Clark D.A. 2007. Demography and habitat selection of northern spotted owls in post-fire landscapes of Southwestern Oregon. M.S. Thesis. Oregon State University. 218 pp.

Clark D.A., R.G. Anthony, and L.S. Andrews. 2011. Survival rates of northern spotted owls in post-fire landscapes of Southwest Oregon. Journal of Raptor Research, 45(1):38-47. 2011.

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. The Journal of Wildlife Management 77(4):672–688; 2013.

Comfort, E.J. 2014. Trade-offs between management for fire risk reduction and northern spotted owl habitat protection in the dry conifer forests of Southern Oregon. PhD. Dissertation; Oregon State University, Corvallis, OR.

Courtney, S.P. and R.J. Gutiérrez. 2004. Scientific evaluation of the status of the northern spotted owl – threats. In: Courtney, S.P., J.A. Blakesley, R.E. Bigley, M.L. Cody, J.P. Dumbacher, R.C. Fleischer, A.B. Franklin, J.F. Franklin, R.J. Gutiérrez, J.M. Marzluff, L. Sztukowski. 2004. Scientific evaluation of the status of the northern spotted owl. Sustainable Ecosystems Institute. Portland, Oregon. September 2004.

Crozier, Michelle L., Mark E. Seamans, R. J. Gutiérrez, Peter J. Loschl, Robert B. Horn, Stan G. Sovern and Eric D. Forsman. 2006. Does the presence of barred owls suppress the calling behavior of spotted owls? The Condor 108: 260-269.

Dale, V.H, L.A. Joyce, S. McNulty, R.P. Neilson, M.P. Ayres, M.D. Flannigan, P.J. Hanson, L.C. Irland, A.E. Lugo, C.J. Peterson, D. Simberloff, F.J. Swanson, B.J. Stocks, and B.M. Wotton. 2001. Climate change and forest disturbances. BioScience 51: 723–734.

Dark, S.J., R.J. Gutiérrez, and G.I. Gould, Jr. 1998. The barred owl (*Strix varia*) invasion in California. The Auk. 115(1): 50-56.

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 trends of Northern Spotted Owl populations and habitats. USDA Forest Service General Technical Report PNW-GTR-850.

Davis, Raymond J.; Hollen, Bruce; Hobson, Jeremy; Gower, Julia E.; Keenum, David. 2016. Northwest Forest Plan—the first 20 years (1994–2013): status and trends of northern spotted owl habitats. Gen. Tech. Rep. PNW-GTR-929. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 54 p.

Davis, R J., Bruce Hollen, Jeremy Hobson, Julia E. Gower, and David Keenum. 2022. "Northwest Forest Plan—the First 25 Years (1994-2018): Status and Trends of Northern Spotted Owl Habitats." Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, 2022. 46 pp

Davidson, J.M., A.C. Wickland, H.A. Patterson, K.R. Falk, and D.M. Rizzo. 2005. Transmission of *Phytophthora ramorum* in mixed-evergreen forest in California. Ecology and Epidemiology. 95(5)587-596.

Delaney, D. K., T. G. Grubb, P. Beier, L. L. Pater, and M. H. Reiser. 1999. Effects of helicopter noise on Mexican spotted owls. Journal of Wildlife Management 63:60-76.

Deubel, V., L. Fiette, P. Gounon, M.T. Drouet, H. Khun, M. Huerre, C. Banet, M. Malkinson, and P. Despres. 2001. Variations in biological features of West Nile viruses. Annals of the New York Academy of Sciences 951:195-206.

Diller, L.V. and D.M. Thome. 1999. Population density of northern spotted owls in managed young-growth forests in coastal northern California. Journal of Raptor Research 33: 275–286.

Diller, L.V., K.A, Hamm, D.E. Early, D.W. Lamphear, K.M. Dugger, C.B. Yackulic, C.J. Schwarz, P.C. Carlson, and T.L. McDonald. 2016. Demographic response of northern spotted owls to barred owl removal. Journal of Wildlife Management 80: 691–707.

Dobson, A. P. and J. Foufopoulos. 2001. Emerging infectious pathogens of wildlife. Philosophical Transactions of The Royal Society B Biological Sciences 356(1411):1001-

1012. Available online:
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1088495/pdf/TB011001.pdf

Doppelt, B., R. Hamilton, C. Deacon, and M. Koopman. 2008. Preparing for climate change in the Rogue River Basin of southwest Oregon. Climate Change Leadership Initiative. University of Oregon, Eugene, Oregon. 43 pp.

Dugger, K.M., F. Wagner, R.G. Anthony, and G.S. Olson. 2005. The relationship between habitat characteristics and demographic performance of northern spotted owls in southern Oregon. The Condor 107:863-878.

Dugger, KM., R.G. Anthony, S. Andrews. 2011. Transient Dynamics of Invasive Competition: barred Owls, Spotted Owls, Habitat and the Demons of Competition Present. Ecological Applications (7). 2459-68.

Dugger KM, Forsman ED, Franklin AB, Davis RJ, White GC, Schwarz CJ, Burnham KP, Nichols JD, Hines JE, Yackulic CB, Doherty Jr PF. The effects of habitat, climate, and Barred Owls on long-term demography of Northern Spotted Owls. The Condor. 2015 Dec 10;118(1):57-116Dunbar, D. L., B. P. Booth, E. D. Forsman, A. E. Hetherington, and D. J. Wilson. 1991. Status of the spotted owl, Strix occidentalis, and barred owl, Strix varia, in southwestern British Columbia.

Eyes, S.A., S. L. Roberts, and M.D. Johnson. 2017. California Spotted Owl (Strix occidentalis occidentalis) habitat use patterns in a burned landscape. The Condor, 119: 375-388.

Frey, S.J.K, A.S. Hadley, S.L. Johnson, M. Schulze, J.A. Jones, and M.G. Betts. 2016. Spatial models reveal the microclimate buffering capacity of old-growth forests. Science Advances 2:e1501392, pp. 1-9.

Folliard, L. 1993. Nest site characteristics of northern spotted owls in managed forest of northwest California. M.S. Thesis. Univ. Idaho, Moscow, ID.

Forsman, E.D. 1975. A preliminary investigation of the spotted owl in Oregon. M.S. thesis, Oregon State University, Corvallis. 127 pp.

Forsman, E.D. 1981. Molt of the spotted owl. Auk 98:735-742

Forsman, E.D., Meslow, E.C., Wight, H.M. 1984. Distribution and biology of the spotted owl in Oregon. Wildlife Monographs, 87:1-64.

Forsman, E.D., S. DeStafano, M.G. Raphael, and R.G. Gutiérrez. 1996. Demography of the northern spotted owl. Studies in Avian Biology No. 17. 122 pp.

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. Journal of Raptor Research 35(2):141-150.

Forsman, E.D., Anthony, R. G., Reid, J. A., Loschl, P. J., Sovern, S. G., Taylor, M., Biswell, B. L., Ellingson, A., Meslow, E. C., Miller, G. S., Swindle, K. A., Thrailkill, J. A., Wagner, F. F., and D. E. Seaman. 2002. Natal and breeding dispersal of northern spotted owls. Wildlife Monographs, No. 149. 35 pp.

Forsman, E.D., R.G. Anthony, E.C. Meslow, and C.J. Zabel. 2004. Diets and foraging behavior of northern spotted owls in Oregon. Journal of Raptor Research 38(3):214-230.

Forsman, E.D., T.J. Kaminiski, 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. J. Raptor Research 39(4):365-377.

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: 1985-2008. Studies in Avian Biology No. 40.

Frankham, R. 1996. Relationship of Genetic Variation to Population Size in Wildlife. Conservation Biology, Vol. 10, No. 6, Special Issue: Festschrift for Michael E. Soule (Dec., 1996), pp. 1500-1508.

Frankham, R., C.J.A. Bradshaw, and B.W. Brook. 2014. Genetics in conservation management: Revised recommendations of the 50/500 rules, Red List criteria and population viability analyses. Biological Conservation 170:56-63.

Franklin, A.B. 1992. Population regulation in northern spotted owls: theoretical implications for management. Pages 815-827 in D. R. McCullough and R. H. Barrett (eds.)., Wildlife 2001: populations. Elsevier Applied Sciences, London, England.

Franklin, A. B., D. R. Anderson, R. J. Gutierrez, and K. P. Burnham. 2000. Climate, habitat quality, and fitness in northern spotted owl populations in northwestern California. Ecological Monographs 70: 539–590.

Franklin, A.B., K.M. Dugger, D.B. Lesmeister, R.J. Davis, J.D. Wiens, G.C. White, J.D. Nichols, J.E. Hines, C.B. Yackulic, C.J. Schwarz, S.H. Ackers, L.S. Andrews, L.L. Bailey, R. Bown, J. Burgher, K.P. Burnham, P.C. Carlson, T. Chestnut, M.M. Conner, K.E. Dilione, E.D. Forsman, E.M. Glenn, S.A. Gremel, K.A. Hamm, D.R. Herter, J.M. Higley, R.B. Horn, J.M. Jenkins, W.L. Kendall, D.W. Lamphear, C. McCafferty, T.L. McDonald, J.A. Reid, J.T. Rockweit, D.C. Simon, S.G. Sovern, J.K. Swingle, and H. Wise. 2021. Range-wide declines of northern spotted owl populations in the Pacific Northwest: a meta-analysis. Biological Conservation 259:109168.

Frey, S.J.K, A.S. Hadley, S.L. Johnson, M. Schulze, J.A. Jones, and M.G. Betts. 2016. Spatial models reveal the microclimatic buffering capacity of old-growth forests. Sci. Adv. 2016; 2: e1501392. Downloaded from http://advances.sciencemag.org/ on October 13, 2017

Funk, W.C., E.D. Forsman, T.D. Mullins, and S.M. Haig. 2008. Introregression and dispersal among spotted owl (Strix occidentalis) subspecies. Evolutionary Applications. 1: 161-171.

Gabriel., M. W., G. M. Wengert, J. M. Higley, S. Krogan, W. Sargent, and D L. Clifford. 2013. Silent Forests? Rodenticides on illegal marijuana crops harm wildlife. The Wildlife Society. The Wildlife Professional, Spring 2013. Pp. 46-50.

Gabriel, M.W., L. W. Woods, G. M. Wengert, N. Stephenson, J.M. Higley, C. Thompson, S. M. Matthews, R. A. Sweitzer, K. Purcell, R. H. Barrett, S.M. Keller, P. Gaffney, M. Jones, R. Poppenga, J. E. Foley, R. N. Brown, D. L. Clifford, and B.N. Sacks. 2015. Patterns of Natural and Human-Caused Mortality Factors of a Rare Forest Carnivore, the Fisher (*Pekania pennanti*) in California. PLoS ONE 10(11):e0140640. doi:10.1371/journal.pone.0140640

Gabriel, M.W., L.V. Diller, J.P. Dumbacher, G.M. Wengert, J.M. Higley, R.H. Poppenga, and S. Mendia. 2018. Exposure to rodenticides in Northern Spotted and Barred Owls on remote forest lands in northwestern California: evidence of food web contamination. Avian Conservation and Ecology 13(1):2. https://doi.org/10.5751/ACE-01134-130102. pp. 1-9.

Gaines, W.L., R.A. Strand, and S.D. Piper. 1997. Effects of the Hatchery Complex Fires on northern spotted owls in the eastern Washington Cascades. Pages 123-129 in Dr. J.M. Greenlee, ed. Proceedings of the First Conference on Fire Effects on Rare and Endangered Species and Habitats, November 13-16, 1995. International Association of Wildland Fire. Coeur d'Alene, ID.

Gaines, W. L., R.J. Harrod, J. Dickinson, A. L. Lyonsa, K. Halupka. 2010. Integration of northern spotted owl habitat and fuels treatments in the eastern Cascades, Washington, USA. Forest Ecology and Management 260 (2010) 2045–2052.

Gallagher, C.V., J.J. Keane, P.A. Shaklee, A.A. Kramer, and R. A. Gerrard. 2018 Note: Spotted Owl Foraging Patterns Following Fuels Treatments, Sierra Nevada, California. The Journal of Wildlife Management; DOI: 10.1002/jwmg.21586. pp. 1-15.

Garmendia, A.E., H.J. Van Kruiningen, R.A. French, J.F. Anderson, T.G. Andreadis, A. Kumar, and A.B. West. 2000. Recovery and identification of West Nile virus from a hawk in winter. Journal of Clinical Microbiology 38:3110-3111.

Gibbs, SEJ, MC. Wiberly and M. Madden. 2006. Factors affecting the geographic distribution of West Nile virus in Georgia, USA: 2002–2004. Vector-borne and Zoonotic Diseases. Volume 6, Number 1, 2006. Pp. 73-82.

Glenn, E.M, M.C. Hansen, and R.G. Anthony. 2004. Spotted owl home-range and habitat use in young forests of western Oregon. Journal of Wildlife Management 68(1):33-50.

Glenn, E.M., R.G. Anthony, and E.D. Forsman. 2010. Population trends in northern spotted owls: associations with climate in the Pacific Northwest. Biological Conservation. 143(11): 2543-2552.

Glenn, E.M., R.G. Anthony, E.D. Forsman, and G.S. Olson. 2011a. Local Weather, Regional Climate, and Annual Survival of the Northern Spotted Owl. The Condor 113(1) 159-176, The Cooper Ornithological Society 2011

Glenn, E.M., R.G. Anthony, E.D. Forsman, and G.S. Olson. 2011b. Reproduction of Northern Spotted Owls: The Role of Local Weather and Regional Climate. The Journal of Wildlife Management 75(6): 1279-1294; 2011; DOI: 10.1002/jwmg.177.

Goheen, E.M., E.M. Hansen, A. Kanaskie, M.G. Williams, N. Oserbauer, and W. Sutton. 2002. Sudden oak death caused by Phytophthora ramorum in Oregon. Plant Disease 86:441.

Gremel, S. 2005. Factors controlling distribution and demography of Northern Spotted Owls in a reserved landscape. A thesis submitted in partial fulfillment for a Master of Science degree. University of Washington.

Gremel, S. 2015. Spotted owl monitoring in Olympic National Park, 2015 annual report. USDI National Park Service, Olympia, WA. 16 pp.

Gronau, Christian W. 2005. Evidence of an unusual prey item in a barrel owl pellet. In Wildlife Afield, 2:2, December 2005.

Gutiérrez, R.J., A.B. Franklin, and W.S. LaHaye. 1995. Spotted owl (Strix occidentalis) in: A. Poole and F. Gill, editors. The birds of North America, No. 179. The Academy of Natural Sciences and The American Ornithologists' Union, Washington, D.C. 28 pages.

Gutiérrez, R.J. 1996. Biology and distribution of the northern spotted owl. Pages 2-5 in E.D. Forsman, S. DeStefano, M.G. Raphael, and R.J. Gutiérrez (Eds): Studies in Avian Biology No. 17.

Gutiérrez, R. J., M. Cody, S. Courtney, and D. Kennedy. 2004. Assessment of the potential threat of the northern barred owl. In: Courtney, S.P., J.A. Blakesley, R.E. Bigley, M.L. Cody, J.P. Dumbacher, R.C. Fleischer, A.B. Franklin, J.F. Franklin, R.J. Gutiérrez, J.M. Marzluff, L. Sztukowski. 2004. Scientific evaluation of the status of the northern spotted owl. Sustainable Ecosystems Institute. Portland, Oregon. September 2004.

Haig, S.M., R.S. Wagner, E.D. Forsman, and T.D. Mullins. 2001. Geographic variation and genetic structure in spotted owls. Conservation Genetics 2(1): 25-40.

Haig, S.M., T.D. Mullins, E.D. Forsman, P. Trail, and L. Wennerberg. 2004. Genetic identification of spotted owls, barred owls, and their hybrids: legal implications of hybrid identity. Conservation Biology 18:1347-1357.

Haig, S.M., M.P. Miller, R. Bellinger, H.M. Draheim, D.M. Mercer, and T.D. Mullins. 2016. The conservation genetics juggling act: integrating genetics and ecology, science and policy. Evolutionary Applications. VOL9 Pp. 181-195.

Hamer, T.E., S.G. Seim, and K.R. Dixon. 1989. Northern spotted owl and northern barred owl habitat use and home range size in Washington: preliminary report. Washington Department of Wildlife, Olympia, Washington.

Hamer, T.E., E.D. Forsman, A.D. Fuchs, and M.L. Walters. 1994. Hybridization between barred and spotted owls. Auk 111(2):487-492.

Hamer, T.E., D.L. Hays, C.M. Senger, and E.D. Forsman. 2001. Diets of northern barred owls and northern spotted owls in an area of sympatry. Journal of Raptor Research 35(3):221-227.

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. i-116. 126 pp.

Harestad, A., J. Hobbs, and I. Blackburn. 2004. Précis of the Northern Spotted Owl in British Columbia. Pages. 12-14 in Zimmerman, K., K. Welstead, E. Williams, J. Turner, (editors). Northern Spotted Owl Workshop Proceedings. Forrex Series (online No. 14), Vancouver, British Columbia, Canada.

Henke, A.L., T.Y. Chi, J. Smith, C. Brinegar. Unpublished Draft. Microsatellite Analysis of Northern and California Spotted Owls in California. Conservation Genetics Laboratory, Department of Biological Sciences, San Jose State University, San Jose, California.

Hershey, K.T., E.C. Meslow, and F.L. Ramsey. 1998. Characteristics of forests at spotted owl nest sites in the Pacific Northwest. Journal of Wildlife Management 62(4):1398-1410.

Herter, D. 2016. Rainier spotted owl demography study area. 2016. Annual Report to Weyerhaeuser Company, Hancock Forest management, National Park Service – Mt. Rainier National Park, and U.S. Forest Service – Mt. Baker-Snoqualmie National Forest. Raedeke Associates, Inc. 15 pp.

Herter, D.R., and L.L. Hicks. 2000. Barred owl and spotted owl populations and habitat in the central Cascade Range of Washington. Journal of Raptor Research 34(4): 279-286.

Herter, D.R., L.L. Hicks, H.C. Stabins, J.J. Millspaugh, A.J. Stabins, and L.D. Melampy. 2002. Roost site characteristics of northern spotted owls in the nonbreeding season in central Washington. Forest Science 48(2):437-446.

Higley, J. M., M.W. Gabriel., G. M. Wengert; and B. Poppenga. Barred Owl Exposure to Anticoagulant Rodenticide on the Hoopa Valley Indian Reservation, Potential Implications for Northern Spotted Owls. *In* abstracts of presentation to the Society of Northwest Vertebrate Biology. Arcata, California. February 2017. http://thesnvb.org/wp-content/uploads/2017/02/2017_all-MEETING-ABSTRACTS.pdf

Hoberg, E.P., G.S. Miller, E. Wallner-Pendleton, and O.R. Hedstrom. 1989. Helminth parasites of northern spotted owls (Strix occidentalis caurina). Journal of Wildlife Diseases 25:246–251.

Holm, S.R., Noon, B.R., Wiens, J.D. and Ripple, W.J. .2016. Potential trophic cascades triggered by the barred owl range expansion. Wildlife Society Bulletin. 40: 615-624. https://doi.org/10.1002/wsb.714

IEc (Industrial Economics, Incorporated). 2012. Economic analysis of critical habitat for the northern spotted owl. Prepared for: U.S. Fish and Wildlife Service. Arlington, VA. November 20, 2012. Cambridge, MA. 244 pp.

IPCC (Intergovernmental Panel on Climate Change). 2007. Climate Change 2007: The Physical Science Basis. Summary for Policymakers. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, February 2007.

Irwin, L.L., D.F. Rock, and G.P. Miller. 2000. Stand structures used by northern spotted owls in managed forests. Journal of Raptor Research 34(3):175-186.

Irwin, Larry, Dennis Rock, and Suzanne Rock. 2010. Adaptive Management Monitoring of Spotted Owls. Annual Progress Report. National Council for Air and Stream Improvement, Inc.

Irwin, L.L., T.L. Fleming, and J. Beebe. 2004. Are spotted owl populations sustainable in fire-prone forests? Journal of Sustainable Forestry 18:1–28.

Irwin, L.L., Rock, D.F., Rock, S.C., Heyerly, A.K. and Clark, L.A. 2020. Barred Owl Effects on Spotted Owl Resource Selection: A Meta-Analysis. Journal of Wildlife Management. 84: 96-117. https://doi.org/10.1002/jwmg.21784

Iverson, W.F. 1993. Is the barred owl displacing the spotted owl in western Washington? M.S. Thesis, Western Washington University, Bellingham, Washington.

Jenness, J.S., P. Beier, and J.L. Ganey. 2004. Associations between forest fire and Mexican Spotted Owls. Forest Science 50(6) 2004.

Johnson, D. H., K. Norman, Jerry F. Franklin, Jack Ward Thomas, and John Gordon. 1991. Alternatives for Management of Late-Successional Forests of the Pacific Northwest. A report for the Conservation of Late-successional Forests and Aquatic Ecosystems.

Johnson, D.H. 1992. Spotted owls, great horned owls, and forest fragmentation in the central Oregon Cascades. M.S. Thesis, Oregon State University, Corvallis, Oregon.

Jones, G.M., R.J. Gutiérrez, D. J Tempel, S.A. Whitmore, W.J. Berigan, and M.Z. Peery. 2016. Megafires: an emerging threat to old-forest species. Front Ecol Environ 14(6): 300–306.

Jones, G.M., R.J. Gutiérrez, W.M. Block, P.C. Carlson, E.J. Comfort, S.A. Cushman, R.J. Davis, S.A. Eyes, A.B. Franklin, J.L. Ganey, S. Hedwall, J.J. Keane, R. Kelsey, D.B. Lesmeister, M.P. North, S.L. Roberts, J.T. Rockweit, J.S. Sanderlin, S.C. Sawyer, B. Solvesky, D.J. Tempel, H.Y. Wan, A.L. Westerling, G.C. White, and M.Z. Peery. 2020a. Spotted owls and forest fire: comment. Ecosphere 11:e03312.

Jones, G.M., H.A. Kramer, S.A. Whitmore, W.J. Berigan, D.J. Tempel, C.M. Wood, B.K. Hobart, T. Erker, F.A. Atuo, N.F. Pietrunti, R. Kelsey, R.J. Gutiérrez, M.Z. Peery. 2020b. Habitat selection by spotted owls after a megafire reflects their adaptation to historical frequent-fire regimes. Landscape Ecology 25:1199-1213.

Jones, G.M., H.A. Kramer, W.J. Berigan, S.A. Whitmore, R.J. Gutiérrez, and M.Z. Peery. 2021. Megafire causes persistent loss of an old-forest species. Animal Conservation doi:10.1111/acv.12697.

Karl, T.R. J.M. Melillo, and T.C. Peterson. 2009. Global Climate Change Impacts in the United States. Cambridge University Press.

Karl, T.R., G.A. Meehl, C.D. Miller, S.J. Hassol, A.M. Waple, and W.L. Murray, Eds., 2008: Weather and climate extremes in a changing climate. Regions of focus: North America, Hawaii, Caribbean, and U.S. Pacific islands. U.S. Climate Change Science Program Synthesis and Assessment Product 3.3, 180 pp.

Kelly, E.G. 2001. The Range Expansion of the Northern Barred Owl: An Evaluation of the Impact on Spotted Owls. M.S. Thesis. Oregon State University, Corvallis, Oregon. 92 pp.

Kelly, E.G., E.D. Forsman, and R.G. Anthony. 2003. Are barred owls replacing spotted owls? Condor 105:45-53.

Kelly, E.G. and E.D. Forsman. 2004. Recent records of hybridization between barred owls (Strix varia) and northern spotted owls (S. occidentalis caurina). Auk 121:806-810.

King, Gina M, K. R. Bevis, M. A. Rowe and E. E. Hanson. 1998. Spotted Owl Use of Habitat Impacted by 1994 Fires on the Yakama Indian Reservation: Three Years Post-Fire. Presentation at the Second Fore Effects on Rare and Endangered Species Conference; International Association of Wildland Fire, Coeur d'Alene. March 29-April 1, 1998.

Knight, R. L. and S. K. Skagen. 1988. Effects of recreational disturbance on birds of prey: a review. Pages 355-359 in R. L. Glinski et al., editors. Proceedings of the Southwest Raptor Management Symposium and Workshop, National Wildlife Federation, Washington, D. C.

Komar, N., N.A. Panella, J.E. Burns, S.W. Dusza, T.M. Mascarenhas, and T.O. Talbot. 2001. Serologic evidence for West Nile virus infection in birds in the New York City vicinity during an outbreak in 1999. Emerging Infectious Diseases 7(4):621-5.

Kramer, A., G.M. Jones, S.A. Whitmore, J.J. Keane, F.A. Atuo, B.P. Dotters, S.C. Sawyer, S.L. Stock, R.J. Gutiérrez, and M.Z. Peery. 2021. California spotted owl habitat selection in a fire-managed landscape suggests conservation benefit of restoring historical fire regimes. Forest Ecology and Management 479:118576.

Laidig, K.J., and D.S. Dobkin. 1995. Spatial overlap and habitat association of Barred Owls and Great Horned Owls in southern New Jersey. J. Raptor Res. 29:151–157.

LaHaye, W.S., R.J. Gutiérrez, and J.R. Dunk. 2001. Natal dispersion of the spotted owl in southern California: dispersal profile of an insular population. Condor 103:691-700.

Layman, S.A. 1991. Diurnal foraging by spotted owls. Wilson Bulletin. 103(1): 138-140.

Lee, D.E. 2018. Spotted owls and forest fire: a systematic review and meta-analysis of the evidence. Ecosphere 9:e02354.

Lee, D.L., M.L. Bond, and R.B. Siegel. 2012. Dynamics of California Spotted Owl breeding-season site occupancy in burned forests. The Condor 114:792-802.

Lee, D.L., and M.L. Bond. 2015a. Occupancy of California spotted owl sites following a large fire in the Sierra Nevada. The Condor. Ornithological Applications. V. 117:228-236.

Lee, D.L., and M.L. Bond. 2015b. Previous year's reproductive state affects spotted owl site occupancy. The Condor. Ornithological Applications. V. 117:307-319.

Leskiw, T., and R.J. Gutiérrez. 1998. Possible predation of a Spotted Owl by a Barred Owl. Western Birds 29:225–226.

Lesmeister, D. and S. Pruett. 2017. Demographic Characteristics of Northern Spotted Owls (*Strix occidentalis caurina*) in the Olympic National Forest, Washington, 1987-2016. Annual research report. USDA Forest Service, Pacific Northwest Research Station, Corvallis, Oregon. 13 pp.

Lesmeister, D.B., S.G. Sovern, R.J. Davis, D.M. Bell, M.J. Gregory, and J.C. Vogeler. 2019. Mixed-severity wildfire and habitat of an old-forest obligate. Ecosphere. www.esajournals.org April 2019, Volume 10(4), Article e02696. Pp. 1-22.

Lesmeister, D., S. Sovern, and A. Mikkelsen. 2017. Demography of Spotted Owls on the east slope of the Cascade Range, Washington, 1989-2016. Annual research report. USDA Forest Service, Pacific Northwest Research Station, Corvallis, Oregon. 25 pp.

Lint, J. 2005. Northwest Forest Plan – The first ten years (1994-2003): Status and trend of northern spotted owl populations and habitat. PNW Station Edit Draft (Lint, Technical Coordinator, 2005). USDA Forest Service, PNW Research Station, PNW-GTR-2005. Draft. Portland, OR 230pp

Littell, J. S., E. E. Oneil, D. McKenzie, J. A. Hicke, J. A. Lutz, R. A. Norheim, and M. M. Elsner. 2010. Forest ecosystems, disturbance, and climatic change in Washington State, USA. Climatic Change.

Livezey, K.B. 2005. Iverson (2004) on spotted owls and barred owls: comments on methods and conclusions. Journal of Raptor Research 39(1):102-103.

Livezey, K.B. and T.L. Fleming. 2007. Effects of barred owls on spotted owls: the need for more than incidental detections and correlational analyses. Journal of Raptor Research. 41(4): 319-325.

Livezey, K. B. 2009. Range Expansion of Barred Owls, Part II: Facilitating Ecological Changes. The American Midland Naturalist 161:323–349.

Loehle, Craig, Larry Irwin, John Beebe, and Tracy Fleming. 2011. Factors Influencing the Distribution of Northern Spotted Owls in the Eastern Cascades, Washington. Published by the Society for Northwestern Vertebrate Biology. http://www.bioone.org/doi/full/10.1898/09-33.1

Long, L.L. and Wolfe, J.D. 2019. Review of the effects of barred owls on spotted owls. Journal of Wildlife Management. 83: 1281-1296. https://doi.org/10.1002/jwmg.21715

Mangan, A.O., T. Chestnut, J.C. Vogeler, I.K. Breckheimer, W.M. King, K.E. Bagnall, and K.M. Dugger. 2019. Barred owls reduce occupancy and breeding propensity of northern spotted owl in a Washington old-growth forest. Condor 121:1-20.

Marlon, J.R., P. J. Bartleinb, D. G. Gavinb, C. J. Long, R. S. Anderson, C. E. Brilese, K. J. Brown, D. Colombaroli, D. J. Hallett, M. J. Power, E. A. Scharf, and M. K. Walsh. 2012. Long-term perspective on wildfires in the western USA. Proceedings of the National Academy of Sciences of the United States of America. 2012. Vol. 109 no. 9. Edited by B. L. Turner, Arizona State University, Tempe, AZ. Pp. E535-E543.

Marra, P. P., S. Griffing, C. Caffrey, A. M. Kilpatrick, R. McLean, C. Brand, E. Saito, A. P. Dupuis, L. Kramer, and R. Novak. 2004. West Nile virus and wildlife. BioScience 54: 393-402.

McGarigal, K., R.G. Anthony, and F.B. Isaacs. 1991. Interactions of humans and bald eagles on the Columbia River estuary. Wildl. Monogr. 115. 47 pp. McKenzie, D., D.L. Peterson, and J.J. Littell. 2009. Global warming and stress complexes in forests of western North America. Pages 319–338 In A. Bytnerowicz, M.J. Araugh, A.R. Riebau, and C. Andersen, editors. Developments in Environmental Science, Volume 8. Elsevier, The Netherlands.

McLean, R. G., S. R. Ubico, D. E. Docherty, W. R. Hansen, L. Sileo, and T. S. McNamara. 2001. West Nile virus transmission and ecology in birds: Annals of the New York Academy of Sciences 951: 54–57.

Meyer, J.S., Irwin, L.L., and M.S. Boyce. 1998. Influence of habitat abundance and fragmentation on northern spotted owls in western Oregon. Wildlife Monographs 139: 1-51.

Miller, G.S., S.K. Nelson, and W.C. Wright. 1985. Two-year-old female spotted owl breeds successfully. Western Birds 16:69-73.

Miller, G.S. 1989. Dispersal of juvenile northern spotted owls in western Oregon. M.S. Thesis. Oregon State University, Corvallis, Oregon. 139 pages.

Miller, G.S., R.J. Small, and E.C. Meslow. 1997. Habitat selection by spotted owls during natal dispersal in western Oregon. J. Wildl. Manage. 61(1):140-150.

Miller, M.P., S.M. Haig, E.D. Forsman, R.G. Anthony, L. Diller, K.M. Dugger, A.B. Franklin, T.L. Fleming, S. Gremel, D.B. Lesmeister, M. Higley, D.R. Herter, and S.G. Sovern. 2018. Variation in inbreeding rates across the range of northern spotted owls (*Strix occidentalis caurina*): insights from over 30 years of monitoring data. Auk 135:821-833.

Moen, C.A., A.B. Franklin, and R.J. Gutiérrez. 1991. Age determination of subadult northern spotted owls in northwest California. Wildlife Society Bulletin 19:489-493.

Moeur, Melinda; Spies, Thomas A.; Hemstrom, Miles; Martin, Jon R.; Alegria, James; Browning, Julie; Cissel, John; Cohen, Warren B.; Demeo, Thomas E.; Healey, Sean; Warbington, Ralph. 2005. Northwest Forest Plan–The first 10 years (1994-2003): status and trend of late-successional and old-growth forest. Gen. Tech. Rep. PNW-GTR-646. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 142 pp.

Moritz, M.A., M.A. Parisien, E. Batllori, M.A. Krawchuk, J. VanDorn, D.J. Ganz, and K. Hayhoe. 2012. Climate change and disruptions to global fire activity. 2012. Ecosphere. V. 3(6). Article 49, pp. 1-29.

Mote, P. W., A. Hamlet, and E. Salathé. 2008: Has spring snowpack declined in the Washington Cascades? Hydrology and Earth System Sciences, 12, 193-206, doi:10.5194/hess-12-93-2008. [Available online at http://www.hydrol-earth-syst-sci.net/12/193/2008/hess-12-193-2008.pdf]

Mote, P., A. K. Snover, S. Capalbo, S. D. Eigenbrode, P. Glick, J. Littell, R. Raymondi, and S. Reeder. 2014: Ch. 21: Northwest. Climate Change Impacts in the United States: The Third National Climate Assessment, J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 487-513. doi:10.7930/J04Q7RWX

Noon, B.R. and J.A. Blakesley. 2006. Conservation of the northern spotted owl under the Northwest Forest Plan. Conservation Biology 20:288–296.

North, Malcom P., J. F. Franklin, A. B. Carey, E. D Forsman and T. Hamer. 1999. Forest Stand Structure of the Northern Spotted Owl's Foraging Habitat. Journal of Forest Science 45(14).

North, M.P., G. Steger, R. Denton, G. Eberlein, T. Munton, and K. Johnson. 2000. Association of weather and nest-site structure with reproductive success in California spotted owls. Journal of Wildlife Management 64(3):797-807.

ODFW (Oregon Department of Fish and Wildlife). 2017. Threatened, Endangered, and Candidate Fish and Wildlife Species in Oregon. Revised June 2017. 2 pp.

