United States Department of the Interior
FISH AND WILDLIFE SERVICE
Washington Fish and Wildlife Office
510 Desmond Dr. S.E., Suite 102
Lacey, Washington 98503

In Reply Refer To:
13410-2009-F-0388-R001
X Ref: 13410-2009-F-0388
X Ref: 01EWFW00-2014-F-0055

June 24, 2020

Kelly Lawrence, Forest Supervisor
Olympic National Forest
1835 Black Lake Blvd.
Olympia, Washington 98512-5623

Dear Ms. Lawrence:

This letter transmits the U.S. Fish and Wildlife Service's (USFWS) Biological Opinion (Opinion) addressing Forest Management Activities on the Olympic National Forest (Forest), in response to the Forest's request for reinitiation of formal consultation on the USFWS's 2013 Biological Opinion (USFWS Ref: 13410-2009-F-0388) addressing selected Programmatic Forest Management Activities. The enclosed Opinion addresses effects to the threatened northern spotted owl (*Strix occidentalis caurina*) (spotted owl) and its designated critical habitat, the threatened marbled murrelet (*Brachyramphus marmoratus*) (murrelet) and its designated critical habitat, and the threatened bull trout (*Salvelinus confluentus*) and its designated critical habitat in accordance with section 7(a)(2) of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*). We received your request for reinitiation of formal consultation on March 11, 2020.

The enclosed Opinion is based on information provided in the Forest's 2009 and 2019 Biological Assessments, our 2013 Opinion, and other sources of information. A complete record of this consultation is on file at the USFWS Washington Fish and Wildlife Office in Lacey, Washington.

We appreciate the good working relationship we have with the Olympic National Forest staff and line officers and we look forward to continued collaboration to enhance conservation outcomes under the Northwest Forest Plan over the years ahead. If you have any questions regarding the enclosed Opinion or our joint responsibilities under the Endangered Species Act, please contact Carolyn Scafidi (carolyn_scafidi@fws.gov; 360-753-4068) or Curtis Tanner (curtis_tanner@fws.gov; 360-753-4326).

Sincerely,

CURTIS TANNER

Digitally signed by CURTIS TANNER
Date: 2020.06.24 21:13:47 -07'00'

for Brad Thompson, State Supervisor
Washington Fish and Wildlife Office

Enclosures

cc:
Olympic National Forest, Olympia, WA (K. Senderak)

Endangered Species Act - Section 7 Consultation

BIOLOGICAL OPINION

U.S. Fish and Wildlife Service Reference:
13410-2009-F-0388-R001

Programmatic Forest Management Activities on the Olympic National Forest
June 15, 2020 to June 15, 2030

Olympic National Forest, Washington

Federal Action Agency:

U.S. Department of Agriculture
U.S. Forest Service

Consultation Conducted By:

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

CURTIS TANNER Digitally signed by CURTIS TANNER Date: 2020.06.24 21:17:00 -07'00'

for Brad Thompson, State Supervisor
Washington Fish and Wildlife Office

Date

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ACS	Aquatic Conservation Strategy
AMA	Adaptive Management Area
ARBO	Oregon-Washington Aquatic Restoration Biological Opinion
BA	Biological Assessment
BMP	Best Management Practices
CH	Critical Habitat
CHSU	Critical Habitat Subunit
CHU	Critical Habitat Unit
CM	Conservation Measure
cy	cubic yard
dB	decibel
dBA	decibels (A-weighted)
dbh	Diameter at breast height
DPS	Distinct Population Segment
ECA	Equivalent Clearcut Area
ESA	Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et. seq*.)
FMO	foraging, migration, and overwintering
Forest Service	U.S. Forest Service
FSEIS	Final Supplemental Environmental Impact Statement
GC	glucocorticoids
GHG	Greenhouse Gas
GIS	geographic information system
Ha	hectare
HCP	Habitat Conservation Plan
IGDO	inter-gravel dissolved oxygen
IPCC	Intergovernmental Panel on Climate Change
LEQ	Equivalent Average Sound Level
LSR	Late Successional Reserve
MHHW	mean higher high-water
ML	Maintenance Levels
MOU	Memorandum of Understanding
murrelet	Marbled Murrelet
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
flying squirrel	northern flying squirrel
NWFP	Northwest Forest Plan
ONF	Olympic National Forest
Opinion	Biological Opinion

ACROYNMS AND ABBREVIATIONS

PCE	Primary Constituent Element
PCEF	Project Consistency Evaluation Form
PD	Project Descriptions
PDC	Project Design Criteria
PNT	Potential Nest Tree
PNW	Pacific Northwest Research Station
RD	relative density
REO	Regional Ecosystem Office
Recovery Plan	Revised Recovery Plan for the Northern Spotted Owl
RPM	Reasonable and Prudent Measures
RU	Coastal Recovery Unit
SEL	Sound Exposure Level
SNT	Suitable Nest Tree
SOSEA	Spotted Owl Special Emphasis Areas
spotted owl	Northern Spotted Owl
tpa	trees per acre
USFWS	U.S. Fish and Wildlife Service
WAC	Washington Administrative Code
WARSEM	Washington Road Surface Erosion Model
WDFW	Washington Department of Fish and Wildlife
WDNR	Washington State Department of Natural Resources

1 INTRODUCTION

This document presents the U.S. Fish and Wildlife Service's (USFWS) programmatic Biological Opinion (Opinion) based on our review of programmatic forest management activities and the effects to federally listed species within Olympic National Forest (ONF) in Washington. Those federally listed species include the threatened northern spotted owl (*Strix occidentalis caurina*) (spotted owl) and its designated critical habitat, the threatened marbled murrelet (*Brachyramphus marmoratus*) (murrelet) and its designated critical habitat, and the threatened bull trout (*Salvelinus confluentus*) and its designated critical habitat. This document has been prepared in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et. seq*.) (ESA). Effects to Taylor's checkerspot butterfly from certain forest management activities have been addressed separately in the 2016 Opinion for Habitat Improvement Projects for Taylor's Checkerspot Butterfly, Selected Forest Management Activities, and the Invasive Plant Treatment Program. Your request for reinitiation of consultation on the 2013 Opinion for Selected Programmatic Forest Management Activities (USFWS Reference number 13410-2009-F-0388) was received on March 11, 2020, and requested that the proposed action be amended to include Vegetation Management and associated activities.

This document is based on information provided in the June 18, 2009, Biological Assessment (BA) entitled *Programmatic Biological Assessment for Selected Forest Management Activities Olympic National Forest 2010-2019*, the September 14, 2019 BA for Vegetation Management and Associated Activities on the Olympic National Forest and other communications between our respective staffs. Copies of all correspondence regarding this consultation are on file at the USFWS' Washington Fish and Wildlife Office in Lacey, Washington.

2 CONSULTATION HISTORY

The USFWS completed a consultation (USFWS 1994) on Alternative 9 in the *Final 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* (FSEIS) (USDA and USDI 1994a). National Forest Plans and Bureau of Land Management Resource Area Plans were amended by the Record of Decision for *Amendments to Forest Service and Bureau of Land Management Planning Documents within the Range of the Northern Spotted Owl* (Northwest Forest Plan (NWFP)) (USDA and USDI 1994b).

In the Opinion for the NWFP, the USFWS determined that the adoption of the NWFP would not jeopardize the continued existence of listed species or result in adverse modification or destruction of designated critical habitat. However, because the NWFP is a range-wide management strategy, the USFWS did not quantify incidental take for site-specific management actions. Thus, incidental-take assessments were deferred to future consultations such as this one.

An assumption in the Opinion for the NWFP was that all future actions would be consistent with the NWFP. The USFWS assumes that all ONF projects are designed to be in compliance with the NWFP. Through Level 1 Team reviews, projects will be reviewed for compliance with the NWFP and existing programmatic consultations. We assume the ONF programmatic Biological Assessments (USFS 2009; USFS 2019 [BA]) on which this programmatic consultation is based and the actions covered by this consultation are consistent with all pertinent NWFP and Land and Resource Management Plan standards and guidelines, including the Aquatic Conservation Strategy of the NWFP (USDA and USDI 1994b).

On June 23, 2009, we received a programmatic BA and request from the ONF for formal and informal consultation on Selected Forest Management Activities conducted by the ONF and completed this consultation in 2013 (USFWS Reference Number 13410-2009-F-0388)(2013 Programmatic Opinion).

Between 2018 and 2020, the ONF and the USFWS collaborated to prepare for the ONF's request for reinitiation to extend the consultation period and to include additional activity categories such as commercial timber harvest. This revised Programmatic Opinion reflects information received throughout that period, with extensive discussion and email correspondence between the ONF and the USFWS regarding various aspects of the proposed action.

3 DESCRIPTION OF THE PROPOSED ACTION

3.1 Scope of Consultation

This document is a 10-year, multi-program consultation for activities expected to occur on lands administered by the ONF, including any right-of-way easements that the ONF has over State and other lands. It is a continuation of the multi-program consultation that occurred from 2013 to 2020 (13410-2009-F-0388), in addition to programmatic consultation for the ONF's restoration thinning program. This consultation is designed to address projects that have a similar design and occur repeatedly on the ONF. This programmatic consultation covers actions that are "not likely to adversely affect" (NLAA) and "likely to adversely affect" (LAA) spotted owls and spotted owl critical habitat, murrelets and murrelet critical habitat, and bull trout and bull trout critical habitat. The ONF requested that this programmatic consultation cover 10 years of program activities. Consequently, this Opinion addresses actions initiated between June 15, 2020, and June 15, 2030. Many of these activities may occur not just yearly for the period of ten years, but may take additional years to be fully completed.

3.2 Consultation Process and Monitoring

Section 7(a)(1) of the Endangered Species Act of 1973, as amended, requires Federal agencies to carry out their programs for the conservation of listed endangered and threatened species. Section 7(a)(2) of the ESA, as amended, also requires Federal agencies to review actions authorized, funded or carried out by them to ensure such actions do not jeopardize the continued existence of federally listed species, or result in the destruction or adverse modification of listed critical habitat. This consultation evaluates potential effects of specific management actions to three federally listed threatened species (spotted owl, marbled murrelet, bull trout) and their designated critical habitats.

Projects and activities implemented as a result of this consultation will avoid or minimize adverse effects to federally listed species and designated critical habitat. Table 1 presents how the USFWS and the ONF will process actions to be covered under this programmatic consultation. "PCEF" refers to the Project Consistency Evaluation Form used by the ONF to document consistency with this programmatic consultation and effects to listed species.

If a proposed project has a project description and conservation measures that do not strictly comply with the programmatic, the Level 1 team will determine whether the effects of that project are the same as those analyzed for the consultation. If the Level 1 team determines that the effects of the project do not exceed those analyzed for that activity category in this consultation, the project may be consulted on under this programmatic Opinion. If the Level 1 team determines that the project results in effects other than those analyzed for the consultation, a separate consultation is required.

The ONF shall monitor the implementation of this programmatic Opinion by keeping a record of the quantity of implemented projects by species in addition to all terms and conditions for monitoring incidental take. This information shall be sent electronically via a reporting form to the USFWS no later than February 15 of each year. The ONF also will update their record after project implementation to account for actual acres within disturbance distances and SNTs removed, on an annual basis. Additionally, annual monitoring of implementation and compliance of ongoing or recently completed projects will be conducted by the Level 1 Team, to be reported in annually scheduled meetings between the U.S. Forest Service (Forest Service) and USFWS[1].