Odion, D.C., C.T. Hanson, A. Arsenault, W.L. Baker, D.A. DellaSala, R.L. Hutto, W. Klenner, M.A. Moritz, R.L. Sherriff, T.T. Veblen, and M.A. Williams 2014a. Examining Historical and Current Mixed-Severity Fire Regimes in Ponderosa Pine and Mixed-Conifer Forests of Western North America. PLoS ONE 9(2): e87852. doi:10.1371/journal.pone.0087852 14 pp.

Odion, D.C., C.T. Hanson, D.A. DellaSala, W.L. Baker, and M.L. Bond. 2014b. Effects of Fire and Commercial Thinning on Future Habitat of the Northern Spotted Owl. The Open Ecology Journal, 2014, 7, 37-51.Olson, G.S., E.M. Glenn, R.G. Anthony, E.D. Forsman, J.A. Reid, P.J. Loschl, and W.J. Ripple. 2004. Modeling demographic performance of northern spotted owls relative to forest habitat in Oregon. Journal of Wildlife Management 68(4):1039-1053.

Olson, G.S., E. Glenn, R.G. Anthony, E.D. Forsman, J.A. Reid, P.J. Loschl, and W.J. Ripple. 2004. Modeling demographic performance of northern spotted owls relative to forest habitat in Oregon. Journal of Wildlife Management.

Olson, G.S., R.G. Anthony, E.D. Forsman, S.H. Ackers, P.J. Loschl, J.A. Reid, K.M Dugger, E.M. Glenn, and W.J. Ripple. 2005. Modeling of site occupancy dynamics for northern spotted owls, with emphasis on the effects of barred owls. Journal of Wildlife Management 69(3):918-932.

Omi, P.N., and E.J. Martinson. 2002. Effects of fuels treatment on wildfire severity. Final report submitted to the Joint Fire Science Program Governing Board. i-36. 40 pp.

Oregon Department of Forestry (ODF). 2014. Forest Practices Administrative Rules and Forest Practices Act. Salem, OR. Available online: https://www.oregon.gov/ODF/Documents/WorkingForests/FPARulebook.pdf

Pearson, R.R., and K.B. Livezey. 2003. Distribution, numbers, and site characteristics of spotted owls and barred owls in the Cascade Mountains of Washington. Journal of Raptor Research 37(4):265-276.

Peterson, E.K., E.M. Hansen, and A. Kanaski. 2015. Temporal epidemiology of sudden oak death in Oregon. Phytopathology. 105:937-946.

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. Wildlife Department of Wildlife Research Report.

Rizzo, D.M., M. Garbeloto, J.M. Davidson, G.W. Slaughter, and S.T. Koike. 2002. Phytophthora ramorum as the cause of extensive mortality of Quercus spp. and Lithocarpus densiflorus in California. Plant Disease 86:205-214.

Rizzo, David and Matteo Garbelotto. 2003. Sudden oak death: endangering California and Oregon forest ecosystems1: 197–204. http://dx.doi.org/10.1890/1540-9295(2003)001[0197:SODECA]2.0.CO;2

Rockweit, J. T., A. B. Franklin, and P. C. Carlson. 2017. Differential impacts of wildfire on the population dynamics of an old-forest species. Ecology 98:1574–1582.

Rosenburg, Daniel K., and R. G. Anthony. 1992. Characteristics of Northern Flying Squirrel Populations in Young Second and Old Growth Forests in Western Oregon. Canadian Journal of Zoology. Volume 70.

Rosenberg, D.K., K.A. Swindle, and R.G. Anthony. 2003. Influence of prey abundance on northern spotted owl reproductive success in western Oregon. Canadian Journal of Zoology 81:1715-1725.

Saplosky Robert, L. Michael Romero, and Allan U. Munck. 2000. How do Glucocorticoids affect stress responses? Integrating Permissive, Suppressive, Stimulatory and Preparatory Actions. http://edrv/endojournals.org/cgi/content. 12-19-2000.

Schilling, J.W., K.M. Dugger, and R.G. Anthony. 2013. Survival and home range size of northern spotted owls in southwest Oregon. Journal of Raptor Research. 47(1):1-4.

Schmidt, K. 2006. Northern spotted owl monitoring and inventory, Redwood National and State Parks, 2005 annual report. Redwood National and State Parks, Orick, California.

Schumaker, N.H., A. Brookes, J.R. Dunk, B. Woodbridge, J.A. Heinrichs, J.J. Lawler, C. Carroll, and D. LaPlante. 2014. Mapping sources, sinks, and connectivity using a simulation model of northern spotted owls. Landscape Ecology, 29, 579–592.

Service (U.S. Fish and Wildlife Service). 1983. Endangered and threatened species listing and recovery priority guidelines: correction. Federal Register 48:51985.

Service (U.S. Fish and Wildlife Service). 1989. The Northern Spotted Owl; a status review supplement. Portland, Oregon. 113 pp.

Service (U.S. Fish and Wildlife Service). 1990a. Endangered and threatened wildlife and plants; determination of threatened status for the northern spotted owl; final rule. Federal Register, 50 CFR 17: 26,114-26,194.

Service (U.S. Fish and Wildlife Service). 1990b. 1990 status review: northern spotted owl; Strix occidentalis caurina. Report to the U.S. Fish and Wildlife Service, Portland, OR.

Service (U.S. Fish and Wildlife Service). 1992a. Endangered and Threatened Wildlife and Plants; Draft Recovery Plan for the northern spotted owl.

Service (U.S. Fish and Wildlife Service). 1992b. Endangered and Threatened Wildlife and Plants; determination of critical habitat for the northern spotted owl. Federal Register 57: 1796-1838.

Service (U.S. Fish and Wildlife Service). 1994. Final biological opinion for the preferred alternative of the supplemental environmental impact statement on management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl. Fish and Wildlife Service, Portland, Oregon.

Service (U.S. Fish and Wildlife Service). 1995. Endangered and threatened wildlife and plants; proposed special rule for the conservation of the northern spotted owl on non-federal lands. Federal Register 60:9483–9527.

Service (U.S. Fish and Wildlife Service). 2001. A range wide baseline summary and evaluation of data collected through section 7 consultation for the northern spotted owl and its critical habitat: 1994-2001. Portland, OR. Unpublished document. 41 pages.

Service (U.S. Fish and Wildlife Service). 2004. Northern Spotted Owl Five Year Review: Summary and Evaluation, Portland, OR. 72pp.

Service (U.S. Fish and Wildlife Service). 2008. Recovery Plan for the Northern Spotted Owl. Region 1. U.S. Fish and Wildlife Service. Portland, Oregon.

Service (U.S. Fish and Wildlife Service). 2009. Regulatory and scientific basis for the U.S. Fish and Wildlife Service guidance for evaluation of take for northern spotted owls on private timberlands in California's northern interior region.

Service (U.S. Fish and Wildlife Service). 2011a. Northern Spotted Owl: Five Year Review Summary and Evaluation. U.S. Fish and Wildlife Service. Portland, Oregon. 7 pp.

Service (U.S. Fish and Wildlife Service). 2011b. Revised Recovery Plan for the Northern Spotted Owl. Region 1. U.S. Fish and Wildlife Service. Portland, Oregon.

Service (U.S. Fish and Wildlife Service). 2012a. Revised Critical Habitat for the Northern Spotted Owl. Region 1. U.S. Fish and Wildlife Service. Portland, Oregon. Published in the Federal Register December 4, 2012.

Service (U.S. Fish and Wildlife Service). 2012b. Protocol for surveying proposed management activities that may impact northern spotted owls. Revised January 9, 2012. 42pp.

Service (U.S. Fish and Wildlife Service). 2013a. Experimental removal of barred owls to benefit threatened northern spotted owls. Environmental Impact Statement. July, 2013. Oregon Fish and Wildlife Office, Portland, Oregon. 467 pp.

Service (U.S. Fish and Wildlife Service). 2013b. Experimental Removal of Barred Owls to Benefit Threatened Northern Spotted Owls; Record of Decision for Final Environmental Impact Statement. Notice of availability September 17, 2013. 57171-57173.

Service (U.S. Fish and Wildlife Service). 2015. Endangered and Threatened Wildlife and Plants; 90-Day Findings on 10 Petitions; Evaluation of a Petition to Reclassify the Northern Spotted Owl as an Endangered Species Under the Act Federal Register 80 (69): 19262

Service (U.S. Fish and Wildlife Service). 2016. Biological Opinion for the Western Oregon Resource Management Plan. August, 2016,

Service (U.S. Fish and Wildlife Service). 2019. Northern spotted owl (*Strix occidentalis caurina*) species status report. Oregon Fish and Wildlife Office, Region 1, U.S. Fish and Wildlife Service, Portland. 130 pp.

Service (U.S. Fish and Wildlife Service). 2020. Endangered and Threatened Wildlife and Plants; 12-Month Finding for the Northern Spotted Owl. Federal Register 85 (241): 81144-81152.

Service (U.S. Fish and Wildlife Service). 2021. Endangered and Threatened Wildlife and Plants; Revised Designation of Critical Habitat for the Northern Spotted Owl. Federal Register 86(136): 38246.

Service and NOAA (U.S. Fish and Wildlife Service and National Oceanic and Atmospheric Administration. 2016. Interagency Cooperation—Endangered Species Act of 1973, as Amended; Definition of Destruction or Adverse Modification of Critical Habitat Federal Register. Vol. 81, No. 28 Thursday, February 11, 2016. Final Rule. Pp. 7214-7225. Available online: https://www.fws.gov/endangered/improving_ESA/pdf/Adverse%20Modification-2016-02675-02112015.pdf

Service and NMFS (Fish and Wildlife Service, National Marine Fisheries Service). 1998. Procedures for Conducting Consultation and Conference Activities under Section 7 of the Endangered Species Act.

Singleton, P, S. Graham, W. Gaines, and J. Lehmkuhl. 2005. The ecology of barred owls in fire-prone forests. USDA PNW December 2005 Progress Report; Wenatchee, Washington. Sisco, C.L. 1990. Seasonal home range and habitat ecology of spotted owls in northwestern California. M.S. Thesis. Humboldt State University, Arcata, California.

Singleton, P., 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(2): 285-294.

Sisco, C.L. 1990. Seasonal home range and habitat ecology of spotted owls in northwestern California. M.S. Thesis. Humboldt State University, Arcata, California.

Solis, D. M. and R. J. Gutierrez. 1990. Summer habitat ecology of northern spotted owls in northwestern California. The Condor 92:739-748.

Sovern, S.G., E.D. Forsman, B.L. Biswell, D.N. Rolph, and M. Taylor. 1994. Diurnal behavior of the spotted owl in Washington. Condor 96(1):200-202.

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. The Journal of Wildlife Management 79(2):254–262; 2015.Steger, G. N., L. R. Werner, and T. E. Munton, 2006. USDA Forest Service, Pacific Southwest Research Station, First Documented Record of the Barred Owl in the Southern Sierra Nevada. Pacific Southwest Research Station. Western Birds. 37:106-109. 2006.

Spies, T.A., M.A. Hemstrom, A. Youngblood, and S. Hummel. 2006. Conserving old-growth forest diversity in disturbance-prone landscapes. Conservation Biology. 20:351-362.

Spies, T.A., Miller, J.D., Buchanan, J.B., Lehmkuhl, J.F., Franklin, J.F., Healy, S.P. Hessburg, P.F., Safford, H.D., Cohen, W.D., Kennedy, R.S.H., Knapp, E.K., Agee, J.K., Moeur, M., 2009. Underestimating risks to the Northern Spotted Owl in fireprone forests: response to Hanson et al. Conservation Biology 24 (1), 330–333.

Spies, T.A., D.B. Lindenmayer, A.M. Gill, S.L. Stephens, and J.K. Agree. 2012. Challenges and a checklist for biodiversity conservation in fire-prone forests: perspectives from the Pacific Northwest of USA and southeastern Australia. Biological Conservation 145: 5-14.

Stenseth, N.C, A. Mysterud, G. Ottersen, J.W. Hurrell, K. Chan, M. Lima. Ecological Effects of Climate Fluctuations. 2002. Science V. 23 August 2002. Pp.1292-1296. Vol. 297 no. 5585 pp. 1292-1296

Swarthout, E.C.H. and R.J. Steidl. 2001. Flush responses of Mexican spotted owls to recreationists. J. Wildlife Management 65(2):312-317.

Swindle, Keith A., William J. Ripple, and E. Charles Meslow. 1997. Landscape Composition around Northern Spotted Owl Nests, Central Cascade Mountains, Oregon. An Abstract of the Thesis for Master of Science degree. Oregon Cooperative Wildlife Research Unit, Oregon State University, Corvallis, Oregon.

Tempel D.J. and R. J. Gutiérrez. 2003. Fecal Corticosterone Levels in California Spotted Owls Exposed to Low-intensity Chainsaw Noise.

Tempel D.J. and R. J. Gutiérrez. 2004. Factors Relating to Fecal Corticosterone Levels in California Spotted Owls: Implications for Assessing Chronic Stress.

Thomas, J.W.; E.D. Forsman; J.B. Lint; E.C. Meslow; B.R. Noon; and J. Verner. 1990. A conservation strategy for the northern spotted owl: a report of the Interagency Scientific Committee to address the conservation of the northern spotted owl. Portland, Oregon. U.S. Department of Agriculture, Forest Service; U.S. Department of Interior, Bureau of Land Management, U.S. Fish and Wildlife Service, National Park Service. 427 pp.

Thomas, J.W., M.G. Raphael, R.G. Anthony, E.D. Forsman, A.G. Gunderson, R.S. Holthausen, B.G. Marcot, G.H. Reeves, J.R. Sedell, and D.M. Solis. 1993. Viability assessments and management considerations for species associated with late-successional and old-growth forests of the Pacific Northwest. USDA Forest Service, Portland, Oregon.

Thomas, J.W., and M.G. Raphael (Eds.). 1993. Forest Ecosystem Management: An Ecological, Economic, and Social Assessment. Report of the Forest Ecosystem Management Assessment Team (FEMAT). July 1993. Portland, OR: USDA Forest Service and the USDI Bureau of Land Management.

Thome, Darrin M., C. J. Zabel and L. V. Diller. 1999. Forest Stand Characteristics and Reproduction of Northern Spotted Owls in Managed North-Coastal California Forests. Journal of Wildlife Management 63(1):44-59.

USFS and BLM (US Forest Service and Bureau of Land Management). 1994a. Record of Decision for amendments to Forest Service and Bureau of Land Management planning documents within the range of the northern spotted owl. U.S. Forest Service, Bureau of Land Management, Portland, OR. 2 vols. and appendices.

USFS and BLM (US Forest Service and Bureau of Land Management). 1994b. Final supplemental environmental impact statement on management of habitat for late-successional and old-growth forests related species within the range of the northern spotted owl. U.S. Forest Service, Bureau of Land Management, Portland, OR.

Wagner, F.F., E.C. Meslow, G.M. Bennett, C.J. Larson, S.M. Small, and S. DeStefano. 1996. Demography of northern spotted owls in the southern Cascades and Siskiyou, Mountains, Oregon. Pages: 67-76 In: Forsman, E.D., S. DeStefano, M.G. Raphael, and R.J. Gutierrez, (editors). 1996. Demography of the northern spotted owl. Studies in Avian Biology No. 17. Cooper Ornithology Society.

Walther, G.E., E. Post, P. Convey, A. Menzel, C. Parmesan. 2002. Ecological responses to recent climate change. Nature. V. 416. 28 March 2002. Pp. 389-395.

Ward, J. W. Jr. 1990. Spotted owl reproduction, diet and prey abundance in northwest California. M.S. Thesis. Humboldt State University, Arcata.

Washington Forest Practices Board. 1996. Permanent rules for the northern spotted owl. Washington Department of Natural Resources, Olympia, Washington.

Wasser, S. K., K. Bevis, G. King, and E. Hanson. 1997. Noninvasive physiological measures of disturbance in the northern spotted owl. Conservation Biology 11: 1019-1022.

WDFW (Washington Department of Fish and Wildlife). 2017. State Listed Species. Revised February 2017. 2 pp.

Weathers, W.W., Hodum, P.J., and J.A. Blakesley. 2001. Thermal ecology and ecological energetics of California spotted owls. The Condor 103: 678-690.

Wengert, G.M., M. Higley, M.W. Gabriel, H.R. Romsos, and W. Spencer. 2015. Modeling to predict the probability of trespass marijuana cultivation site presence in fisher, northern spotted owl, and Humboldt marten habitat. PowerPoint presentation to U.S. Fish and Wildlife Service. November 2015.

Westerling, A. L., H. Hidalgo, D.R. Cayan, and T. Swetnam. 2006: Warming and Earlier Spring Increases Western US Forest Wildfire Activity, Science, 313: 940-943.

White, C. M., and T. L. Thurow. 1985. Reproduction of ferruginous hawks exposed to controlled disturbance. The Condor 87:14-22.

Wiens, J.D. 2012. Competitive Interactions and Resource Partitioning Between Northern Spotted Owls and Barred Owls in Western Oregon. Dissertation. Oregon State University. 156 pp.

Wiens, J.D., R.G. Anthony, and E.D. Forsman. 2011. Barred Owl Occupancy Surveys Within the Range of the Northern Spotted Owl. The Journal of Wildlife Management 75(3):531–538.

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. Wildlife Monographs No. 185. 50 pp.

Wiens, J.D., K.E. Dilione, C.A. Eagles-Smith, G. Herring, D.B. Lesmeister, M.W. Gabriel, G.M. Wengert, and D.C. Simon. 2019. Anticoagulant rodenticides in *Strix* owls indicate widespread exposure in west coast forests. Biological Conservation 238:108238.

Wiens, J.D., Dugger, K.M., Lewicki, K.E., and Simon, D.C. 2017. Effects of experimental removal of barred owls on population demography of northern spotted owls in Washington and Oregon—2016 progress report: U.S. Geological Survey Open-File Report 2017-1040, 23 p., https://doi.org/10.3133/ofr20171040.

Wiens, J.D., Dugger, K.M., Lesmeister, D.B., Dilione, K.E., and Simon, D.C., 2019, Effects of Barred Owl (*Strix* varia) removal on population demography of Northern Spotted Owls (*Strix* occidentalis *caurina*) in Washington and Oregon, 2015–18: U.S. Geological Survey Open-File Report 2019-1074, 17 pp. https://doi.org/10.3133/ofr20191074.

Yackulic, C.B., L.L. Bailey, K.M. Dugger, R.J. Davis, A.B. Franklin, E.D. Forsman, S.H. Ackers, L.S. Andrews, L.V. Diller, S.A. Gremel, K.A. Hamm, D.R. Herter, J.M. Higley, R.B. Horn, C. McCafferty, J.A. Reid, J.T. Rockweit, and S.G. Sovern. 2019. The past and future roles of competition and habitat in the rangewide occupancy dynamics of northern spotted owls. Ecological Applications 29(3):e01861.

Yospin, G.I., S.D. Bridgham, R.P. Neilson, J.P. Bolte, D.M. Bachelet, P.J. Gould, C.A. Harrington, J.A. Kertis, C. Evers, and B.R. Johnson. 2015. A new model to simulate climate-change impacts on forest succession for local land management. Ecological Applications, 25(1), 226-242. doi:10.1890/13-0906.

Zabel, C. J., K. M. McKelvey, and J. P. Ward, Jr. 1995. Influence of primary prey on home-range size and habitat-use patterns of northern spotted owls (Strix occidentalis caurina). Canadian Journal of Zoology 73:433-439.

Zabel C.J., S.E. Salmons, and M. Brown. 1996. Demography of northern spotted owls in southwestern Oregon. Studies in Avian Biology 17:77-82.

Zabel, C. J., J. R. Dunk, H. B. Stauffer, L. M. Roberts, B. S. Mulder, and A. Wright. 2003. Northern spotted owl habitat models for research and management application in California. Ecological Applications 13:1027–1040.

Personal Communications

Caruthers, Robert, USDA FS. 2017. April 7 telephone conversation with Jan Johnson. Documented in PDF file.

Clayton, David. USDA FS. 2017 May 5 email thread to Jan Johnson. Subject: FW: MjOwls in the 0.5-mile buffer group

Forsman, E. pers. comm. 2006. Citation, p. B-11 in Service (U.S. Fish and Wildlife Service). 2011b. Revised Recovery Plan for the Northern Spotted Owl. Region 1. U.S. Fish and Wildlife Service. Portland, Oregon. 277 pp.

Grubb, T. pers. comm. No date. Pers. comm. citation on Ch 8 p. 33 in Blakesley, J.A., W. LaHaye, J.M.M. Marzluff, B.R. Noon, and S. Courtney. 2004. Scientific evaluation of the status of the northern spotted owl – demography. 1-46 pp. In: Courtney, S.P., J.A. Blakesley, R.E. Bigley, M.L. Cody, J.P. Dumbacher, R.C. Fleischer, A.B. Franklin, J.F. Franklin, R.J. Gutiérrez, J.M. Marzluff, L. Sztukowski. 2004. Scientific evaluation of the status of the northern spotted owl. Sustainable Ecosystems Institute. Portland, Oregon. September 2004. 508 pp.

Hunter B. pers. comm. No date. Pers. comm. citation on Ch 8 p. 34 in Blakesley, J.A., W. LaHaye, J.M.M. Marzluff, B.R. Noon, and S. Courtney. 2004. Scientific evaluation of the status of the northern spotted owl – demography. 1-46 pp. In: Courtney, S.P., J.A. Blakesley, R.E. Bigley, M.L. Cody, J.P. Dumbacher, R.C. Fleischer, A.B. Franklin, J.F. Franklin, R.J. Gutiérrez, J.M. Marzluff, L. Sztukowski. 2004. Scientific evaluation of the status of the northern spotted owl. Sustainable Ecosystems Institute. Portland, Oregon. September 2004. 508 pp. Loschl, P. and E. Forsman pers. comm. 2006. Pers. comm. citation on p. A-1 in Service (U.S. Fish and Wildlife Service). 2011b. Northern Spotted Owl: Five Year Review Summary and Evaluation. U.S. Fish and Wildlife Service. Portland, Oregon. 7 pp. 277 p.

Loschl, P. and E. Forsman. 2006. Pers. comm. citation, p. A-1 in Service (U.S. Fish and Wildlife Service). 2011b. Northern Spotted Owl: Five Year Review Summary and Evaluation. U.S. Fish and Wildlife Service. Portland, Oregon. 7 pp. 277 p.

McGowan, K. pers. comm. No date. Pers. comm. citation on Ch 8 p. 33 in Blakesley, J.A., W. LaHaye, J.M.M. Marzluff, B.R. Noon, and S. Courtney. 2004. Scientific evaluation of the status of the northern spotted owl – demography. 1-46 pp. In: Courtney, S.P., J.A. Blakesley, R.E. Bigley, M.L. Cody, J.P. Dumbacher, R.C. Fleischer, A.B. Franklin, J.F. Franklin, R.J. Gutiérrez, J.M. Marzluff, L. Sztukowski. 2004. Scientific evaluation of the status of the northern spotted owl. Sustainable Ecosystems Institute. Portland, Oregon. September 2004. 508 pp.

Associated Federal Register Documents

55 FR 26114: Determination of Threatened Status for the Northern Spotted Owl. Final Rule. Published in the Federal Register on January 26, 1990. 26114-26194.

57 FR 1796: Endangered and Threatened Wildlife and Plants; determination of critical habitat for the northern spotted owl. Final Rule. Published in the Federal Register on January 15, 1992. 1796-1838.

58 FR 14248: Final Rule to List the Mexican Spotted Owl as a Threatened Species. Final Rule. Published in the Federal Register on March 16, 1993. 14248-14271.

73 FR 29471: Proposed Revised Designation of Critical Habitat for the Northern Spotted Owl (*Strix occidentalis caurina*). Proposed rule. In addition, this document announced that the Final Recovery Plan for the Northern Spotted Owl is available. Published in the Federal Register on May 21, 2008. 29471-29477.

73 FR 47326: Revised Designation of Critical Habitat for the Northern Spotted Owl; Final Rule. Published in the Federal Register on Federal Register on August 13, 2008. 47326-47522.

76 FR 38575: Revised Recovery Plan for the Northern Spotted Owl (*Strix occidentalis caurina*). Notice of document availability: revised recovery plan. Published in the Federal Register on July 1, 2011. 38575-38576.

76 FR 63719: 12-Month Finding on a Petition to List a Distinct Population Segment of the Red Tree Vole as Endangered or Threatened. Proposed Rule. Published in the Federal Register on October 13, 2011. 63720-63762.

77 FR 71876: Designation of Revised Critical Habitat for the Northern Spotted Owl. Final Rule. Published in the Federal Register on December 4, 2012. 71876-72068.

78 FR 57171: Experimental Removal of Barred Owls to Benefit Threatened Northern Spotted Owls; Record of Decision for Final Environmental Impact Statement. Notice of availability September 17, 2013. 57171-57173.

80 FR 19259. 90-Day Findings on 10 Petitions. Notice of petition findings and initiation of status reviews. Published in the Federal Register on April 10, 2015. 19259-19263.

85 FR 81144. 12-Month Finding for the Northern Spotted Owl. Published in the Federal Register on December 15, 2020. 81144-81152.

86 FR 38246: Revised Designation of Critical Habitat for the Northern Spotted Owl. Proposed Rule. Published in the Federal Register on July 21, 2021. 38246-38262.

Appendix A – Critical habitat acres by critical habitat unit

Summary of spotted owl critical habitat by major critical habitat unit. Projection: Albers Equal Area Conic (EPSG:5070). Davis et al. raster data (NSO_CTS_CLASS_2022).

Critical Habitat Unit Number	Critical Habitat Unit Name	Total designated CH (acres)	Unsuitable habitat (acres)	Marginal habitat (acres)	Suitable habitat (acres)	Highly suitable habitat (acres)	Unclassified or not habitable habitat capable (acres)	Percent nesting, roosting habitat in designated CH
1	North Coast Ranges and Olympic Peninsula	819,519	248,037	255,602	141,728	166,590	7,562	37.6
2	Oregon Coast Ranges	809,454	243,129	191,509	112,080	261,746	989	46.2
3	Redwood Coast	146,839	23,042	45,898	26,694	46,570	4,636	49.9
4	West Cascades North	542,146	124,482	118,037	145,273	138,660	15,694	52.4
5	West Cascades Central	899,154	220,989	220,149	195,849	248,689	13,478	49.4
6	West Cascades South	1,375,608	403,899	167,944	184,581	609,196	9,988	57.7
7	East Cascades North	1,359,263	596,391	287,883	218,305	211,865	44,820	31.6
8	East Cascades South	284,974	85,295	112,238	69,917	14,189	3,336	29.5
9	Klamath West	1,251,746	340,433	169,115	200,699	534,041	7,458	58.7
10	Klamath East	882,764	251,524	148,720	158,763	317,024	6,733	53.9
11	Interior California Coast	1,001,425	503,189	153,426	146,592	168,920	29,299	31.5
	Grand Total	**9,372,892**	**3,040,410**	**1,870,520**	**1,600,481**	**2,717,490**	**143,991**	**46.1**

Notes:

1. Due to rounding errors associated with GIS, the acreage values reported here may differ slightly from values reported elsewhere. Spotted owl habitat estimates are approximate values derived from habitat maps developed for the NWFP 25-year monitoring report (Davis et al. 2022).
2. Spotted owl critical habitat as designated on November 10, 2021 (86 FR 62606).

Appendix B – Critical habitat acres by physiographic province

Summary of designated spotted owl critical habitat by physiographic province. Projection: Albers Equal Area Conic (EPSG:5070). Davis et al. raster data (NSO_CTS_CLASS_2022).

State	Physiographic Province	Total designated critical habitat (acres)	Unsuitable habitat (acres)	Marginal habitat (acres)	Suitable habitat (acres)	Highly suitable habitat (acres)	Unclassified or not habitable capable (acres)	Percent nesting, roosting habitat in designated CH
WA	Western Cascades	1,387,567	333,199	329,112	335,778	361,675	27,803	50.3
WA	Eastern Cascades	1,022,959	424,732	194,434	151,208	216,016	36,569	35.9
WA	Olympic Peninsula	507,165	132,902	147,527	100,147	120,313	6,278	43.5
OR	Coast Range	1,109,556	356,089	295,998	150,683	304,494	2,293	41.0
OR	Cascades West	1,908,408	546,775	265,256	284,307	797,639	14,431	56.7
OR	Klamath Mountains	821,888	204,578	102,852	136,213	375,742	2,503	62.3
OR	Cascades East	514,361	214,526	141,360	108,127	34,960	15,388	27.8
CA	Cascades	243,164	71,982	87,501	53,706	28,240	1,735	33.7
CA	Klamath	1,708,781	724,545	257,851	253,580	438,760	34,045	40.5
CA	Coast	149,043	30,351	47,058	25,852	39,386	6,397	43.8
TOTAL		**9,372,892**	**3,039,679**	**1,868,946**	**1,599,601**	**2,717,225**	**147,441**	**46.1**

Notes:

1. Due to rounding errors associated with GIS, the acreage values reported here may differ slightly from values reported elsewhere. Spotted owl habitat estimates are approximate values derived from habitat maps developed for the NWFP 25-year monitoring report (Davis et al. 2022).
2. Spotted owl critical habitat as designated on November 10, 2021 (86 FR 62606).
3. 3,712 acres of CH were found outside of the physiographic province. These acres were added to adjacent provinces relative to where they were found.

Appendix C – Critical habitat acres by critical habitat subunit

Summary of designated spotted owl critical habitat by subunit. Projection: Albers Equal Area Conic (EPSG:5070). Davis et al. raster data (NSO_CTS_CLASS_2022).

Critical Habitat Unit Name	Critical Habitat (CH) Subunit Name	Total designated CH (acres)	Unsuitable habitat (acres)	Marginal habitat (acres)	Suitable habitat (acres)	Highly suitable habitat (acres)	Unclassified or not habitable habitat capable (acres)	Percent nesting, roosting habitat in designated CH
East Cascades North	ECN 1	101,656	52,689	18,029	13,130	11,202	6,606	23.9
East Cascades North	ECN 2	60,087	45,431	4,592	3,087	2,328	4,649	9.0
East Cascades North	ECN 3	301,220	113,096	62,019	56,580	55,754	13,771	37.3
East Cascades North	ECN 4	223,282	93,942	45,356	28,731	50,219	5,034	35.4
East Cascades North	ECN 5	201,140	88,121	41,717	31,161	35,708	4,433	33.2
East Cascades North	ECN 6	81,842	19,188	13,649	13,180	35,148	678	59.0
East Cascades North	ECN 7	139,979	45,364	31,136	41,597	18,570	3,313	43.0
East Cascades North	ECN 8	94,622	59,635	21,772	10,918	1,001	1,297	12.6
East Cascades North	ECN 9	155,434	78,925	49,613	19,921	1,935	5,040	14.1
East Cascades South	ECS 1	109,090	24,620	37,901	34,441	10,439	1,689	41.1
East Cascades South	ECS 2	63,705	21,875	25,365	14,107	1,412	947	24.4
East Cascades South	ECS 3	112,179	38,800	48,972	21,369	2,337	700	21.1
Interior California Coast	ICC 1	332,061	157,496	51,331	47,546	65,001	10,687	33.9
Interior California Coast	ICC 2	204,461	103,306	18,812	28,765	46,313	7,265	36.7
Interior California Coast	ICC 3	104,813	74,750	13,117	8,645	6,197	2,105	14.2
Interior California Coast	ICC 4	119,957	88,081	13,304	10,302	5,742	2,529	13.4
Interior California Coast	ICC 5	34,955	17,624	6,531	5,496	3,323	1,980	25.2
Interior California Coast	ICC 6	2,072	1,103	380	32	10	547	2.0
Interior California Coast	ICC 7	119,729	43,350	30,617	24,240	17,654	3,866	35.0
Interior California Coast	ICC 8	83,376	17,478	19,335	21,565	24,679	320	55.5

Appendix C Continued

Critical Habitat Unit Name	Critical Habitat (CH) Subunit Name	Total designated CH (acres)	Unsuitable habitat (acres)	Marginal habitat (acres)	Suitable habitat (acres)	Highly suitable habitat (acres)	Unclassified or not habitable habitat capable (acres)	Percent nesting, roosting habitat in designated CH
Klamath East	KLE 1	242,875	78,467	26,552	34,991	101,714	1,151	56.3
Klamath East	KLE 2	70,432	14,582	5,627	9,796	40,297	129	71.1
Klamath East	KLE 3	64,362	20,415	10,472	10,778	22,166	530	51.2
Klamath East	KLE 4	256,077	57,040	56,566	57,223	82,381	2,867	54.5
Klamath East	KLE 5	26,076	7,508	4,989	5,738	7,244	597	49.8
Klamath East	KLE 6	156,464	40,930	31,700	31,148	51,810	875	53.0
Klamath East	KLE 7	66,478	32,581	12,814	9,089	11,412	583	30.8
Klamath West	KLW 1	131,936	32,358	13,040	17,025	69,107	406	65.3
Klamath West	KLW 2	149,947	45,376	14,279	20,067	69,783	441	59.9
Klamath West	KLW 3	144,406	40,535	16,761	18,457	68,232	420	60.0
Klamath West	KLW 4	158,049	29,351	24,903	38,409	65,140	246	65.5
Klamath West	KLW 5	31,084	4,390	3,416	8,274	14,677	327	73.8
Klamath West	KLW 6	117,541	10,895	13,590	23,208	69,210	639	78.6
Klamath West	KLW 7	254,465	97,244	34,964	30,788	88,574	2,895	46.9
Klamath West	KLW 8	114,677	42,528	26,239	21,136	23,991	784	39.4
Klamath West	KLW 9	149,641	37,757	21,923	23,335	65,326	1,300	59.2
North Coast Ranges and Olympic Peninsula	NCO 1	293,469	83,071	82,001	48,947	77,691	1,759	43.2
North Coast Ranges and Olympic Peninsula	NCO 2	213,697	49,830	65,526	51,200	42,621	4,519	43.9
North Coast Ranges and Olympic Peninsula	NCO 4	122,379	51,462	53,058	10,071	7,113	676	14.0
North Coast Ranges and Olympic Peninsula	NCO 5	189,975	63,673	55,017	31,511	39,165	609	37.2
Oregon Coast Ranges	OCR 1	109,378	31,566	24,961	18,947	33,779	125	48.2
Oregon Coast Ranges	OCR 2	253,497	85,213	63,626	35,058	69,380	221	41.2
Oregon Coast Ranges	OCR 3	199,274	57,826	47,026	24,577	69,758	87	47.3
Oregon Coast Ranges	OCR 4	8,263	1,482	3,074	2,566	1,133	7	44.8
Oregon Coast Ranges	OCR 5	161,320	44,204	33,504	21,364	62,043	204	51.7
Oregon Coast Ranges	OCR 6	77,721	22,838	19,318	9,567	25,653	345	45.3

Appendix C Continued

Critical Habitat Unit Name	Critical Habitat (CH) Subunit Name	Total designated CH (acres)	Unsuitable habitat (acres)	Marginal habitat (acres)	Suitable habitat (acres)	Highly suitable habitat (acres)	Unclassified or not habitable habitat capable (acres)	Percent nesting, roosting habitat in designated CH
Redwood Coast	RDC 1	60,766	8,182	20,654	12,802	18,313	816	51.2
Redwood Coast	RDC 2	65,389	9,138	18,533	11,133	25,521	1,065	56.1
Redwood Coast	RDC 5	20,684	5,723	6,712	2,759	2,736	2,755	26.6
West Cascades Central	WCC 1	225,272	73,672	55,109	40,439	55,009	1,043	42.4
West Cascades Central	WCC 2	279,420	63,370	72,534	68,142	68,836	6,538	49.0
West Cascades Central	WCC 3	394,462	83,948	92,505	87,268	124,844	5,897	53.8
West Cascades North	WCN 1	438,247	97,943	91,627	121,240	117,169	10,267	54.4
West Cascades North	WCN 2	103,899	26,538	26,410	24,033	21,491	5,427	43.8
West Cascades South	WCS 1	91,705	21,285	13,767	19,058	36,724	871	60.8
West Cascades South	WCS 2	150,330	61,718	22,173	24,677	40,582	1,180	43.4
West Cascades South	WCS 3	316,459	103,458	33,182	38,774	138,935	2,109	56.2
West Cascades South	WCS 4	379,017	90,680	47,512	44,990	193,224	2,611	62.9
West Cascades South	WCS 5	356,716	92,483	41,102	49,179	170,893	3,059	61.7
West Cascades South	WCS 6	81,381	34,276	10,207	7,903	28,837	158	45.1
TOTAL		**9,372,892**	**3,040,410**	**1,870,520**	**1,600,481**	**2,717,490**	**143,991**	**46.1**

Notes:

1. Due to rounding errors associated with GIS, the acreage values reported here may differ slightly from values reported elsewhere. Spotted owl habitat estimates are approximate values derived from habitat maps developed for the NWFP 25-year monitoring report (Davis et al. 2022).
2. Spotted owl critical habitat as designated on November 10, 2021 (86 FR 62606).

Appendix D – Critical habitat acres by subunit in 2021 relative to 2012

Designated spotted owl critical habitat in 2021 relative to the 2012 baseline. The 2021 data was calculated using Davis et al. raster data (NSO_CTS_CLASS_2022) and an Albers Equal Area Conic (EPSG:5070) projection.

	2012			2021			2021 relative to 2012	
CH SubUnit	Total Designated CH Acres	Raw Nesting/ Roosting (acres)	Percent of CH in Nesting/ Roosting	Total designated critical habitat (acres)	Nesting/ Roosting (acres)	Percent of CH in Nesting/ Roosting	Difference in Nesting/ Roosting (acres)	Difference in Nesting/ Roosting (%)
NCO 1	293,469	122,566	41.8%	293,469	126,638	43.2%	4,071	1.4%
NCO 2	213,697	88,532	41.4%	213,697	93,821	43.9%	5,289	2.5%
NCO 4	124,219	11,016	8.9%	122,379	17,184	14.0%	6,168	5.2%
NCO 5	198,463	55,100	27.8%	189,975	70,676	37.2%	15,576	9.4%
ORC 1	110,658	59,029	53.3%	109,378	52,726	48.2%	-6,303	-5.1%
ORC 2	261,403	114,935	44.0%	253,497	104,438	41.2%	-10,497	-2.8%
ORC 3	204,185	86,850	42.5%	199,274	94,335	47.3%	7,485	4.8%
ORC 4	8,263	4,935	59.7%	8,263	3,700	44.8%	-1,236	-15.0%
ORC 5	176,402	84,459	47.9%	161,320	83,407	51.7%	-1,053	3.8%
ORC 6	81,912	35,783	43.7%	77,721	35,221	45.3%	-562	1.6%
RDC 1	60,766	25,413	41.8%	60,766	31,115	51.2%	5,701	9.4%
RDC 2	65,389	34,213	52.3%	65,389	36,654	56.1%	2,441	3.7%
RDC 5	20,684	4,895	23.7%	20,684	5,495	26.6%	600	2.9%
WCN 1	438,247	206,086	47.0%	438,247	238,410	54.4%	32,323	7.4%
WCN 2	103,899	37,001	35.6%	103,899	45,524	43.8%	8,522	8.2%
WCC 1	225,272	91,005	40.4%	225,272	95,448	42.4%	4,443	2.0%
WCC 2	279,420	118,775	42.5%	279,420	136,978	49.0%	18,204	6.5%
WCC 3	394,462	188,190	47.7%	394,462	212,112	53.8%	23,923	6.1%
WCS 1	92,586	60,082	64.9%	91,705	55,782	60.8%	-4,300	-4.1%
WCS 2	151,418	79,831	52.7%	150,330	65,259	43.4%	-14,572	-9.3%
WCS 3	318,382	213,274	67.0%	316,459	177,710	56.2%	-35,564	-10.8%
WCS 4	379,023	247,786	65.4%	379,017	238,214	62.9%	-9,572	-2.5%
WCS 5	356,718	239,337	67.1%	356,716	220,072	61.7%	-19,265	-5.4%
WCS 6	99,516	55,979	56.3%	81,381	36,740	45.1%	-19,238	-11.1%
ECN 1	101,656	34,781	34.2%	101,656	24,332	23.9%	-10,448	-10.3%
ECN 2	60,087	17,878	29.8%	60,087	5,415	9.0%	-12,463	-20.7%
ECN 3	301,220	140,001	46.5%	301,220	112,334	37.3%	-27,666	-9.2%

	2012			2021			2021 relative to 2012	
CH SubUnit	**Total Designated CH Acres**	**Raw Nesting/ Roosting (acres)**	**Percent of CH in Nesting/ Roosting**	**Total designated critical habitat (acres)**	**Nesting/ Roosting (acres)**	**Percent of CH in Nesting/ Roosting**	**Difference in Nesting/ Roosting (acres)**	**Difference in Nesting/ Roosting (%)**
ECN 4	223,282	96,889	43.4%	223,282	78,950	35.4%	-17,939	-8.0%
ECN 5	201,140	86,317	42.9%	201,140	66,869	33.2%	-19,448	-9.7%
ECN 6	81,842	49,931	61.0%	81,842	48,327	59.0%	-1,604	-2.0%
ECN 7	139,979	61,330	43.8%	139,979	60,167	43.0%	-1,163	-0.8%
ECN 8	94,622	18,499	19.6%	94,622	11,919	12.6%	-6,580	-7.0%
ECN 9	155,434	39,007	25.1%	155,434	21,856	14.1%	-17,151	-11.0%
ECS 1	125,560	65,012	51.8%	109,090	44,880	41.1%	-20,131	-10.6%
ECS 2	66,086	17,204	26.0%	63,705	15,519	24.4%	-1,685	-1.7%
ECS 3	112,179	39,105	34.9%	112,179	23,707	21.1%	-15,398	-13.7%
KLW 1	147,263	89,790	61.0%	131,936	86,132	65.3%	-3,658	4.3%
KLW 2	149,965	97,495	65.0%	149,947	89,851	59.9%	-7,645	-5.1%
KLW 3	146,092	86,070	58.9%	144,406	86,690	60.0%	619	1.1%
KLW 4	158,835	101,599	64.0%	158,049	103,549	65.5%	1,950	1.6%
KLW 5	31,084	22,402	72.1%	31,084	22,951	73.8%	550	1.8%
KLW 6	117,541	82,180	69.9%	117,541	92,418	78.6%	10,238	8.7%
KLW 7	254,465	157,736	62.0%	254,465	119,362	46.9%	-38,374	-15.1%
KLW 8	114,676	61,161	53.3%	114,677	45,126	39.4%	-16,035	-14.0%
KLW 9	149,641	93,435	62.4%	149,641	88,661	59.2%	-4,774	-3.2%
KLE 1	242,905	170,105	70.0%	242,875	136,705	56.3%	-33,401	-13.7%
KLE 2	100,454	65,140	64.8%	70,432	50,093	71.1%	-15,047	6.3%
KLE 3	112,799	48,607	43.1%	64,362	32,944	51.2%	-15,662	8.1%
KLE 4	256,079	158,197	61.8%	256,077	139,604	54.5%	-18,593	-7.3%
KLE 5	38,252	17,996	47.0%	26,076	12,982	49.8%	-5,014	2.7%
KLE 6	167,849	76,343	45.5%	156,464	82,958	53.0%	6,615	7.5%
KLE 7	66,478	30,669	46.1%	66,478	20,500	30.8%	-10,169	-15.3%
ICC 1	332,061	180,136	54.2%	332,061	112,547	33.9%	-67,589	-20.4%
ICC 2	204,461	123,811	60.6%	204,461	75,079	36.7%	-48,733	-23.8%
ICC 3	104,813	43,322	41.3%	104,813	14,842	14.2%	-28,480	-27.2%
ICC 4	119,957	43,050	35.9%	119,957	16,043	13.4%	-27,007	-22.5%
ICC 5	34,955	11,495	32.9%	34,955	8,820	25.2%	-2,675	-7.7%
ICC 6	2,072	100	4.8%	2,072	42	2.0%	-58	-2.8%
ICC 7	119,729	55,372	46.2%	119,729	41,895	35.0%	-13,477	-11.3%
ICC 8	83,376	44,497	53.4%	83,376	46,244	55.5%	1,747	2.1%
Totals	**9,577,342**	**4,791,734**	**50.0%**	**9,372,892**	**4,317,971**	**46.1%**	**-473,763**	**-4.0%**

Notes

1. Table made by Jennifer Elliott using Davis et al. raster data (NSO_CTS_CLASS_2022) and the Albers Equal Area Conic (EPSG:5070) projection.
2. 2012 total designated critical habitat acres listed here (9,577,342 acres) reflects GIS data for the 2012 final designation (77 FR 71876).
3. A total of 204,294 acres of designated critical habitat were removed in November 10, 2021 (86 FR 62606).
4. Changes in nesting roosting acres from 2012 to 2021 do not account for the changes in designated critical habitat acres.

APPENDIX E

Estimates of Spotted Owl Habitat on WDNR HCP Lands

USFWS – Lacey, WA, January 2024.

This Appendix provides supporting documentation for spotted owl habitat information summarized in the *Environmental Baseline* and *Effects of the Action* portions of the Biological Opinion.

Estimates of Spotted Owl Habitat on WDNR Lands in 2023

We have two sources for estimates of spotted owl habitat on WDNR HCP lands. One source is GIS data provided by WDNR, which tracks the amount of spotted owl habitat located within designated spotted owl management units (SOMUs) (Figure 1). WDNR uses the agencies forest inventory data to estimate the amount areas that meet HCP-specific spotted owl habitat definitions (WDNR 2023, p. A-1 -A-9). These data are typically summarized annually and presented in the HCP Annual Reports. WDNR does not monitor spotted owl habitat outside of SOMUs.

The other source of data is from habitat models developed for the federal Northwest Forest Plan monitoring program which classify the landscape into spotted owl cover types (Davis et al. 2022, entire). This data allows for comparison across broad ownerships and provides context for the total area of spotted owl habitat on WDNR lands relative to federal lands and other ownerships. As described in the *Environmental Baseline*, the Service considered both sources of data for this analysis.

<u>Definitions</u>

Dispersal or DFC management area: HCP-specific designations were each SOMU within a dispersal management area is managed to maintain and /or restore 50 percent of designated area in dispersal habitat based on HCP-specific definitions for spotted owl habitat types. Desired Future Condition (DFC) designations within the Klickitat planning area with appropriate vegetation series are also designated for dispersal management (WDNR 2004).

NRF: Spotted owl nesting, roosting, foraging habitat

NRF management area: HCP-specific designation where each SOMU within the NRF management area is managed to maintain and /or restore 50 percent of the SOMU in NRF habitat based on HCP-specific definitions for spotted owl habitat types.

OESF: Olympic Experimental State Forest

SOMU: Spotted owl management unit.

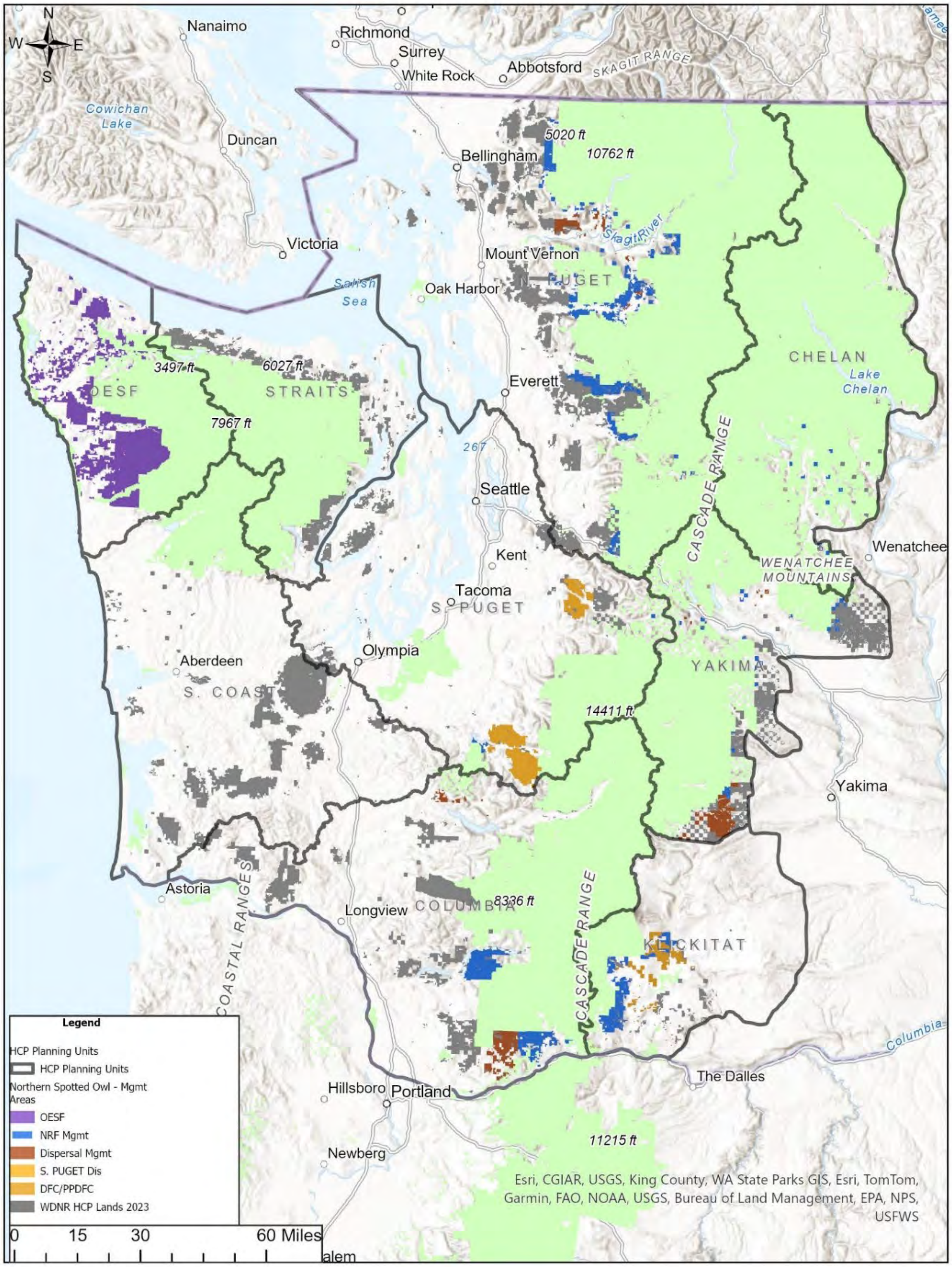


Figure 1. HCP planning units and HCP-designated spotted owl management areas.

Assumptions and Notes Regarding GIS Estimates

We used the best available geographic information system (GIS) data to represent land ownership and spotted owl habitat across WDNR lands and other lands. We note here that the GIS values presented throughout this document should be viewed as approximate, even though they appear to be precise to the nearest acre. When we summarize the habitat information in narrative at broad landscape scales, we generally round the values to the nearest 1,000. We also note that there are inconsistencies in the acres of WDNR lands between tables. For example, the WDNR GIS data indicates 272,425 acres of HCP lands within the OESF. When we analyzed this area with the Northwest Forest Plan data, we have a value of 273,053 acres of HCP lands in the OESF. This difference is due to differences in the underlying GIS data representing land ownership, and we acknowledge those difference here, and recommend that all values estimated from GIS should be interpreted as approximate values. Relationships such as the overall percentage of a landscape in habitat are accurate.

Spotted Owl Habitat Estimates from WDNR Forest Inventory Data

The following tables summarize estimates of spotted owl habitat in each of HCP-designated SOMU based on WDNR's GIS database for 2023.

Table NSO1. Spotted owl habitat estimates in the **OESF** based on WDNR forest inventory data.

OESF SOMU Name	WDNR HCP lands (acres)	Spotted owl habitat (acres)	Percent of HCP lands with habitat	Old forest habitat (acres)	Percent of acres with old forest habitat	Threshold Status (2023)
CLALLAM RIVER	18,022	5,199	29%	148	1%	Below all habitat thresholds
COPPER MINE	20,483	11,048	54%	3,098	15%	Below Old Forest 20% threshold; above total habitat 40% threshold
DICKODOCHTEDAR	28,335	5,808	20%	2,430	9%	Below all habitat thresholds
GOODMAN CREEK	25,180	5,923	24%	4,165	17%	Below all habitat thresholds
KALALOCH	20,128	10,613	53%	2,622	13%	Below Old Forest 20% threshold; above total habitat 40% threshold
QUEETS	24,153	13,103	54%	4,957	21%	**Above** all habitat thresholds
READE HILL	10,431	3,306	32%	1,338	13%	Below all habitat thresholds
SEKIU	9,028	1,101	12%	0	0%	Below all habitat thresholds
UPPER CLEARWATER	57,402	30,507	53%	15,081	26%	**Above** all habitat thresholds
UPPER SOL DUC	19,937	5,218	26%	206	1%	Below all habitat thresholds
WILLY HUEL	39,328	18,764	48%	7,993	20%	**Above** all habitat thresholds
Totals	**272,425**	**110,591**	**41%**	**42,039**	**15%**	

Notes: OESF spotted owl habitat = areas classified by WDNR as old-forest habitat, sub-mature habitat, or young forest marginal habitat. 20 percent of landscape = 54,485 acres (target level for old forest habitat). 40 percent of landscape = 108,970 acres (target level for suitable spotted owl habitat). Source: WDNR GIS data, 2023.

Table NSO2. Summary of spotted owl habitat estimates and thresholds in **North Puget** designated NRF management areas based on WDNR forest inventory data.

SOMU Name	WDNR HCP lands (acres)	Spotted owl NRF habitat (acres)	Percent of HCP lands in spotted owl NRF habitat	Spotted owl NRF habitat and "Next Best" (acres)	Percent of HCP land area in NRF habitat or "Next Best"	Threshold Status
CANYON-WARNICK	3,528	140	4%	1,773	50%	Below all habitat thresholds
CAVANAUGH	1,445	0	0%	727	50%	Below all habitat thresholds
CLEARWATER	5,077	23	0%	2,566	51%	Below all habitat thresholds
DEER CREEK	2,138	27	1%	1,120	52%	Below all habitat thresholds
E SHANNON NRF	1,863	28	1%	941	51%	Below all habitat thresholds
EBEY HILL	2,148	99	5%	1,081	50%	Below all habitat thresholds
FRENCH BOULDER	7,938	218	3%	4,069	51%	Below all habitat thresholds
HAZEL	4,363	84	2%	2,214	51%	Below all habitat thresholds
HOWARD CREEK	2,604	163	6%	1,307	50%	Below all habitat thresholds
LORETTA	1,365	186	14%	695	51%	Below all habitat thresholds
MARMOT RIDGE	5,146	95	2%	2,607	51%	Below all habitat thresholds
MID SKAGIT NRF	999	0	0%	593	59%	Below all habitat thresholds
NORTH FORK SKYKOMISH	1,815	119	7%	940	52%	Below all habitat thresholds
NORTH SNOQUALMIE	3,967	366	9%	2,006	51%	Below all habitat thresholds
PILCHUCK MTN	14,905	1,145	8%	7,450	50%	Below all habitat thresholds
RINKER	8,110	324	4%	4,067	50%	Below all habitat thresholds
SAUK PRAIRIE NRF	4,737	12	0%	2,370	50%	Below all habitat thresholds
SILVERTON	2,040	302	15%	1,024	50%	Below all habitat thresholds
SOUTH FORK SKYKOMISH	1,457	0	0%	739	51%	Below all habitat thresholds
SOUTH SNOQUALMIE	1,741	29	2%	896	51%	Below all habitat thresholds

Notes: Spotted owl NRF habitat = areas classified by WDNR as High quality nesting habitat, Type A habitat, or Type B habitat (West Cascades HCP definitions). Source: WDNR GIS data, 2023.

Table NSO2 (cont.). Summary of spotted owl habitat estimates and thresholds in **North Puget** designated **NRF management** areas based on WDNR forest inventory data.

SOMU Name	WDNR HCP lands (acres)	Spotted owl NRF habitat (acres)	Percent of HCP lands in spotted owl NRF habitat	Spotted owl NRF habitat and "Next Best" (acres)	Percent of HCP land area in NRF habitat or "Next Best"	Threshold Status
SPADA	7,339	757	10%	3,699	50%	Below all habitat thresholds
TENAS	4,485	0	0%	2,251	50%	Below all habitat thresholds
UPPER NF STILLY	3,330	0	0%	1,685	51%	Below all habitat thresholds
UPPER SKAGIT NORTH	2,199	51	2%	1,112	51%	Below all habitat thresholds
UPPER SKAGIT SOUTH NRF	8,282	346	4%	4,190	51%	Below all habitat thresholds
W SHANNON NRF	1,221	0	0%	615	50%	Below all habitat thresholds
WALLACE RIVER	6,442	243	4%	3,222	50%	Below all habitat thresholds
N. PUGET TOTALS	**110,687**	**4,758**	**4%**	**55,960**	**51%**	

Notes: Spotted owl NRF habitat = areas classified by WDNR as High-quality nesting habitat, Type A habitat, or Type B habitat (West Cascades HCP definitions). Source: WDNR GIS data, 2023.

Table NSO3. Summary of spotted owl habitat estimates and thresholds in **North Puget** designated **dispersal management** areas based on WDNR forest inventory data.

SOMU Name	WDNR HCP lands (acres)	Spotted owl dispersal habitat (acres)	Percent of HCP lands in spotted owl dispersal habitat	Spotted owl dispersal habitat and "Next Best" (acres)	Percent of HCP land area in dispersal habitat or "Next Best"	Threshold Status
ALDER	6,625	3,332	50%	3,332	50%	Above all habitat thresholds
E SHANNON DISP	1,418	846	60%	846	60%	Above all habitat thresholds
MID SKAGIT DISP	3,381	1,251	37%	1,667	49%	Below all habitat thresholds
SAUK PRAIRIE DISP	1,408	705	50%	705	50%	Above all habitat thresholds
UPPER SKAGIT SOUTH DISP	921	510	55%	510	55%	Above all habitat thresholds
W SHANNON DISP	1,414	903	64%	903	64%	Above all habitat thresholds
TOTALS	**15,166**	**7,546**	**50%**	**7,962**	**52%**	

Notes: Spotted owl disperal habitat = areas classified by WDNR as dispersal habitat based on the West Cascades HCP definitions). Source: WDNR GIS data, 2023.

Table NSO4. Summary of spotted owl habitat estimates and thresholds in the **Columbia** HCP designated NRF and Dispersal management areas based on WDNR forest inventory data.

SOMU Name	**WDNR HCP lands (acres)**	**Spotted owl NRF habitat (acres)**	**Percent of HCP lands in spotted owl NRF habitat**	**Spotted owl habitat and "Next Best" (acres)**	**Percent of HCP land area in habitat or "Next Best"**	**Threshold Status**
COUGAR NRF	8,943	7,181	80%	7,181	80%	**Above all habitat thresholds**
HAMILTON CREEK NRF	4,173	1,434	34%	2,165	52%	Below all habitat thresholds
ROCK CREEK NRF	15,640	4,364	28%	7,842	50%	Below all habitat thresholds
SIOUXON NRF	16,288	9,660	59%	9,660	59%	**Above all habitat thresholds**
SWIFT CREEK NRF	4,853	2,408	50%	2,428	50%	Below all habitat thresholds
WIND RIVER NRF	3,542	203	6%	1,781	50%	Below all habitat thresholds
NRF Mgmt. Area Totals	**53,439**	**25,250**	**47%**	**31,057**	**58%**	
HAMILTON CREEK DISP	3,311	2,069	62%	2,069	62%	Above all habitat thresholds
HARMONY DISP	4,361	2,640	61%	2,640	61%	Above all habitat thresholds
SILVERSTAR DISP	3,774	2,116	56%	2,116	56%	Above all habitat thresholds
UPPER WASHOUGAL DISP	20,138	13,615	68%	13,615	68%	Above all habitat thresholds
Dispersal Mgmt. Area Totals	**31,583**	**20,439**	**65%**	**20,439**	**65%**	

Notes: Spotted owl NRF habitat = areas classified by WDNR as High-quality nesting habitat, Type A habitat, or Type B habitat (West Cascades HCP definitions). Spotted owl dispersal habitat = areas classified by WDNR as dispersal habitat based on the West Cascades HCP definitions. Source: WDNR GIS data, 2023

Table NSO5. Summary of spotted owl habitat estimates and thresholds in the **South Puget** designated NRF and Dispersal management areas based on WDNR forest inventory data.

SOMU Name	WDNR HCP lands (acres)	Spotted owl habitat (acres)	Percent of HCP lands in spotted owl habitat	Spotted owl habitat and "Next Best" (acres)	Percent of HCP land area in habitat or "Next Best"	Threshold Status
BLACK DIAMOND S. PUGET DISP	24,137	12,483	52%	12,483	52%	Below MoRF 35% threshold; above total habitat 50% threshold
ELBE HILLS S. PUGET DISP	22,050	12,804	58%	12,804	58%	Below MoRF 35% threshold; above total habitat 50% threshold
PLEASANT VALLEY S. PUGET DISP	1,433	820	57%	820	57%	Below MoRF 35% threshold; above total habitat 50% threshold
TAHOMA S. PUGET DISP	30,466	16,323	54%	16,323	54%	Below MoRF 35% threshold; above total habitat 50% threshold
Dispersal Mgmt. Area Totals	**78,086**	**42,430**	**54%**	**42,430**	**54%**	**Below MoRF 35% threshold; above total dispersal habitat 50% threshold**
GREEN NRF	625	0	0%	497	79%	Below all habitat thresholds
PLEASANT VALLEY NRF	1,929	0	0%	968	50%	Below all habitat thresholds
NRF Mgmt. Area Totals	**2,554**	**0**	**0%**	**1,465**	**57%**	**Below NRF habitat thresholds**
S. PUGET TOTALS	**80,641**	**42,430**	**53%**	**43,895**	**54%**	

Notes: MoRF = Movement, Roosting, and Foraging Habitat. The South Puget landscape plan applies two definitions: Movement habitat (dispersal habitat) and movement, roosting, and foraging habitat (MoRF) which includes minimum requirements for snags and down wood (WDNR 2010). Source: WDNR GIS data, 2023.

Table NSO6. Summary of **Klickitat** planning unit spotted owl NRF management areas based on WDNR forest inventory data.

SOMU Name	WDNR HCP lands (acres)	Spotted Owl NRF habitat (acres)	Near NRF habitat (acres)	Spotted Owl NRF habitat and "Near NRF" (acres)	Percent of SOMU in NRF or Near NRF	Threshold Status
GLENWOOD; NRF	7,883	1,921	1,825	3,746	48%	Below habitat threshold
HUSUM; NRF	26,219	10,695	4,943	15,637	60%	Above habitat threshold
TROUT LAKE; NRF	5,249	3,341	360	3,701	71%	Above habitat threshold
Totals	**39,351**	**15,957**	**7,127**	**23,084**	59%	

Notes: Spotted owl NRF habitat = areas classified by WDNR as Type A habitat, or Sub-mature habitat, and near-NRF habitat (East Cascades HCP definitions).

Table NSO7. Summary of **Klickitat** planning unit spotted owl DFC management areas based on WDNR forest inventory data.

SOMU Name / Mgmt Designation	DFC (acres)	Non-habitat (acres)	PPDFC (acres)	Sub-mature (acres)	Type A (acres)	Total (acres)
GLENWOOD; DOUGLAS-FIR; DFC	427	112	0	0	0	540
GLENWOOD; GF FRIGID COLD; DFC	412	1,582	0	0	0	1,994
GLENWOOD; GF FRIGID WARM; DFC	0	1	0	0	0	1
GLENWOOD; PP FROST; PPDFC	8,119	6,926	249	0	0	15,293
GLENWOOD; SAF CRYIC WARM; DFC	417	2,436	0	0	0	2,853
KLICKITAT SCATTERED; DOUGLAS-FIR; DFC	181	6	0	0	0	187
KLICKITAT SCATTERED; GF FRIGID WARM; DFC	3,449	560	0	30	0	4,039
KLICKITAT SCATTERED; OREGON WHITE OAK / PPDFC	238	74	0	2	7	320
KLICKITAT SCATTERED; PP FROST; PPDFC	138	45	6	0	0	188
TROUT LAKE; GF FRIGID COOL; DFC	412	87	0	0	0	499
TROUT LAKE; GF FRIGID WARM; DFC	4,464	1,155	0	0	0	5,619
TROUT LAKE; PP FROST; PPDFC	290	210	0	0	0	500
Totals	**18,547**	**13,193**	**254**	**31**	**7**	**32,033**
Percent	58%	41%	1%	0%	0%	100%

Notes: DFC (desired future condition) areas based on vegetation series apply East Cascades HCP definitions for spotted owl dispersal habitat. Ponderosa pine series (PPDFC) may provide dispersal habitat but will not be managed to maintain dispersal habitat. Source: WDNR GIS data, 2023.

Table NSO8. Summary of **Yakima** planning unit spotted owl dispersal management areas based on WDNR forest inventory data.

SOMU Name	WDNR HCP lands (acres)	Dispersal habitat (acres)	Percent of SOMU in dispersal habitat	Threshold Status
AHTANUM DISPSERSAL	30,156	16,729	55%	Above habitat thresholds
KLICKITAT MEADOWS DISPERSAL	1,524	770	50%	Above habitat thresholds
TEANAWAY DISPERSAL EAST	1,252	804	64%	Above habitat thresholds
TEANAWAY DISPERSAL WEST	624	573	92%	Above habitat thresholds
Totals	**33,556**	**18,876**	**56%**	**All SOMUs above thresholds**

Notes: Spotted owl dispersal habitat = areas classified by WDNR as dispersal habitat, following East Cascades HCP definitions. Source: WDNR GIS data, 2023.

Table NSO9. Summary of **Yakima** planning unit spotted owl NRF management areas based on WDNR forest inventory data.

SOMU Name / Management	Non-habitat (acres)	Unknown (acres)	Totals (acres)
BETHEL NRF MGMT	329	0	329
DEVILS CANYON NRF MGMT	215	0	215
DOME PEAK NRF MGMT	2,501	0	2,501
L.T. MURRAY NRF MGMT	994	0	994
NANEUM NRF MGMT	4,025	0	4,025
NF MANASTASH NRF	550	0	550
OAK CREEK NRF	250	0	250
RIMROCK NRF	104	0	104
SF MANASTASH NRF	475	0	475
TEANAWAY NRF EAST	1,895	0	1,895
TEANAWAY NRF WEST	702	1,003	1,705
VALLEY NRF	31	0	31
Totals	**12,071**	**1,003**	**13,074**
Percent	92%	8%	100%

Notes: Spotted owl NRF habitat = areas classified by WDNR as Type A habitat, or Sub-mature habitat, and near-NRF habitat (East Cascades HCP definitions). Source: WDNR GIS data, 2023.

Table NSO10. Summary of **Chelan** planning unit spotted owl NRF management areas based on WDNR forest inventory data.

SOMU Name / Mgmt	Non-habitat (acres)	Unknown (acres)	Total (acres)
CHIWAUKUM NRF	173	0	173
CHUMSTICK NRF	1,271	0	1,271
DERBY NRF	405	0	405
MISSION CREEK NRF	665	0	665
MT STUART NRF	571	0	571
SPROMBERG NRF	304	0	304
SWAKANE NRF	222	0	222
TUMWATER CANYON NRF	222	1	222
TWIN LAKES NRF	653	0	653
Totals	**4,485**	**1**	**4,486**

Notes: Spotted owl NRF habitat = areas classified by WDNR as Type A habitat, or Sub-mature habitat, and near-NRF habitat (East Cascades HCP definitions). Source: WDNR GIS data, 2023.