At a minimum, the required Level 1 site visits for commercial thinning activities and rockpit development/expansion should ensure that:

- timber harvest occurring within low-quality foraging habitat will improve habitat conditions within treated stands
- rockpit expansion activities occurring adjacent to suitable habitat for murrelets or spotted owls do not exceed effects anticipated within this Biological Opinion
- activities occurring outside suitable habitat, but within historical spotted owl core areas or within 0.5 mile of murrelet occupancy records, do not exceed effects anticipated in this Biological Opinion
- hauling on unpaved roads within 200 feet of bull trout occupied streams will implement appropriate Best Management Practices (BMPs) so as to not exceed effects anticipated within this Biological Opinion

At a minimum, annual implementation and compliance meetings should address the following:

- Annual report results, including amount and form of take that occurred that reporting year
- Any advisable changes to PDCs, monitoring, or reporting requirements

[1] The frequency of annual reporting Level 1 meetings can be adjusted by agreement between Level 2 representatives.

Table 1. Consultation process for certain project types covered by this programmatic consultation.

Species and/or Critical Habitat Affected	**Project Type**	**Consultation Process**
Spotted Owl and/or Marbled Murrelet	Project is **LAA** for spotted owls or murrelets and has the potential to result in direct injury or mortality. These activities include: • **Felling Suitable Nest Trees (SNT) (including hazard and danger trees) during nesting seasons.** • **Blasting within 100 yards of suitable habitat during nesting seasons** • **Helicopter sling operations or helicopter landing zones located within 50 yards of suitable habitat during the nesting seasons** • **Commercial timber harvest within, or within 100 yards of, suitable habitat** Other activities that require PCEF review because the timing, location, and duration of the activities are not specified by Project Design Criteria's (PDC) include: • **New Road Construction** • **Temporary Road Construction** • **Commercial Timber Salvage Sales** • **Bridge Construction/Reconstruction** • **Patch removal for Large Wood Acquisition**	Forest Service emails PCEF for any project with the applicable activities to the USFWS for a 30-day assessment period. USFWS reviews PCEF (and project in the field, if desired), quantifies take (if appropriate), and signs for consistency. Removal or downgrading of foraging habitat within historic spotted owl territories requires an analysis of the impact of that removal to ensure that the overall percentage of habitat within the owl territory remains within accepted thresholds per Recovery Action 10 (USFWS 2011). The Level 1 Team has the option to recommend additional conservation measures for individual projects based on site-specific information. For commercial timber harvest activities and rockpit expansion that results in a LAA effect determination, a site visit by USFWS and Forest Service staff should be included. The USFWS enters PCEF information into the TAILS consultation database for tracking and compliance purposes.
	Project is **LAA** for spotted owls or murrelets due to anticipated noise and visual disturbance only, but the project is a routine forest management activity associated with maintenance of existing roads, trails, administrative facilities, etc.	Forest Service records the action in a reporting form for end-of-year reporting. See reporting paragraph below for details.

Table 1. Consultation process for certain project types covered by this programmatic consultation.

Species and/or Critical Habitat Affected	Project Type	Consultation Process
Bull Trout	Project has an applicable conservation measure requiring Level 1 review.	Forest Service emails PCEF to the USFWS for a 30-day assessment period. The USFWS reviews PCEF (and project in the field, if desired) and signs for consistency. The Level 1 Team has the option to recommend additional conservation measures for individual projects based on site-specific information.
	Project *does not* have an applicable conservation measure requiring Level 1 review.	Forest Service records the LAA actions in a database for end-of-year reporting. See reporting paragraph below for details.

3.3 Limitations and Assumptions

Only those activities that are described herein are covered by this consultation to the extent described. Projects that do not meet these descriptions, or exceed the extent described, will be addressed by separate consultations. Only ONF actions (including issuance of special use permits, easements, and right-of-ways) and cooperative projects in which the ONF plays a direct role in designing and implementing the project are covered under this consultation. Activities conducted on National Forest lands by any other agencies or groups or their contractors, permittees, licensees, lessees, grantees, or agents, where the ONF does not play a direct role in the project, are not covered by this consultation, and must be addressed in separate consultations by those respective agencies. The Federal action of the ONF issuing an easement or right-of-way may be covered as an interrelated and interdependent action through the consultation conducted with the other agencies regarding the larger action; for example, if Bonneville Power Administration consulted with the USFWS on expanding an existing powerline, the ONF would not have to complete additional consultation to issue a special use permit.

Non-federal activities over which the ONF has no control, such as unauthorized flights, illegal actions, emergency situations, and natural disasters are not addressed in this consultation. Emergency situations involving an act of nature, casualties, national defense or security emergencies, and response activities that must be taken to prevent imminent loss of human life or property will be consulted on separately, using the emergency consultation process (50 CFR §402.05).

3.4 Adaptive Approach

During the duration of this programmatic consultation, the USFWS and the ONF expect to gather additional information regarding projects, conservation measures, effects determinations, and communication processes. We expect to use that information to adjust our approach under this programmatic consultation to improve efficiency and enhance conservation. For instance, if we discover that more effective conservation measures can be employed, existing conservation measures may be replaced with improved ones following Level 1 agreement.

3.5 Process for Updating and Revising

Use of this document, monitoring of activities implemented under it, and new information may identify changes that are needed. When changes are substantial enough in number or content to warrant an update of this document, the ONF will work with the USFWS to amend the consultation as appropriate. The Level 1 Team will review and agree to the proposed changes. If additional species become listed under the ESA, the ONF will work with the USFWS to incorporate them into this consultation through reinitiation.

3.6 Compliance with the Northwest Forest Plan

The NWFP established a series of standards and guidelines for all activities on National Forest lands within the range of the spotted owl (USDA and USDI 1994b). Depending on the project and its location, compliance with the NWFP also may require completion of a Late-Successional Reserve (LSR) Assessment, Adaptive Management Area (AMA) Guide, Watershed Analysis, and/or approval of the project by the Regional Ecosystem Office (REO). Projects may be proposed in any of the land allocations designated by the NWFP: LSR, AMA, Matrix, Congressionally Withdrawn Areas, Administratively Withdrawn Areas, Riparian Reserve, or Key Watershed. All projects covered by this consultation will comply with the NWFP (USDA and USDI 1994b).

For a project to be consistent with the NWFP, it must, by definition, also be consistent with the Aquatic Conservation Strategy (USDA and USDI 1994b). Consistency with this strategy for projects covered under this programmatic consultation will be documented during the National Environmental Policy Act (NEPA) process.

3.7 Timing of Nesting Seasons

For this consultation, the early spotted owl nesting season (when most young are in the nest) is considered to be from March 1 to July 15, the late spotted owl nesting season (when most young have fledged) is from July 16 to September 30, and the entire marbled murrelet nesting season is from April 1 to September 23. Appendix A – *Marbled Murrelet Nesting Season and Analytical Framework for Section 7 Consultation in Washington*, presents support for the use of these dates for the murrelet nesting season.

3.8 Descriptions of Suitable Nest Trees

Table 2 presents the criteria by which we determine whether a tree is a SNT for spotted owls. Table 3 presents the criteria by which we determine whether a tree is an SNT for murrelets and Appendix B – *Guidance for Identifying Marbled Murrelet Nest Trees in Washington* is our recently completed guidance for identifying suitable marbled murrelet nest trees in Washington State.

Table 2. Description of a suitable nest tree for spotted owls in Olympic, Mt. Baker-Snoqualmie, and Gifford Pinchot National Forests.

A spotted owl SNT:

1. Is located in suitable nesting, roosting, or foraging habitat;
2. Is a conifer (alive or dead);
3. Is at least 18 inches dbh[1]; and
4. Either a) contains a nesting structure such as a broken top, cavity, nest of a large raptor, mistletoe broom, or branch platform large enough to support a spotted owl nest, or b) cannot be seen well enough to determine whether it contains such a nesting structure.

[1] Published research of spotted owl nest trees in Washington document nests in trees as small as 11 inches dbh. We anticipate that this 18-inch diameter-at-breast-height (dbh) threshold includes at least 99 percent of nest trees, thereby leaving a discountable number in smaller trees. Because the means in Table 2 supplement (below) were published as means and SEs (not means and SDs), we cannot estimate the smallest dbhs that included, for example, 99 percent of the samples.

Table 2 (supplement). Descriptive data of spotted owl nest trees in Washington

Area	Mean dbh (in.)	Mean dbh SE (in.)	Dbh range (in.)	*n*	Source
Eastern WA Cascades	26.2	10.1	11.0–61.0	85	Buchanan et al. (1993, pp. 2, 4)[2]
Eastern WA Ponderosa Pine	19.8	5.6	not provided	14	Buchanan and Irwin (1998, p. 37)[1]
Eastern WA Pine/Douglas-fir	23.9	6.1	not provided	31	Buchanan and Irwin (1998, p. 37)[1]
Eastern WA mixed conifer	24.3	7.8	not provided	19	Buchanan and Irwin (1998, p. 37)[1]
Olympic Peninsula (cavities)	55.8	2.4	11.9–149.2	99	Forsman and Giese (1997, p. 33)
Olympic Peninsula (platforms)	34.9	6.2		11	Forsman and Giese (1997, p. 33)
Olympic Peninsula	57.9	9.6	23.6–176.0	15	Hershey et al. (1998, p. 1403)
Western WA Cascades	74	7.8	47–115	10	WDNR (1997, p. IV-14)

[2] Buchanan et al. (1993) and Buchanan and Irwin (1998) reported results from the same nest trees.

Table 3. Description of a SNT for marbled murrelet in Olympic, Mt. Baker-Snoqualmie, and Gifford Pinchot National Forests.

A marbled murrelet SNT: 1. Is a live conifer at least 18 inches dbh that contains one or more platforms[1] located in the live crown of the tree 33 feet or more above the ground, and is within 55 miles of marine waters. 2. SNTs are located within or along the edges of old-growth, mature, or younger forested areas that provide both overstory (vertical) and adjacent (horizontal) canopy cover to platforms. Platform cover can be provided by branches and foliage within the live crown of the SNT.
[1] A platform is defined as any horizontal tree structure such as a limb, an area where a limb branches, or a surface created by a deformity such as a dwarf mistletoe broom, or a debris/moss platform or stick nest equal to or greater than 4 inches in diameter including associated moss, lichen, or duff if present (Hamer and Nelson 1995a, p. 74; Nelson and Wilson 2002, p. 59). The smallest nest tree documented within the listed range of the species to date was a 19-inch (48.3-cm) dbh, 107-foot tall western hemlock in Oregon (Nelson and Wilson 2002, p. 43). We have conservatively chosen the 18 inch dbh as a tree size indicator because suitable platforms are not uncommon in mature western hemlock trees of this size class.

Past surveys for SNTs by Forest Service staff within previously managed stands on the ONF found that Western hemlock and Western red cedar trees smaller than 28-inch DBH, and Douglas-fir and Sitka spruce trees smaller than 32-inch DBH had a lower likelihood of meeting the definition of a SNT given in Table 2, although not discountable.

3.9 Definitions

The proposed activities were analyzed, in part, using the following terms.

Contiguous habitat for spotted owls and marbled murrelets: Contiguous habitat is defined as suitable habitat greater than or equal to 5 acres in size, and all suitable habitat fragments larger than 2 acres and at least 300 feet in width that are located within 300 feet of any 5-acre patch of suitable habitat.

Disturbance distance: Consists of the distance from the project boundary outward that would potentially cause a spotted owl or murrelet, if one was present, to be distracted from its normal activity (Table 8 and Table 16).