Spotted Owl Habitat Estimates from Northwest Forest Plan Monitoring Data

The federal Northwest Forest Plan monitoring program has produced a series of spotted owl habitat cover-type maps that are used to monitor trends in spotted owl habitat across the federal lands within the range of the spotted owl (Davis et al. 2022, entire). These maps are generated every 5 years. The last model was based on 2017 remote-sensing data. However, these data sets are now updated annually to reflect habitat losses from wildfires (USFS 2023). The spotted owl cover-type model classified habitat into four general categories (Davis et al. 2023, p.:

- *Suitable* and *highly suitable* categories represent forest types that typically support spotted owl nesting and roosting.

- *Marginal* habitat represents forest types that are approaching suitable nesting-roosting habitat,

- *Unsuitable* habitat represents forest types that spotted owls typically avoid for nesting and roosting.

- Not habitat capable represent non-forested areas.

Based on the Northwest Forest Plan spotted owl habitat models, there is approximately 3.23 million acres of suitable spotted owl nesting / roosting habitat in Washington including approximately 306,000 acres of habitat on WDNR HCP lands (Table XX11). Based on the Northwest Forest Plan data, about 97 percent of all WDNR HCP lands are within forest-capable lands, but currently 16 percent are classified as nesting / roosting habitat (Table NSO11).

Table NSO11. Estimates of spotted owl habitat on WDNR lands by HCP planning unit derived from Northwest Forest Plan monitoring data.

HCP Unit Name	Unsuitable habitat (acres)	Marginal habitat (acres)	Suitable and highly suitable nesting / roosting habitat (acres)	Not habitat capable (acres)	WDNR HCP lands - 2023 (acres)
CHELAN	8,433	2,562	2,605	3,741	17,340
COLUMBIA	149,829	71,073	64,099	3,441	288,442
KLICKITAT	32,673	26,997	34,382	2,178	96,229
N. PUGET	252,872	113,873	79,385	11,126	457,256
OESF	158,975	59,480	52,947	1,651	273,053
S. COAST	184,237	52,974	14,970	8,536	260,716
S. PUGET	96,516	57,809	21,945	1,861	178,130
STRAITS	76,241	29,263	21,520	895	127,919
YAKIMA	145,051	29,659	14,313	23,395	212,419
Totals	**1,104,826**	**443,689**	**306,165**	**56,824**	**1,911,504**
Percent	58%	23%	16%	3%	100%

Notes: Data presented in this table represent estimates of spotted owl habitat from habitat models developed for the Northwest Forest Plan monitoring program, representing 2023 conditions. Suitable and highly suitable categories represent forest types that typically support spotted owl nesting and roosting; marginal habitat represents forest types that are approaching suitable nesting-roosting habitat, unsuitable habitat represents forest types that spotted owls typically avoid for nesting and roosting. Not habitat capable represent non-forested areas (Davis et al. 2022; USFS 2023).

Assumptions Regarding Spotted Owl Habitat in the OESF

In the OESF, there is an estimated 59,480 acres of forest classified as “marginal” spotted owl habitat, and 52,947 acres of nesting / roosting forest (Table NSO11, above). Adding these two categories together yields 112,427 acres. This value is close to WDNR’s estimate of 110,591 acres of spotted owl habitat in the OESF (Table NSO1, above). WDNR’s classification of spotted owl habitat in the OESF includes “young-forest marginal” habitat, which provides suitable habitat to support spotted owl foraging, but lacks more complex structures associated with nesting habitat. Because of the close alignment between these two estimates, we are using both “marginal” and “suitable” and “highly suitable” cover-types to represent spotted owl habitat in the OESF. From this point forward in the document, the estimated amount of habitat on the OESF is represented as 122,427 acres (Table NSO11, above). By including these additional acres in the OESF, the total estimated nesting / roosting habitat on WDNR lands is 365,645 acres (Table NSO12).

Table NSO12. Estimates of existing spotted owl habitat potentially available for harvest over the remaining term of the HCP.

HCP Planning Unit	WDNR HCP lands - 2023 (acres)	Spotted owl nesting / roosting habitat (acres)	Areas of mapped long-term forest cover (LTFC) (acres)	Spotted owl nesting / roosting habitat within areas of LTFC (acres)	Nesting / roosting habitat in general management (GM) lands (acres)	Existing nesting roosting habitat potentially available for harvest in GM lands (acres)
CHELAN	17,340	2,605	2,417	705	1,900	430
COLUMBIA	288,442	64,099	104,493	31,569	32,530	23,047
KLICKITAT	96,229	34,382	26,426	14,959	19,423	13,020
N. PUGET	457,256	79,385	220,467	56,364	23,021	15,545
OESF	273,053	112,427	145,927	107,604	3,206	3,206
S. COAST	260,716	14,970	99,090	6,787	8,182	8,182
S. PUGET	178,130	21,945	69,075	10,625	11,319	11,095
STRAITS	127,919	21,520	49,267	12,131	9,389	9,389
YAKIMA	212,419	14,313	15,875	2,058	12,255	9,177
Totals	**1,911,504**	**365,645**	**733,037**	**242,802**	**121,225**	**93,091**
Percent	100% of lands	100% of habitat	38% of lands	66 % of habitat	33% of habitat	25% of habitat

Notes: Data presented in this table represent estimates of spotted owl habitat from habitat models developed for the Northwest Forest Plan monitoring program, representing 2023 conditions (Davis et al. 2022; USFS 2023). Values in this table are approximate estimates derived for all HCP lands within a specific planning unit.

Methods and Assumptions Used to Estimate Spotted Owl Habitat Losses and Gains.

This analysis is focused on the amount of spotted owl nesting roosting foraging (NRF) habitat that occurs on WDNR HCP lands, where NRF habitat may be subject to timber harvest, and where NRF habitat has the potential to develop in areas conserved by the HCP. The amount and distribution of NRF habitat in a landscape is the best available indicator of landscape capacity to support spotted owl conservation.

For this assessment, we used WDNR's data base of areas deferred from regeneration timber harvest by various HCP conservation strategies and other WDNR policy deferrals. These areas are referred to as **long-term forest cover** (**LTFC**). LTFC is defined as areas that are generally not available for regeneration timber harvesting. These areas include marbled murrelet occupied sites, marbled murrelet occupied site buffers, marbled murrelet special habitat areas, riparian management zones (RMZs), unstable slopes, old-growth forest, Natural Area Preserves, and other deferrals (WDNR and USFWS 2019, Appendix G). In this assessment, LTFC generally excludes areas that are naturally non-forested (e.g., wetlands, alpine areas, etc.).

Some areas within LTFC are available for commercial thinning treatments for habitat enhancement or restoration purposes. These treatments can include riparian forest management, or treatments in mid-seral stands to promote or enhance spotted owl habitat development. The configuration of LTFC can vary from narrow stringers in riparian management zones, to large deferrals that encompass thousands of acres (e.g., marbled murrelet special habitat areas). It is important to note that outside of specific land use designations, the mapped area of LTFC is approximate (e.g., estimates of riparian management zones and unstable slopes). LTFC can be subject to localized impacts for road construction across riparian areas, yarding corridors, etc, but these impacts are generally highly localized and limited in scale.

WDNR HCP lands that are located outside of mapped LTFC are classified as General Management lands (GM lands). For this assessment, we assume that GM lands are where the majority of WDNR commercial timber harvesting occurs, and we assume that all timber harvest conducted is in full compliance with HCP directives, WDNR policies for sustainable harvest, and the Washington Forest Practices rules (Title 222 WAC).

Specific Assumptions

For this assessment, we used the following assumptions:

Existing NRF habitat: We used the spotted owl habitat cover type maps developed for Northwest Forest Plan monitoring to represent existing NRF habitat. Cover type classifications of “suitable” and “highly suitable” were selected to represent NRF habitat. Suitable and highly suitable categories represent forest types that typically support spotted owl nesting and roosting (Davis et al. 2022, p. 9). We assume that existing NRF habitat conserved within areas of LTFC will remain on the landscape over the remaining term of the HCP (2067).

Marginal habitat: Represents forest types that are approaching suitable nesting-roosting habitat, (Davis et al. 2022, p. 9). We use marginal habitat to represent areas that currently provide spotted owl dispersal habitat or young forest marginal habitat. We assume that areas of existing marginal habitat that are conserved in LTFC are likely to transition into suitable NRF habitat over the remaining term of the HCP (four decades - 2067). In the OESF, we included marginal habitat as part of the existing baseline to represent “young forest marginal”, based on the close comparison of this data with WDNR’s forest inventory data for the OESF.

NRF management areas: If the current amount of habitat within a designated NRF management area is below the 50 percent landscape threshold, we assume that all existing NRF habitat in the landscape will be conserved until the 50 percent threshold is met, including all existing NRF habitat within GM lands. We also assume that existing marginal habitat in GM lands will be managed to develop NRF habitat up to the 50 percent threshold (i.e., if the NRF area is below threshold, we assume it will reach the NRF threshold by 2067. If the current amount of NRF habitat within the NRF designated area is above the 50 percent threshold, we assume NRF habitat will be harvested from with GM lands in the NRF area.

Dispersal management areas: We assume that existing NRF habitat within dispersal management areas that is located outside of LTFC will be harvested, while existing NRF habitat and marginal habitat within LTFC will remain on the landscape, with marginal habitat areas transitioning to NRF habitat over the remaining term of the HCP. There is no requirement for WDNR to conserve existing NRF habitat within dispersal management areas outside of LTFC, but many areas of existing NRF habitat may be retained to meet landscape dispersal objectives.

Landscape Assessment vs. SOMU Assessment: We chose to evaluate habitat losses and gains at the scale of entire HCP planning units, calculating values for all designated NRF areas, dispersal areas, and areas with no spotted owl role within each HCP planning unit, rather than evaluate each individual spotted owl management unit separately (SOMUs). We recognize this generalizes the analysis to a broader landscape scale but expect that this level of analysis is sufficient for estimating impacts (habitat loss) and mitigation (habitat gains) across the entire HCP area. Detailed assessments of NRF and dispersal habitat in SOMUs are provided in Appendix XX – *Estimates of Spotted Owl Habitat on WDNR HCP Lands.*

LTFC and GIS Estimates: The areas of mapped LTFC is the best available information representing various deferrals. It is important to note that outside of specific land use designations (e.g., Natural Area Preserves, or marbled murrelet special habitat areas) the map of LTFC is approximate, and the specific footprint of these areas can change with improvements in forest inventory data or field verification. In the tables below, we present GIS summaries as specific values to the nearest acre, but these in fact are approximate values, and should be interpreted as such.

<u>Example: North Puget Landscape Habitat Assessment</u>

The North Puget HCP planning unit is the largest planning area with over 457,000 acres of WDNR HCP lands. North Puget includes HCP designated NRF management areas (~110,000 acre) (24 percent), dispersal management areas (~15,000 acres) (3 percent), and over 331,000 acres that have no designated spotted owl role (72 percent). The North Puget landscape also include 220,000 acres of LTFC, including large areas conserved for marbled murrelets and Natural Resource Conservation Areas, and extensive areas of RMZs.

About 71 percent of the existing NRF habitat is located in areas of LTFC, while 29 percent is within GM Lands (~23,000 acres). Because the designated NRF management landscape is currently below threshold for NRF, none of the existing NRF habitat in GM lands within the NRF area is available for harvest. Accounting for both habitat loss in GM lands, and habitat gains in LTFC and designated NRF management areas, we estimate that NRF habitat will increase from about 79,300 acres (17 percent) to approximately 133,800 acres (29 percent), a potential net gain of about 54,000 acres of NRF habitat by the end of 70-year HCP term in 2067 (Table NSO16).

To evaluate habitat losses and habitat gains in the context of mitigation, we calculated the difference between habitat losses and habitat gains and summarized the distribution of habitat gains vs. losses within NRF management areas and other HCP areas (Table NSO17). In North Puget, the estimated habitat that will be maintained or restored in NRF management areas

(~55,000 acres) exceeds estimated habitat losses outside of NRF areas (~15,500 acres), and overall amounts of NRF habitat across the entire North Puget is projected to increase (Table NSO17).

Below are example tables that summarizes estimated habitat losses and gains in the North Puget landscape (Table NSO16, Table NSO17). We produced similar tables for each landscape planning unit.

NSO13. **North Puget** planning unit – detailed assessment of estimated spotted owl habitat losses and gains.

HCP Mgmt	WDNR HCP lands - 2023 (acres)	Long-term forest cover (LTFC) (acres)	50 % threshold for NRF or Dispersal	Existing NRF habitat (acres)	Existing NRF habitat in LTFC	Existing marginal habitat in LTFC	Existing NRF habitat in GM lands	Existing NRF habitat amount that exceeds 50% threshold	Existing NRF habitat available for harvest (GM lands outside of LTFC)	Estimated NRF habitat in 2067 (acres)
NRF Mgmt	110,629	69,306	55,315	30,498	23,022	20,367	7,476	-24,817	0	55,315
Disp. Mgmt	15,158	5,815	7,579	2,248	1,055	1,566	1,193	0	1,193	2,621
No owl role	331,469	145,346	0	46,640	32,287	43,631	14,353	0	14,353	75,917
Totals	**457,256**	**220,467**	**0**	**79,385**	**56,364**	**65,564**	**23,021**	**0**	**15,545**	**133,853**
Percent	100%	48%	14%	**17%**	71%	14%	29%	0%	**20%**	**29%**

Notes: Habitat is based on spotted owl habitat cover type models developed for the Northwest Forest Plan, and updated to 2023 conditions (Davis et al. 2022, USFS 2023). Estimated future NRF habitat in 2067 is derived from: Existing NRF habitat in LTFC + Existing Marginal Habitat in LTFC. Marginal habitat in LTFC is assumed to transition into NRF habitat over next 4 decades.

Table NSO14. **North Puget** planning unit – summary of estimated habitat gains and losses in spotted owl management areas.

HCP Mgmt	WDNR HCP lands - 2023 (acres)	Existing NRF habitat (acres)	Current percent of land in NRF habitat	Estimated NRF habitat losses (acres)	Estimated NRF habitat gains (above existing baseline)	Difference (gains minus losses) (acres)	Estimated NRF habitat in 2067 (acres)	Percent of land in NRF in 2067
NRF Mgmt	110,629	30,498	28%	0	24,817	+24,817	55,315	50%
Disp. Mgmt	15,158	2,248	15%	1,193	374	-819	2,621	17%
No owl role	331,469	46,640	14%	14,353	29,278	+14,925	75,917	23%
Totals	**457,256**	**79,385**	**17%**	**15,545**	**54,468**	**+38,923**	**133,853**	**29%**

Notes: Habitat is based on spotted owl habitat cover type models developed for the Northwest Forest Plan, and updated to 2023 conditions (Davis et al. 2022, USFS 2023). Expected gains in NRF habitat that accrue from marginal habitat areas conserved in LTFC are not listed in this table (refer to Table NSO 16, above for example). It is possible for losses to exceed gains, and still have a projected net increase in habitat by the end of the HCP due to marginal habitat within LTFC transitioning into NRF habitat.

Table NSO15. **South Puget** planning unit - detailed assessment of estimated spotted owl habitat losses and gains.

HCP Mgmt	WDNR HCP lands - 2023 (acres)	LTFC Acres	50 % Threshold	Existing NRF habitat (acres)	Existing NRF habitat in LTFC	Existing Marginal Habitat in LTFC	Existing NRF habitat in GM lands	Existing NRF habitat amount that exceeds 50% threshold	Existing NRF habitat potentially available for harvest (GM lands outside LTFC)	Estimated NRF habitat in 2067
NRF Mgmt:	2,552	1,166	1,276	675	451	330	224	-602	0	1,276
Dispersal Mgmt:	78,036	28,928	39,018	15,069	6,966	1,080	8,103	0	8,103	8,046
No owl role:	97,542	38,981	0	6,201	3,209	24,376	2,992	0	2,992	27,585
Totals:	**178,130**	**69,075**	**0**	**21,945**	**10,625**	**25,787**	11,319	0	**11,095**	**36,908**
Percent	100%	39%	23%	12%	48%		52%	0%	51%	21%

Notes: LTFC = Long-term forest cover – areas deferred from regeneration timber harvest. Habitat is based on spotted owl habitat cover type models developed for the Northwest Forest Plan, and updated to 2023 conditions (Davis et al. 2022, USFS 2023).

NSO16. **South Puget** planning unit. summary of estimated habitat gains and losses in spotted owl management areas.

HCP Mgmt	WDNR HCP lands - 2023 (acres)	Existing NRF habitat (acres)	Current percent of HCP lands in NRF	Estimated NRF habitat losses (acres)	Estimated NRF habitat gain (above existing baseline) (acres)	Difference (gains minus losses)	Estimated NRF habitat in 2067	Percent of HCP lands in NRF in 2067
NRF Mgmt	2,552	675	26%	0	602	+602	1,276	50%
Disp. Mgmt	78,036	15,069	19%	-8,103	-7,023	-15,126	8,046	10%
No owl role	97,542	6,201	6%	-2,992	21,384	18,392	27,585	28%
Totals	**178,130**	**21,945**	**12%**	**-11,095**	**+14,963**	**+3,868**	**36,908**	**21%**

Notes: Habitat is based on spotted owl habitat cover type models developed for the Northwest Forest Plan, and updated to 2023 conditions (Davis et al. 2022, USFS 2023). Note: Expected gains in NRF habitat that accrue from marginal habitat areas conserved in LTFC are not included in this table (refer to Table NSO 16, above for example). It is possible for losses to exceed gains, and still have a projected net increase in habitat by the end of the HCP due to marginal habitat within LTFC transitioning to NRF habitat.

Table NSO17. **Columbia** Planning Unit - detailed assessment of estimated spotted owl habitat losses and gains.

HCP Mgmt	WDNR HCP lands - 2023 (acres)	LTFC Acres	50% Threshold	Existing NRF habitat (acres)	Existing NRF habitat in LTFC	Existing Marginal Habitat in LTFC	Existing NRF habitat in GM lands	Existing NRF habitat amount that exceeds 50% threshold	Existing NRF habitat potentially available for harvest (GM lands outside LTFC)	Estimated NRF habitat in 2067
NRF Mgmt	53,440	26,367	26,720	23,142	13,658	8,218	9,483	-3,578	0	26,720
Dispersal Mgmt	31,562	10,925	15,781	12,682	4,587	3,620	8,095	0	8,095	8,208
No owl role	203,440	67,201	0	28,275	13,323	20,936	14,952	0	14,952	34,259
Totals	**288,442**	**104,493**	**0**	**64,099**	**31,569**	**32,774**	32,530	0	**23,047**	**69,187**
Percent	100%	36%	15%	22%	49%	11%	51%	0%	36%	24%

Notes: Habitat is based on spotted owl habitat cover type models developed for the Northwest Forest Plan, and updated to 2023 conditions (Davis et al. 2022, USFS 2023).

Table NSO18. **Columbia** Planning Unit - summary of estimated habitat gains and losses in spotted owl management areas.

HCP Mgmt	WDNR HCP lands - 2023 (acres)	Existing NRF habitat (acres)	Current percent of HCP lands in NRF	Estimated NRF habitat losses (acres)	Estimated NRF habitat gain (above existing baseline) (acres)	Difference (gains minus losses)	Estimated NRF habitat in 2067	Percent of HCP lands in NRF in 2067
NRF Mgmt	53,440	23,142	43%	0	3,578	3,578	26,720	50%
Disp. Mgmt	31,562	12,682	40%	8,095	-4,474	-12,569	8,208	26%
No owl role	203,440	28,275	14%	14,952	5,984	-8,969	34,259	17%
Totals	**288,442**	**64,099**	**22%**	**23,047**	**5,088**	**-17,959**	**69,187**	**24%**

Notes: Habitat is based on spotted owl habitat cover type models developed for the Northwest Forest Plan, and updated to 2023 conditions (Davis et al. 2022, USFS 2023). Note: Expected gains in NRF habitat that accrue from marginal habitat areas conserved in LTFC are not included in this table (refer to Table NSO 16, above for example). It is possible for losses to exceed gains, and still have a projected net increase in habitat by the end of the HCP due to marginal habitat within LTFC transitioning to NRF habitat.

Table NSO19. **South Coast** planning unit - detailed assessment of estimated spotted owl habitat losses and gains.

HCP Mgmt	WDNR HCP lands - 2023 (acres)	LTFC Acres	50% Threshold	Existing NRF habitat (acres)	Existing NRF habitat in LTFC	Existing Marginal in LTFC	Existing NRF habitat in GM lands	Existing NRF habitat amount that exceeds 50% threshold	Existing habitat potentially available for harvest (GM lands outside LTFC)	Estimated NRF habitat in 2067
No owl role	260,716	99,090	0	14,970	6,787	25,787	8,182	0	8,182	32,574
Percent	100%	38%	0%	6%	45%	10%	55%	0%	55%	12%

Notes: Habitat is based on spotted owl habitat cover type models developed for the Northwest Forest Plan, and updated to 2023 conditions (Davis et al. 2022, USFS 2023).

Table NSO20. South Coast planning unit - summary of estimated habitat gains and losses in spotted owl management areas.

HCP Mgmt	WDNR HCP lands - 2023 (acres)	Existing NRF habitat (acres)	Current percent of HCP lands in NRF	Estimated NRF habitat losses (acres)	Estimated NRF habitat gain (above existing baseline) (acres)	Difference (gains minus losses)	Estimated NRF habitat in 2067	Percent of HCP lands in NRF in 2067
No owl role	260,716	14,970	6%	8,182	17,604	9,422	32,574	12%

Notes: Habitat is based on spotted owl habitat cover type models developed for the Northwest Forest Plan, and updated to 2023 conditions (Davis et al. 2022, USFS 2023). Note: Expected gains in NRF habitat that accrue from marginal habitat areas conserved in LTFC are not included in this table (refer to Table NSO 16, above for example). It is possible for losses to exceed gains, and still have a projected net increase in habitat by the end of the HCP due to marginal habitat within LTFC transitioning to NRF habitat.

Table NSO21. Straits planning unit - detailed assessment of estimated spotted owl habitat losses and gains.

HCP Mgmt	WDNR HCP lands - 2023 (acres)	LTFC Acres	50% Threshold	Existing NRF habitat (acres)	Existing NRF habitat in LTFC	Existing Marginal habitat in LTFC	Existing NRF habitat in GM lands	Existing NRF habitat amount that exceeds 50% threshold	Existing NRF habitat potentially available for harvest (GM lands outside LTFC)	Estimated NRF Habitat in 2067
No owl role:	127,919	49,267	0	21,520	12,131	14,515	9,389	0	9,389	26,646
Percent of WDNR lands	100%	39%	0%	17%	56%	11%	44%	0%	44%	21%

Notes: Habitat is based on spotted owl habitat cover type models developed for the Northwest Forest Plan, and updated to 2023 conditions (Davis et al. 2022, USFS 2023).

Table NSO22. Straits planning unit - summary of estimated habitat gains and losses in spotted owl management areas.

HCP Mgmt	WDNR HCP lands - 2023 (acres)	Existing NRF habitat (acres)	Current percent of HCP lands in NRF	Estimated NRF habitat losses (acres)	Estimated NRF habitat gain (above existing baseline) (acres)	Difference (gains minus losses)	Estimated NRF habitat in 2067	Percent of HCP lands in NRF in 2067
No owl role	127,919	21,520	17%	9,389	5,127	-4,262	26,646	21%

Notes: Habitat is based on spotted owl habitat cover type models developed for the Northwest Forest Plan, and updated to 2023 conditions (Davis et al. 2022, USFS 2023). Note: Expected gains in NRF habitat that accrue from marginal habitat areas conserved in LTFC are not listed in this table (refer to prior table above for example). It is possible for losses to exceed gains, and still have a projected net increase in habitat by the end of the HCP due to marginal habitat within LTFC transitioning to NRF habitat.

Table NSO23. OESF planning unit - detailed assessment of estimated spotted owl habitat losses and gains.

HCP Mgmt	WDNR HCP lands - 2023 (acres)	LTFC Acres	40% Threshold	Existing NRF habitat (suitable, highly suitable, and marginal habitat (acres)	Existing NRF and Marginal habitat in LTFC	Existing NRF habitat in GM lands	Existing NRF habitat amount that exceeds 40% threshold	Existing NRF habitat potentially available for harvest (GM lands outside LTFC)	Estimated NRF habitat in 2067
OESF Owl Mgmt	273,053	145,927	109,221	112,427	107,604	4,822	3,206	3,206	109,221
Percent	100%	53%	0%	41%	79%	21%	0%	0%	40%

Notes: Habitat is based on spotted owl habitat cover type models developed for the Northwest Forest Plan, and updated to 2023 conditions (Davis et al. 2022, USFS 2023).

Table NSO24. OESF planning unit - summary of estimated habitat gains and losses in spotted owl management areas.

HCP Mgmt	WDNR HCP lands - 2023 (acres)	Existing NRF/YFM habitat (acres)	Current percent of HCP lands in NRF	Estimated NRF/YFM habitat losses (acres)	Estimated NRF habitat gain (above existing baseline) (acres)	Difference (gains minus losses)	Estimated NRF habitat in 2067	Percent of HCP lands in NRF in 2067
OESF	273,053	112,427	41%	3,206	-3,206	-6,411	109,221	40%

Notes: Habitat is based on spotted owl habitat cover type models developed for the Northwest Forest Plan, and updated to 2023 conditions (Davis et al. 2022, USFS 2023). Note: Expected gains in NRF habitat that accrue from marginal habitat areas conserved in LTFC are not listed in this table (see previous table). It is possible for losses to exceed gains, and still have a projected net increase in habitat by the end of the HCP due to marginal habitat within LTFC transitioning to NRF habitat.

Table NSO25. Chelan planning unit - detailed assessment of estimated spotted owl habitat losses and gains

HCP Mgmt	WDNR HCP lands - 2023 (acres)	LTFC (acres)	50% threshold (acres)	Existing NRF habitat (acres)	Existing NRF habitat in LTFC	Existing Marginal habitat in LTFC	Existing NRF habitat in GM lands	Existing NRF habitat amount that exceeds 50% threshold (acres)	Existing NRF habitat potentially available for harvest (GM lands outside LTFC) (acres)	Estimated NRF habitat in 2067 (acres)
NRF Mgmt	5,551	738	2,776	1,697	228	236	1,469	-1,078	0	1,933
Dispersal Mgmt	0	0	0	0	0	0	0	0	0	0
No owl role	11,789	1,679	0	907	477	2,326	430	0	430	2,803
Totals	**17,340**	**2,417**	**2,776**	**2,605**	**705**	**2,562**	1,899	0	**430**	**4,736**
Percent	100%	14%	16%	15%	27%	15%	73%	0%	17%	27%

Notes: Habitat is based on spotted owl habitat cover type models developed for the Northwest Forest Plan, and updated to 2023 conditions (Davis et al. 2022, USFS 2023).

Table NSO26. Chelan planning unit - summary of estimated habitat gains and losses in spotted owl management areas.

HCP Mgmt	WDNR HCP lands - 2023 (acres)	Existing NRF habitat (acres)	Current percent of HCP lands in NRF	Estimated NRF habitat losses (acres)	Estimated NRF habitat gain (above existing baseline) (acres)	Difference (gains minus losses)	Estimated NRF habitat in 2067 (acres)	Percent of HCP lands in NRF in 2067
NRF Mgmt	5,551	1,697	31%	0	1,078	1,078	2,776	50%
Disp. Mgmt	0	0	0%	0	0	0	0	0%
No owl role	11,789	907	8%	430	604	174	1,511	13%
Totals	**17,340**	**2,605**	**15%**	**430**	**1,682**	**1,252**	**4,287**	**25%**

Notes: Habitat is based on spotted owl habitat cover type models developed for the Northwest Forest Plan, and updated to 2023 conditions (Davis et al. 2022, USFS 2023). Note: Expected gains in NRF habitat that accrue from marginal habitat areas conserved in LTFC are not listed in this table (see previous table). It is possible for losses to exceed gains, and still have a projected net increase in habitat by the end of the HCP due to marginal habitat within LTFC transitioning to NRF habitat.

Table NSO27. Klickitat planning unit - detailed assessment of estimated spotted owl habitat losses and gains.

HCP Mgmt	WDNR HCP lands - 2023 (acres)	LTFC Acres	50% Threshold	Existing Habitat (Suitable and Highly Suitable habitat (acres)	Existing Marginal Habitat	Existing NRF habitat in LTFC	Existing Marginal Habitat in LTFC	Existing habitat in GM lands	Existing habitat amount that exceeds 50% threshold	Existing habitat potentially available for harvest (GM lands outside LTFC)	Estimated NRF Habitat in 2067
NRF Mgmt	39,346	18,016	19,673	23,711	9,347	13,270	3,908	10,442	4,038	4,038	19,673
DFC	15,981	1,850	7,991	3,023	6,036	469	724	2,554	0	2,554	1,192
PPDFC	15,976	2,594	7,988	3,039	3,532	399	559	2,641	0	2,641	958
No owl role	24,926	6,560	0	4,609	8,082	822	1,269	3,787	0	3,787	2,091
Totals	**96,229**	**29,020**	**0**	**34,382**	26,997	**14,959**	**6,460**	19,423	0	**13,020**	**23,914**
Percent	**100%**	30%	37%	**36%**	28%	**16%**	7%	56%	0%	38%	25%

Notes: Habitat is based on spotted owl habitat cover type models developed for the Northwest Forest Plan, and updated to 2023 conditions (Davis et al. 2022, USFS 2023).

Table NSO28. Klickitat Planning Unit - summary of estimated habitat gains and losses in spotted owl management areas.

HCP Mgmt	WDNR HCP lands - 2023 (acres)	Existing NRF habitat (acres)	Current percent of HCP lands in NRF	Estimated NRF habitat losses (acres)	Estimated NRF habitat gain (above existing baseline) (acres)	Difference (gains minus losses)	Estimated NRF habitat in 2067	Percent of HCP lands in NRF in 2067
NRF Mgmt	39,346	23,711	60%	4,038	0	-4,038	19,673	50%
DFC	15,981	3,023	19%	2,554	0	-1,831	1,192	7%
PPDFC	15,976	3,039	19%	2,641	0	-2,081	958	6%
No owl role	24,926	4,609	18%	3,787	0	-2,519	2,091	8%
Totals	**96,229**	**34,382**	**36%**	**13,020**	**0**	-10,469	**23,914**	**25%**

Notes: Habitat is based on spotted owl habitat cover type models developed for the Northwest Forest Plan, and updated to 2023 conditions (Davis et al. 2022, USFS 2023). Note: Expected gains in NRF habitat that accrue from marginal habitat areas conserved in LTFC are not listed in this table (see previous table). It is possible for losses to exceed gains, and still have a projected net increase in habitat by the end of the HCP due to marginal habitat within LTFC transitioning to NRF habitat.

Table NSO29. Yakima planning unit - detailed assessment of estimated spotted owl habitat losses and gains

HCP Mgmt	WDNR HCP lands - 2023 (acres)	LTFC Acres	50% Threshold	Existing Habitat (Suitable and Highly Suitable habitat (acres)	Existing NRF habitat in LTFC	Existing Marginal Habitat in LTFC	Existing habitat in GM lands	Existing habitat amount that exceeds 50% threshold	Existing habitat potentially available for harvest (GM lands outside LTFC)	Estimated NRF Habitat in 2067
NRF Mgmt	13,067	761	6,534	3,308	231	8,218	3,077	-3,226	0	6,534
Dispersal Mgmt	33,479	2,660	16,740	4,045	585	3,620	3,461	0	3,461	4,205
No owl role	165,872	12,454	0	6,960	1,243	17,821	5,717	0	5,717	19,063
Totals	**212,419**	**15,875**	**0**	**14,313**	**2,058**	**29,659**	**12,255**	0	**9,177**	**29,802**
Percent	100%	7%	11%	100%	14%	14%	86%	0%	64%	14%

Notes: Habitat is based on spotted owl habitat cover type models developed for the Northwest Forest Plan, and updated to 2023 conditions (Davis et al. 2022, USFS 2023).

Table NSO30. Yakima planning unit - summary of estimated habitat gains and losses in spotted owl management areas.

HCP Mgmt	WDNR HCP lands - 2023 (acres)	Existing NRF habitat (acres)	Current percent of HCP lands in NRF	Estimated NRF habitat losses (acres)	Estimated NRF habitat gain (above existing baseline) (acres)	Difference (gains minus losses)	Estimated NRF habitat in 2067	Percent of HCP lands in NRF in 2067
NRF Mgmt	13,067	3,308	25%	0	3,226	3,226	6,534	50%
Disp. Mgmt	33,479	4,045	12%	3,461	160	-3,301	4,205	13%
No owl role	165,872	6,960	4%	5,717	12,104	6,387	19,063	11%
Totals	**212,419**	**14,313**	**7%**	**9,177**	**15,489**	**6,312**	**29,802**	**14%**

Notes: Habitat is based on spotted owl habitat cover type models developed for the Northwest Forest Plan, and updated to 2023 conditions (Davis et al. 2022, USFS 2023). Note: Expected gains in NRF habitat that accrue from marginal habitat areas conserved in LTFC are not listed in this table (see previous table). It is possible for losses to exceed gains, and still have a projected net increase in habitat by the end of the HCP due to marginal habitat within LTFC transitioning to NRF habitat.

Summary: Estimates of Habitat Loss and Habitat Gains across the WDNR HCP Landscape

At the scale of all HCP lands, we estimated approximately 93,000 acres of existing NRF habitat is located in GM lands with a potential for timber harvest over the next 4 decades. There is a projected net gain of 101,000 acres of NRF habitat across all areas over the same time period. Total NRF habitat is projected to increase from 19 percent of HCP lands to about 24 percent of HCP lands (Table NSO31).

Table NSO31. Summary of estimated NRF habitat loss and gains across all WDNR HCP lands.