Disruption distance: Consists of the distance from the project boundary outward that would potentially cause a spotted owl or murrelet, if one was present, to be distracted from its normal activity to such an extent as to significantly impact its normal behavior and create the likelihood of injury (harass). The disruption distance is a subset of the disturbance distance (Table 8 and Table 16).

Habitat downgraded: Refers to activities that change spotted owl low quality foraging habitat to dispersal habitat and dispersal habitat to non-habitat. In the context of this definition, marbled murrelet habitat is never downgraded; their post-treatment habitat either continues to support its original nesting function [maintain] or it does not [remove].

Habitat maintained: Refers to activities that alter forest stand characteristics but maintain the components of spotted owl and marbled murrelet habitat within the stand such that spotted owls and marbled murrelets can continue to have their life history requirements supported (i.e., the functionality of the habitat as nesting, roosting, foraging, or dispersal habitat remains intact post activity).

Habitat removed: Refers to activities that alter suitable spotted owl or dispersal habitat, so that the habitat no longer supports nesting, roosting, foraging, or dispersal.

Harm: A term used specifically in the context of an ESA Incidental Take Statement. 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: A term used specifically in the context of an ESA Incidental Take Statement. 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).

Stand: An aggregation of trees occupying a specific area and sufficiently uniform in composition, age, arrangement, and condition as to be distinguishable from the forest in adjoining areas.

3.9.1 Spotted Owl Definitions

Core area (spotted owl): The area most heavily used by spotted owls during the nesting season. For management purposes, a circle is used to map the estimated core area around a known spotted owl site. In the Washington Cascades, a 0.7-mile radius circle is used to represent a core area. On the Olympic Peninsula, the core area is represented with a 1.4-mile radius circle around a spotted owl activity center (Forsman et al. 2005, p.370).

Critical habitat (spotted owl): The primary constituent elements (PCEs) identified in the final 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).

Dispersal habitat (spotted owl): Habitat used by dispersing spotted owls that does not contain suitable habitat. These stands provide protection from avian predators and at least minimal foraging opportunities during dispersal. In general, this may include, but is not limited to, trees with at least 11 inches dbh and a minimum 40 percent canopy cover; and, younger and less diverse forest stands than foraging habitat, such as even-aged, pole-sized stands (77 FR 72052).

Foraging habitat (spotted owl): Foraging habitat includes stands of nesting and roosting habitat; additionally, owls may use younger forests with some structural characteristics (legacy features) of old forests, hardwood forest patches, and edges between old forest and hardwoods. Foraging stands contain moderate to high canopy cover (60 to over 80 percent); a diversity of tree diameters and heights; increasing density of trees greater than or equal to 31 inches dbh increases foraging habitat quality (especially above 12 trees per acre); increasing density of trees 20 to 31 inches dbh increases foraging habitat quality (especially above 24 trees per acre); increasing snag basal area, and density of snags greater than 20 inches dbh all contribute to increasing foraging habitat quality, especially above 4 snags/acre. Stands also include large accumulations of fallen trees and other woody debris on the ground, and sufficient open space below the canopy for spotted owls to fly (77 FR 72051).

Historic spotted owl site: Spotted owl sites that contained territorial spotted owls (resident pairs or singles) at any point in the past. All known spotted owl sites/activity centers that have not been surveyed to protocol or surveyed for demographic monitoring purposes within a period of 5 years is considered a historic spotted owl site. For management purposes, historic spotted owl sites are considered to be currently occupied or have the potential to be reoccupied by spotted owls at any time, unless extensive habitat changes (e.g., wildfire) have rendered the site unsuitable for spotted owl occupancy, or a current protocol survey has determined the site is not currently occupied. These spotted owl sites are considered a subset of known spotted owl sites.

Home range (spotted owl): For analysis purposes, a circle is used to estimate the median landscape area used by a pair of spotted owls. In the Washington Cascades, a 1.82-mile radius circle is used (6,657 acres); on the Olympic Peninsula, a 2.7-mile radius circle is used (14, 271 acres) to estimate the home range area around a known or historic spotted owl site (USDA and USDI 1994b, p. C-24).

Known spotted owl site/Activity Center: A spotted owl nest site or a mapped activity center that has been determined to be occupied by a pair or resident single spotted owl (1990 to present) as defined by the survey protocol for spotted owls (USFWS 2012). For management purposes, known spotted owl sites/activity centers are considered to be currently occupied or have the potential to be reoccupied by spotted owls at any time, unless extensive habitat changes (e.g., wildfire) have rendered the site unsuitable for spotted owl occupancy; or, a current protocol survey has determined the site is not currently occupied. The specific site location is determined by the unit biologist based on the best and/or most recent information. A known site may be determined to be inactive only in accordance with the survey protocol (USFWS 2012; p.31).

Nesting and roosting habitat (spotted owl): Stands for nesting and roosting are generally characterized by moderate to high canopy cover (60 to over 80 percent); multilayered, multispecies canopies with large (20 to 30 inches (51 to 76 centimeters (cm)) or greater diameter at breast height (dbh)) overstory trees; high basal area (greater than 240 ft^2/acre); high diversity of different diameters of trees; 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 fallen trees and other woody debris on the ground; and, sufficient open space below the canopy for spotted owls to fly (77 FR 72051). Nesting and roosting habitat also functions as foraging and dispersal habitat (77 FR 71884).

Nest patch (or stand) (spotted owl): The area of forest surrounding a known spotted owl nest site that is used by juvenile spotted owls prior to natal dispersal averages 70 acres in size (Miller 1989, p. 19). For analysis and management purposes, a 300-meter radius circle can be used to represent a nest patch (70 acres); or, where 100-acre LSRs (LSR4) were designated around known spotted owl activity centers under the NWFP (USDA and USDI 1994b, p. C-10).

Nesting season (spotted owl): In Washington, the spotted owl nesting season extends from March 1 through September 30. The nesting season is divided into early and late seasons. The early nesting season is defined as March 1 to July 15. 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). The late nesting season extends from July 16 through September 30. During this period, the juvenile spotted owls have left the nest and are able to fly short distances, but they remain close to the nest site and depend upon the adults for feeding (Forsman et al. 1984, p. 38). Juvenile owls typically disperse away from their natal sites in late September or early October (Forsman et al. 2002, p. 2).

Suitable nest tree (spotted owl): Typically a large tree (live or partial dead) or snag within a suitable stand that exhibits features such as a broken top, large side cavities, a large platform such as mistletoe brooms or other deformities capable of supporting a nesting spotted owl and rearing of young.

Suitable spotted owl habitat: An area of forest vegetation with forest types and structural conditions that contain one or more of the habitat types (nesting, roosting, and foraging habitats) to meet some or all of the life needs of the spotted owl throughout the year. Generally, these conditions are associated with mature or old-growth conifer-dominated stands, multi-storied in structure, where overstory canopy closure exceeds 60 percent.

3.9.2 Marbled Murrelet Definitions

Buffer tree (marbled murrelet): A conifer tree that buffers a suitable marbled murrelet nest tree is one that is at least one half the site potential tree height and that has a crown that interlocks with the crown of the potential nest tree. There is some degree of cover to the potential nesting platform that is provided by adjacent trees.

Critical habitat PCEs (marbled murrelet): The PCEs of murrelet critical habitat are: 1) individual trees with potential nesting platforms (PCE 1), and 2) forested areas within 0.5 mile of individual trees with potential nesting platforms, and with a canopy height of at least one-half the site-potential tree height (PCE 2) (61 FR 26255:26264 [May 24, 1996]).

Nesting season (marbled murrelet): The breeding period for murrelets in Washington is April 1 through September 23 (Appendix A).

Occupied habitat (marbled murrelet): Forest habitat where murrelet occupancy behaviors have been documented through protocol surveys (Evans-Mack et al. 2003) or other credible observations. All contiguous existing and recruitment habitat within a 0.5-mile radius of the observed occupancy behavior is occupied habitat (USDA and USDI 1994b, p. C-10).

Suitable habitat (marbled murrelet): Conifer-dominated stands with suitable nesting structure.

Suitable Nest Tree (marbled murrelet): Potential nest trees are conifer trees within 55 miles of marine waters that support at least one 4-inch diameter platform located at least 33 feet above the ground, with horizontal and vertical cover. A platform may be a wide bare branch, a branch covered with moss or lichen, and may also possess mistletoe, witch's brooms, or other deformities.

3.10 Conservation Measures for All Activities

The conservation measures below apply to all proposed activities but are not a complete list of the conservation measures required to ensure the proposed activities are consistent with this programmatic consultation. Additional PDCs can be found in Appendix L, under the "ALL" category. Additional conservation measures for specific actions are listed under the proposed program or activity. Some conservation measures that apply to all proposed actions are repeated under the specific program or activity for emphasis and practical reference for ONF employees who are designing and completing the proposed actions.

1. Activities shall be consistent with the ONF Land and Resource Management Plan (USFS 1990) as amended by the NWFP (USDA and USDI 1994b).
2. Projects shall be informed by applicable watershed assessments, LSR assessments, and the Olympic Adaptive Management Area Guide.
3. To the maximum extent practicable, activities shall be consistent with all recovery plans and conservation strategies for listed species, or established interim management guidelines, as amended, including:
    a. Northern Spotted Owl Recovery Plan (USFWS 2011)
    b. Marbled Murrelet Recovery Plan (USFWS 1997)
    c. Recovery Plan for the Coterminous United States Population of Bull Trout (*Salvelinus confluentus*) (USFWS 2015)
4. No collection of listed species is permitted, unless otherwise authorized.
5. When the ONF builds, rebuilds, repairs, or hauls on a segment of road, they are required to bring that road segment into compliance with a collective set of conditions referred to as the 'Forest Service Standard' in this Opinion. The Forest Service Standards are described in several different Forest Service publications, including but not limited to the list in Appendix J: *Forest Service Road Standards*.

3.10.1 Conservation Measures for Spotted Owls and Marbled Murrelets Applicable to All Activities

1. An ONF wildlife biologist shall be notified immediately if a spotted owl or murrelet active nest or individual is found, and measures to minimize or eliminate disruption to normal behaviors will be applied.
2. No trees known to be active or historical nest trees for spotted owls or marbled murrelets shall be removed during any time of year, no matter how many years have passed since the tree was known to be a nest tree.
3. Trees to be removed in suitable habitat during the murrelet nesting season shall be inspected by a Forest Service wildlife biologist when feasible or, if necessary, a qualified, designated non-biologist to determine, using Tables 2 and 3, whether it is an SNT.
4. The number of SNTs and other large trees removed shall be minimized. Trees shall be felled in a manner to minimize impacts to surrounding trees, and away from suitable habitat if it is possible and safe to do so. If the site does not meet the requirements for large wood, felled trees shall be left on site.
5. When feasible, projects shall: a) be designed to occur at times of the year and locations that reduce the potential for disturbance to spotted owls and murrelets; b) begin activities in the area farthest from suitable habitat when conducting activities during the nesting season that must occur within the adverse-effect threshold distances; and c) be adjusted to use topographic and vegetative buffers to minimize sound levels where it is necessary to conduct activities within the adverse-effect threshold distance of suitable habitat of either species during their nesting seasons.
6. During the early nesting season of the spotted owl and the entire nesting season of the marbled murrelet, helicopters shall maintain an altitude and distance from suitable habitat as described in Tables 8 and 16 except when they are on direct approach or departure from landing zones and during emergencies.
7. To the extent feasible, number of overflights shall be minimized and use of the same flight paths shall be maximized over suitable habitat during nesting seasons.
8. To the extent feasible, the smallest, quietest helicopters that can accomplish the task efficiently and safely shall be used.
9. There shall be no blasting within 0.25 mile of suitable habitat between March 1 and September 23. Effects of blasting shall be minimized following guidelines described in "Guidelines for Blasting on Olympic National Forest" (Appendix C).
10. Throughout the entire nesting seasons of spotted owls and marbled murrelets, burning shall be conducted at least 0.25 mile away from suitable nesting habitats to minimize the chance that adults, nestlings, or fledglings are injured from the smoke. Burning within 0.25 mile of these habitats shall be reviewed by Level 1 staff to ensure the projects result in insignificant effects.