HCP Unit	WDNR HCP lands - 2023 (acres)	Existing NRF habitat (acres)	Current percent of HCP lands in NRF habitat	Estimated NRF habitat losses (acres)	Estimated NRF habitat gains (above existing baseline) (acres)	Difference (gains minus losses)	Estimated NRF habitat in 2067	Percent of HCP lands in NRF in 2067
Chelan	17,340	2,605	15%	430	2,132	+1,702	4,736	27%
Columbia	288,442	64,099	22%	23,047	5,088	-17,959	69,187	24%
Klickitat	96,229	34,382	36%	13,020	0	-10,469	23,914	25%
North Puget	457,256	79,385	17%	15,545	54,468	+38,923	133,853	29%
OESF	273,053	112,427	41%	3,206	0	-3,206	109,221	40%
South Coast	260,716	14,970	6%	8,182	17,604	+9,422	32,574	12%
South Puget	178,130	21,945	12%	11,095	14,963	+3,868	36,908	21%
Straits	127,919	21,520	17%	9,389	5,127	-4,262	26,646	21%
Yakima	212,419	14,313	7%	9,177	15,489	+6,312	29,802	14%
Totals	**1,911,504**	**365,645**	**19%**	**-93,091**	**+101,196**	**+8,105**	**466,841**	**24%**

Note: Expected gains in NRF habitat that accrue from marginal habitat areas conserved in LTFC are not included in this table. It is possible for losses to exceed gains, and still have a projected net increase in habitat by the end of the HCP due to marginal habitat within LTFC transitioning to NRF habitat.

References

Davis, R. J., D.B. Lesmeister, Z. Yang, B. Hollen, B. Tuerler, J. Hobson, J. Guetterman, and A. Stratton. 2022. Northwest Forest Plan—the first 25 years (1994–2018): status and trends of northern spotted owl habitats. Gen. Tech. Rep. PNW-GTR-1003. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 38 p. https://doi.org/10.2737/PNW-GTR-1003.

USFS. 2023. Northern spotted owl nesting/roosting forest maps and trend viewer. Online Earth Engine Application hosted by USDA Forest Service, Northwest Forest Plan monitoring program. https://r06-nwfp.projects.earthengine.app/view/nwfp-nso-cts-mspa-trend-view

WDNR. 1997. Final Habitat Conservation Plan. Washington Department of Natural Resources. Olympia, WA. 209 pp. + appendices.

WDNR. 2004. Administrative Amendment to the northern spotted owl conservation strategy for the Klickitat HCP Planning Unit. April, 2004. Washington Department of Natural Resources, Olympia, WA. 96 pp.

WDNR. 2010. South Puget HCP Planning Unit Forest Land Plan. Final Environmental Impact Statement. January, 2010. Washington Department of Natural Resources, Olympia, WA. 233 pp.

WDNR. 2016. Olympic Experimental State Forest HCP Planning Unit Forest Land Plan. Final Environmental Impact Statement. Washington Department of Natural Resources, Olympia, WA. 381 pp + appendices.

APPENDIX F

Status of the Species: Bull Trout

USFWS – Lacey, WA, January 2024.

Taxonomy

The bull trout (*Salvelinus confluentus*) is a native char found in the coastal and intermountain west of North America. Dolly Varden (*Salvelinus malma)* and bull trout were previously considered a single species and were thought to have coastal and interior forms. However, Cavender (1978, entire) described morphometric, meristic and osteological characteristics of the two forms, and provided evidence of specific distinctions between the two. Despite an overlap in the geographic range of bull trout and Dolly Varden in the Puget Sound area and along the British Columbia coast, there is little evidence of introgression (Haas and McPhail 1991, p. 2191). The Columbia River Basin is considered the region of origin for the bull trout. From the Columbia, dispersal to other drainage systems was accomplished by marine migration and headwater stream capture. Behnke (2002, p. 297) postulated dispersion to drainages east of the continental divide may have occurred through the North and South Saskatchewan Rivers (Hudson Bay drainage) and the Yukon River system. Marine dispersal may have occurred from Puget Sound north to the Fraser, Skeena and Taku Rivers of British Columbia.

Species Description

Bull trout have unusually large heads and mouths for salmonids. Their body colors can vary tremendously depending on their environment, but are often brownish green with lighter (often ranging from pale yellow to crimson) colored spots running along their dorsa and flanks, with spots being absent on the dorsal fin, and light colored to white under bellies. They have white leading edges on their fins, as do other species of char. Bull trout have been measured as large as 103 centimeters (41 inches) in length, with weights as high as 14.5 kilograms (32 pounds) (Fishbase 2015, p. 1). Bull trout may be migratory, moving throughout large river systems, lakes, and even the ocean in coastal populations, or they may be resident, remaining in the same stream their entire lives (Rieman and McIntyre 1993, p. 2; Brenkman and Corbett 2005, p. 1077). Migratory bull trout are typically larger than resident bull trout (USFWS 1998, p. 31668).

Legal Status

The coterminous United States population of the bull trout was listed as threatened on November 1, 1999 (USFWS 1999, entire). The threatened bull trout generally occurs in the Klamath River Basin of south-central Oregon; the Jarbidge River in Nevada; the Willamette River Basin in Oregon; Pacific Coast drainages of Washington, including Puget Sound; major rivers in Idaho, Oregon, Washington, and Montana, within the Columbia River Basin; and the St. Mary-Belly River, east of the Continental Divide in northwestern Montana (Bond 1992, p. 4; Brewin and Brewin 1997, pp. 209-216; Cavender 1978, pp. 165-166; Leary and Allendorf 1997, pp. 715-720).

Throughout its range, the bull trout are threatened by the combined effects of habitat degradation, fragmentation, and alterations associated with dewatering, road construction and maintenance, mining, grazing, the blockage of migratory corridors by dams or other diversion structures, poor water quality, entrainment (a process by which aquatic organisms are pulled through a diversion or other device) into diversion channels, and introduced non-native species (USFWS 1999, p. 58910). Although all salmonids are likely to be affected by climate change, bull trout are especially vulnerable given that spawning and rearing are constrained by their location in upper watersheds and the requirement for cold water temperatures (Battin et al. 2007, entire; Rieman et al. 2007, entire; Porter and Nelitz. 2009, pages 4-8). Poaching and incidental mortality of bull trout during other targeted fisheries are additional threats.

Life History

The iteroparous reproductive strategy of bull trout has important repercussions for the management of this species. Bull trout require passage both upstream and downstream, not only for repeat spawning but also for foraging. Most fish ladders, however, were designed specifically for anadromous semelparous salmonids (fishes that spawn once and then die, and require only one-way passage upstream). Therefore, even dams or other barriers with fish passage facilities may be a factor in isolating bull trout populations if they do not provide a downstream passage route. Additionally, in some core areas, bull trout that migrate to marine waters must pass both upstream and downstream through areas with net fisheries at river mouths. This can increase the likelihood of mortality to bull trout during these spawning and foraging migrations.

Growth varies depending upon life-history strategy. Resident adults range from 6 to 12 inches total length, and migratory adults commonly reach 24 inches or more (Goetz 1989, p. 30; Pratt 1985, pp. 28-34). The largest verified bull trout is a 32-pound specimen caught in Lake Pend Oreille, Idaho, in 1949 (Simpson and Wallace 1982, p. 95).

Bull trout typically spawn from August through November during periods of increasing flows and decreasing water temperatures. Preferred spawning habitat consists of low-gradient stream reaches with loose, clean gravel (Fraley and Shepard 1989, p. 141). Redds are often constructed in stream reaches fed by springs or near other sources of cold groundwater (Goetz 1989, pp. 15-16; Pratt 1992, pp. 6-7; Rieman and McIntyre 1996, p. 133). Depending on water temperature, incubation is normally 100 to 145 days (Pratt 1992, p. 1). After hatching, fry remain in the substrate, and time from egg deposition to emergence may surpass 200 days. Fry normally emerge from early April through May, depending on water temperatures and increasing stream flows (Pratt 1992, p. 1; Ratliff and Howell 1992, p. 10).

Early life stages of fish, specifically the developing embryo, require the highest inter-gravel dissolved oxygen (IGDO) levels, and are the most sensitive life stage to reduced oxygen levels. The oxygen demand of embryos depends on temperature and on stage of development, with the greatest IGDO required just prior to hatching.

A literature review conducted by the Washington Department of Ecology (WDOE 2002, p. 9) indicates that adverse effects of lower oxygen concentrations on embryo survival are magnified as temperatures increase above optimal (for incubation). Normal oxygen levels seen in rivers used by bull trout during spawning ranged from 8 to 12 mg/L (in the gravel), with corresponding instream levels of 10 to 11.5 mg/L (Stewart et al. 2007, p. 10). In addition, IGDO concentrations, water velocities in the water column, and especially the intergravel flow rate, are interrelated variables that affect the survival of incubating embryos (ODEQ 1995, Ch 2 pp.

23-24). Due to a long incubation period of 220+ days, bull trout are particularly sensitive to adequate IGDO levels. An IGDO level below 8 mg/L is likely to result in mortality of eggs, embryos, and fry.

Population Dynamics

Population Structure

Bull trout exhibit both resident and migratory life history strategies. Both resident and migratory forms may be found together, and either form may produce offspring exhibiting either resident or migratory behavior (Rieman and McIntyre 1993, p. 2). Resident bull trout complete their entire life cycle in the tributary (or nearby) streams in which they spawn and rear. The resident form tends to be smaller than the migratory form at maturity and also produces fewer eggs (Goetz 1989, p. 15). Migratory bull trout spawn in tributary streams where juvenile fish rear 1 to 4 years before migrating to either a lake (adfluvial form), river (fluvial form) (Fraley and Shepard 1989, p. 138; Goetz 1989, p. 24), or saltwater (anadromous form) to rear as subadults and to live as adults (Brenkman and Corbett 2005, entire; McPhail and Baxter 1996, p. i; WDFW et al. 1997, p. 16). Bull trout normally reach sexual maturity in 4 to 7 years and may live longer than 12 years. They are iteroparous (they spawn more than once in a lifetime). Repeat- and alternate-year spawning has been reported, although repeat-spawning frequency and post-spawning mortality are not well documented (Fraley and Shepard 1989, p. 135; Leathe and Graham 1982, p. 95; Pratt 1992, p. 8; Rieman and McIntyre 1996, p. 133).

Bull trout are naturally migratory, which allows them to capitalize on temporally abundant food resources and larger downstream habitats. Resident forms may develop where barriers (either natural or manmade) occur or where foraging, migrating, or overwintering habitats for migratory fish are minimized (Brenkman and Corbett 2005, pp. 1075-1076; Goetz et al. 2004, p. 105). For example, multiple life history forms (e.g., resident and fluvial) and multiple migration patterns have been noted in the Grande Ronde River (Baxter 2002, pp. 96, 98-106). Parts of this river system have retained habitat conditions that allow free movement between spawning and rearing areas and the mainstem Snake River. Such multiple life history strategies help to maintain the stability and persistence of bull trout populations to environmental changes. Benefits to migratory bull trout include greater growth in the more productive waters of larger streams, lakes, and marine waters; greater fecundity resulting in increased reproductive potential; and dispersing the population across space and time so that spawning streams may be recolonized should local populations suffer a catastrophic loss (Frissell 1999, pp. 861-863; MBTSG 1998, p. 13; Rieman and McIntyre 1993, pp. 2-3). In the absence of the migratory bull trout life form, isolated populations cannot be replenished when disturbances make local habitats temporarily unsuitable. Therefore, the range of the species is diminished, and the potential for a greater reproductive contribution from larger size fish with higher fecundity is lost (Rieman and McIntyre 1993, p. 2).

Whitesel et al. (2004, p. 2) noted that although there are multiple resources that contribute to the subject, Spruell et al. (2003, entire) best summarized genetic information on bull trout population structure. Spruell et al. (2003, entire) analyzed 1,847 bull trout from 65 sampling locations, four located in three coastal drainages (Klamath, Queets, and Skagit Rivers), one in the Saskatchewan River drainage (Belly River), and 60 scattered throughout the Columbia River Basin. They concluded that there is a consistent pattern among genetic studies of bull trout, regardless of whether examining allozymes, mitochondrial DNA, or most recently microsatellite loci. Typically, the genetic pattern shows relatively little genetic variation within populations, but substantial divergence among populations. Microsatellite loci analysis supports the existence of at least three major genetically differentiated groups (or evolutionary lineages) of bull trout (Spruell et al. 2003, p. 17). They were characterized as:

i. "Coastal", including the Deschutes River and all of the Columbia River drainage downstream, as well as most coastal streams in Washington, Oregon, and British Columbia. A compelling case also exists that the Klamath Basin represents a unique evolutionary lineage within the coastal group.

ii. "Snake River", which also included the John Day, Umatilla, and Walla Walla rivers. Despite close proximity of the John Day and Deschutes Rivers, a striking level of divergence between bull trout in these two systems was observed.

iii. "Upper Columbia River" which includes the entire basin in Montana and northern Idaho. A tentative assignment was made by Spruell et al. (2003, p. 25) of the Saskatchewan River drainage populations (east of the continental divide), grouping them with the upper Columbia River group.

Spruell et al. (2003, p. 17) noted that within the major assemblages, populations were further subdivided, primarily at the level of major river basins. Taylor et al. (1999, entire) surveyed bull trout populations, primarily from Canada, and found a major divergence between inland and coastal populations. Costello et al. (2003, p. 328) suggested the patterns reflected the existence of two glacial refugia, consistent with the conclusions of Spruell et al. (2003, p. 26) and the biogeographic analysis of Haas and McPhail (2001, entire). Both Taylor et al. (1999, p. 1166) and Spruell et al. (2003, p. 21) concluded that the Deschutes River represented the most upstream limit of the coastal lineage in the Columbia River Basin.

More recently, the U.S. Fish and Wildlife Service (Service) identified additional genetic units within the coastal and interior lineages (Ardren et al. 2011, p. 18). Based on a recommendation in the Service's 5-year review of the species' status (USFWS 2008a, p. 45), the Service reanalyzed the 27 recovery units identified in the draft bull trout recovery plan (USFWS 2002a, p. 48) by utilizing, in part, information from previous genetic studies and new information from additional analysis (Ardren et al. 2011, entire). In this examination, the Service applied relevant factors from the joint Service and National Marine Fisheries Service Distinct Population Segment (DPS) policy (USFWS 1996, entire) and subsequently identified six draft recovery units that contain assemblages of core areas that retain genetic and ecological integrity across the range of bull trout in the coterminous United States. These six draft recovery units were used to inform designation of critical habitat for bull trout by providing a context for deciding what habitats are essential for recovery (USFWS 2010, p. 63898). The six draft recovery units identified for bull trout in the coterminous United States include: Coastal, Klamath, Mid-Columbia, Columbia Headwaters, Saint Mary, and Upper Snake. These six draft recovery units were also identified in the Service's revised recovery plan (USFWS 2015, p. vii) and designated as final recovery units.

Population Dynamics

Although bull trout are widely distributed over a large geographic area, they exhibit a patchy distribution, even in pristine habitats (Rieman and McIntyre 1993, p. 4). Increased habitat fragmentation reduces the amount of available habitat and increases isolation from other populations of the same species (Saunders et al. 1991, entire). Burkey (1989, entire) concluded that when species are isolated by fragmented habitats, low rates of population growth are typical in local populations and their probability of extinction is directly related to the degree of isolation and fragmentation. Without sufficient immigration, growth for local populations may be low and probability of extinction high (Burkey 1989, entire; Burkey 1995, entire).

Metapopulation concepts of conservation biology theory have been suggested relative to the distribution and characteristics of bull trout, although empirical evidence is relatively scant (Rieman and McIntyre 1993, p. 15; Dunham and Rieman 1999, entire; Rieman and Dunham 2000, entire). A metapopulation is an interacting network of local populations with varying frequencies of migration and gene flow among them (Meffe and Carroll 1994, pp. 189-190). For inland bull trout, metapopulation theory is likely most applicable at the watershed scale where habitat consists of discrete patches or collections of habitat capable of supporting local populations; local populations are for the most part independent and represent discrete reproductive units; and long-term, low-rate dispersal patterns among component populations influences the persistence of at least some of the local populations (Rieman and Dunham 2000, entire). Ideally, multiple local populations distributed throughout a watershed provide a mechanism for spreading risk because the simultaneous loss of all local populations is unlikely. However, habitat alteration, primarily through the construction of impoundments, dams, and water diversions has fragmented habitats, eliminated migratory corridors, and in many cases isolated bull trout in the headwaters of tributaries (Rieman and Clayton 1997, pp. 10-12; Dunham and Rieman 1999, p. 645; Spruell et al. 1999, pp. 118-120; Rieman and Dunham 2000, p. 55).

Human-induced factors as well as natural factors affecting bull trout distribution have likely limited the expression of the metapopulation concept for bull trout to patches of habitat within the overall distribution of the species (Dunham and Rieman 1999, entire). However, despite the theoretical fit, the relatively recent and brief time period during which bull trout investigations have taken place does not provide certainty as to whether a metapopulation dynamic is occurring (e.g., a balance between local extirpations and recolonizations) across the range of the bull trout or whether the persistence of bull trout in large or closely interconnected habitat patches (Dunham and Rieman 1999, entire) is simply reflective of a general deterministic trend towards extinction of the species where the larger or interconnected patches are relics of historically wider distribution (Rieman and Dunham 2000, pp. 56-57). Recent research (Whiteley et al. 2003, entire) does, however, provide genetic evidence for the presence of a metapopulation process for bull trout, at least in the Boise River Basin of Idaho.

Habitat Characteristics

Bull trout have more specific habitat requirements than most other salmonids (Rieman and McIntyre 1993, p. 4). Habitat components that influence bull trout distribution and abundance include water temperature, cover, channel form and stability, valley form, spawning and rearing substrate, and migratory corridors (Fraley and Shepard 1989, entire; Goetz 1989, pp. 23, 25; Hoelscher and Bjornn 1989, pp. 19, 25; Howell and Buchanan 1992, pp. 30, 32; Pratt 1992, entire; Rich 1996, p. 17; Rieman and McIntyre 1993, pp. 4-6; Rieman and McIntyre 1995, entire; Sedell and Everest 1991, entire; Watson and Hillman 1997, entire). Watson and Hillman (1997, pp. 247-250) concluded that watersheds must have specific physical characteristics to provide the habitat requirements necessary for bull trout to successfully spawn and rear and that these specific characteristics are not necessarily present throughout these watersheds. Because bull trout exhibit a patchy distribution, even in pristine habitats (Rieman and McIntyre 1993, pp. 4-6), bull trout should not be expected to simultaneously occupy all available habitats.

Migratory corridors link seasonal habitats for all bull trout life histories. The ability to migrate is important to the persistence of bull trout (Rieman and McIntyre 1993, p. 2). Migrations facilitate gene flow among local populations when individuals from different local populations interbreed or stray to nonnatal streams. Local populations that are extirpated by catastrophic events may also become reestablished by bull trout migrants. However, it is important to note that the genetic structuring of bull trout indicates there is limited gene flow among bull trout populations, which may encourage local adaptation within individual populations, and that reestablishment of extirpated populations may take a long time (Rieman and McIntyre 1993, p. 2; Spruell et al. 1999, entire). Migration also allows bull trout to access more abundant or larger prey, which facilitates growth and reproduction. Additional benefits of migration and its relationship to foraging are discussed below under "Diet."

Cold water temperatures play an important role in determining bull trout habitat quality, as these fish are primarily found in colder streams, and spawning habitats are generally characterized by temperatures that drop below 9 °C in the fall (Fraley and Shepard 1989, p. 137; Pratt 1992, p. 5; Rieman and McIntyre 1993, p. 2).

Thermal requirements for bull trout appear to differ at different life stages. Spawning areas are often associated with cold-water springs, groundwater infiltration, and the coldest streams in a given watershed (Pratt 1992, pp 7-8; Rieman and McIntyre 1993, p. 7). Optimum incubation temperatures for bull trout eggs range from 2 °C to 6 °C whereas optimum water temperatures for rearing range from about 6 °C to 10 °C (Buchanan and Gregory 1997, p. 4; Goetz 1989, p. 22). In Granite Creek, Idaho, Bonneau and Scarnecchia (1996, entire) observed that juvenile bull trout selected the coldest water available in a plunge pool, 8 °C to 9 °C, within a temperature gradient of 8 °C to 15 °C. In a landscape study relating bull trout distribution to maximum water temperatures, Dunham et al. (2003, p. 900) found that the probability of juvenile bull trout occurrence does not become high (i.e., greater than 0.75) until maximum temperatures decline to 11 °C to 12 °C.

Although bull trout are found primarily in cold streams, occasionally these fish are found in larger, warmer river systems throughout the Columbia River basin (Buchanan and Gregory 1997, p. 2; Fraley and Shepard 1989, pp. 133, 135; Rieman and McIntyre 1993, pp. 3-4; Rieman and

McIntyre 1995, p. 287). Availability and proximity of cold water patches and food productivity can influence bull trout ability to survive in warmer rivers (Myrick 2002, pp. 6 and 13).

All life history stages of bull trout are associated with complex forms of cover, including large woody debris, undercut banks, boulders, and pools (Fraley and Shepard 1989, p. 137; Goetz 1989, p. 19; Hoelscher and Bjornn 1989, p. 38; Pratt 1992, entire; Rich 1996, pp. 4-5; Sedell and Everest 1991, entire; Sexauer and James 1997, entire; Thomas 1992, pp. 4-6; Watson and Hillman 1997, p. 238). Maintaining bull trout habitat requires natural stability of stream channels and maintenance of natural flow patterns (Rieman and McIntyre 1993, pp. 5-6). Juvenile and adult bull trout frequently inhabit side channels, stream margins, and pools with suitable cover (Sexauer and James 1997, p. 364). These areas are sensitive to activities that directly or indirectly affect stream channel stability and alter natural flow patterns. For example, altered stream flow in the fall may disrupt bull trout during the spawning period, and channel instability may decrease survival of eggs and young juveniles in the gravel from winter through spring (Fraley and Shepard 1989, p. 141; Pratt 1992, p. 6; Pratt and Huston 1993, p. 70). Pratt (1992, p. 6) indicated that increases in fine sediment reduce egg survival and emergence.

Diet

Bull trout are opportunistic feeders, with food habits primarily a function of size and life-history strategy. Fish growth depends on the quantity and quality of food that is eaten, and as fish grow their foraging strategy changes as their food changes, in quantity, size, or other characteristics (Quinn 2005, pp. 195-200). Resident and juvenile migratory bull trout prey on terrestrial and aquatic insects, macrozooplankton, and small fish (Boag 1987, p. 58; Donald and Alger 1993, pp. 242-243; Goetz 1989, pp. 33-34). Subadult and adult migratory bull trout feed on various fish species (Donald and Alger 1993, pp. 241-243; Fraley and Shepard 1989, pp. 135, 138; Leathe and Graham 1982, pp. 13, 50-56). Bull trout of all sizes other than fry have been found to eat fish half their length (Beauchamp and VanTassell 2001, p. 204). In nearshore marine areas of western Washington, bull trout feed on Pacific herring (*Clupea pallasi*), Pacific sand lance (*Ammodytes hexapterus*), and surf smelt (*Hypomesus pretiosus*) (Goetz et al. 2004, p. 105; WDFW et al. 1997, p. 23).

Bull trout migration and life history strategies are closely related to their feeding and foraging strategies. Migration allows bull trout to access optimal foraging areas and exploit a wider variety of prey resources. For example, in the Skagit River system, anadromous bull trout make migrations as long as 121 miles between marine foraging areas in Puget Sound and headwater spawning grounds, foraging on salmon eggs and juvenile salmon along their migration route (WDFW et al. 1997, p. 25). Anadromous bull trout also use marine waters as migration corridors to reach seasonal habitats in non-natal watersheds to forage and possibly overwinter (Brenkman and Corbett 2005, pp. 1078-1079; Goetz et al. 2004, entire).

Status and Distribution

Distribution and Demography

The historical range of bull trout includes major river basins in the Pacific Northwest at about 41 to 60 degrees North latitude, from the southern limits in the McCloud River in northern

California and the Jarbidge River in Nevada to the headwaters of the Yukon River in the Northwest Territories, Canada (Cavender 1978, pp. 165-166; Bond 1992, p. 2). To the west, the bull trout's range includes Puget Sound, various coastal rivers of British Columbia, Canada, and southeast Alaska (Bond 1992, p. 2). Bull trout occur in portions of the Columbia River and tributaries within the basin, including its headwaters in Montana and Canada. Bull trout also occur in the Klamath River basin of south-central Oregon. East of the Continental Divide, bull trout are found in the headwaters of the Saskatchewan River in Alberta and Montana and in the MacKenzie River system in Alberta and British Columbia, Canada (Cavender 1978, pp. 165-166; Brewin et al. 1997, entire).

Each of the following recovery units (below) is necessary to maintain the bull trout's distribution, as well as its genetic and phenotypic diversity, all of which are important to ensure the species' resilience to changing environmental conditions. No new local populations have been identified and no local populations have been lost since listing.

Coastal Recovery Unit

The Coastal Recovery Unit is located within western Oregon and Washington. Major geographic regions include the Olympic Peninsula, Puget Sound, and Lower Columbia River basins. The Olympic Peninsula and Puget Sound geographic regions also include their associated marine waters (Puget Sound, Hood Canal, Strait of Juan de Fuca, and Pacific Coast), which are critical in supporting the anadromous[1] life history form, unique to the Coastal Recovery Unit. The Coastal Recovery Unit is also the only unit that overlaps with the distribution of Dolly Varden (*Salvelinus malma*) (Ardren *et al*. 2011), another native char species that looks very similar to the bull trout (Haas and McPhail 1991). The two species have likely had some level of historic introgression in this part of their range (Redenbach and Taylor 2002). The Lower Columbia River major geographic region includes the lower mainstem Columbia River, an important migratory waterway essential for providing habitat and population connectivity within this region. In the Coastal Recovery Unit, there are 21 existing bull trout core areas which have been designated, including the recently reintroduced Clackamas River population, and 4 core areas have been identified that could be re-established. Core areas within the recovery unit are distributed among these three major geographic regions (Puget Sound also includes one core area that is actually part of the lower Fraser River system in British Columbia, Canada) (USFWS 2015a, p. A-1).

The current demographic status of bull trout in the Coastal Recovery Unit is variable across the unit. Populations in the Puget Sound region generally tend to have better demographic status, followed by the Olympic Peninsula, and finally the Lower Columbia River region. However, population strongholds do exist across the three regions. The Lower Skagit River and Upper Skagit River core areas in the Puget Sound region likely contain two of the most abundant bull trout populations with some of the most intact habitat within this recovery unit. The Lower Deschutes River core area in the Lower Columbia River region also contains a very abundant

[1] Anadromous: Life history pattern of spawning and rearing in fresh water and migrating to salt water areas to mature.

bull trout population and has been used as a donor stock for re-establishing the Clackamas River population (USFWS 2015a, p. A-6).

Puget Sound Region

In the Puget Sound region, bull trout populations are concentrated along the eastern side of Puget Sound with most core areas concentrated in central and northern Puget Sound.

Although the Chilliwack River core area is considered part of this region, it is technically connected to the Fraser River system and is transboundary with British Columbia making its distribution unique within the region. Most core areas support a mix of anadromous and fluvial life history forms, with at least two core areas containing a natural adfluvial life history (Chilliwack River core area [Chilliwack Lake] and Chester Morse Lake core area). Overall demographic status of core areas generally improves as you move from south Puget Sound to north Puget Sound. Although comprehensive trend data are lacking, the current condition of core areas within this region are likely stable overall, although some at depressed abundances. Two core areas (Puyallup River and Stillaguamish River) contain local populations at either very low abundances (Upper Puyallup and Mowich Rivers) or that have likely become locally extirpated (Upper Deer Creek, South Fork Canyon Creek, and Greenwater River). Connectivity among and within core areas of this region is generally intact. Most core areas in this region still have significant amounts of headwater habitat within protected and relatively pristine areas (e.g., North Cascades National Park, Mount Rainier National Park, Skagit Valley Provincial Park, Manning Provincial Park, and various wilderness or recreation areas) (USFWS 2015a, p. A-7).

Olympic Peninsula Region

In the Olympic Peninsula region, distribution of core areas is somewhat disjunct, with only one located on the west side of Hood Canal on the eastern side of the peninsula, two along the Strait of Juan de Fuca on the northern side of the peninsula, and three along the Pacific Coast on the western side of the peninsula. Most core areas support a mix of anadromous and fluvial life history forms, with at least one core area also supporting a natural adfluvial life history (Quinault River core area [Quinault Lake]). Demographic status of core areas is poorest in Hood Canal and Strait of Juan de Fuca, while core areas along the Pacific Coast of Washington likely have the best demographic status in this region. The connectivity between core areas in these disjunct regions is believed to be naturally low due to the geographic distance between them.

Internal connectivity is currently poor within the Skokomish River core area (Hood Canal) and is being restored in the Elwha River core area (Strait of Juan de Fuca). Most core areas in this region still have their headwater habitats within relatively protected areas (Olympic National Park and wilderness areas) (USFWS 2015a, p. A-7).

Lower Columbia River Region

In the Lower Columbia River region, the majority of core areas are distributed along the Cascade Crest on the Oregon side of the Columbia River. Only two of the seven core areas in this region are in Washington. Most core areas in the region historically supported a fluvial life history form, but many are now adfluvial due to reservoir construction. However, there is at least one core area supporting a natural adfluvial life history (Odell Lake) and one supporting a natural, isolated, resident life history (Klickitat River [West Fork Klickitat]). Status is highly variable across this region, with one relative stronghold (Lower Deschutes core area) existing on the Oregon side of the Columbia River. The Lower Columbia River region also contains three watersheds (North Santiam River, Upper Deschutes River, and White Salmon River) that could potentially become re-established core areas within the Coastal Recovery Unit. Although the South Santiam River has been identified as a historic core area, there remains uncertainty as to whether or not historical observations of bull trout represented a self-sustaining population. Current habitat conditions in the South Santiam River are thought to be unable to support bull trout spawning and rearing. Adult abundances within the majority of core areas in this region are relatively low, generally 300 or fewer individuals.

Most core populations in this region are not only isolated from one another due to dams or natural barriers, but they are internally fragmented as a result of manmade barriers. Local populations are often disconnected from one another or from potential foraging habitat. In the Coastal Recovery Unit, adult abundance may be lowest in the Hood River and Odell Lake core areas, which each contain fewer than 100 adults. Bull trout were reintroduced in the Middle Fork Willamette River in 1990 above Hills Creek Reservoir. Successful reproduction was first documented in 2006, and has occurred each year since (USFWS 2015a, p. A-8). Natural reproducing populations of bull trout are present in the McKenzie River basin (USFWS 2008d, pp. 65-67). Bull trout were more recently reintroduced into the Clackamas River basin in the summer of 2011 after an extensive feasibility analysis (Shively et al. 2007, Hudson et al. 2015). Bull trout from the Lower Deschutes core area are being utilized for this reintroduction effort (USFWS 2015a, p. A-8).

Klamath Recovery Unit

Bull trout in the Klamath Recovery Unit have been isolated from other bull trout populations for the past 10,000 years and are recognized as evolutionarily and genetically distinct (Minckley et al. 1986; Leary et al. 1993; Whitesel et al. 2004; USFWS 2008a; Ardren et al. 2011). As such, there is no opportunity for bull trout in another recovery unit to naturally re- colonize the Klamath Recovery Unit if it were to become extirpated. The Klamath Recovery Unit lies at the southern edge of the species range and occurs in an arid portion of the range of bull trout.

Bull trout were once widespread within the Klamath River basin (Gilbert 1897; Dambacher et al. 1992; Ziller 1992; USFWS 2002b), but habitat degradation and fragmentation, past and present land use practices, agricultural water diversions, and past fisheries management practices have greatly reduced their distribution. Bull trout abundance also has been severely reduced, and the remaining populations are highly fragmented and vulnerable to natural or manmade factors that place them at a high risk of extirpation (USFWS 2002b). The presence of nonnative brook trout (*Salvelinus fontinalis*), which compete and hybridize with bull trout, is a particular threat to bull trout persistence throughout the Klamath Recovery Unit (USFWS 2015b, pp. B-3-4).

Upper Klamath Lake Core Area

The Upper Klamath Lake core area comprises two bull trout local populations (Sun Creek and Threemile Creek). These local populations likely face an increased risk of extirpation because they are isolated and not interconnected with each other. Extirpation of other local populations in the Upper Klamath Lake core area has occurred in recent times (1970s). Populations in this core area are genetically distinct from those in the other two core areas in the Klamath Recovery Unit (USFWS 2008b), and in comparison, genetic variation within this core area is lowest. The two local populations have been isolated by habitat fragmentation and have experienced population bottlenecks. As such, currently unoccupied habitat is needed to restore connectivity between the two local populations and to establish additional populations. This unoccupied habitat includes canals, which now provide the only means of connectivity as migratory corridors. Providing full volitional connectivity for bull trout, however, also introduces the risk of invasion by brook trout, which are abundant in this core area.

Bull trout in the Upper Klamath Lake core area formerly occupied Annie Creek, Sevenmile Creek, Cherry Creek, and Fort Creek, but are now extirpated from these locations. The last remaining local populations, Sun Creek and Threemile Creek, have received focused attention. Brook trout have been removed from bull trout occupied reaches, and these reaches have been intentionally isolated to prevent brook trout reinvasion. As such, over the past few generations these populations have become stable and have increased in distribution and abundance. In 1996, the Threemile Creek population had approximately 50 fish that occupied a 1.4-km (0.9-mile) reach (USFWS 2002b). In 2012, a mark-resight population estimate was completed in Threemile Creek, which indicated an abundance of 577 (95 percent confidence interval = 475 to 679) age-1+ fish (ODFW 2012). In addition, the length of the distribution of bull trout in Threemile Creek had increased to 2.7 km (1.7 miles) by 2012 (USFWS unpublished data). Between 1989 and 2010, bull trout abundance in Sun Creek increased approximately tenfold (from approximately 133 to 1,606 age-1+ fish) and distribution increased from approximately 1.9 km (1.2 miles) to 11.2 km (7.0 miles) (Buktenica et al. 2013) (USFWS 2015b, p. B-5).

Sycan River Core Area

The Sycan River core area is comprised of one local population, Long Creek. Long Creek likely faces greater risk of extirpation because it is the only remaining local population due to extirpation of all other historic local populations. Bull trout previously occupied Calahan Creek, Coyote Creek, and the Sycan River, but are now extirpated from these locations (Light et al. 1996). This core area's local population is genetically distinct from those in the other two core areas (USFWS 2008b). This core area also is essential for recovery because bull trout in this core area exhibit both resident[2] and fluvial life histories, which are important for representing diverse life history expression in the Klamath Recovery Unit. Migratory bull trout are able to grow larger than their resident

[2] Resident: Life history pattern of residing in tributary streams for the fish's entire life without migrating.

counterparts, resulting in greater fecundity and higher reproductive potential (Rieman and McIntyre 1993). Migratory life history forms also have been shown to be important for population persistence and resilience (Dunham et al. 2008).

The last remaining population (Long Creek) has received focused attention in an effort to ensure it is not also extirpated. In 2006, two weirs were removed from Long Creek, which increased the amount of occupied foraging, migratory, and overwintering (FMO) habitat by 3.2 km (2.0 miles). Bull trout currently occupy approximately 3.5 km (2.2 miles) of spawning/rearing habitat, including a portion of an unnamed tributary to upper Long Creek, and seasonally use 25.9 km (16.1 miles) of FMO habitat. Brook trout also inhabit Long Creek and have been the focus of periodic removal efforts. No recent statistically rigorous population estimate has been completed for Long Creek; however, the 2002 Draft Bull Trout Recovery Plan reported a population estimate of 842 individuals (USFWS 2002b). Currently unoccupied habitat is needed to establish additional local populations, although brook trout are widespread in this core area and their management will need to be considered in future recovery efforts. In 2014, the Klamath Falls Fish and Wildlife Office of the Service established an agreement with the U.S. Geological Survey to undertake a structured decision making process to assist with recovery planning of bull trout populations in the Sycan River core area (USFWS 2015b, p. B-6).

Upper Sprague River Core Area

The Upper Sprague River core area comprises five bull trout local populations, placing the core area at an intermediate risk of extinction. The five local populations include Boulder Creek, Dixon Creek, Deming Creek, Leonard Creek, and Brownsworth Creek. These local populations may face a higher risk of extirpation because not all are interconnected. Bull trout local populations in this core area are genetically distinct from those in the other two Klamath Recovery Unit core areas (USFWS 2008b). Migratory bull trout have occasionally been observed in the North Fork Sprague River (USFWS 2002b). Therefore, this core area also is essential for recovery in that bull trout here exhibit a resident life history and likely a fluvial life history, which are important for conserving diverse life history expression in the Klamath Recovery Unit as discussed above for the Sycan River core area.

The Upper Sprague River core area population of bull trout has experienced a decline from historic levels, although less is known about historic occupancy in this core area. Bull trout are reported to have historically occupied the South Fork Sprague River, but are now extirpated from this location (Buchanan et al. 1997). The remaining five populations have received focused attention. Although brown trout (*Salmo trutta*) co-occur with bull trout and exist in adjacent habitats, brook trout do not overlap with existing bull trout populations. Efforts have been made to increase connectivity of existing bull trout populations by replacing culverts that create barriers. Thus, over the past few generations, these populations have likely been stable and increased in distribution. Population abundance has been estimated recently for Boulder Creek (372 + 62 percent; Hartill and Jacobs 2007), Dixon Creek (20 + 60 percent; Hartill and Jacobs 2007), Deming Creek (1,316 + 342; Moore 2006), and Leonard Creek (363 + 37 percent;

Hartill and Jacobs 2007). No statistically rigorous population estimate has been completed for the Brownsworth Creek local population; however, the 2002 Draft Bull Trout Recovery Plan reported a population estimate of 964 individuals (USFWS 2002b). Additional local populations need to be established in currently unoccupied habitat within the Upper Sprague River core area, although brook trout are widespread in this core area and will need to be considered in future recovery efforts (USFWS 2015b, p. B-7).

Mid-Columbia Recovery Unit

The Mid-Columbia Recovery Unit (RU) comprises 24 bull trout core areas, as well as 2 historically occupied core areas and 1 research needs area. The Mid-Columbia RU is recognized as an area where bull trout have co-evolved with salmon, steelhead, lamprey, and other fish populations. Reduced fish numbers due to historic overfishing and land management changes have caused changes in nutrient abundance for resident migratory fish like the bull trout. The recovery unit is located within eastern Washington, eastern Oregon, and portions of central Idaho. Major drainages include the Methow River, Wenatchee River, Yakima River, John Day River, Umatilla River, Walla Walla River, Grande Ronde River, Imnaha River, Clearwater River, and smaller drainages along the Snake River and Columbia River (USFWS 2015c, p. C-1).

The Mid-Columbia RU can be divided into four geographic regions the Lower Mid-Columbia, which includes all core areas that flow into the Columbia River below its confluence with the 1) Snake River; 2) the Upper Mid-Columbia, which includes all core areas that flow into the Columbia River above its confluence with the Snake River; 3) the Lower Snake, which includes all core areas that flow into the Snake River between its confluence with the Columbia River and Hells Canyon Dam; and 4) the Mid-Snake, which includes all core areas in the Mid-Columbia RU that flow into the Snake River above Hells Canyon Dam. These geographic regions are composed of neighboring core areas that share similar bull trout genetic, geographic (hydrographic), and/or habitat characteristics. Conserving bull trout in geographic regions allows for the maintenance of broad representation of genetic diversity, provides neighboring core areas with potential source populations in the event of local extirpations, and provides a broad array of options among neighboring core areas to contribute recovery under uncertain environmental change USFWS 2015c, pp. C-1-2).

The current demographic status of bull trout in the Mid-Columbia Recovery Unit is highly variable at both the RU and geographic region scale. Some core areas, such as the Umatilla, Asotin, and Powder Rivers, contain populations so depressed they are likely suffering from the deleterious effects of small population size. Conversely, strongholds do exist within the recovery unit, predominantly in the Lower Snake geographic area. Populations in the Imnaha, Little Minam, Clearwater, and Wenaha Rivers are likely some of the most abundant. These populations are all completely or partially within the bounds of protected wilderness areas and have some of the most intact habitat in the recovery unit. Status in some core areas is relatively unknown, but all indications in these core areas suggest population trends are declining, particularly in the core areas of the John Day Basin (USFWS 2015c, p. C-5).

Lower Mid-Columbia Region

In the Lower Mid-Columbia Region, core areas are distributed along the western portion of the Blue Mountains in Oregon and Washington. Only one of the six core areas is located completely in Washington. Demographic status is highly variable throughout the region. Status is the poorest in the Umatilla and Middle Fork John Day Core Areas. However, the Walla Walla River core area contains nearly pristine habitats in the headwater spawning areas and supports the most abundant populations in the region. Most core areas support both a resident and fluvial life history; however, recent evidence suggests a significant decline in the resident and fluvial life history in the Umatilla River and John Day core areas respectively. Connectivity between the core areas of the Lower Mid-Columbia Region is unlikely given conditions in the connecting FMO habitats. Connection between the Umatilla, Walla Walla and Touchet core areas is uncommon but has been documented, and connectivity is possible between core areas in the John Day Basin. Connectivity between the John Day core areas and Umatilla/Walla Walla/Touchet core areas is unlikely (USFWS 2015c, pp. C-5-6).

Upper Mid-Columbia Region

In the Upper Mid-Columbia Region, core areas are distributed along the eastern side of the Cascade Mountains in Central Washington. This area contains four core areas (Yakima, Wenatchee, Entiat, and Methow), the Lake Chelan historic core area, and the Chelan River, Okanogan River, and Columbia River FMO areas. The core area populations are generally considered migratory, though they currently express both migratory (fluvial and adfluvial) and resident forms. Residents are located both above and below natural barriers (*i.e.*, Early Winters Creek above a natural falls; and Ahtanum in the Yakima likely due to long lack of connectivity from irrigation withdrawal). In terms of uniqueness and connectivity, the genetics baseline, radio-telemetry, and PIT tag studies identified unique local populations in all core areas. Movement patterns within the core areas; between the lower river, lakes, and other core areas; and between the Chelan, Okanogan, and Columbia River FMO occurs regularly for some of the Wenatchee, Entiat, and Methow core area populations. This type of connectivity has been displayed by one or more fish, typically in non-spawning movements within FMO. More recently, connectivity has been observed between the Entiat and Yakima core areas by a juvenile bull trout tagged in the Entiat moving in to the Yakima at Prosser Dam and returning at an adult size back to the Entiat. Genetics baselines identify unique populations in all four core areas (USFWS 2015c, p. C-6).

The demographic status is variable in the Upper-Mid Columbia region and ranges from good to very poor. The Service's 2008 5-year Review and Conservation Status Assessment described the Methow and Yakima Rivers at risk, with a rapidly declining trend. The Entiat River was listed at risk with a stable trend, and the Wenatchee River as having a potential risk, and with a stable trend. Currently, the Entiat River is considered to be declining rapidly due to much reduced redd counts. The Wenatchee River is able to exhibit all freshwater life histories with connectivity to Lake Wenatchee, the Wenatchee River and all its local populations, and to the Columbia River and/or other core areas in the region. In the Yakima core area some populations exhibit life history forms different from what they were historically. Migration between local populations and to and from spawning habitat is generally prevented or impeded by headwater storage dams on irrigation reservoirs, connectivity between tributaries and reservoirs, and within lower portions of spawning and rearing habitat and the mainstem Yakima River due to changed flow patterns, low instream flows, high water temperatures, and other habitat impediments. Currently, the connectivity in the Yakima Core area is truncated to the degree that not all populations are able to contribute gene flow to a functional metapopulation (USFWS 2015c, pp. C-6-7).

Lower Snake Region

Demographic status is variable within the Lower Snake Region. Although trend data are lacking, several core areas in the Grande Ronde Basin and the Imnaha core area are thought to be stable. The upper Grande Ronde Core Area is the exception where population abundance is considered depressed. Wenaha, Little Minam, and Imnaha Rivers are strongholds (as mentioned above), as are most core areas in the Clearwater River basin. Most core areas contain populations that express both a resident and fluvial life history strategy. There is potential that some bull trout in the upper Wallowa River are adfluvial. There is potential for connectivity between core areas in the Grande Ronde basin, however conditions in FMO are limiting (USFWS 2015c, p. C-7).

Middle Snake Region

In the Middle Snake Region, core areas are distributed along both sides of the Snake River above Hells Canyon Dam. The Powder River and Pine Creek basins are in Oregon and Indian Creek and Wildhorse Creek are on the Idaho side of the Snake River. Demographic status of the core areas is poorest in the Powder River Core Area where populations are highly fragmented and severely depressed. The East Pine Creek population in the Pine-Indian-Wildhorse Creeks core area is likely the most abundant within the region. Populations in both core areas primarily express a resident life history strategy; however, some evidence suggests a migratory life history still exists in the Pine-Indian-Wildhorse Creeks core area. Connectivity is severely impaired in the Middle Snake Region. Dams, diversions and temperature barriers prevent movement among populations and between core areas. Brownlee Dam isolates bull trout in Wildhorse Creek from other populations (USFWS 2015c, p. C-7).

Columbia Headwaters Recovery Unit

The Columbia Headwaters Recovery Unit (CHRU) includes western Montana, northern Idaho, and the northeastern corner of Washington. Major drainages include the Clark Fork River basin and its Flathead River contribution, the Kootenai River basin, and the Coeur d'Alene Lake basin. In this implementation plan for the CHRU we have slightly reorganized the structure from the 2002 Draft Recovery Plan, based on latest available science and fish passage improvements that have rejoined previously fragmented habitats. We now identify 35 bull trout core areas (compared to 47 in 2002) for this recovery unit. Fifteen of the 35 are referred to as "complex" core areas as they represent large interconnected habitats, each containing multiple spawning streams considered to host separate and largely genetically identifiable local populations. The 15 complex core areas contain the majority of individual bull trout and the bulk of the designated critical habitat (USFWS 2010).

However, somewhat unique to this recovery unit is the additional presence of 20 smaller core areas, each represented by a single local population. These "simple" core areas are found in remote glaciated headwater basins, often in Glacier National Park or federally-designated wilderness areas, but occasionally also in headwater valley bottoms. Many simple core areas are upstream of waterfalls or other natural barriers to fish migration. In these simple core areas bull trout have apparently persisted for thousands of years despite small populations and isolated existence. As such, simple core areas meet the criteria for core area designation and continue to be valued for their uniqueness, despite limitations of size and scope. Collectively, the 20 simple core areas contain less than 3 percent of the total bull trout core area habitat in the CHRU, but represent significant genetic and life history diversity (Meeuwig et al. 2010). Throughout this recovery unit implementation plan, we often separate our analyses to distinguish between complex and simple core areas, both in respect to threats as well as recovery actions (USFWS 2015d, pp. D-1-2).

In order to effectively manage the recovery unit implementation plan (RUIP) structure in this large and diverse landscape, the core areas have been separated into the following five natural geographic assemblages.

Upper Clark Fork Geographic Region

Starting at the Clark Fork River headwaters, the *Upper Clark Fork Geographic Region* comprises seven complex core areas, each of which occupies one or more major watersheds contributing to the Clark Fork basin (*i.e.*, Upper Clark Fork River, Rock Creek, Blackfoot River, Clearwater River and Lakes, Bitterroot River, West Fork Bitterroot River, and Middle Clark Fork River core areas) (USFWS 2015d, p. D-2).

Lower Clark Fork Geographic Region

The seven headwater core areas flow into the *Lower Clark Fork Geographic Region*, which comprises two complex core areas, Lake Pend Oreille and Priest Lake. Because of the systematic and jurisdictional complexity (three States and a Tribal entity) and the current degree of migratory fragmentation caused by five mainstem dams, the threats and recovery actions in the Lake Pend Oreille (LPO) core area are very complex and are described in three parts. LPO-A is upstream of Cabinet Gorge Dam, almost entirely in Montana, and includes the mainstem Clark Fork River upstream to the confluence of the Flathead River as well as the portions of the lower Flathead River (*e.g.*, Jocko River) on the Flathead Indian Reservation. LPO-B is the Pend Oreille lake basin proper and its tributaries, extending between Albeni Falls Dam downstream from the outlet of Lake Pend Oreille and Cabinet Gorge Dam just upstream of the lake; almost entirely in Idaho. LPO-C is the lower basin (*i.e.*, lower Pend Oreille River), downstream of Albeni Falls Dam to Boundary Dam (1 mile upstream from the Canadian border) and bisected by Box Canyon Dam; including portions of Idaho, eastern Washington, and the Kalispel Reservation (USFWS 2015d, p. D-2).

Historically, and for current purposes of bull trout recovery, migratory connectivity among these separate fragments into a single entity remains a primary objective.

<u>*Flathead Geographic Region*</u>

The *Flathead Geographic Region* includes a major portion of northwestern Montana upstream of Kerr Dam on the outlet of Flathead Lake. The complex core area of Flathead Lake is the hub of this area, but other complex core areas isolated by dams are Hungry Horse Reservoir (formerly South Fork Flathead River) and Swan Lake. Within the glaciated basins of the Flathead River headwaters are 19 simple core areas, many of which lie in Glacier National Park or the Bob Marshall and Great Bear Wilderness areas and some of which are isolated by natural barriers or other features (USFWS 2015d, p. D-2).

<u>*Kootenai Geographic Region*</u>

To the northwest of the Flathead, in an entirely separate watershed, lies the *Kootenai Geographic Region*. The Kootenai is a uniquely patterned river system that originates in southeastern British Columbia, Canada. It dips, in a horseshoe configuration, into northwest Montana and north Idaho before turning north again to re-enter British Columbia and eventually join the Columbia River headwaters in British Columbia. The *Kootenai Geographic Region* contains two complex core areas (Lake Koocanusa and the Kootenai River) bisected since the 1970's by Libby Dam, and also a single naturally isolated simple core area (Bull Lake). Bull trout in both of the complex core areas retain strong migratory connections to populations in British Columbia (USFWS 2015d, p. D-3).

<u>*Coeur d'Alene Geographic Region*</u>

Finally, the *Coeur d'Alene Geographic Region* consists of a single, large complex core area centered on Coeur d'Alene Lake. It is grouped into the CHRU for purposes of physical and ecological similarity (adfluvial bull trout life history and nonanadromous linkage) rather than due to watershed connectivity with the rest of the CHRU, as it flows into the mid-Columbia River far downstream of the Clark Fork and Kootenai systems (USFWS 2015d, p. D-3).

Upper Snake Recovery Unit

The Upper Snake Recovery Unit includes portions of central Idaho, northern Nevada, and eastern Oregon. Major drainages include the Salmon River, Malheur River, Jarbidge River, Little Lost River, Boise River, Payette River, and the Weiser River. The Upper Snake Recovery Unit contains 22 bull trout core areas within 7 geographic regions or major watersheds: Salmon River (10 core areas, 123 local populations), Boise River (2 core areas, 29 local populations), Payette River (5 core areas, 25 local populations), Little Lost River (1 core area, 10 local populations), Malheur River (2 core areas, 8 local populations), Jarbidge River (1 core area, 6 local populations), and Weiser River (1 core area, 5 local populations). The Upper Snake Recovery Unit includes a total of 206 local populations, with almost 60 percent being present in the Salmon River watershed (USFWS 2015e, p. E-1).

Three major bull trout life history expressions are present in the Upper Snake Recovery Unit, adfluvial[3], fluvial[4], and resident populations. Large areas of intact habitat exist primarily in the Salmon drainage, as this is the only drainage in the Upper Snake Recovery Unit that still flows directly into the Snake River; most other drainages no longer have direct connectivity due to irrigation uses or instream barriers. Bull trout in the Salmon basin share a genetic past with bull trout elsewhere in the Upper Snake Recovery Unit. Historically, the Upper Snake Recovery Unit is believed to have largely supported the fluvial life history form; however, many core areas are now isolated or have become fragmented watersheds, resulting in replacement of the fluvial life history with resident or adfluvial forms. The Weiser River, Squaw Creek, Pahsimeroi River, and North Fork Payette River core areas contain only resident populations of bull trout (USFWS 2015e, pp. E-1-2).

Salmon River

The Salmon River basin represents one of the few basins that are still free-flowing down to the Snake River. The core areas in the Salmon River basin do not have any major dams and a large extent (approximately 89 percent) is federally managed, with large portions of the Middle Fork Salmon River and Middle Fork Salmon River - Chamberlain core areas occurring within the Frank Church River of No Return Wilderness. Most core areas in the Salmon River basin contain large populations with many occupied stream segments. The Salmon River basin contains 10 of the 22 core areas in the Upper Snake Recovery Unit and contains the majority of the occupied habitat. Over 70 percent of occupied habitat in the Upper Snake Recovery Unit occurs in the Salmon River basin as well as 123 of the 206 local populations. Connectivity between core areas in the Salmon River basin is intact; therefore it is possible for fish in the mainstem Salmon to migrate to almost any Salmon River core area or even the Snake River.

Connectivity within Salmon River basin core areas is mostly intact except for the Pahsimeroi River and portions of the Lemhi River. The Upper Salmon River, Lake Creek, and Opal Lake core areas contain adfluvial populations of bull trout, while most of the remaining core areas contain fluvial populations; only the Pahsimeroi contains strictly resident populations. Most core areas appear to have increasing or stable trends but trends are not known in the Pahsimeroi, Lake Creek, or Opal Lake core areas. The Idaho Department of Fish and Game reported trend data from 7 of the 10 core areas. This trend data indicated that populations were stable or increasing in the Upper Salmon River, Lemhi River, Middle Salmon River-Chamberlain, Little Lost River, and the South Fork Salmon River (IDFG 2005, 2008). Trends were stable or decreasing in the Little-Lower Salmon River, Middle Fork Salmon River, and the Middle Salmon River-Panther (IDFG 2005, 2008).

[3] Adfluvial: Life history pattern of spawning and rearing in tributary streams and migrating to lakes or reservoirs to mature.
[4] Fluvial: Life history pattern of spawning and rearing in tributary streams and migrating to larger rivers to mature.

Boise River

In the Boise River basin, two large dams are impassable barriers to upstream fish movement: Anderson Ranch Dam on the South Fork Boise River, and Arrowrock Dam on the mainstem Boise River. Fish in Anderson Ranch Reservoir have access to the South Fork Boise River upstream of the dam. Fish in Arrowrock Reservoir have access to the North Fork Boise River, Middle Fork Boise River, and lower South Fork Boise River. The Boise River basin contains 2 of the 22 core areas in the Upper Snake Recovery Unit. The core areas in the Boise River basin account for roughly 12 percent of occupied habitat in the Upper Snake Recovery Unit and contain 29 of the 206 local populations. Approximately 90 percent of both Arrowrock and Anderson Ranch core areas are federally owned; most lands are managed by the U.S. Forest Service, with some portions occurring in designated wilderness areas. Both the Arrowrock core area and the Anderson Ranch core area are isolated from other core areas. Both core areas contain fluvial bull trout that exhibit adfluvial characteristics and numerous resident populations. The Idaho Department of Fish and Game in 2014 determined that the Anderson Ranch core area had an increasing trend while trends in the Arrowrock core area is unknown (USFWS 2015e).

Payette River

The Payette River basin contains three major dams that are impassable barriers to fish: Deadwood Dam on the Deadwood River, Cascade Dam on the North Fork Payette River, and Black Canyon Reservoir on the Payette River. Only the Upper South Fork Payette River and the Middle Fork Payette River still have connectivity, the remaining core areas are isolated from each other due to dams. Both fluvial and adfluvial life history expression are still present in the Payette River basin but only resident populations are present in the Squaw Creek and North Fork Payette River core areas. The Payette River basin contains 5 of the 22 core areas and 25 of the 206 local populations in the recovery unit. Less than 9 percent of occupied habitat in the recovery unit is in this basin. Approximately 60 percent of the lands in the core areas are federally owned and the majority is managed by the U.S. Forest Service. Trend data are lacking and the current condition of the various core areas is unknown, but there is concern due to the current isolation of three (North Fork Payette River, Squaw Creek, Deadwood River) of the five core areas; the presence of only resident local populations in two (North Fork Payette River, Squaw Creek) of the five core areas; and the relatively low numbers present in the North Fork core area (USFWS 2015e, p. E-8).

Jarbidge River

The Jarbidge River core area contains two major fish barriers along the Bruneau River: the Buckaroo diversion and C. J. Strike Reservoir. Bull trout are not known to migrate down to the Snake River. There is one core area in the basin, with populations in the Jarbidge River; this watershed does not contain any barriers. Approximately 89 percent of the Jarbidge core area is federally owned. Most lands are managed by either the Forest Service or Bureau of Land Management. A large portion of the core area is within the Bruneau-Jarbidge Wilderness area. A tracking study has documented bull trout population connectivity among many of the local populations, in particular between West Fork Jarbidge River and Pine Creek. Movement between the East and West Fork Jarbidge River has also been documented; therefore, both resident and fluvial populations are present. The core area contains six local populations and 3 percent of the occupied habitat in the recovery unit. Trend data are lacking within this core area (USFWS 2015e, p. E-9).

Little Lost River

The Little Lost River basin is unique in that the watershed is within a naturally occurring hydrologic sink and has no connectivity with other drainages. A small fluvial population of bull trout may still exist, but it appears that most populations are predominantly resident populations. There is one core area in the Little Lost basin, and approximately 89 percent of it is federally owned by either the U.S. Forest Service or Bureau of Land Management. The core area contains 10 local populations and less than 3 percent of the occupied habitat in the recovery unit. The current trend condition of this core area is likely stable, with most bull trout residing in Upper Sawmill Canyon (IDFG 2014).

Malheur River

The Malheur River basin contains major dams that are impassable to fish. The largest are Warm Springs Dam, impounding Warm Springs Reservoir on the mainstem Malheur River, and Agency Valley Dam, impounding Beulah Reservoir on the North Fork Malheur River. The dams result in two core areas that are isolated from each other and from other core areas. Local populations in the two core areas are limited to habitat in the upper watersheds. The Malheur River basin contains 2 of the 22 core areas and 8 of the 206 local populations in the recovery unit. Fluvial and resident populations are present in both core areas while adfluvial populations are present in the North Fork Malheur River. This basin contains less than 3 percent of the occupied habitat in the recovery unit, and approximately 60 percent of lands in the two core areas are federally owned. Trend data indicates that populations are declining in both core areas (USFWS 2015e, p. E-9).

Weiser River

The Weiser River basin contains local populations that are limited to habitat in the upper watersheds. The Weiser River basin contains only a single core area that consists of 5 of the 206 local populations in the recovery unit. Local populations occur in only three stream complexes in the upper watershed: 1) Upper Hornet Creek, 2) East Fork Weiser River, and 3) Upper Little Weiser River. These local populations include only resident life histories. This basin contains less than 2 percent of the occupied habitat in the recovery unit, and approximately 44 percent of lands are federally owned. Trend data from the Idaho Department of Fish and Game indicate that the populations in the Weiser core area are increasing (IDFG 2014) but it is considered vulnerable because local populations are isolated and likely do not express migratory life histories (USFWS 2015e, p.E-10).

St. Mary Recovery Unit

The Saint Mary Recovery Unit is located in northwest Montana east of the Continental Divide and includes the U.S. portions of the Saint Mary River basin, from its headwaters to the international boundary with Canada at the 49th parallel. The watershed and the bull trout population are linked to downstream aquatic resources in southern Alberta, Canada; the U.S. portion includes headwater spawning and rearing (SR) habitat in the tributaries and a portion of the FMO habitat in the mainstem of the Saint Mary River and Saint Mary lakes (Mogen and Kaeding 2001).

The Saint Mary Recovery Unit comprises four core areas; only one (Saint Mary River) is a complex core area with five described local bull trout populations (Divide, Boulder, Kennedy, Otatso, and Lee Creeks). Roughly half of the linear extent of available FMO habitat in the mainstem Saint Mary system (between Saint Mary Falls at the upstream end and the downstream Canadian border) is comprised of Saint Mary and Lower Saint Mary Lakes, with the remainder in the Saint Mary River. The other three core areas (Slide Lakes, Cracker Lake, and Red Eagle Lake) are simple core areas. Slide Lakes and Cracker Lake occur upstream of seasonal or permanent barriers and are comprised of genetically isolated single local bull trout populations, wholly within Glacier National Park, Montana. In the case of Red Eagle Lake, physical isolation does not occur, but consistent with other lakes in the adjacent Columbia Headwaters Recovery Unit, there is likely some degree of spatial separation from downstream Saint Mary Lake. As noted, the extent of isolation has been identified as a research need (USFWS 2015f, p. F-1).

Bull trout in the Saint Mary River complex core area are documented to exhibit primarily the migratory fluvial life history form (Mogen and Kaeding 2005a, 2005b), but there is doubtless some occupancy (though less well documented) of Saint Mary Lakes, suggesting a partly adfluvial adaptation. Since lake trout and northern pike are both native to the Saint Mary River system (headwaters of the South Saskatchewan River drainage draining to Hudson Bay), the conventional wisdom is that these large piscivores historically outcompeted bull trout in the lacustrine environment (Donald and Alger 1993, Martinez et al. 2009), resulting in a primarily fluvial niche and existence for bull trout in this system. This is an untested hypothesis and additional research into this aspect is needed (USFWS 2015f, p. F-3).

Bull trout populations in the simple core areas of the three headwater lake systems (Slide, Cracker, and Red Eagle Lakes) are, by definition, adfluvial; there are also resident life history components in portions of the Saint Mary River system such as Lower Otatso Creek (Mogen and Kaeding 2005a), further exemplifying the overall life history diversity typical of bull trout. Mogen and Kaeding (2001) reported that bull trout continue to inhabit nearly all suitable habitats accessible to them in the Saint Mary River basin in the United States. The possible exception is portions of Divide Creek, which appears to be intermittently occupied despite a lack of permanent migratory barriers, possibly due to low population size and erratic year class production (USFWS 2015f, p. F-3).

It should be noted that bull trout are found in minor portions of two additional U.S. watersheds (Belly and Waterton rivers) that were once included in the original draft recovery plan (USFWS 2002) but are no longer considered core areas in the final recovery plan (USFWS 2015) and are not addressed in that document. In Alberta, Canada, the Saint Mary River bull trout population is considered at "high risk," while the Belly River is rated as "at risk" (ACA 2009). In the Belly River drainage, which enters the South Saskatchewan system downstream of the Saint Mary River in Alberta, some bull trout spawning is known to occur on either side of the international boundary. These waters are in the drainage immediately west of the Saint Mary River headwaters. However, the U.S. range of this population constitutes only a minor headwater migratory SR segment of an otherwise wholly Canadian population, extending less than 1 mile (0.6 km) into backcountry waters of Glacier National Park. The Belly River population is otherwise totally dependent on management within Canadian jurisdiction, with no natural migratory connection to the Saint Mary (USFWS 2015f, p. F-3).

Current status of bull trout in the Saint Mary River core area (U.S.) is considered strong (Mogen 2013). Migratory bull trout redd counts are conducted annually in the two major SR streams, Boulder and Kennedy creeks. Boulder Creek redd counts have ranged from 33 to 66 in the past decade, with the last 4 counts all 53 or higher. Kennedy Creek redd counts are less robust, ranging from 5 to 25 over the last decade, with a 2014 count of 20 (USFWS 2015f, p. F-3).

Generally, the demographic status of the Saint Mary River core area is believed to be good, with the exception of the Divide Creek local population. In this local population, there is evidence that a combination of ongoing habitat manipulation (Smillie and Ellerbroek 1991, F-5 NPS 1992) resulting in occasional historical passage issues, combined with low and erratic recruitment (DeHaan et al. 2011) has caused concern for the continuing existence of the local population.

While less is known about the demographic status of the three simple cores where redd counts are not conducted, all three appear to be self-sustaining and fluctuating within known historical population demographic bounds. Of the three simple core areas, demographic status in Slide Lakes and Cracker Lake appear to be functioning appropriately, but the demographic status in Red Eagle Lake is less well documented and believed to be less robust (USFWS 2015f, p. F-3).

Reasons for Listing

Bull trout distribution, abundance, and habitat quality have declined rangewide (Bond 1992, pp. 2-3; Schill 1992, p. 42; Thomas 1992, entire; Ziller 1992, entire; Rieman and McIntyre 1993, p. 1; Newton and Pribyl 1994, pp. 4-5; McPhail and Baxter 1996, p. 1). Several local extirpations have been documented, beginning in the 1950s (Rode 1990, pp. 26-32; Ratliff and Howell 1992, entire; Donald and Alger 1993, entire; Goetz 1994, p. 1; Newton and Pribyl 1994, pp. 8-9; Light et al. 1996, pp. 6-7; Buchanan et al. 1997, p. 15; WDFW 1998, pp. 2-3). Bull trout were extirpated from the southernmost portion of their historic range, the McCloud River in California, around 1975 (Rode 1990, p. 32). Bull trout have been functionally extirpated (i.e., few individuals may occur there but do not constitute a viable population) in the Coeur d'Alene River basin in Idaho and in the Lake Chelan and Okanogan River basins in Washington (USFWS 1998, pp. 31651-31652).

These declines result from the combined effects of habitat degradation and fragmentation, the blockage of migratory corridors; poor water quality, angler harvest and poaching, entrainment (process by which aquatic organisms are pulled through a diversion or other device) into diversion channels and dams, and introduced nonnative species. Specific land and water management activities that depress bull trout populations and degrade habitat include the effects of dams and other diversion structures, forest management practices, livestock grazing, agriculture, agricultural diversions, road construction and maintenance, mining, and urban and rural development (Beschta et al. 1987, entire; Chamberlain et al. 1991, entire; Furniss et al. 1991, entire; Meehan 1991, entire; Nehlsen et al. 1991, entire; Sedell and Everest 1991, entire; Craig and Wissmar 1993pp, 18-19; Henjum et al. 1994, pp. 5-6; McIntosh et al. 1994, entire; Wissmar et al. 1994, entire; MBTSG 1995a, p. 1; MBTSG 1995b. pp. i-ii; MBTSG 1995c, pp. i-ii; MBTSG 1995d, p. 22; MBTSG 1995e, p. i; MBTSG 1996a, p. i-ii; MBTSG 1996b, p. i; MBTSG 1996c, p. i; MBTSG 1996d, p. i; MBTSG 1996e, p. i; MBTSG 1996f, p. 11; Light et al. 1996, pp. 6-7; USDA and USDI 1995, p. 2).

Emerging Threats

<u>*Climate Change*</u>

Climate change was not addressed as a known threat when bull trout was listed. The 2015 bull trout recovery plan and RUIPs summarize the threat of climate change and acknowledges that some extant bull trout core area habitats will likely change (and may be lost) over time due to anthropogenic climate change effects, and use of best available information will ensure future conservation efforts that offer the greatest long-term benefit to sustain bull trout and their required coldwater habitats (USFWS 2015, p. vii, and pp. 17-20, USFWS 2015a-f).

Global climate change and the related warming of global climate have been well documented (IPCC 2007, entire; ISAB 2007, entire; Combes 2003, entire). Evidence of global climate change/warming includes widespread increases in average air and ocean temperatures and accelerated melting of glaciers, and rising sea level. Given the increasing certainty that climate change is occurring and is accelerating (IPCC 2007, p. 253; Battin et al. 2007, p. 6720), we can no longer assume that climate conditions in the future will resemble those in the past.