3.10.2 Conservation Measures for Removing Spotted Owl Suitable Habitat and Suitable Nest Trees

1. A Forest Service wildlife biologist or, if necessary, a qualified, designated non-biologist shall inspect each suspected suitable spotted owl nest tree proposed for removal during the entire spotted owl nesting season (March 1 to September 30) for signs the tree is being used as a nest tree (e.g., spotted owls, pellets, "whitewash").
2. No more than 750 spotted owl SNTs shall be removed during this 10-year consultation. Of these, no more than 110 spotted owl SNTs (average of 11 annually) shall be removed during the spotted owl nesting season (See Table 4 for SNT removal by program).
3. Trees will be directionally felled to minimize damage to adjacent trees.
4. Known occupied spotted owl nests shall not be exposed to noise and visual disturbance within the defined disruption distances (Table 8) during the early nesting season.

3.10.3 Conservation Measures for Marbled Murrelets

1. A Forest Service wildlife biologist or, if necessary, a qualified, designated non-biologist shall inspect each suspected suitable murrelet nest tree proposed for removal during the entire murrelet nesting season (April 1 to September 23) for the presence of platforms.
2. No more than 930 murrelet SNTs shall be removed during this 10-year consultation. Of these, no more than 200 murrelet SNTs (an average of 20 per year) shall be removed during the murrelet nesting season.
3. Project activities that generate noise or visual disturbance during any portion of the nesting season of murrelets (April 1 to September 23) within disruption distances of unsurveyed but potentially occupied murrelet habitat shall begin at least 2 hours after sunrise and shall end at least 2 hours before sunset to lessen disturbance to murrelets flying to and from the nest. The following activities would be excepted under this operational condition: loading of log trucks at landings and log haul along existing roads. Operations during the evening hours between two hours after sunset and two hours before sunrise are permitted.
4. Known occupied murrelet nest stands shall not be exposed to project activities during the entire nesting season within the disruption distances defined in Table 16.
5. During all project activities, wildlife will be prevented from accessing food or food waste on site or in the vicinity of project operations. Any food or food waste shall be removed or securely stored daily to prevent animal access at all times.
6. When feasible, removal of platforms, trees with platforms, and trees providing cover to platforms shall be avoided even if it is not known whether the stand is occupied by murrelets.

3.10.4 Conservation Measure for Marbled Murrelet Critical Habitat

1. Activities shall encourage protection and development of suitable nest trees (PCE 1s).

3.10.5 Conservation Measures for Bull Trout and Bull Trout Critical Habitat

Conservation measures in this section and throughout the document are required when a project occurs within a bull trout core area watershed or critical habitat for bull trout. Many of these conservation measures will also be implemented in non-core watersheds and outside of critical habitat for bull trout because they are required under different authorities, such as the Memorandum of Understanding (MOU) between the Forest Service and the Washington Department of Fish and Wildlife (WDFW) regarding Forest Service hydraulic projects, including appropriate in-water work timing periods (WDFW and USFS 2017). The conservation measures will be implemented or overseen by at least one of the ONF's appropriate natural resource experts for the action (e.g., road engineer, hydrologist, fish biologist).

Each program and proposed project includes conservation measures that must be implemented for the specific activity to be covered by this Opinion. Conservation measures are intended to avoid or minimize adverse effects to listed species and critical habitats. They represent the best professional judgment of the Forest Service and the USFWS technical specialists and Level 1 Team representatives that participated in this consultation.

Under the proposed action, the conservation measures are organized in a tiered approach. The first tier of conservation measures are general requirements for all activities that are listed below; these measures must be adhered to for all projects covered under this Opinion. The second tier of conservation measures are more-specific conservation measures that apply to each program area. These measures will be implemented for each project within the program area covered under this Opinion. In some cases, additional specific conservation measures will also be listed under an individual project type. These measures will be applied to all projects within that specific project type.

3.10.5.1 Conservation Measures for All Program Activities

1. Projects potentially affecting the bed or banks of streams, lakes, or other water bodies must meet all conditions specified in the MOU with WDFW regarding ONF hydraulic projects, including appropriate in-water work timing periods (WDFW and USFS 2017).

2. Erosion prevention and control methods shall be used as necessary during and immediately after project implementation (and as long as necessary) to minimize the loss or displacement of soils and to prevent delivery of sediment into a waterbody. These measures may include, but are not limited to, operational techniques, straw bales, silt fencing, erosion-control blankets, temporary sediment ponds, and/or immediate mulching of exposed areas. Disturbed ground with the potential to deliver sediment into waterbodies shall be revegetated or protected from surface erosion by seeding, mulching, or other methods with sufficient time prior to the fall rainy season to allow for germination and growth. After project completion, disturbed streambanks and

lakeshores shall be revegetated with site-appropriate vegetation to maintain soil stability and provide shade and future sources of large wood. Revegetation can be accomplished by planting or natural reproduction, depending on site conditions.

3. With the exception of riprap placement to protect existing infrastructure, no work under this programmatic shall occur within the wetted width of bull trout habitat in core watersheds.

4. If wet-weather conditions during project operations generate and transport sediment to a stream channel or other waterbody, ONF staff and contractors shall cease operations until the weather conditions improve, unless delaying operations would increase the risk of adverse resource impacts. Coordination with aquatic specialists will be part of this decision process.

5. To ensure adequate amounts of large wood in streams, any trees greater than 12 inches dbh to be felled that can function as wood within the bank-full stream channel shall be felled toward the stream and left in place if feasible. If an aquatic specialist determines the trees are not needed to meet current instream large wood objectives, they may be removed for use in instream aquatic improvement projects or other administrative uses, left on-site to improve terrestrial large woody habitat, or sold.

6. All machinery maintenance involving potential contaminants (fuel, oil, hydraulic fluid, etc.) shall occur at a site that is at least 100 feet from stream channels, water bodies, or wetlands.

7. Bio-degradable and/or vegetable based oils and fuels shall be used in machinery when operating within the bankfull channel of waterbodies.

3.11 Conservation Measures for Commercial Thinning and Associated Activities

The generalized list of conservation measures below are a summary of the conservation measures that apply to all commercial thinning and associated activities. For the full list of conservation measures, refer to Appendix L.

1. Restrictions and limits on suitable habitat and SNT removal for murrelets and spotted owls

2. Minimum distance buffers for activities adjacent to suitable habitat and bodies of water

3. Seasonal limited operating periods (LOP) for murrelets and spotted owls

4. Daily LOPs for murrelets

5. Work windows and maintenance requirements for roads adjacent to bodies of water and stream crossings

6. Food and food waste management for murrelets

7. Survey requirements for SNTs

8. Restrictions on activity types in LSR

These conservation measures apply to the following activities:

1. Commercial Thinning, including:
    a. Silviculture treatment in LSR and AMA stands less than 80 years of age
    b. Silviculture treatment in LSR stands over 80 years of age and/or over 20 inches average dbh
    c. Silviculture treatment in AMA stands over 80 years of age and/or over 20 inches average dbh
    d. Silviculture treatment in alder-dominated stands
    e. Forest health (sanitation) harvest in forest stands

2. Other Vegetation Management, including:
    a. Forest health (sanitation) harvest in campgrounds and administrative sites
    b. Road daylighting
    c. Communication site line-of-sight vegetation removal
    d. Historical cabin and roadside viewpoint viewshed management
    e. Expansion of trailheads and campgrounds

3. Associated Activities for all Vegetation Management Actions, including:
    a. Use of equipment for vegetation removal
    b. Yarding, sorting, loading, and hauling
    c. Road and landing construction

3.12 Conservation Measures for Activities other than Commercial Thinning

The conservation measures below apply to all proposed activities, other than those listed in the section 3.11 (Conservation Measures for Commercial Thinning and Associated Activities), but are not a complete list of the conservation measures required to ensure the proposed activities are consistent with this programmatic consultation. Additional conservation measures for specific actions are listed under the proposed program or activity. Some conservation measures that apply to all proposed actions are repeated under the specific program or activity for emphasis and practical reference for ONF employees who are designing and completing the proposed actions.

3.12.1 Conservation Measures for Spotted Owls and Marbled Murrelets

1. Activities shall not result in removing or downgrading stands of nesting, roosting, or foraging spotted owl habitat except for selected projects (see Sections 3.13.1 - Removal of Northern Spotted Owl and Marbled Murrelet Suitable Habitat and 3.13.2 - Downgrading or Removal of Northern Spotted Owl Foraging Habitat).

2. Rock pit expansion and development will implement restrictions on spotted owl and murrelet suitable habitat removal, seasonal timing restrictions, and daily timing restrictions. For a full list of applicable conservation measures and PDCs, see PDCs labeled "ROCK" in Appendix L.

3.13 Program Descriptions

This section describes the programs that are included in the actions proposed by the ONF. Each program has one or more project types. This section is intended to provide the basis for determinations of effect of the proposed action on listed species and critical habitats by identifying the types and approximate amounts of work associated with program activities, the types of equipment used, and the typical timing of various activities that may occur in areas where listed species or critical habitat may be present. Conservation measures in this section are specific for each program area and project type within the program areas.

3.13.1 Removal of Northern Spotted Owl and Marbled Murrelet Suitable Habitat

In certain circumstances, removal of small patches (< 1 acre) of spotted owl and marbled murrelet suitable habitat may be necessary when there is no other viable or economical alternative to implement a project. Up to 10 acres of suitable (nesting/roosting/foraging) habitat for the spotted owl or suitable (nesting or stand providing buffer to a suitable nest tree) habitat for the marbled murrelet may be removed for the following projects: forest health issues in campgrounds; road construction/reconstruction to access commercial thinning stands; and rock pit expansion and development.

3.13.1.1 Specific Conservation Measures for Suitable Habitat Removal

1. The proposed activities will require Level 1 review during project planning.

2. Construction activity removing suitable habitat will be done between September 24 and February 28 (spotted owl) or September 24 and March 31 (marbled murrelet).

3.13.2 Downgrading or Removal of Northern Spotted Owl Foraging Habitat

This programmatic consultation includes downgrading or removal of up to 910 acres of spotted owl foraging habitat for specific projects. These include commercial thinning of low-quality or questionable foraging habitat that requires thinning to maintain a trajectory toward developing moderate to high quality habitat in the future. Up to 900 acres of thinning stands that are typed out as lower quality foraging habitat proposed for thinning would temporarily downgrade the foraging habitat to dispersal habitat. The 900 acres includes 500 acres within LSR and AMA < 80 years of age, and 400 acres in AMA > 80 years of age. Up to 10 acres of foraging habitat would be removed for development of helicopter landings (service, log, emergency).

3.13.2.1 Specific Conservation Measures for Downgrading or Removal of Northern Spotted Owl Foraging Habitat

1. The proposed activities covered under the programmatic consultation will require Level 1 review during project planning.

3.13.3 Suitable Nest Tree Removal or Alteration

This programmatic consultation includes the removal or alteration of trees that have the nest structure characteristics of marbled murrelet and spotted owl nest trees or trees that buffer a suitable murrelet or spotted owl nest tree. Specific programs that may remove or alter suitable nest trees include trail and trail bridge construction/reconstruction; hazard and danger tree removal for public safety; road use and access permits that allow for road construction across Federal land to access non-Federal land; commercial thinning and associated activities, including creating landings and road building/reconstruction; forest health within campgrounds; communication site development; rock pit expansion and development; tailhold and guyline anchor permits; road decommissioning during watershed restoration; bridge removal; and requests by Native American Tribes for ceremonial trees. Each of these project types are described further in their respective section and include the allocated take of suitable nest trees (i.e., large diameter trees that have characteristics of a nest tree or that provide protection to a nest tree). The majority of the trees will be removed outside the spotted owl and marbled murrelet nesting season. Numbers of spotted owl and marbled murrelet SNTs anticipated to be cut by program during the period of this consultation are presented in Table 4.

Table 4. Number of SNTs for spotted owls and marbled murrelets anticipated to be removed or altered during this 10-year consultation.

Species Program	**Trees per 10 years**
Spotted owl	
Trail Construction and Reconstruction; Trail Bridge/Foot Log Construction, Reconstruction, and Removal	20
Expansion of Trailheads and Campgrounds	10
Hazard/Danger Tree Removal	590
Road Construction/Reconstruction and Landings for Commercial Thinning	15
Forest Health including Campgrounds	20
Storm-proofing and Road Drainage Upgrading	20
Rock Pit Expansion and Development	20
Road Use and Access Permits	8

Table 4. Number of SNTs for spotted owls and marbled murrelets anticipated to be removed or altered during this 10-year consultation.

Species Program	Trees per 10 years
Spotted owl	
Communication Site Permits	15
Lands and Special Use Permits, Tailhold Permits	20
Tribal Requests	12
Total for spotted owl	750
Marbled murrelet	
Trail Bridge/Foot Log Construction, Reconstruction, and Removal	30
Expansion of Trailheads and Campgrounds	30
Hazard/Danger Tree Removal	500
Commercial Thinning	100
Road Construction/Reconstruction and Landings for Commercial Thinning	100
Forest Health including Campgrounds	35
Storm-proofing and Road Drainage Upgrading	30
Road Use and Access Permits	20
Communication Site Permits	15
Rock Pit Expansion and Development	20
Lands and Special Use Permits, Tailhold Permits	30
Tribal Requests	20
Total for marbled murrelet	930

3.13.3.1 Specific Conservation Measures for Large Diameter Tree Removal

1. The proposed activities covered under the programmatic consultation will require Level 1 review during project planning.

2. Marbled murrelet and spotted owl SNTs will be retained wherever possible.

3. If a SNT must be removed during the nesting season, a Forest Service wildlife biologist will be consulted prior to felling to assess signs of occupancy by nesting owls or nestlings. USFWS will be notified if the tree did have nesting birds.

3.14 Recreation Management Program

Recreation management is designed to provide opportunities for public enjoyment of the forest while maintaining resources and reasonable public safety. Management activities include campground and other developed-site maintenance and operations, and trail management.

3.14.1 Conservation Measures for Activities Conducted for the Recreation Management Program

All Species:

1. All conservation measures specified under the Hazard/Danger Tree Removal Program shall be applied.

3.14.2 Developed-Site Operation and Maintenance

Developed sites include developed campgrounds, rustic camps, recreation cabin rentals, interpretive sites, scenic overlooks, picnic areas, launching facilities, and trailheads (trails are described separately below). The purpose of the developed-site maintenance program is to provide a safe and clean camping experience for the public. Campgrounds and developed sites generally are located along rivers, streams, or lakeshores, and are accessed by major roads. Campground maintenance normally is conducted in the spring from mid-March until campgrounds are opened. Campgrounds generally are operated during, and receive peak use between, Memorial Day and Labor Day. Crews can spend up to 3 weeks completing pre-season maintenance on developed campgrounds. There are 78 developed recreation sites on the ONF including 18 developed campgrounds, one group campground, two picnic areas, one horse camp, four observation sites, three boat launches, three rental cabins, 44 trailheads, two minor interpretative sites, and two information sites. Heavy-equipment use occurs in maintenance of developed campgrounds but is less common in rustic campgrounds. The observation points are located along major highways. Four of these developed sites (Hamma Hamma Cabin, Louella Cabin, Interorrem Cabin, and Brown Creek Campground) are open and maintained year-round. Campground capacities range from 8 to 64 sites.

Recreation facility maintenance includes road and campsite maintenance, yurt maintenance, hazard/danger tree removal (see below), revegetation where necessary, and general cleanup and repair (tables, stoves, toilets, signs, barrier (re)placement, water systems, pumps, foot bridges, paths and steps, fences). Toilet repair/replacement and maintenance may involve digging new vaults, some vegetation removal, including for management of scenic value, and toilet pumping. Several new wells may be drilled because of campground relocations and current wells with inadequate water supply. Several abandoned wells on the ONF may be removed. Heavy maintenance may include extended use of mechanized equipment.

Minor maintenance activities in campgrounds or other developed sites include lawn-mowing, weed cutting, leaf blowing, sign placement, kiosk development, roadway sweeping, and trash collection. Equipment used ranges from road equipment for road maintenance to chainsaws, lawn mowers, augers, and small power tools. Minor campground maintenance continues through September 15 or later. Activities within this project type may include hauling of existing materials from rock sources.

Excluding hazard/danger tree removal, which is addressed below, developed site operations and maintenance would not remove any suitable spotted owl habitat or marbled murrelet habitat. Use of mechanized equipment would occur during the spotted owl and marbled murrelet nesting seasons. Hazard/danger tree removal is done predominately in the fall and winter.

In-stream work generally will be conducted from July through September, during the low-flow season. Timing will vary by watershed to meet allowable work windows for hydraulic projects (WDFW and USFS 2017).

3.14.3 Dispersed Site Maintenance

Dispersed sites are minimally maintained and do not contain structures such as toilets. The ONF proposes to maintain each of its approximately 1,405 dispersed sites during each year. Maintenance in dispersed sites may include barrier placement and replacement, cleaning fire rings, collecting and removing garbage, and removing nails from trees. The equipment used may include dump trucks, front-end loaders, or power and hand tools. Some campgrounds may be decommissioned during the 10-year term of the proposed action.

The vast majority of dispersed sites are located near or along roads. A number of dispersed sites are located at higher elevations and may require maintenance during the late spring or summer. The ONF expects that heavy equipment would be used in only 10 sites annually during the early murrelet or spotted owl nesting seasons in areas of low background sound and visual levels. Dispersed site maintenance would not result in the removal of patches of suitable habitat of spotted owls or marbled murrelets.

3.14.4 Trail Maintenance

The purpose of the trail maintenance program is to provide the public safe access into the forest. Maintenance work normally is conducted in the spring and summer to repair winter damage to trails. This work may be completed by the ONF, or partner and volunteer organizations, including the Washington Trail Association, Eyes in the Woods, The Mountaineers, and the Olympic Access Coalition. Regardless of who completes the trail maintenance work, the activity description and applicable conservation measures will remain the same. There is a total of 290 miles of trails on the ONF, of which 88 miles are in Congressionally-designated Wilderness. Approximately 20 miles of roads will be converted to trail during the time covered by this consultation. In general, non-mechanized hand tools are used in congressionally designated Wilderness; blasting is permitted, whereas use of chainsaws is not permitted. Equipment used for trail maintenance outside of Wilderness includes chainsaws, motorized wheelbarrows, and weed-eaters. All 182 miles of non-wilderness trails and 88 miles of Wilderness trails will be maintained each year during the 10-year term of the proposed action.

Trail maintenance includes removal of trees downed by wind (windfall) within the trail prism where necessary, brushing, drainage maintenance, tread maintenance, and repair of cribwalls and puncheons. The amount of maintenance required can range from very limited, where only the minimum necessary to prevent serious damage from erosion and keep the trail passable is required, to higher levels where logs and windfall are removed to an 8-foot width, brush is cleared to a 10-foot height and 8-foot width, the tread is restored to its original width, and all drainage structures are repaired or replaced. This involves work in the established clearing width and does not involve relocating the trail. A portion of this work is completed during chainsaw training and certification of ONF crews and volunteers.

The majority of trail maintenance is done during the spring and summer. Clearing trails to open them for public travel is a priority between March 15 and July 1, before the heavy-use period begins. However, general maintenance such as clearing downed trees continues throughout the year on the majority of the trails. The ONF anticipates that all of the non-wilderness trails (182 miles) may have some maintenance on them during the early spotted owl nesting season. Occasionally, crews will need to clear several trees, which could take from 4 hours to 2 days per project (trail or portion of trail) depending on variables including the size of trees and tree position on the slope.

Blasting or use of helicopters occasionally may be required for trail maintenance. It is expected that blasting will occur outside the spotted owl and murrelet nesting seasons except for an average of 20 sites per year. All blasting for this activity will be done with charges of 2 pounds (lbs.) or less. A “site” is defined as the area within the harassment distance for charges of 2 lbs. or less. No more than four helicopter flights are anticipated each year. Trail maintenance will not result in the removal of patches of suitable habitat for spotted owls or marbled murrelets.

3.14.4.1 Specific Conservation Measures for Trail Maintenance Projects

Bull Trout:

1. To retain the largest pieces of downed wood possible in stream channels and floodplains, bucking of large trees during trail-clearing activities in riparian areas shall be minimized.

2. Work on trails and bridges that occur within the bank-full width and riparian areas of all active streams must occur within the in-stream work windows and following the measures described in the Washington State-Forest Service MOU (2017) and requires Forest Service biologist review.

3. Blasting in proximity to bull trout habitat in core watersheds, to be consistent with this programmatic, must be set back from the wetted width of adjacent bull trout habitat a distance determined by the protocol in Appendix D (Blasting Guidelines for Determining Bull Trout Effect Determinations) – or determined by the Level 1 team to be consistent with the proposed action considered in this Opinion.

3.14.5 Trail Relocation, Construction, and Restoration

The purpose of trail relocation, construction and reconstruction is to provide access in the ONF which meets Forest Service standards for safety, provides recreational opportunities to the public, and provides for resource protection. The current trail system includes some trails that were user created or were designed for fire-suppression access, or were previously roads that have been decommissioned and converted to trails. Many of these trails include segments with steep grades and are located in areas prone to erosion or drainage problems. Trails often follow major drainage or stream systems and have been impacted by shifting stream channels. Trail re-routes are necessary when site conditions are too adverse and/or damaged on a particular segment of trail to keep away from a wet, riparian, or unstable area. Re-routes can be as long as 100 to 200 yards, and as short as around a ball of tree roots. A re-route generally can be done by simply moving loose brush, cutting out fallen logs, pruning live brush and limbs, establishing a tread on the ground with hand tools, and providing for drainage.

To provide trails that meet ONF standards and resource concerns, a program of trail construction/reconstruction is part of the yearly program of work. Trail construction herein does not include construction of new trails into undeveloped areas. Existing trail locations may be realigned or relocated to better address resource or safety concerns. New construction of trails within developed recreation sites for such uses as campsite access and interpretive trails are included in this assessment. The length of new trail within these sites can vary from a short spur up to 1-mile in length. The ONF proposes to relocate, construct, or reconstruct 85 miles of trail during the 10-year term of the proposed action. This work may be completed by the ONF, or partner and volunteer organizations, including the Washington Trail Association, Eyes in the Woods, The Mountaineers, and the Olympic Access Coalition. Regardless of who completes the trail maintenance work, the activity description and applicable conservation measures will remain the same.