Patterns consistent with changes in climate have already been observed in the range of many species and in a wide range of environmental trends (ISAB 2007, entire; Hari et al. 2006, entire; Rieman et al. 2007, entire). In the northern hemisphere, the duration of ice cover over lakes and rivers has decreased by almost 20 days since the mid-1800's (Magnuson et al. 2000, p. 1743). The range of many species has shifted poleward and elevationally upward. For cold-water associated salmonids in mountainous regions, where their upper distribution is often limited by impassable barriers, an upward thermal shift in suitable habitat can result in a reduction in range, which in turn can lead to a population decline (Hari et al. 2006, entire).

In the Pacific Northwest, most models project warmer air temperatures and increases in winter precipitation and decreases in summer precipitation. Warmer temperatures will lead to more precipitation falling as rain rather than snow. As the seasonal amount of snow pack diminishes, the timing and volume of stream flow are likely to change and peak river flows are likely to increase in affected areas. Higher air temperatures are also likely to increase water temperatures (ISAB 2007, pp. 15-17). For example, stream gauge data from western Washington over the past 5 to 25 years indicate a marked increasing trend in water temperatures in most major rivers.

Climate change has the potential to profoundly alter the aquatic ecosystems upon which the bull trout depends via alterations in water yield, peak flows, and stream temperature, and an increase in the frequency and magnitude of catastrophic wildfires in adjacent terrestrial habitats (Bisson et al. 2003, pp 216-217).

All life stages of the bull trout rely on cold water. Increasing air temperatures are likely to impact the availability of suitable cold water habitat. For example, ground water temperature is generally correlated with mean annual air temperature, and has been shown to strongly influence the distribution of other chars. Ground water temperature is linked to bull trout selection of spawning sites, and has been shown to influence the survival of embryos and early juvenile rearing of bull trout (Baxter 1997, p. 82). Increases in air temperature are likely to be reflected in increases in both surface and groundwater temperatures.

Climate change is likely to affect the frequency and magnitude of fires, especially in warmer drier areas such as are found on the eastside of the Cascade Mountains. Bisson et al. (2003, pp. 216-217) note that the forest that naturally occurred in a particular area may or may not be the forest that will be responding to the fire regimes of an altered climate. In several studies related to the effect of large fires on bull trout populations, bull trout appear to have adapted to past fire disturbances through mechanisms such as dispersal and plasticity. However, as stated earlier, the future may well be different than the past and extreme fire events may have a dramatic effect on bull trout and other aquatic species, especially in the context of continued habitat loss, simplification and fragmentation of aquatic systems, and the introduction and expansion of exotic species (Bisson et al. 2003, pp. 218-219).

Migratory bull trout can be found in lakes, large rivers and marine waters. Effects of climate change on lakes are likely to impact migratory adfluvial bull trout that seasonally rely upon lakes for their greater availability of prey and access to tributaries. Climate-warming impacts to lakes will likely lead to longer periods of thermal stratification and coldwater fish such as adfluvial bull trout will be restricted to these bottom layers for greater periods of time. Deeper thermoclines resulting from climate change may further reduce the area of suitable temperatures in the bottom layers and intensify competition for food (Shuter and Meisner 1992. p. 11).

Bull trout require very cold water for spawning and incubation. Suitable spawning habitat is often found in accessible higher elevation tributaries and headwaters of rivers. However, impacts on hydrology associated with climate change are related to shifts in timing, magnitude and distribution of peak flows that are also likely to be most pronounced in these high elevation stream basins (Battin et al. 2007, p. 6720). The increased magnitude of winter peak flows in high elevation areas is likely to impact the location, timing, and success of spawning and incubation for the bull trout and Pacific salmon species. Although lower elevation river reaches are not expected to experience as severe an impact from alterations in stream hydrology, they are unlikely to provide suitably cold temperatures for bull trout spawning, incubation and juvenile rearing.

As climate change progresses and stream temperatures warm, thermal refugia will be critical to the persistence of many bull trout populations. Thermal refugia are important for providing bull trout with patches of suitable habitat during migration through or to make feeding forays into areas with greater than optimal temperatures.

There is still a great deal of uncertainty associated with predictions relative to the timing, location, and magnitude of future climate change. It is also likely that the intensity of effects will vary by region (ISAB 2007, p 7) although the scale of that variation may exceed that of States. For example, several studies indicate that climate change has the potential to impact ecosystems in nearly all streams throughout the State of Washington (ISAB 2007, p. 13; Battin et al. 2007, p. 6722; Rieman et al. 2007, pp. 1558-1561). In streams and rivers with temperatures approaching or at the upper limit of allowable water temperatures, there is little if any likelihood that bull trout will be able to adapt to or avoid the effects of climate change/warming. There is little doubt that climate change is and will be an important factor affecting bull trout distribution. As its distribution contracts, patch size decreases and connectivity is truncated, bull trout populations that may be currently connected may face increasing isolation, which could accelerate the rate of local extinction beyond that resulting from changes in stream temperature alone (Rieman et al. 2007, pp. 1559-1560). Due to variations in land form and geographic location across the range of the bull trout, it appears that some populations face higher risks than others. Bull trout in areas with currently degraded water temperatures and/or at the southern edge of its range may already be at risk of adverse impacts from current as well as future climate change.

The ability to assign the effects of gradual global climate change to bull trout or to a specific location on the ground is beyond our technical capabilities at this time.

Conservation

Conservation Needs

The 2015 recovery plan for bull trout established the primary strategy for recovery of bull trout in the coterminous United States: 1) conserve bull trout so that they are geographically widespread across representative habitats and demographically stable1 in six recovery units; 2) effectively manage and ameliorate the primary threats in each of six recovery units at the core area scale such that bull trout are not likely to become endangered in the foreseeable future; 3) build upon the numerous and ongoing conservation actions implemented on behalf of bull trout since their listing in 1999, and improve our understanding of how various threat factors potentially affect the species; 4) use that information to work cooperatively with our partners to design, fund, prioritize, and implement effective conservation actions in those areas that offer the greatest long-term benefit to sustain bull trout and where recovery can be achieved; and 5) apply adaptive management principles to implementing the bull trout recovery program to account for new information (USFWS 2015, p. v.).

Information presented in prior draft recovery plans published in 2002 and 2004 (USFWS 2002a, 2004) have served to identify recovery actions across the range of the species and to provide a framework for implementing numerous recovery actions by our partner agencies, local working groups, and others with an interest in bull trout conservation.

The 2015 recovery plan (USFWS 2015) integrates new information collected since the 1999 listing regarding bull trout life history, distribution, demographics, conservation successes, etc., and integrates and updates previous bull trout recovery planning efforts across the range of the single DPS listed under the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act).

The Service has developed a recovery approach that: 1) focuses on the identification of and effective management of known and remaining threat factors to bull trout in each core area; 2) acknowledges that some extant bull trout core area habitats will likely change (and may be lost) over time; and 3) identifies and focuses recovery actions in those areas where success is likely to meet our goal of ensuring the certainty of conservation of genetic diversity, life history features, and broad geographical representation of remaining bull trout populations so that the protections of the Act are no longer necessary (USFWS 2015, p. 45-46).

To implement the recovery strategy, the 2015 recovery plan establishes categories of recovery actions for each of the six Recovery Units (USFWS 2015, p. 50-51):

1. Protect, restore, and maintain suitable habitat conditions for bull trout.
2. Minimize demographic threats to bull trout by restoring connectivity or populations where appropriate to promote diverse life history strategies and conserve genetic diversity.
3. Prevent and reduce negative effects of nonnative fishes and other nonnative taxa on bull trout.
4. Work with partners to conduct research and monitoring to implement and evaluate bull trout recovery activities, consistent with an adaptive management approach using feedback from implemented, site-specific recovery tasks, and considering the effects of climate change.

Bull trout recovery is based on a geographical hierarchical approach. Bull trout are listed as a single DPS within the five-state area of the coterminous United States. The single DPS is subdivided into six biologically-based recover units: 1) Coastal Recovery Unit; 2) Klamath Recovery Unit; 3) Mid-Columbia Recovery Unit; 4) Upper Snake Recovery Unit; 5) Columbia Headwaters Recovery Unit; and 6) Saint Mary Recovery Unit (USFWS 2015, p. 23). A viable recovery unit should demonstrate that the three primary principles of biodiversity have been met: representation (conserving the genetic makeup of the species); resiliency (ensuring that each population is sufficiently large to withstand stochastic events); and redundancy (ensuring a sufficient number of populations to withstand catastrophic events) (USFWS 2015, p. 33).

Each of the six recovery units contain multiple bull trout core areas, 116 total, which are non-overlapping watershed-based polygons, and each core area includes one or more local populations. Currently there are 109 occupied core areas, which comprise 611 local populations (USFWS 2015, p. 3). There are also six core areas where bull trout historically occurred but are now extirpated, and one research needs area where bull trout were known to occur historically, but their current presence and use of the area are uncertain (USFWS 2015, p. 3). Core areas can be further described as complex or simple (USFWS 2015, p. 3-4). Complex core areas contain multiple local bull trout populations, are found in large watersheds, have multiple life history forms, and have migratory connectivity between spawning and rearing habitat and FMO habitats. Simple core areas are those that contain one bull trout local population. Simple core areas are small in scope, isolated from other core areas by natural barriers, and may contain unique genetic or life history adaptations.

A local population is a group of bull trout that spawn within a particular stream or portion of a stream system (USFWS 2015, p. 73). A local population is considered to be the smallest group of fish that is known to represent an interacting reproductive unit. For most waters where specific information is lacking, a local population may be represented by a single headwater tributary or complex of headwater tributaries. Gene flow may occur between local populations (e.g., those within a core population), but is assumed to be infrequent compared with that among individuals within a local population.

Recovery Units and Local Populations

The final recovery plan (USFWS 2015) designates six bull trout recovery units as described above. These units replace the 5 interim recovery units previously identified (USFWS 1999). The Service will address the conservation of these final recovery units in our section 7(a)(2) analysis for proposed Federal actions. The recovery plan (USFWS 2015), identified threats and factors affecting the bull trout within these units. A detailed description of recovery implementation for each recovery unit is provided in separate recovery unit implementation plans (RUIPs)(USFWS 2015a-f), which identify conservation actions and recommendations needed for each core area, forage/ migration/ overwinter areas, historical core areas, and research needs areas. Each of the following recovery units (below) is necessary to maintain the bull trout's distribution, as well as its genetic and phenotypic diversity, all of which are important to ensure the species' resilience to changing environmental conditions.

Coastal Recovery Unit

The coastal recovery unit implementation plan describes the threats to bull trout and the site-specific management actions necessary for recovery of the species within the unit (USFWS 2015a). The Coastal Recovery Unit is located within western Oregon and Washington. The Coastal Recovery Unit is divided into three regions: Puget Sound, Olympic Peninsula, and the Lower Columbia River Regions. This recovery unit contains 20 core areas comprising 84 local populations and a single potential local population in the historic Clackamas River core area where bull trout had been extirpated and were reintroduced in 2011, and identified four historically occupied core areas that could be re-established (USFWS 2015, pg. 47; USFWS 2015a, p. A-2). Core areas within Puget Sound and the Olympic Peninsula currently support the only anadromous local populations of bull trout. This recovery unit also contains ten shared FMO habitats which are outside core areas and allows for the continued natural population dynamics in which the core areas have evolved (USFWS 2015a, p. A-5). There are four core areas within the Coastal Recovery Unit that have been identified as current population strongholds: Lower Skagit, Upper Skagit, Quinault River, and Lower Deschutes River (USFWS 2015, p.79). These are the most stable and abundant bull trout populations in the recovery unit. The current condition of the bull trout in this recovery unit is attributed to the adverse effects of climate change, loss of functioning estuarine and nearshore marine habitats, development and related impacts (e.g., flood control, floodplain disconnection, bank armoring, channel straightening, loss of instream habitat complexity), agriculture (e.g., diking, water control structures, draining of wetlands, channelization, and the removal of riparian vegetation, livestock grazing), fish passage (e.g., dams, culverts, instream flows) residential development, urbanization, forest management practices (e.g., timber harvest and associated road building activities), connectivity impairment, mining, and the introduction of non-native species. Conservation measures or recovery actions implemented include relicensing of major hydropower facilities that have provided upstream and downstream fish passage or complete removal of dams, land acquisition to conserve bull trout habitat, floodplain restoration, culvert removal, riparian revegetation, levee setbacks, road removal, and projects to protect and restore important nearshore marine habitats.

Klamath Recovery Unit

The Klamath recovery unit implementation plan describes the threats to bull trout and the site-specific management actions necessary for recovery of the species within the unit (USFWS 2015b). The Klamath Recovery Unit is located in southern Oregon and northwestern California. The Klamath Recovery Unit is the most significantly imperiled recovery unit, having experienced considerable extirpation and geographic contraction of local populations and declining demographic condition, and natural re-colonization is constrained by dispersal barriers and presence of nonnative brook trout (USFWS 2015, p. 39). This recovery unit currently contains three core areas and eight local populations (USFWS 2015, p. 47; USFWS 2015b, p. B-1). Nine historic local populations of bull trout have become extirpated (USFWS 2015b, p. B-1). All three core areas have been isolated from other bull trout populations for the past 10,000 years (USFWS 2015b, p. B-3. The current condition of the bull trout in this recovery unit is attributed to the adverse effects of climate change, habitat degradation and fragmentation, past and present land use practices, agricultural water diversions, nonnative species, and past fisheries management practices. Conservation measures or recovery actions implemented include removal of nonnative fish (e.g., brook trout, brown trout, and hybrids), acquiring water rights for instream flows, replacing diversion structures, installing fish screens, constructing bypass channels, installing riparian fencing, culvert replacement, and habitat restoration.

Mid-Columbia Recovery Unit

The Mid-Columbia recovery unit implementation plan describes the threats to bull trout and the site-specific management actions necessary for recovery of the species within the unit (USFWS 2015c). The Mid-Columbia Recovery Unit is located within eastern Washington, eastern Oregon, and portions of central Idaho. The Mid-Columbia Recovery Unit is divided into four geographic regions: Lower Mid-Columbia, Upper Mid-Columbia, Lower Snake, and Mid-Snake Geographic Regions. This recovery unit contains 24 occupied core areas comprising 142 local populations, two historically occupied core areas, one research needs area, and seven FMO habitats (USFWS 2015, pg. 47; USFWS 2015c, p. C-1–4). The current condition of the bull trout in this recovery unit is attributed to the adverse effects of climate change, agricultural practices (e.g. irrigation, water withdrawals, livestock grazing), fish passage (e.g. dams, culverts), nonnative species, forest management practices, and mining. Conservation measures or recovery actions implemented include road removal, channel restoration, mine reclamation, improved grazing management, removal of fish barriers, and instream flow requirements.

Columbia Headwaters Recovery Unit

The Columbia headwaters recovery unit implementation plan describes the threats to bull trout and the site-specific management actions necessary for recovery of the species within the unit (USFWS 2015d, entire). The Columbia Headwaters Recovery Unit is located in western Montana, northern Idaho, and the northeastern corner of Washington. The Columbia Headwaters Recovery Unit is divided into five geographic regions: Upper Clark Fork, Lower Clark Fork, Flathead, Kootenai, and Coeur d'Alene Geographic Regions (USFWS 2015d, pp. D-2 – D-4). This recovery unit contains 35 bull trout core areas; 15 of which are complex core areas as they represent larger interconnected habitats and 20 simple core areas as they are isolated headwater lakes with single local populations. The 20 simple core areas are each represented by a single local population, many of which may have persisted for thousands of years despite small populations and isolated existence (USFWS 2015d, p. D-1). Fish passage improvements within the recovery unit have reconnected some previously fragmented habitats (USFWS 2015d, p. D-1), while others remain fragmented. Unlike the other recovery units in Washington, Idaho and Oregon, the Columbia Headwaters Recovery Unit does not have any anadromous fish overlap. Therefore, bull trout within the Columbia Headwaters Recovery Unit do not benefit from the recovery actions for salmon (USFWS 2015d, p. D-41). The current condition of the bull trout in this recovery unit is attributed to the adverse effects of climate change, mostly historical mining and contamination by heavy metals, expanding populations of nonnative fish predators and competitors, modified instream flows, migratory barriers (e.g., dams), habitat fragmentation, forest practices (e.g., logging, roads), agriculture practices (e.g. irrigation, livestock grazing), and residential development. Conservation measures or recovery actions implemented include habitat improvement, fish passage, and removal of nonnative species.

Upper Snake Recovery Unit

The Upper Snake recovery unit implementation plan describes the threats to bull trout and the site-specific management actions necessary for recovery of the species within the unit (USFWS 2015e, entire). The Upper Snake Recovery Unit is located in central Idaho, northern Nevada, and eastern Oregon. The Upper Snake Recovery Unit is divided into seven geographic regions: Salmon River, Boise River, Payette River, Little Lost River, Malheur River, Jarbidge River, and Weiser River. This recovery unit contains 22 core areas and 207 local populations (USFWS 2015, p. 47), with almost 60 percent being present in the Salmon River Region. The current condition of the bull trout in this recovery unit is attributed to the adverse effects of climate change, dams, mining, forest management practices, nonnative species, and agriculture (e.g., water diversions, grazing). Conservation measures or recovery actions implemented include instream habitat restoration, instream flow requirements, screening of irrigation diversions, and riparian restoration.

St. Mary Recovery Unit

The St. Mary recovery unit implementation plan describes the threats to bull trout and the site-specific management actions necessary for recovery of the species within the unit (USFWS 2015f). The Saint Mary Recovery Unit is located in Montana but is heavily linked to downstream resources in southern Alberta, Canada. Most of the Saskatchewan River watershed which the St. Mary flows into is located in Canada. The United States portion includes headwater spawning and rearing habitat and the upper reaches of FMO habitat. This recovery unit contains four core areas, and seven local populations (USFWS 2015f, p. F-1) in the U.S. Headwaters. The current condition of the bull trout in this recovery unit is attributed primarily to the outdated design and operations of the Saint Mary Diversion operated by the Bureau of Reclamation (e.g., entrainment, fish passage, instream flows), and, to a lesser extent habitat impacts from development and nonnative species.

Tribal Conservation Activities

Many Tribes throughout the range of the bull trout are participating on bull trout conservation working groups or recovery teams in their geographic areas of interest. Some tribes are also implementing projects which focus on bull trout or that address anadromous fish but benefit bull trout (e.g., habitat surveys, passage at dams and diversions, habitat improvement, and movement studies).

LITERATURE CITED

[ACA] Alberta Sustainable Resource Development and Alberta Conservation Association. 2009. Status of the bull trout (*Salvelinus confluentus*) in Alberta: Update 2009. Alberta Sustainable Resource Development. Wildlife Status Report No. 39 (Update 2009). Edmonton, Alberta.

Ardren, W. R., P. W. DeHaan, C. T. Smith, E. B. Taylor, R. Leary, C. C. Kozfkay, L. Godfrey, M. Diggs, W. Fredenberg, and J. Chan. 2011. Genetic structure, evolutionary history, and conservation units of bull trout in the coterminous United States. Transactions of the American Fisheries Society 140:506-525. 22 pp.

Battin, J., M.W. Wiley, M.H. Ruckelshaus, R.N. Palmer, E. Korb, K.K. Bartz, and H. Imaki. 2007. Projected impacts of climate change on salmon habitat restoration. Proceedings of the National Academy of Sciences of the United States of America 104(16):6720-6725. 6 pp.

Baxter, C.V. 2002. Fish movement and assemblage dynamics in a Pacific Northwest riverscape. Doctoral dissertation. Oregon State University, Corvallis, OR. 174 pp.

Baxter, J. S. 1997. Aspects of the reproductive ecology of bull trout in the Chowade River, British Columbia. Master's thesis. University of British Columbia, Vancouver. 110 pp.

Beauchamp, D.A., and J.J. VanTassell. 2001. Modeling seasonal trophic interactions of adfluvial bull trout in Lake Billy Chinook, Oregon. Transactions of the American Fisheries Society 130:204-216. 13 pp.

Behnke, R.J. 2002. Trout and Salmon of North America; Chapter: Bull Trout. Free Press, Simon and Shuster, Inc. N.Y., N.Y. Pp. 293-299.

Beschta, R.L., R.E. Bilby, G.W. Brown, L.B. Holtby, and T.D. Hofstra. 1987. Stream temperature and aquatic habitat: fisheries and forestry interactions. Pages 191-232 in E.D. Salo and T.W. Cundy (eds). Streamside Management Forestry and Fisheries Interactions. Institute of Forest Resources, University of Washington, Seattle, Washington, Contribution No. 57. 46 pp.

Bisson, P.A., B.E. Rieman, C. Luce, P.F. Hessburg, D.C. Lee, J.L. Kershner, G.H. Reeves, and R.E. Gresswell. 2003. Fire and aquatic ecosystems of the western USA: Current knowledge and key questions. Forest Ecology and Management. 178 (2003) 213-229. 17 pp.

Boag, T.D. 1987. Food habits of bull char, *Salvelinus confluentus*, and rainbow trout, Salmo gairdneri, coexisting in a foothills stream in northern Alberta. Canadian Field-Naturalist 101(1): 56-62. 6 pp.

Bond, C.E. 1992. Notes on the nomenclature and distribution of the bull trout and the effects of human activity on the species. Pages 1-4 in Howell, P.J. and D.V. 4 pp.

Bonneau, J.L. and D.L. Scarnecchia. 1996. Distribution of juvenile bull trout in a thermal gradient of a plunge pool in Granite Creek, Idaho. Transactions of the American Fisheries Society 125: 628-630. 3 pp.

Brenkman, S.J. and S.C. Corbett. 2005. Extent of Anadromy in Bull Trout and Implications for Conservation of a Threatened Species. North American Journal of Fisheries Management. 25:1073–1081. 9 pp.

Brewin, P.A. and M. K. Brewin. 1997. Distribution Maps for Bull Trout in Alberta. Pages 206-216 in Mackay, W.C., M.K. Brewin and M. Monita. Friends of the bull Trout Conference Proceedings. 10 pp.

Buchanan, D.V., and S.V. Gregory. 1997. Development of water temperature standards to protect and restore habitat for bull trout and other cold water species in Oregon. Mackay, W.C., Pp. 119-126

Buchanan, D.V., M.L. Hanson, and R.M. Hooton. 1997. Status of Oregon's bull trout. Oregon Department of Fish and Wildlife. 168 pp.

Buktenica, M. W., D. K. Hering, S. F. Girdner, B. D. Mahoney, and B. D. Rosenlund. 2013. Eradication of nonnative brook trout with electrofishing and antimycin-A and the response of a remnant bull trout population. North American Journal of Fisheries Management 33:117-129.

Burkey, T.V. 1989. Extinction in nature reserves: the effect of fragmentation and the importance of migration between reserve fragments. Oikos 55:75-81. 7 pp.

Burkey, T.V. 1995. Extinction rates in archipelagoes: Implications for populations in fragmented habitats. Conservation Biology 9: 527-541. 16 pp.

Cavender, T. M. 1978. Taxonomy and distribution of the bull trout, *Salvelinus confluentus* (Suckley), from the American Northwest. California Fish and Game 64: 139-174. 19 pp.

Chamberlain, T. W., R. D. Harr, and F. H. Everest. 1991. Timber harvesting, silviculture and watershed processes. Pages 181-205 in W. R. Meehan (ed). Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication 19. 26 pp.

Combes, S. 2003. Protecting freshwater ecosystems in the face of global climate change. In: Hansen LJ et al. (eds) Buying time: a user's manual for building resistance and resilience to climate change in natural systems. WWF, Washington, UDA. Pp. 175-214. 44 pp.

Costello, A.B., T.E. Down, S.M. Pollard, C.J. Pacas, and E.B. Taylor. 2003. The influence of history and contemporary stream hydrology on the evolution of genetic diversity within species: an examination of microsatellite DNA variation in bull trout, *Salvelinus confluentus* (Pisces: Salmonidae). Evolution. 57(2):328-344. 17 pp.

Craig, S.D., and R.C. Wissmar. 1993. Habitat conditions influencing a remnant bull trout spawning population, Gold Creek, Washington (draft report). Fisheries Research Institute, University of Washington. Seattle, Washington. 47 pp.

Dambacher, J. M., M. W. Buktenica, and G. L. Larson. 1992. Distribution, abundance, and habitat utilization of bull trout and brook trout in Sun Creek, Crater Lake National Park, Oregon. Proceedings of the Gearhart Mountain Bull Trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis, Oregon.

DeHaan, P., M. Diggs, and J. VonBargen. 2011. Genetic analysis of bull trout in the Saint Mary River System. U.S. Fish and Wildlife Service. Abernathy Fish Technology Center, Longview, Washington.

Donald, D.B. and D.J. Alger. 1993. Geographic distribution, species displacement, and niche overlap for lake trout and bull trout in mountain lakes. Canadian Journal of Zoology 71: 238-247. 10 pp.

Dunham, J.B. and B.E. Rieman. 1999. Metapopulation structure of bull trout: Influences of physical, biotic, and geometrical landscape characteristics. Ecological Applications 9:642-655. 15 pp.

Dunham, J., B. Rieman, and G. Chandler. 2003. Influences of temperature and environmental variables on the distribution of bull trout within streams at the southern margin of its range. North American Journal of Fisheries Management 23:894-905. 11 pp.

Dunham, J., C. Baxter, K. Fausch, W. Fredenberg, S. Kitano, I. Koizumi, K. Morita, T. Nakamura, B. Rieman, K. Savvaitova, J. Stanford, E. Taylor, and S. Yamamoto. 2008. Evolution, ecology, and conservation of Dolly Varden, white-spotted char, and bull trout. Fisheries 33:537–550.

Fishbase 2015. http://www.fishbase.org/Summary/SpeciesSummary.php?ID=2690&AT=bull+trout 2pp.

Fraley, J.J., and B.B. Shepard. 1989. Life history, ecology and population status of migratory bull trout (*Salvelinus confluentus*) in the Flathead Lake and River System, Montana. Northwest Science 63(4):133-143.

Frissell, C.A. 1999. An ecosystem approach to habitat conservation for bull trout: groundwater and surface water protection. Open File Report Number 156-99. Flathead Lake Biological Station, University of Montana, Polson, MT, 46 pp.

Furniss, M.J., T.D. Roelofs, and C.S. Yee. 1991. Road construction and maintenance. American Fisheries Society Special Publication 19:297-323. 14 pp.

Gilbert C. H. 1897. The fishes of the Klamath Basin. Bulletin of the U.S. Fish Commission 17:1-13.

Goetz, F. 1989. Biology of the bull trout, *Salvelinus confluentus*, a literature review. Willamette National Forest. Eugene, Oregon. 60 pp.

Goetz, F. 1994. Distribution and juvenile ecology of bull trout (*Salvelinus confluentus*) in the Cascade Mountains. M.S. thesis. Oregon State University, Corvallis. 190 pp.

Goetz, F., E. Jeanes, and E. Beamer. 2004. Bull trout in the nearshore. Preliminary draft. U.S. Army Corps of Engineers, Seattle, Washington, June, 2004, 396 pp.

Haas, G. R., and J. D. McPhail. 1991. Systematics and distributions of Dolly Varden (*Salvelinus malma*) and bull trout (*Salvelinus confluentus*) in North America. Can. J. Fish. Aquat. Sci. 48: 2191-2211. 21 pp.

Hartill, T. and S. Jacobs. 2007. Distribution and abundance of bull trout in the Sprague River (Upper Klamath Basin), 2006. Oregon Department of Fish and Wildlife. Corvallis, Oregon.

Hari, R. E., D. M. Livingstone, R. Siber, P. Burkhardt-Holm, and H. Guttinger. 2006. Consequences of climatic change for water temperature and brown trout populations in alpine rivers and streams. Global Change Biology 12:10–26. 17 pp.

Henjum, M.G., J.R. Karr, D.L. Bottom, D.A. Perry, J.C. Bednarz, S.G. Wright, S.A. Beckwitt, and E. Beckwitt. 1994. Interim protection for late-successional forests, fisheries, and watersheds. National forests east of the Cascade Crest, Oregon, and Washington. A report to the Congress and President of the United States Eastside Forests Scientific Society Panel. American Fisheries Society, American Ornithologists Union Incorporated, The Ecological Society of America, Society for Conservation Biology, The Wildlife Society. The Wildlife Society Technical Review 94-2. 112 pp.

Hoelscher, B. and T.C. Bjornn. 1989. Habitat, density and potential production of trout and char in Pend O'reille Lake tributaries. Project F-71`-R-10, Subproject III, Job No. 8. Idaho Department of Fish and Game, Boise, ID. 72 pp.

Howell, P.J. and D.V. Buchanan, eds. 1992. Proceedings of the Gearhart Mountain bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis, OR. 72 pp.

Howell, P. J., J. B. Dunham, and P. M. Sankovich. 2009. Relationships between water temperatures and upstream migration, cold water refuge use, and spawning of adult bull trout from the Lostine River, Oregon, USA. Published in 2009: Ecology of Freshwater Fish 2010:19: 96-106. Malaysia. 11 pp.

Hudson, J. M., R. Koch, J. Johnson, J. Harris, M. L. Koski, B. Galloway, and J. D. Williamson. 2015. Clackamas River Bull Trout Reintroduction Project, 2014 Annual Report. Oregon Department of Fish and Wildlife and U.S. Fish and Wildlife Service, 33 pp.

[IDFG] High, B, Meyer, K., Schill, D., and E. Mamer. 2005. Bull trout status review and assessment in the State of Idaho. Grant #F-73-R-27. Idaho Department of Fish and Game. 57pp.

[IDFG] High, B, Meyer, K., Schill, D., and E. Mamer. 2008. Distribution, abundance, and population trends of bull trout in Idaho. North American Journal of Fisheries Management 28:1687-1701.

IPCC (Intergovernmental Panel on Climate Change). 2007. Climate change 2007: the physical science basis. Available: www.ipcc.ch. (February 2007). 1007 pp.

ISAB (Independent Scientific Advisory Board). 2007. Climate change impacts on Columbia River basin fish and wildlife. ISAB 2007-2. Portland, Oregon. 2007. 146 pp.

Johnson, L. 1990. State of Nevada, Department of Wildlife, Bull trout management plan. State of Nevada statewide Fisheries Program, project number F-20-26, Job number 2017.4. 17 pp.

Leary, R.F. and F.W. Allendorf. 1997. Genetic confirmation of sympatric bull trout and Dolly Varden in western Washington. Transactions of the American Fisheries Society 126:715-720. 6 pp.

Leary, R.F., F.W. Allendorf, and S.H. Forbes. 1993. Conservation genetics of bull trout in the Columbia and Klamath River drainages. Conservation Biology [CONSERV. BIOL.] 7:856-865.

Leathe, S.A. and P. Graham. 1982. Flathead Lake Fish Food Habits Study. Environmental Protection Agency, through Steering Committee for the Flathead River Basin Environmental Impact Study. 208 pp.

Light, J., L. Herger, and M. Robinson. 1996. Upper Klamath basin bull trout conservation strategy, a conceptual framework for recovery. Part one. The Klamath Basin Bull Trout Working Group. 88 pp.

Magnuson, J.J., Robertson, D.M., Benson, B.J., Wynne, R.H., Livingstone, D.M., Arai, T., Assel, R.A., Barry, R.G., Card, V., Kuusisto, E., Granin, N.G., Prowse, T.D., Stewart, K.M., and Vuglinski, V.S. 2000. Historical trends in lake and river cover in the Northern Hemisphere. Science 289:1743-1746. 5 pp.

Martinez, P. J., P. E. Bigelow, M. A. Deleray, W. A. Fredenberg, B. S. Hansen, N. J. Horner, S. K. Lehr, R. W. Schneidervin, S. A. Tolentino, and A. E. Viola. 2009. Western lake trout woes. Fisheries 34:424-442.

MBTSG (Montana Bull Trout Scientific Group). 1995a. Upper Clark Fork River drainage bull trout status report (including Rock Creek). Prepared for Montana Bull Trout Restoration Team. Helena, Montana. 46 pp.

______. 1995b. Bitterroot River drainage bull trout status report. Prepared for Montana Bull Trout Restoration Team. Helena, Montana. 34 pp.

______. 1995c. Blackfoot River drainage bull trout status report. Prepared for Montana Bull Trout Restoration Team. Helena, Montana. 43 pp.

______. 1995d. Flathead River drainage bull trout status report (including Flathead Lake, the North and Middle forks of the Flathead River and the Stillwater and Whitefish River). Prepared for Montana Bull Trout Restoration Team. Helena, Montana. 52 pp.

______. 1995e. South Fork Flathead River drainage bull trout status report (upstream of Hungry Horse Dam). Prepared for Montana Bull Trout Restoration Team. Helena, Montana. 43 pp.

______. 1996a. Swan River drainage bull trout status report (including Swan Lake). Prepared for Montana Bull Trout Restoration Team. Helena, Montana. 48 pp.

______. 1996b. Lower Clark Fork River drainage bull trout status report (Cabinet Gorge Dam to Thompson Falls). Prepared for Montana Bull Trout Restoration Team. Helena, Montana. 43 pp.

______. 1996c. Middle Clark Fork River drainage bull trout status report (from Thompson Falls to Milltown, including the lower Flathead River to Kerr Dam). Prepared for Montana Bull Trout Restoration Team. Helena, Montana. 31 pp.

______. 1996d. Lower Kootenai River drainage bull trout status report (below Kootenai Falls). Prepared for Montana Bull Trout Restoration Team. Helena, Montana. 39 pp.

______. 1996e. Middle Kootenai River drainage bull trout status report (between Kootenai Falls and Libby Dam). Prepared for Montana Bull Trout Restoration Team. Helena, Montana. 27 pp.

______. 1996f. Upper Kootenai River drainage bull trout status report (including Lake Koocanusa, upstream of Libby Dam). Prepared for Montana Bull Trout Restoration Team. Helena, Montana. 31 pp.

______. 1998. The relationship between land management activities and habitat requirements of bull trout. Prepared for Montana Bull Trout Restoration Team. Helena, Montana. 86 pp.