Trail construction and reconstruction projects can require the use of chainsaws, small power tools, hand tools, and trail machines such as small excavators and tractors. Some understory clearing will occur, including the removal of small trees less than 12 inches dbh. Even though trails usually are designed to minimize the removal of larger trees because of their aesthetic value, a few larger trees or snags greater than 24 inches dbh may need to be removed. During the 10-year term of the proposed action, SNTs for spotted owls and may be removed as part of trail relocation, construction, and reconstruction (Table 4). Some trail restoration may involve the use of blasting or aircraft. It is anticipated that no more than 10 sites per year would be blasted using explosives weighing 2 lbs. or less. No more than two helicopter flights are anticipated each year. Trail location work will not remove trees that have suitable nest structures for spotted owls or murrelets or that provide cover for suitable murrelet nest trees.

3.14.5.1 Specific Conservation Measures for Trail Relocation, Construction, and Restoration Projects

Spotted Owls and Marbled Murrelets:

1. Trail routes shall avoid the removal of trees that have suitable nest structures for spotted owls or murrelets or that provide cover for potential murrelet and or spotted owl nest trees.

Bull Trout:

1. To retain the largest pieces of downed wood possible in stream channels and floodplains and minimize the need to cut large riparian trees during trail clearing activities, trails shall be relocated away from streambanks and out of floodplains where feasible.

2. To retain the largest pieces of downed wood possible in stream channels and floodplains, bucking of large trees during trail-clearing activities in riparian areas shall be minimized.

3. Blasting in proximity to bull trout habitat in core watersheds, to be consistent with this programmatic, must be set back from the wetted width of adjacent bull trout habitat a distance determined by the protocol in Appendix D - or determined by the Level 1 team to be consistent with the proposed action considered in this Opinion.

All Species:

1. Old trail sections shall be obliterated to prevent further use by people or livestock.

3.14.6 Trail Bridge/Foot Log Construction, Reconstruction, and Removal

Most trail bridges and foot logs (cross-section of a tree used as a boardwalk) are reconstructed because the current crossing structure has reached the end of its expected design-life and is becoming or has become unsafe. Trail bridges range from log stringers installed exclusively with hand tools in Wilderness to steel and/or glue-laminated structures installed with heavy equipment or aircraft. Manufactured bridges are preferred because of their longevity (50 to 75 years) versus native materials (up to 20 years). In addition, some live trees (Douglas-fir or western red cedar) ranging from 21 to 44 inches dbh found on site are likely to be used for bridge construction during the 10-year term of the proposed action. During the 10-year term of the proposed action, spotted owls and murrelet SNTs may be removed as part of trail bridge/foot log construction, reconstruction and removal (Table 4). Trees found on-site would be winched no more than 500 feet to the bridge location. It is anticipated that no more than 18 bridges would need to be replaced with manufactured or native material during the 10-year term of the proposed action. New trail bridge construction will be limited to previously disturbed locations such as existing trail crossings or modifications of existing structures and new locations associated with trail reroutes. Foot logs are made from a single western red cedar or Douglas-fir with diameter up to 4 feet and 60 feet in length. Generally, foot logs are constructed within designated wilderness. Trees used for foot logs are found on site. Construction of bridges and foot logs generally is done in mid-summer, but occasionally can be done in the fall. The ONF proposes to restore, modify, or remove 25 trail bridges and foot logs during the 10-year term of the proposed action. Occasionally, trail bridges and foot logs are removed and converted to wet crossings.

Equipment used for trail bridge/foot log construction, reconstruction, and removal usually consists of chainsaws, small power tools, a power wheelbarrow, and hand tools, but could include use of small excavators, tractors, or single-rotor or double-rotor helicopters. It is anticipated that no more than two sites per year would be blasted using blasts of 2 lbs. or less. A helicopter may be used to fly in a manufactured bridge or natural stringers; distances of flight vary up to 3 miles and typically are completed within 1 day (less than 10 hours of flight time during an entire project). Bridges generally are flown on site between August and October. During the 10-year term of the proposed action, of the 18 bridges to be replaced, 10 manufactured bridges would be flown in.

For new bridge construction, only bridges that fully span the bankfull stream channel with supports or abutments outside of the bankfull channel are included under the proposed action. Reconstruction of existing bridges which fully span the bankfull stream channel and reconstruction activities of other bridges which does not involve any instream work, such as replacing bridge decking, are included. Reconstruction of existing bridge supports or abutments within the bankfull channel are not included in the proposed action herein.

Instream work for trail bridge/foot log construction, reconstruction, and removal generally will be conducted from July through September, during the low-flow season. Timing will vary by watershed to meet allowable work windows for hydraulic projects (WDFW and USFS 2017).

3.14.6.1 Specific Conservation Measures for Trail Bridge/Footlog Construction/Reconstruction Projects

Spotted Owls and Marbled Murrelets:

1. SNTs for spotted owls or marbled murrelets or trees that buffer a potential murrelet nest tree may be used as bridge stringers or foot logs when necessary but shall require approval by an ONF wildlife biologist.

Bull Trout:

1. Any tree within 100 feet of bull trout habitat that is proposed for use as a bridge stringer or footlog shall be reviewed by an Aquatic Specialist to ensure the tree is not critical to riparian/ stream function.

2. Disturbed ground where log stringers were dragged shall be evaluated and erosion-control measures applied where needed.

3. Blasting in proximity to bull trout habitat in core watersheds, to be consistent with this programmatic, must be set back from the wetted width of adjacent bull trout habitat a distance determined by the protocol in Appendix D - or determined by the Level 1 team to be consistent with the proposed action considered in this Opinion.

3.14.7 <u>Trail-Bridge Maintenance</u>

Trail-bridge maintenance often is done in conjunction with regular trail maintenance. The ONF proposes to maintain 65 bridges during the 10-year term of the proposed action. Typical items of work can include, but are not limited to replacement of hand rails and rail posts; replacement of deck planks (which can involve use of treated timber); cleaning/flushing of bridge decks;

removal of brush from beneath and alongside the bridge; and repair of concrete bridge components. Each bridge repair may take up to 6 hours and may need to be done every other year. Equipment used may include chainsaws, brush cutters, gas-powered tooting machines, and power and hand tools.

Instream work generally will be conducted from July through September, during the low-flow season. The timing of maintenance activities will vary by watershed to meet allowable work windows for hydraulic projects (WDFW and USFS 2017).

3.14.8 Expansion of Trailheads and Campgrounds

With the growing population in the Puget Sound and Olympic Peninsula, the increase of recreation visitors to the ONF has resulted in a need for reduced congestion at existing trailheads and campgrounds in order to provide adequate parking and alleviate overcrowding while delivering sufficient public safety.

Expansion of existing trailheads and campgrounds would involve heavy equipment for clearing of trees and vegetation material, including roots, placing gravel and subgrade material and in some instances paving within the development area. There may also be a need to include construction or reconstruction of access roads in the work area. These activities require the use of a variety of heavy equipment such as excavators, dozers, loaders, backhoes, pavers, and trucks. Hand-held equipment will include chainsaws and hand tools.

Under the life of this 10-year programmatic, there would be up to three separate trailhead or campground locations receiving vegetation treatment totaling no more than 10 acres. There will be no removal of contiguous nesting habitat for either spotted owl or marbled murrelet for expansion of trailheads and campgrounds. During the 10-year term of the proposed action, SNTs for spotted owls and murrelets may be removed as part of trailhead and campground expansion (Table 4). Work would be primarily done outside the high visitor use period (Memorial Day to Labor Day); however, it may occur during the nesting season for both species.

3.14.8.1 Specific Conservation Measures for Expansion of Trailheads and Campgrounds

Spotted Owls and Marbled Murrelets:

1. No removal of contiguous nesting habitat for marbled murrelets or spotted owls is allowed.

2. Marbled murrelet and spotted owl SNTs will be retained wherever possible. If a SNT must be removed during the nesting season, a Forest Service wildlife biologist will be consulted prior to felling to assess signs of occupancy by nesting owls or murrelets.

3.14.9 Recreation Site Improvement

This activity includes construction of new picnic areas and new campsites within a campground, and the placement of yurts, graveled parking areas, small boat ramps, or toilets. The ONF proposes to expand 20 sites during the 10-year term of the proposed action. Developments will be located in already disturbed areas such as dispersed sites or sites already being used by the public for parking or picnic activities. Equipment used may include backhoes, front-end loader, graders, dump trucks, chainsaws, explosives, and small power and hand tools. Some removal of hazard/danger trees would be done during construction, if necessary. Expansion of recreation sites will not remove more than one acre of suitable habitat for spotted owls or marbled murrelets. Project activities may occur during the nesting season. Recreation sites shall be designed so they do not degrade more than one acre of suitable habitat for threatened and endangered fish and wildlife.

3.14.10 Administrative Facilities

Administrative sites include office compounds, housing compounds, visitor centers, guard stations, rental cabins, and lookouts. The maintenance and repair of existing sites may require the use of small power and hand tools, chainsaws, trucks, mowers, and weed-eaters. The ONF proposes to maintain 15 administrative facilities per year for the 10-year term of the proposed action. Visitor centers and office compounds tend to be located in already developed areas with high background-sound levels. Administrative facilities generally are accessed by major paved roads. Excluding hazard/danger tree removal (addressed below), maintenance of facilities would not result in the loss or degradation of spotted owl or marbled murrelet habitat. All of the administrative facilities on the ONF are located farther than 75 yards from suitable spotted owl habitat and suitable murrelet habitat.

3.14.11 Hazard/Danger Tree Removal Program

The purpose of the Hazard/Danger Tree Removal Program is to provide for public safety. These trees are identified as hazard trees, which are typically in campgrounds (Harvey and Hessburg 1992) or danger trees, which are usually along roads (Toupin et al. 2008). Removal of hazard/danger trees is a critical maintenance activity because untreated hazards can result in personal injury, death, or facility damage or closure. Hazard/danger trees are defined as live or dead standing trees, or tree parts, that are at substantial risk of failure and may hit people, human-populated areas (e.g., picnic area, parking pad, campsite), or structures (e.g., power line, fence, road, mineral claim). Hazards from these trees increase with increasing tree defect, potential for failure, potential for damage, and value of the objects possibly hit by the trees (Harvey and Hessburg 1992; Toupin et al. 2008).

Corrective actions may include removing limbs or the hazardous portions of the tree or felling of the whole tree. Methods of removal may include using a chainsaw, hand-tools, shooting, or blasting. Hazard/danger trees which cannot be safely felled with a saw may need to be blasted. It is anticipated that no more than five sites per year would be blasted using explosives of 2 lbs. or less. Removal of these trees will be conducted either by ONF employees or contractors hired by the ONF. Trees identified as hazards are generally located within 50 feet downhill and 150 feet uphill of a road, and pose a threat of falling on a road. Approximately 24 percent of all roads within the ONF system are adjacent to spotted owl and murrelet nesting habitat. Removal of hazard/danger trees in campgrounds is generally scheduled in the early spring before the campgrounds are open and after Labor Day when recreation use is lower.

3.14.11.1 Conservation Measures for Activities Conducted for the Hazard/Danger Tree Removal Program

Spotted Owls and Marbled Murrelets:

1. Only trees that are classified as hazard trees per Harvey and Hessburg (1992) or danger trees per Toupin et al. (2008) shall be felled. Individuals performing hazard tree inspection must have current training and certification as required in R6 Supplement No. 2300-2011-1, dated November 25, 2011 and individuals performing danger tree inspection must have current training and certification as required in R6 Supplement R6-7730-2007-2.

2. No trees known to be active or historical nest trees for spotted owls or marbled murrelets shall be removed during any time of year, no matter how many years have passed since the tree was known to be a nest tree.

3. Trees to be removed shall be inspected by a Forest Service wildlife biologist when feasible or, if necessary, a qualified, designated non-biologist to determine, using Tables 4 and 5, whether it is an SNT. If it must be felled during the nesting season, a Forest Service wildlife biologist or a program area lead will be there to see if there was a nest or nestlings affected.

The vast majority of SNTs likely to be removed under the proposed action will be removed under the hazard/danger tree program. During the 10-year term of the proposed action, 590 SNTs for spotted owls and 500 SNTs for murrelets identified as a hazard or danger tree will be removed (Table 4). The ONF is not constrained to each subtotal by project type, but is constrained not to exceed the total number of SNTs cut during the 10-year term of the proposed action.

3.14.12 Forest Health (Sanitation) in Campgrounds and Administrative Sites

In addition to removal of individual hazard trees, the ONF proposes to conduct stand-scale treatments in response to insect or disease events, or dead/infected/susceptible trees within the administrative boundaries of campgrounds and administrative sites. This activity would include trees killed by disturbance such as fire, wind, or ice and may also be removed as salvage for sites that have root-sprung or leaning trees. Common pathogens in the forest include *Phellinus* (laminated) root rot, *Heterobasidion* root disease, and *Armillaria* root disease.

In general, a portion or the entire campground or administrative site would be treated one time during the life of this programmatic. Trees removed would often be greater than 8 inches dbh and tree selection is based on a specific diagnosis and prescription for stand health to ensure safety of forest visitors and structures at these sites. The overstory would retain as many live, sound, resistant, residual trees as possible, such as native conifer and deciduous tree species (western red cedar (*Thuja plicata*), western white pine (*Pinus monticola*), red alder, and bigleaf maple *(Acer macrophyllum)*. There would be no change to the understory except for selected locations where potentially affected small diameter conifers seedlings and saplings (less than 8 inches dbh) need to be severed. Trees felled would be removed from the site and may be either commercially sold or used for other restoration projects. The primary tools used for felling and removing trees includes chainsaws and heavy equipment, such as a log loader.

Once tree removal operations are complete, site restoration could include re-vegetation through plantings and broadcast seeding with appropriate native species such as western white pine and western red cedar, and other species not susceptible to root disease. Plantings of native flowering shrubs and forbs to provide habitat for birds, butterflies, and other pollinators could beplanned. In addition, wildlife trees may be created to provide habitat for wildlife associated with dead wood including cavity nesters.

There are 78 developed recreation sites on the ONF, including 18 developed campgrounds, 1 group campground, 2 picnic areas, 2 horse camps, 4 observation sites, 3 boat launches, 3 historical cabin rentals, 44 trailheads, 2 minor interpretative sites, and 2 information sites.

Vegetation removed in concessionaire-managed campgrounds (Satsop and Coho in the Wynoochee watershed) would occur from October 1 through the end of May. If there is removal of suitable nesting habitat, trees would be felled outside the nesting season for both spotted owl and marbled murrelet. For the other 16 remaining campgrounds, work may occur year-round based upon proximity of nesting habitat or activity centers for spotted owl and marbled murrelet. There would be no removal of nesting habitat larger than 1 acre for either the spotted owl or marbled murrelet under this consultation. Individual suitable nest trees, or clumps of suitable nest trees (smaller than 1 acre) may be removed, but only outside the nesting season for both species. Activities near big blocks of habitat would be prioritized to avoid nesting seasons for both spotted owl and marbled murrelet. In those situations, tree felling would occur outside the nesting season.

Over the course of this consultation, approximately 20 acres across 5 campgrounds or administrative sites would be treated. During the 10-year term of the proposed action, spotted owl and murrelet SNTs will be removed in the quantities expressed in Table 4.

3.14.13 Historical Cabin Viewsheds and Roadside Viewpoints

The Forest Service has three historical cabins (Louella, Hamma Hamma, and Interorrem) that are available for visitor use. Hamma Hamma is situated on a hill and historically had a maintained view of the watershed of about 2 acres. Louella also has about 10 acres of maintained view of the valley, though vegetation encroachment has reduced this viewshed. Interorrem does not have a maintained view but instead looks out to private timberlands across the road. There are also 10 viewpoints along roads that have vegetation growth that has impeded approximately 10 acres of potential viewshed. Most of the encroaching conifer and deciduous trees that impede viewsheds are primarily second growth. Removal of encroaching vegetation will include partial or full tree (conifer and deciduous) removal, while retaining existing old growth.

3.15 Silviculture Program

The ONF Silviculture Program is designed predominantly to improve stand diversity and facilitate the development of late-successional habitat at more-rapid rates than what can be expected without treatment (Comfort et al. 2010). Vehicle traffic on forest roads, including log hauling during future commercial timber sales, is part of this proposed action and consulted on by this Opinion.

3.15.1 Free-Use Permits

Free-Use requests for timber products from tribes and non-profit organizations also are provided through the silviculture program. Timber provided through Free-Use requests may range from individual canoe trees to substantial quantities of blown-down or standing trees for instream, large-wood-structure projects. The value of timber that currently can be provided for individual Free-Use requests typically is limited to $5,000. Any removal of blown-down or standing trees for large-wood structures will be designed to meet silvicultural and wildlife objectives.

3.15.2 Salvage Sales

Salvage sales remove dead, down, or damaged wood from forest stands for commercial sale. Reasons to salvage include, tree mortality from fire, disease infestations such as root rot, and blowdown, especially blowdown resulting from clearcut logging adjacent to ONF land, or in developed recreation and administrative sites. Currently, there are no plans for salvage sales of down wood in LSR land allocations. A typical salvage sale in AMA would remove most of the down wood, but not all dead or damaged dying trees from a stand and will leave quantities of coarse woody materials as prescribed in the NWFP and associated assessments. The ONF proposes to salvage an average of 100 acres per year during the 10-year term of the proposed action. Cutting of trees generally will be done outside of the early spotted owl nesting season unless the site is farther than the appropriate disruption distance from suitable habitat. However, some of this work is expected to be conducted during the murrelet or spotted owl nesting seasons (March 1 to September 23). The levels of snags and coarse woody materials that need to be maintained on-site will vary by situation, depending on how many standing trees remain. Standing healthy green trees, which do not impose operational hazards, as well as some defective trees which are safe and sound, would be left in the sale unit to provide a stand legacy to the regenerating area. Standing green trees would not generally be included in the sale except those leaning or "root sprung" that are likely to blow down in the near future or those that impede operations. There may be small salvage sales of scattered hazard trees found along roadways, power-line corridors, or other access areas. In the past, such sales have been hardwoods or blown-down conifers in, adjacent to, or leaning over the road prism. See also the discussion in the Hazard Tree Removal program above.

3.15.2.1 Specific Conservation Measures for Salvage Sales

In addition to the conservation measures for All Activities covered by the proposed action, the following conservation measures apply specifically to Salvage Sales:

Conservation Measures for Spotted Owl and Marbled Murrelet:

1. Adequate levels of large diameter standing and downed wood will be retained post-project implementation at appropriate levels for the watershed and stand using information in the model DecAID (Decayed Wood Advisor for Managing Snags, Partially Dead Trees, and Down Wood for Biodiversity in Forests of Washington and Oregon) (Mellen-McLean et al. 2012).

2. Known, occupied spotted owl activity centers or marbled murrelet nest sites shall not be exposed to noise-producing activities (that exceed known or estimated noise levels that are likely to disrupt breeding activities) during the early spotted owl nesting season or the complete murrelet nesting season.

Conservation Measures for Bull Trout:

1. Level 1 Team review is required for all salvage sale projects to ensure project impacts are within the range anticipated in this Opinion.

2. Road construction and reconstruction conservation measures are required for any roadwork completed during salvage sales. Those conservation measures are discussed in the Transportation System Program section, below.

3. ONF projects that involve hauling rock or timber shall only take place on roads that meet or exceed the road design and maintenance standards of the Forest Service and this programmatic Opinion. Prior to hauling, a Forest Service engineer and an aquatic specialist will review the subject roads to ensure that adequate drainage and erosion-control measures are in place. During hauling, the ONF will monitor the subject roads again to ensure that Clean Water Act sediment standards are being met.

4. No new culvert installations or culvert replacements will occur in bull trout habitat within bull trout core areas as part of this proposed action.

5. For all *fish-bearing streams*, riparian no-cut buffers shall extend at least 100 feet from the edge of the streambank. The no-cut buffers shall be expanded as necessary to include unstable areas adjacent to stream channels as determined by the Forest Service soils scientist and watershed staff.

6. For all *perennial and intermittent, non-fish-bearing streams*, riparian no-cut buffers shall extend at least 50 feet from the edge of the streambank. The no-cut buffers shall be expanded as necessary to include unstable areas adjacent to stream channels.

7. Slope stability in harvest and salvage harvest areas is generally assessed during the planning phase of the projects and high risk sites are excluded from project areas (this is especially in the case of convergent/concave slopes, where water is often present). Convergent slopes greater than 60 percent shall be assessed and avoided.

3.15.3 Pre-Commercial Thinning

Pre-commercial thinning, also known as young stand thinning, stocking level control, or density control, generally occurs in plantation stands that are 10 to 25 years of age. The ONF anticipates thinning an average of about 800 acres per year of young stands during the 10-year term of the proposed action; however, some of this work (an average of about 200 acres per year) is expected to be conducted during the murrelet or early spotted owl nesting seasons. Many of the units thinned would be outside the disruption distances from suitable habitat. These stands typically originated after removal of an older forest stand by clear cutting, with post-harvest management activities consisting of various types of site preparation and natural regeneration and/or replanting of the unit. The thinning units typically consist of densely stocked conifer stands (800 to 5,000+ trees per acre) with varying numbers of minor species. Generally, treated trees are less than 6 inches dbh.

Typical pre-commercial thinning activities consist of removing small-diameter conifers using various spacing methods to achieve the desired objectives for each unit based on tree size and the growing potential of the site. Thinning increases growth rates and produces larger trees with deeper crowns and heavier limbs. Future beneficial effects of thinning include diversifying species composition, increasing the resilience of the remaining stand, and promoting understory development. Thinning activities will still leave a full range of options available for future stand management. Thinned young stands may retain a combination of planted species and natural regrowth, and less of a monoculture stand condition. Thinning will be used to enhance species diversity by giving some retention preference to minor species in stands otherwise dominated by one or two major species. These minor species might include western red cedar, Pacific silver fir (*Abies amabilis*), Sitka spruce (*Picea sitchensis*), Pacific yew (*Taxus brevifolia*), western white pine, cascara (*Rhamnus purshiana*), wild cherry (*Prunus virginiana*), big-leaf maple, red alder, willow (*Salix spp.*), black cottonwood (*Populus trichocarpa*), vine maple (*Acer circinatum*), and red elderberry (*Sambucus racemosa*). Thinning prescriptions and the quantity of minor species retained will vary among stands depending on presence, land allocations, site-potential, stand objectives, potential wildlife use, and other local site indicators. Thinning objectives should be developed cooperatively by resource specialists to meet desired future conditions of the stands so that the silviculturist can develop responsive prescriptions. Depending on stand objectives and capabilities, the prescription might include small openings and/or unthinned areas to provide wildlife forage areas, cover, variable spacing, and structural diversity. Within riparian reserves and LSRs, prescriptions are generally designed to enhance growth and structural/species diversity in the stand. Pre-commercial thinning prescriptions may also involve small gaps, generally 0.25 to 0.5 acre in size, or skip areas developed with involvement of a wildlife biologist. The cut trees may be left on the ground, lopped and scattered, or piled to form small mammal structures depending on other objectives and the amount of slash.