McIntosh, B.A., J.R. Sedell, J.E. Smith, R.C. Wissmar, S.E. Clarke, G.H. Reeves, and L.A. Brown. 1994. Management history of eastside ecosystems: Changes in fish habitat over 50 years, 1935 to 1992. U.S. Forest Service, Pacific Northwest Research Station, General Technical Report. PNW-GTR 321. 62 pp.

Meeuwig, M., C. S. Guy, S. T. Kalinowski, and W. Fredenberg. 2010. Landscape influences on genetic differentiation among bull trout populations in a stream-lake network. Molecular Ecology 19:3620-3633.

Minckley, W. L., D. A. Henrickson, and C. E. Bond. 1986. Geography of western North American freshwater fishes: description and relationships to intracontinental tectonism. Pages 519-613 *in* C. H. Hocutt and E. O. Wiley, editors. The zoogeography of North American freshwater fishes. Wiley and Sons, New York.

McPhail, J.D., and J.S. Baxter. 1996. A Review of Bull Trout (*Salvelinus confluentus*) Life-history and Habitat Use in Relation to Compensation and Improvement Opportunities. University of British Columbia. Fisheries Management Report #104. 37 pp.

Meehan, W.R. 1991. Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. American Fisheries Society Special Publication 19. 12 pp.

Meffe, G.K., and C.R. Carroll. 1994. Principles of conservation biology. Sinauer Associates, Inc. Sunderland, Massachusetts. 8 pp.

Mogen, J. 2013. Bull trout investigations in the Saint Mary River Drainage, Montana – 2010-2012 summary report. U.S. Fish and Wildlife Service Northern Rockies FWCO, Bozeman, Montana.

Mogen, J. T., and L. R. Kaeding. 2001. Population biology of bull trout (*Salvelinus confluentus*) in the Saint Mary River drainage, progress report 1997-2001. U.S. Fish and Wildlife Service, Bozeman, Montana.

Mogen, J. T., and L. R. Kaeding. 2005a. Identification and characterization of migratory and nonmigratory bull trout populations in the St. Mary River drainage, Montana. Transactions of the American Fisheries Society 134:841-852.

Mogen, J. T., and L.R. Kaeding. 2005b. Large-scale, seasonal movements of radiotagged, adult bull trout in the St. Mary River drainage, Montana and Alberta. Northwest Science 79(4):246-253.

Moore, T. 2006. Distribution and abundance of bull trout and redband trout in Leonard and Deming Creeks, July and August, 2005. Oregon Department of Fish and Wildlife. Corvallis, Oregon.

Myrick, C.A., F.T. Barrow, J.B. Dunham, B.L. Gamett, G.R. Haas, J.T. Peterson, B. Rieman, L.A. Weber, and A.V. Zale. 2002. Bull trout temperature thresholds:peer review summary. USFWS, Lacey, Washington, September 19, 2002. 14 pp

NPS (National Park Service). 1992. Value Analysis, Glacier National Park, Divide Creek. West Glacier, Montana.

Nehlsen, W., J. Williams, and J. Lichatowich. 1991. Pacific salmon at the crossroads: stocks at risk from California, Oregon, Idaho, and Washington. Fisheries 16(02):4-21. 20 pp.

Newton, J.A., and S. Pribyl. 1994. Bull trout population summary: Lower Deschutes River subbasin. Oregon Department of Fish and Wildlife, The Dalles, Oregon. Oregon administrative rules, proposed amendments to OAR 340-41-685 and OAR 340-41-026. January 11, 1996. 18 pp.

ODEQ (Oregon Department of Environmental Quality). 1995. National pollution discharge elimination system permit evaluation report. Facility Bourne Mining Corporation. December 11, 2003. File number 11355. 8pp.

ODFW (Oregon Department of Fish and Wildlife). 2012. Klamath watershed fish district stock status report, September 2012. ODFW, Klamath Falls, Oregon.

Porter, M. and M. Nelitz. 2009. A future outlook on the effects of climate change on bull trout (*Salvelinus confluentus*) habitats in the Cariboo-Chilcotin. Prepared by ESSA Technologies Ltd.for Fraser Salmon and Watersheds Program, B.C. Ministry of Environment, and Pacific Fisheries Resource Conservation Council. 10 pp.

Pratt, K.L. 1985. Pend Oreille trout and char life history study. Idaho Department of Fish and Game, Boise, Idaho. 74 pp.

Pratt, K.L. 1992. A Review of bull trout life history. 00. 5-9. In Proceedings of the Gearhart Mountain Bull Trout Workshop, ed. Howell, P.J. and D.V. Buchanan. Gearhart Mountain, OR. Corvallis, OR: Oregon Chapter of the American Fisheries Society. August 1992. 8 pp.

Pratt, K.L., and J.E. Huston. 1993. Status of bull trout (*Salvelinus confluentus*) in Lake Pend Oreille and the lower Clark Fork River: (draft report) Prepared for the WWPC, Spokane, WA. 200 pp.

Quinn, T. P. 2005. The behavior and ecology of pacific salmon and trout. 2005. University of Washington Press. 1st edition. 9 pp.

Ratliff, D.E., and P.J. Howell. 1992. The status of bull trout populations in Oregon. Pages 10-17 in: P.J. Howell and D.V. Buchanan (eds). Proceedings of the Gearhart Mountain bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis. 8 pp.

Redenbach, Z., and E. B. Taylor. 2002. Evidence for historical introgression along a contact zone between two species of char (Pisces: Salmonidae) in northwestern North America. Evolution 56:1021-1035.

Rich, C.F., Jr. 1996. Influence of abiotic and biotic factors on occurrence of resident bull trout in fragmented habitats, western Montana. MS thesis, Montana State University, Bozeman, MT. 60 pp.

Rieman, B.E., and J.D. McIntyre. 1993. Demographic and habitat requirements of bull trout *Salvelinus confluentus*. General Technical Report INT-GTR- 302. U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, Utah. 42 pp.

Rieman, B.E., and J.D. McIntyre. 1995. Occurrence of bull trout in naturally fragmented habitat patches of varied size. Transactions of the American Fisheries Society 124:285-296. 12 pp.

Rieman, B.E. and J.D. McIntyre. 1996. Spatial and temporal variability in bull trout redd counts. North American J. of Fisheries Manage. 16: 132-146. 10pp.

Rieman, B., and J. Clayton. 1997. Wildfire and native fish: Issues of forest health and conservation of sensitive species. Fisheries 22:6-14. 10 pp.

Rieman, B.E., and J.B. Dunham. 2000. Metapopulations and salmonids: a synthesis of life history patterns and empirical observations. Ecology of Freshwater Fish 9:51-64. 14 pp.

Rieman, B.E., D. Isaak, S. Adams, D. Horan, D. Nagel, C. Luce, D. Myers. 2007. Anticipated Climate Warming Effects on Bull Trout Habitats and Populations Across the Interior Columbia River Basin. Transactions of the American Fisheries Society. 136:1552-1565. 16 pp.

Rode, M. 1990. Bull trout, *Salvelinus confluentus suckley*, in the McCloud River: status and recovery recommendations. Administrative Report Number 90-15. California Department of Fish and Game, Sacramento, California. 44 pp.

Saunders, D.A., R.J. Hobbs, and C.R. Margules. 1991. Biological consequences of ecosystem fragmentation: A review. Conservation Biology 5:18-32. 15 pp.

Schill, D.J. 1992. River and stream investigations. Job Performance Report, Project F-73-R-13. Idaho Department of Fish and Game, Boise, Idaho. 66 pp.

Sedell, J.R. and F.H. Everest. 1991. Historic changes in poll habitat for Columbia River Basin salmon under study for TES listing. Draft USDA Report. Pacific Northwest Research Station. Corvallis, OR. 6 pp.

Sexauer, H.M., and P.W. James. 1997. Microhabitat Use by Juvenile Trout in Four Streams Located in the Eastern Cascades, Washington. Pages 361-370 in W.C. Mackay, M.K. Brown and M. Monita (eds.). Friends of the Bull Trout Conference Proceedings. Bull Trout Task Force (Alberta), c/o Trout Unlimited Calgary, Canada. 10 pp.

Shively, D., C. Allen, T. Alsbury, B. Bergamini, B. Goehring, T. Horning and B. Strobel. 2007.

Clackamas River bull trout reintroduction feasibility assessment. Sandy, Oregon, Published by USDA Forest ervice, Mt. Hood National Forest for the Clackamas River Bull Trout Working Group.

Shuter, B.J., and Meisner, J.D. 1992. Tools for assessing the impact of climate change on freshwater fish populations. GeoJournal 28(1):7-20. 22 pp.

Simpson, J.C., and R.L. Wallace. 1982. Fishes of Idaho. University Press of Idaho. Moscow, ID. 5 pp.

Smillie, G. M., and D. Ellerbroek. 1991. Flood hazard evaluation for Divide and Wild creeks, Glacier National Park. Technical Report NPS/NRWRD/NRTR-91/02. Water Resources Division, National Park Service, Fort Collins, Colorado.

Spruell, P., B.E. Rieman, K.L. Knudsen, F.M. Utter, and F.W. Allendorf. 1999. Genetic population structure within streams: microsatellite analysis of Bull trout populations. Ecology of Freshwater Fish 8:114-121. 8 pp.

Spruell P., A.R. Hemmingsen, P.J. Howell, N. Kanda1 and F.W. Allendorf. 2003. Conservation genetics of bull trout: Geographic distribution of variation at microsatellite loci. Conservation Genetics 4: 17–29. 14 pp.

Stewart, D.B., N.J. Mochnacz, C.D. Sawatzky, T.J. Carmichael, and J.D. Reist. 2007. Fish life history and habitat use in the Northwest territories: Bull trout (*Salvelinus confluentus*). Canadian Manuscript Report of Fisheries and Aquatic Sciences 2801. Department of Fisheries and Oceans, Winnipeg, MB, Canada, 2007, 54 pp.

Taylor, B.E., S. Pollard, and D. Louie. 1999. Mitochondrial DNA variation in bull trout (*Salvelinus confluentus*) from northwestern North America: implications for zoogeography and conservation. Molecular Ecology 8:1155-1170. 16 pp.

Thomas, G. 1992. Status of bull trout in Montana. Report prepared for Montana Department of Fish, Wildlife and Parks, Helena, Montana. 108 pp.

USDA (U.S. Department of Agriculture), and USDI (U.S. Department of the Interior). 1995. Decision Notice/Decision Record Finding of No Significant Impact, Environmental Assessment for the Interim Strategies for Managing Anadromous Fish-producing Watersheds in Eastern Oregon, and Washington, Idaho, and portions of California (PACFISH). 211 pp.

USFWS (U.S. Fish and Wildlife Service). 1996. Policy Regarding the Recognition of Distinct Vertebrate Population Segments under the Endangered Species Act. Federal Register Vol. 61 4722-4725.

______. 1998. Determination of threatened status for the Klamath River and Columbia River distinct population segments of bull trout. Federal Register Vol. 63 31647-31674. 28 pp.

______. 1999. Determination of threatened status for bull trout in the coterminous United States; Final Rule. Federal Register Vol. 64 58190-58933. 25 pp.

______. 2002a. Bull trout (*Salvelinus confluentus*) draft recovery plan - Chapter 1: Introduction. U.S. Fish and Wildlife Service, Portland, Oregon, October, 2002, 137 pp.

______. 2002b. Bull trout (*Salvelinus confluentus*) draft recovery plan - chapter 2 Klamath River. U.S. Fish and Wildlife Service, Portland, Oregon. 93 pp.

______. 2004. Draft Recovery Plan for the Coastal-Puget Sound Distinct Population Segment of Bull Trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Portland, Oregon. 297 pp.

______. 2008a. Bull trout (*Salvelinus confluentus*) 5-year review: summary and evaluation. Portland, Oregon. 55 pp.

______. 2008b. Bull trout draft core area templates - complete core area by core area analysis. W. Fredenberg and J. Chan, editors. U. S. Fish and Wildlife Service. Portland, Oregon. 1,895 pages.

______. 2010. Revised designation of critical habitat for bull trout in the coterminous United States. Federal Register Vol 75, No. 200. 63898-64070.

______. 2015. Recovery plan for the coterminous United States population of bull trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Portland, Oregon. xii + 179 pp.

______. 2015a. Coastal recovery unit implementation plan for bull trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Lacey, Washington, and Portland, Oregon. 155 pp.

______. 2015b. Klamath recovery unit implementation plan for bull trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Klamath Falls, Oregon. 35 pp.

______. 2015c. Mid-Columbia recovery unit implementation plan for bull trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Portland, Oregon. 345 pp.

______. 2015d. Columbia headwaters recovery unit implementation plan for bull trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Kalispell, Montana, and Spokane, Washington. 179 pp.

______. 2015e. Upper Snake recovery unit implementation plan for bull trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Boise, Idaho. 113 pp.

______. 2015f. St. Mary recovery unit implementation plan for bull trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Kalispell, Montana. 30 pp.

Watson, G., and T.W. Hillman. 1997. Factors affecting the distribution and abundance of bull trout: and investigation at hierarchical scales. North American Journal of Fisheries Management 17:237-252. 16 pp.

WDFW (Washington Department of Fish and Wildlife), FishPro Inc., and Beak Consultants. 1997. Grandy Creek trout hatchery biological assessment. March 1997. Olympia,Washington

WDFW. 1998. Washington State Salmonid Stock Inventory - Bull Trout/Dolly Vardin. 444 pp.

WDOE (Washington Department of Ecology). 2002. Evaluating criteria for the protection of freshwater aquatic life in Washington's surface water quality standards - dissolved oyxgen: Draft discussion paper and literature summary. Publication Number 00-10-071. Washington Department of Ecology, Olympia, WA, 90 pp.

Whiteley, A.R., P. Spruell, F.W. Allendorf. 2003. Population Genetics of Boise Basin Bull Trout (*Salvelinus confluentus*). University of Montana, Division of Biological Sciences. Report to the U.S. Forest Service, Rocky Mountain Research Station, Boise, ID. 37 pp.

Whitesel, T. A., J. Brostrom, T. Cummings, J. Delavergne, W. Fredenberg, H. Schaller, P. Wilson, and G. Zydlewski. 2004. Bull trout recovery planning: a review of the science associated with population structure and size. Science team report #2004-01, U.S. Fish and Wildlife Service, Portland, Oregon. 68 pp.

Wissmar, R., J. Smith, B. McIntosh, H. Li, G. Reeves, and J. Sedell. 1994. A history of resource use and disturbance in riverine basins of eastern Oregon and Washington (early 1800s-1990s). Northwest Science 68:1-35. 18 pp.

Ziller, J.S. 1992. Distribution and relative abundance of bull trout in the Sprague River subbasin, Oregon. Pages 18-29 in Howell, P.J. and D.V. Buchanan, editors. Proceedings of the Gearhart Mountain bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis, OR. 12 pp.

APPENDIX G

Status of Designated Critical Habitat: Bull Trout

Past designations of critical habitat have used the terms "primary constituent elements" (PCEs), “physical and biological features” (PBFs) or "essential features" to characterize the key components of critical habitat that provide for the conservation of the listed species. The new critical habitat regulations (81 FR 7214) discontinue use of the terms “PCEs” or “essential features” and rely exclusively on use of the term PBFs for that purpose because that term is contained in the statute. To be consistent with that shift in terminology and in recognition that the terms PBFs, PCEs, and essential habit features are synonymous in meaning, we are only referring to PBFs herein. Therefore, if a past critical habitat designation defined essential habitat features or PCEs, they will be referred to as PBFs in this document. This does not change the approach outlined above for conducting the ‘‘destruction or adverse modification’’ analysis, which is the same regardless of whether the original designation identified PCEs, PBFs or essential features.

Current Legal Status of the Critical Habitat

Current Designation

The U.S. Fish and Wildlife Service (Service) published a final critical habitat designation for the coterminous United States population of the bull trout on October 18, 2010 (USFWS 2010, entire); the rule became effective on November 17, 2010. A justification document was also developed to support the rule and is available on the Service’s website: (http://www.fws.gov/pacific/bulltrout). The scope of the designation involved the species’ coterminous range, which includes the Coastal, Klamath, Mid-Columbia, Upper Snake, Columbia Headwaters and St. Mary’s Recovery Unit population segments. Rangewide, the Service designated reservoirs/lakes and stream/shoreline miles as bull trout critical habitat (Table 1). Designated bull trout critical habitat is of two primary use types: 1) spawning and rearing, and 2) foraging, migration, and overwintering (FMO).

Table 1. Stream/Shoreline Distance and Reservoir/Lake Area Designated as Bull Trout Critical Habitat.

State	Stream/Shoreline Miles	Stream/Shoreline Kilometers	Reservoir/ Lake Acres	Reservoir/ Lake Hectares
Idaho	8,771.6	14,116.5	170,217.5	68,884.9
Montana	3,056.5	4,918.9	221,470.7	89,626.4
Nevada	71.8	115.6	-	-
Oregon[1]	2,835.9	4,563.9	30,255.5	12,244.0
Oregon/Idaho[2]	107.7	173.3	-	-
Washington	3,793.3	6,104.8	66,308.1	26,834.0
Washington (marine)	753.8	1,213.2	-	-
Washington/Idaho	37.2	59.9	-	-
Washington/Oregon	301.3	484.8	-	-
Total[3]	19,729.0	31,750.8	488,251.7	197,589.2

[1] No shore line is included in Oregon
[2] Pine Creek Drainage which falls within Oregon
[3] Total of freshwater streams: 18,975

The 2010 revision increases the amount of designated bull trout critical habitat by approximately 76 percent for miles of stream/shoreline and by approximately 71 percent for acres of lakes and reservoirs compared to the 2005 designation.

The final rule also identifies and designates as critical habitat approximately 1,323.7 km (822.5 miles) of streams/shorelines and 6,758.8 ha (16,701.3 acres) of lakes/reservoirs of unoccupied habitat to address bull trout conservation needs in specific geographic areas in several areas not occupied at the time of listing. No unoccupied habitat was included in the 2005 designation. These unoccupied areas were determined by the Service to be essential for restoring functioning migratory bull trout populations based on currently available scientific information. These unoccupied areas often include lower main stem river environments that can provide seasonally important migration habitat for bull trout. This type of habitat is essential in areas where bull trout habitat and population loss over time necessitates reestablishing bull trout in currently unoccupied habitat areas to achieve recovery.

The final rule continues to exclude some critical habitat segments based on a careful balancing of the benefits of inclusion versus the benefits of exclusion. Critical habitat does not include: 1) waters adjacent to non-Federal lands covered by legally operative incidental take permits for habitat conservation plans (HCPs) issued under section 10(a)(1)(B) of the Endangered Species Act of 1973, as amended (Act), in which bull trout is a covered species on or before the publication of this final rule; 2) waters within or adjacent to Tribal lands subject to certain commitments to conserve bull trout or a conservation program that provides aquatic resource protection and restoration through collaborative efforts, and where the Tribes indicated that inclusion would impair their relationship with the Service; or 3) waters where impacts to national security have been identified (USFWS 2010, p. 63903). Excluded areas are approximately 10 percent of the stream/shoreline miles and 4 percent of the lakes and reservoir acreage of designated critical habitat. Each excluded area is identified in the relevant Critical Habitat Unit

(CHU) text, as identified in paragraphs (e)(8) through (e)(41) of the final rule. It is important to note that the exclusion of waterbodies from designated critical habitat does not negate or diminish their importance for bull trout conservation. Because exclusions reflect the often complex pattern of land ownership, designated critical habitat is often fragmented and interspersed with excluded stream segments.

The Physical and Biological Features

Conservation Role and Description of Critical Habitat

The conservation role of bull trout critical habitat is to support viable core area populations (USFWS 2010, p. 63898). The core areas reflect the metapopulation structure of bull trout and are the closest approximation of a biologically functioning unit for the purposes of recovery planning and risk analyses. CHUs generally encompass one or more core areas and may include FMO areas, outside of core areas, that are important to the survival and recovery of bull trout.

Thirty-two CHUs within the geographical area occupied by the species at the time of listing are designated under the revised rule. Twenty-nine of the CHUs contain all of the physical or biological features identified in this final rule and support multiple life-history requirements. Three of the mainstem river units in the Columbia and Snake River Basins contain most of the physical or biological features necessary to support the bull trout's particular use of that habitat, other than those physical biological features associated with physical and biological features (PBFs) 5 and 6, which relate to breeding habitat.

The primary function of individual CHUs is to maintain and support core areas, which 1) contain bull trout populations with the demographic characteristics needed to ensure their persistence and contain the habitat needed to sustain those characteristics (Rieman and McIntyre 1993, p. 19); 2) provide for persistence of strong local populations, in part, by providing habitat conditions that encourage movement of migratory fish (MBTSG 1998, pp. 48-49; Rieman and McIntyre 1993, pp. 22-23); 3) are large enough to incorporate genetic and phenotypic diversity, but small enough to ensure connectivity between populations (Hard 1995, pp. 314-315; Healey and Prince 1995, p. 182; MBTSG 1998, pp. 48-49; Rieman and McIntyre 1993, pp. 22-23); and 4) are distributed throughout the historic range of the species to preserve both genetic and phenotypic adaptations (Hard 1995, pp. 321-322; MBTSG 1998, pp. 13-16; Rieman and Allendorf 2001, p. 763; Rieman and McIntyre 1993, p. 23).

Physical and Biological Features for Bull Trout

Within the designated critical habitat areas, the PBFs for bull trout are those habitat components that are essential for the primary biological needs of foraging, reproducing, rearing of young, dispersal, genetic exchange, or sheltering. Based on our current knowledge of the life history, biology, and ecology of this species and the characteristics of the habitat necessary to sustain its essential life-history functions, we have determined that the PBFs, as described within USFWS 2010, are essential for the conservation of bull trout. A summary of those PBFs follows.

1. Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia.

2. Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers.
3. An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.
4. Complex river, stream, lake, reservoir, and marine shoreline aquatic environments, and processes that establish and maintain these aquatic environments, with features such as large wood, side channels, pools, undercut banks and unembedded substrates, to provide a variety of depths, gradients, velocities, and structure.
5. Water temperatures ranging from 2 °C to 15 °C, with adequate thermal refugia available for temperatures that exceed the upper end of this range. Specific temperatures within this range will depend on bull trout life-history stage and form; geography; elevation; diurnal and seasonal variation; shading, such as that provided by riparian habitat; streamflow; and local groundwater influence.
6. In spawning and rearing areas, substrate of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount of fine sediment, generally ranging in size from silt to coarse sand, embedded in larger substrates, is characteristic of these conditions. The size and amounts of fine sediment suitable to bull trout will likely vary from system to system.
7. A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, minimal flow departure from a natural hydrograph.
8. Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.
9. Sufficiently low levels of occurrence of non-native predatory (e.g., lake trout, walleye, northern pike, smallmouth bass); interbreeding (e.g., brook trout); or competing (e.g., brown trout) species that, if present, are adequately temporally and spatially isolated from bull trout.

The revised PBF's are similar to those previously in effect under the 2005 designation. The most significant modification is the addition of a ninth PBF to address the presence of nonnative predatory or competitive fish species. Although this PBF applies to both the freshwater and marine environments, currently no non-native fish species are of concern in the marine environment, though this could change in the future.

Note that only PBFs 2, 3, 4, 5, and 8 apply to marine nearshore waters identified as critical habitat. Also, lakes and reservoirs within the CHUs also contain most of the physical or biological features necessary to support bull trout, with the exception of those associated with PBFs 1 and 6. Additionally, all except PBF 6 apply to FMO habitat designated as critical habitat.

Critical habitat includes the stream channels within the designated stream reaches and has a lateral extent as defined by the bankfull elevation on one bank to the bankfull elevation on the opposite bank. Bankfull elevation is the level at which water begins to leave the channel and move into the floodplain and is reached at a discharge that generally has a recurrence interval of 1 to 2 years on the annual flood series. If bankfull elevation is not evident on either bank, the ordinary high-water line must be used to determine the lateral extent of critical habitat. The lateral extent of designated lakes is defined by the perimeter of the waterbody as mapped on standard 1:24,000 scale topographic maps. The Service assumes in many cases this is the full-pool level of the waterbody. In areas where only one side of the waterbody is designated (where only one side is excluded), the mid-line of the waterbody represents the lateral extent of critical habitat.

In marine nearshore areas, the inshore extent of critical habitat is the mean higher high-water (MHHW) line, including the uppermost reach of the saltwater wedge within tidally influenced freshwater heads of estuaries. The MHHW line refers to the average of all the higher high-water heights of the two daily tidal levels. Marine critical habitat extends offshore to the depth of 10 meters (m) (33 ft) relative to the mean low low-water (MLLW) line (zero tidal level or average of all the lower low-water heights of the two daily tidal levels). This area between the MHHW line and minus 10 m MLLW line (the average extent of the photic zone) is considered the habitat most consistently used by bull trout in marine waters based on known use, forage fish availability, and ongoing migration studies and captures geological and ecological processes important to maintaining these habitats. This area contains essential foraging habitat and migration corridors such as estuaries, bays, inlets, shallow subtidal areas, and intertidal flats.

Adjacent shoreline riparian areas, bluffs, and uplands are not designated as critical habitat. However, it should be recognized that the quality of marine and freshwater habitat along streams, lakes, and shorelines is intrinsically related to the character of these adjacent features, and that human activities that occur outside of the designated critical habitat can have major effects on physical and biological features of the aquatic environment.

Activities that cause adverse effects to critical habitat are evaluated to determine if they are likely to "destroy or adversely modify" critical habitat by no longer serving the intended conservation role for the species or retaining those PBFs that relate to the ability of the area to at least periodically support the species. Activities that may destroy or adversely modify critical habitat are those that alter the PBFs to such an extent that the conservation value of critical habitat is appreciably reduced (USFWS 2010, pp. 63898:63943; USFWS 2004a, pp. 140-193; USFWS 2004b, pp. 69-114). The Service's evaluation must be conducted at the scale of the entire critical habitat area designated, unless otherwise stated in the final critical habitat rule (USFWS and NMFS 1998, Ch. 4 p. 39). Thus, adverse modification of bull trout critical habitat is evaluated at the scale of the final designation, which includes the critical habitat designated for the Klamath River, Jarbidge River, Columbia River, Coastal-Puget Sound, and Saint Mary-Belly River population segments. However, we consider all 32 CHUs to contain features or areas essential to the conservation of the bull trout (USFWS 2010, pp. 63898:63901, 63944). Therefore, if a proposed action would alter the physical or biological features of critical habitat to an extent that appreciably reduces the conservation function of one or more critical habitat units for bull trout, a finding of adverse modification of the entire designated critical habitat area may be warranted (USFWS 2010, pp. 63898:63943).

Current Critical Habitat Condition Rangewide

The condition of bull trout critical habitat varies across its range from poor to good. Although still relatively widely distributed across its historic range, the bull trout occurs in low numbers in many areas, and populations are considered depressed or declining across much of its range (Ratliff and Howell 1992, entire; Schill 1992, p. 40; Thomas 1992, p. 28; Buchanan et al. 1997, p. vii; Rieman et al. 1997, pp. 15-16; Quigley and Arbelbide 1997, pp. 1176-1177). This condition reflects the condition of bull trout habitat. The decline of bull trout is primarily due to habitat degradation and fragmentation, blockage of migratory corridors, poor water quality, past fisheries management practices, impoundments, dams, water diversions, and the introduction of nonnative species (USFWS 1998, pp. 31648-31649; USFWS 1999, p. 17111).

There is widespread agreement in the scientific literature that many factors related to human activities have impacted bull trout and their habitat, and continue to do so. Among the many factors that contribute to degraded PBFs, those which appear to be particularly significant and have resulted in a legacy of degraded habitat conditions are as follows: 1) fragmentation and isolation of local populations due to the proliferation of dams and water diversions that have eliminated habitat, altered water flow and temperature regimes, and impeded migratory movements (Dunham and Rieman 1999, p. 652; Rieman and McIntyre 1993, p. 7); 2) degradation of spawning and rearing habitat and upper watershed areas, particularly alterations in sedimentation rates and water temperature, resulting from forest and rangeland practices and intensive development of roads (Fraley and Shepard 1989, p. 141; MBTSG 1998, pp. ii - v, 20-45); 3) the introduction and spread of nonnative fish species, particularly brook trout and lake trout, as a result of fish stocking and degraded habitat conditions, which compete with bull trout for limited resources and, in the case of brook trout, hybridize with bull trout (Leary et al. 1993, p. 857; Rieman et al. 2006, pp. 73-76); 4) in the Coastal-Puget Sound region where amphidromous bull trout occur, degradation of mainstem river FMO habitat, and the degradation and loss of marine nearshore foraging and migration habitat due to urban and residential development; and 5) degradation of FMO habitat resulting from reduced prey base, roads, agriculture, development, and dams.

Effects of Climate Change on Bull Trout Critical Habitat

One objective of the final rule was to identify and protect those habitats that provide resiliency for bull trout use in the face of climate change. Over a period of decades, climate change may directly threaten the integrity of the essential physical or biological features described in PBFs 1, 2, 3, 5, 7, 8, and 9. Protecting bull trout strongholds and cold water refugia from disturbance and ensuring connectivity among populations were important considerations in addressing this potential impact. Additionally, climate change may exacerbate habitat degradation impacts both physically (e.g., decreased base flows, increased water temperatures) and biologically (e.g., increased competition with non-native fishes).

Many of the PBFs for bull trout may be affected by the presence of toxics and/or increased water temperatures within the environment. The effects will vary greatly depending on a number of factors which include which toxic substance is present, the amount of temperature increase, the likelihood that critical habitat would be affected (probability), and the severity and intensity of any effects that might occur (magnitude).

The ability to assign the effects of gradual global climate change bull trout critical habitat or to a specific location on the ground is beyond our technical capabilities at this time.

LITERATURE CITED

Buchanan, D.V., M.L. Hanson, and R.M. Hooton. 1997. Status of Oregon's bull trout. Oregon Department of Fish and Wildlife. 168 pp.

Dunham, J.B. and B.E. Rieman. 1999. Metapopulation structure of bull trout: Influences of physical, biotic, and geometrical landscape characteristics. Ecological Applications 9:642-655. 15 pp.

Fraley, J.J., and B.B. Shepard. 1989. Life history, ecology and population status of migratory bull trout (*Salvelinus confluentus*) in the Flathead Lake and River System, Montana. Northwest Science 63(4):133-143.

Hard, J. 1995. A quantitative genetic perspective on the conservation of intraspecific diversity. American Fisheries Society Symposium 17: 304-326. 22 pp.

Healey, M.C. and A. Prince. 1995. Scales of variation in life history tactics of Pacific salmon and the conservation of phenotype and genotype. American Fisheries Society Symposium 17:176-84. 10 pp.

Leary, R.F., F.W. Allendorf, and S.H. Forbes. 1993. Conservation genetics of bull trout in the Columbia and Klamath River drainages. Conservation Biology [CONSERV. BIOL.] 7:856-865.

MBTSG (Montana Bull Trout Scientific Group). 1998. The relationship between land management activities and habitat requirements of bull trout. Prepared for Montana Bull Trout Restoration Team. Helena, Montana. 86 pp.

Quigley, T.M., and S.J. Arbelbide, tech. eds. 1997. An assessment of ecosystem components in the Interior Columbia Basin and portions of the Klamath and Great Basins: volume III. Gen. Tech. Rep. PNW-GTR-405. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 4 vol. 13 pp.

Ratliff, D.E., and P.J. Howell. 1992. The status of bull trout populations in Oregon. Pages 10-17 in: P.J. Howell and D.V. Buchanan (eds). Proceedings of the Gearhart Mountain bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis. 8 pp.

Rieman, B.E., and J.D. McIntyre. 1993. Demographic and habitat requirements of bull trout *Salvelinus confluentus*. General Technical Report INT-GTR- 302. U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, Utah. 42 pp.

Rieman, B.E., and F.W. Allendorf. 2001. Effective population size and genetic conservation criteria for bull trout. North American Journal of Fisheries Management 21:756-764. American Fisheries Society, Bethesda, Maryland. 10 pp.

Rieman, B.E., D.C. Lee and R.F. Thurow. 1997. Distribution, status and likely future trends of Bull trout within the Columbia River and Klamath River basins. North American Journal of Fisheries Management 17:1111-1125. 48 pp.

Rieman, B.E., J.T. Peterson and D.L. Myers. 2006. Have brook trout (*Salvelinus fontinalis*) displaced bull trout (*Salvelinus confluentus*) along longitudinal gradients in central Idaho streams? Canadian Journal of Fisheries and Aquatic Sciences. Vol. 63, No. 1, pp. 63–78. 16 pp.

Schill, D.J. 1992. River and stream investigations. Job Performance Report, Project F-73-R-13. Idaho Department of Fish and Game, Boise, Idaho. 66 pp.

Thomas, G. 1992. Status of bull trout in Montana. Report prepared for Montana Department of Fish, Wildlife and Parks, Helena, Montana. 108 pp.

USFWS (U.S. Fish and Wildlife Service) and NMFS (National Marine Fisheries Service). 1998. Consultation handbook: procedures for conducting consultation and conference activities under Section 7 of the Endangered Species Act. 315pp.

USFWS (U.S. Fish and Wildlife Service). 1998. Determination of threatened status for the Klamath River and Columbia River distinct population segments of bull trout. Federal Register Vol. 63 31647-31674. 28 pp.

______. 1999. Determination of threatened status for bull trout for the Jarbidge River population segment of bull trout. Federal Register Vol. 64 17110-17125. 16 pp.

______. 2004a. Draft Recovery Plan for the Coastal-Puget Sound Distinct Population Segment of Bull Trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Portland, Oregon. 297 pp.

______. 2004b. Draft Recovery Plan for the Jarbidge Distinct Population Segment of Bull Trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Portland, Oregon. 148 pp.

______. 2010. Revised designation of critical habitat for bull trout in the coterminous United States. Federal Register Vol 75, No. 200. 63898-64070.