Some removal of remnant trees may be required if they create a hazard for silvicultural workers, but such removal should be avoided through use of skip areas wherever possible. Such removal is included in the Hazard Tree Removal program described above.

Another type of pre-commercial thinning that the ONF proposes to implement involves thinning the dense hemlock understories of older stands. These older stands generally were commercially thinned 20 to 30 years ago, allowing a dense carpet of hemlock seedlings to become established and grow to sapling size before becoming stagnated because of shading from the overstory and competition among themselves. The dense understory can shade out desirable shrubs and herbs on the forest floor, inhibiting the development of a multi-layered forest structure. Thinning the sapling understory can maintain these shrubs and herbs and allow the residual understory trees to grow and develop into a mid-level canopy layer. Typical prescriptions may specify thinning the understory trees up to 6 inches dbh to spacing ranging from 16 to 20 feet, ignoring all trees over 6 inches dbh. Minor hardwood species such as vine maple shrubs are not cut. As with pre-commercial thinning, the cut trees may be left on the ground, lopped and scattered, or piled to form small mammal structures depending on other objectives and the amount of slash. Under the proposed action, the ONF anticipates thinning an average of approximately 200 acres per year of understory treatments during the 10-year term of the proposed action.

Under the proposed action, young stand manipulations such as stocking-level control will be implemented over the next several years, at a rate that reflects available funding. The ONF has identified several thousand acres that are ready for treatment. Work crews will use chainsaws to accomplish the thinning. The cut trees may either be left on site to decompose into the soil or be removed. Narrow strips along traveled roads may be piled and burned to reduce potential fire hazards or include other fuel treatment methods, such as lop and scatter or chipping. Project work is frequently carried out from October through February with crews of six members each working in a unit. The average rate of thinning is 1.3 acres per day per person. For a typical 40-acre unit, it would take 5 days to complete the unit with a crew of 6 people, but 10 days to complete the unit with a 33-person limit.

3.15.3.1 Specific Conservation Measures for Pre-commercial Thinning

In addition to the conservation measures for All Activities, the following conservation measures specifically apply for Pre-commercial Thinning actions:

1. To prevent large quantities of small, mobile debris from entering streams, small trees shall not be felled toward streams.

2. Riparian buffers shall be reviewed by an aquatic specialist to ensure consistency with aquatic resource objectives.

3.15.4 Timber Stand Improvement

Timber Stand Improvement work includes “release,” pruning, and conversion of stands from a hardwood-dominated condition to a conifer-dominated stand or a mix of conifer and hardwoods. The ONF proposes to improve an average of 100 acres per year during the 10-year term of the proposed action. Most of this work would be conducted outside the early spotted owl nesting season, but some work is likely to occur during the murrelet nesting season. Those units scheduled for treatment in the spring would be farther than the appropriate disruption distance from spotted owl and murrelet suitable habitat. Treatment units would range in size from about 5 acres to about 150 acres with an average size of about 40 acres. Under the proposed action, up to 13, 40-acre units will receive timber stand improvement.

Timber stand improvement in riparian areas will be implemented in accordance with the USFWS's Oregon-Washington Aquatic Restoration Biological Opinion (USFWS 2013). If timber stand improvement is proposed to occur in upland areas adjacent to riparian areas (but not in riparian areas), aquatic specialists will design and implement no-cut buffers to protect aquatic habitat. In most situations, treatments will only extend to the topographic break in slope, at least 50 feet prior to the edge of an inner gorge or unstable area, or to the extent of riparian vegetation, leaving a no-cut buffer along the stream.

Release involves work crews with chainsaws and brush cutters to remove competing brush vegetation. The vegetation removal prescriptions are designed to promote growth on residual trees, but will vary based on site-specific stand needs. Treatments within Riparian Reserves will be designed to meet the Aquatic Conservation Strategy objectives of the NWFP (USDA and USDI 1994b) by enhancing tree growth and structural and species diversity in the stand. Release generally occurs from April through October to minimize regrowth and maximize effectiveness. Cut trees will be left on the ground. Release treatments are not proposed to occur in suitable spotted owl or marbled murrelet nesting habitat.

Pruning entails the removal of limbs using hand tools, usually from about the first 8 to 32 feet above the ground on trees within existing plantations to open the stand and encourage understory development. Pruning might be used to create knot-free wood for future availability. Pruning occurs in any of the snowfree months but mainly in the spring or fall. Pruning is not proposed to occur in suitable spotted owl or marbled murrelet habitat.

Stand-conversion projects adjust the composition of hardwood and conifer trees in stands to move stands toward desired forest characteristics. Under the proposed action, stand-conversion projects will only occur where conifers would naturally have occurred and there is evidence that conifer once occurred there. This activity may include removal of hardwoods including red alder, big-leaf maple, black cottonwood, and vine maple. However, such activities are expected to retain minor hardwood species, especially mast-producing species such as bitter cherry (*Prunus emarginata*), cascara, Pacific dogwood (*Cornus nuttallii*), maple species, and beaked hazelnut (*Corylus cornuta*). Tree removal may be accomplished by a variety of means such as cutting or girdling. The intent of the activity is to remove competition and promote the re-establishment of conifers to provide for future large conifers for late-successional forest characteristics, large diameter snags, or downed wood for riparian, stream, or upland areas, while maintaining the diversity of less-common hardwood trees. Stand-conversion projects in riparian areas would be implemented under the USFWS's Oregon-Washington Aquatic Restoration Biological Opinion (USFWS 2013).

3.15.5 Planting

Artificial regeneration will be done in the spring months using a variety of native stock seedling types (bare root, plug, transplants, and wild seedlings) and species (conifer, hardwood) to meet resource objectives. An average of 125 acres per year of reforestation will be planted over the 10-year term of the proposed action. Usually hand tools such as shovels, hoes, and planting spades are used, with conditions and planter preference determining which tools will be used in a given situation. Crews of 1 to 20 people are best suited for this type of work, with crew size dependent upon project size and timeframes.

3.15.6 Cone Collection

Cone collection is a part of the reforestation program and may occur two to six times during the 10-year term of the proposed action. Cone collection is done by tree climbing large trees and hand picking the cones, or felling smaller trees less than 18 inches dbh. This work is done outside of the established seed orchard. Cones from Douglas-fir, hemlock, larch, spruce, fir, and pine are collected. Most work is done between September 24 and October 31, but, due to the variation in maturation times of cones among years, as many as 40 trees during this 10-year term of the proposed action may need to be climbed from mid-August to September 23, which is during the latter part of the murrelet nesting season.

3.15.6.1 Specific Conservation Measures for Cone Collection Projects

Conservation Measures for Spotted Owls and Marbled Murrelets:

1. No spotted owl or murrelet SNTs shall be felled for cone collection.

2. No known spotted owl or murrelet nest trees shall be climbed for cone collection.

3. The climber shall immediately descend the tree if, when climbing a tree, it is discovered that the tree is an active nest tree for spotted owls or murrelets. All such sightings will be reported to an ONF wildlife biologist.

4. If the climber sees what appears to be a spotted owl or murrelet nest from a previous year, he/she will notify an ONF wildlife biologist.

5. If practicable, climbers shall be trained in identification of spotted owl and murrelet nest trees, and also take photos if possible.

3.15.7 Seed Orchard Operation and Maintenance

There is one active seed orchard on the ONF, and it is more than 0.25 mile from suitable spotted owl and murrelet habitat. Operation and maintenance activities in the orchard include mowing and bark scoring, pruning, removal of dead trees, repair of fences or buildings, fertilizing, and some planting, grafting, and cone collecting. ONF staff annually piles and burns woody debris at a designated site within the orchard. Equipment used for orchard operation and maintenance activities includes a tractor, mower, chainsaw and other hand tools.

3.15.8 Commercial Thinning

The ONF is proposing commercial tree thinning in both LSR and AMA allocations. Riparian Reserves overlap LSR and AMA, and primarily would not have thinning within them with the exception of fall and leave thinning and mechanical access for stream-restoration activities (large wood and boulder placement, stream-bank restoration) inside the no-harvest buffer. Thinning prescriptions in LSR and AMA allocations utilize variable-density thinning techniques to accelerate the creation of within-stand structural and compositional variety of mid-successional stands and move them more towards an understory-reinitiation stage. Variable-density thinning unevenly thins a stand using differing densities, unthinned areas (skips), heavy thins, which are defined later in text, and openings (gaps) to promote a structural mosaic. AMAs are thinned based on research which indicates that lower stand density following thinning treatments may allow for the more rapid development of late-successional characteristics (Chan et al. 2006, Garman et al. 2003, Newton and Cole 1987, Tappeiner et al. 2007).

In general, the target relative density (Curtis 1982) (RD20 to 30 RD in AMA and 30 to 40 RD in LSR) will return the stand to the start of crown competition which will emphasize high individual tree growth. These densities should create conditions that make more light available in the understory and result in higher soil moisture which in turn should promote large tree growth and development of a diverse understory. Imposing tree-diameter limits and retaining minor species including hardwoods would also contribute to diversification. Post-treatment stand densities will vary from stand to stand to create variability across the landscape as well. This prescription will vary depending on stand age and size diameter for both LSR and AMA, as described below.

Over the 10-year term of this programmatic, the ONF has evaluated the potential for six 5th field watersheds for future landscape-scale thinning activities. This includes the Wynoochee; Jimmy-Comelately/Snow Creek/Dungeness; Solduc-Quillayute; Satsop; Quinault/Humptulips; and Big and Little Quilcene/Dosewallips. Depending on the market for wood products, field reconnaissance of road conditions to access potential thinning units, and other factors, the proposed list may change after the Wynoochee project.

The ONF also proposes to implement small-sized thinning projects (less 1,000 acres) outside of these selected watersheds for smaller-scale projects that have been identified by partners such as the Washington State Department of Natural Resources (WDNR) or a collaborative group. Up to five of these smaller-sized thinning projects will be covered under this programmatic consultation, and may be located within bull trout core areas. Over the course of this programmatic consultation, the ONF proposes to commercially thin 30,000 acres in LSR (14,000 acres) and AMA (16,000 acres).

3.15.8.1 Treatment Specific to LSR and AMA Stands Less Than 80 Years of Age

The majority of silvicultural treatments in LSR or AMA stand that are younger than 80 years old would include a “thinning-from-below” prescription (generally removing smaller trees and leaving larger trees). Normally this means that 50 percent of the existing commercial-sized trees (greater than 8 inches dbh) are removed from the stand, which usually equates to one-third of the stocking level in terms of basal area. In terms of canopy cover, it means approximately one-third to one-half of the canopy cover is removed leaving between 40 to 60 percent canopy cover at the stand level. Throughout the thinning unit there would be areas of heavier thinning and gaps (small openings) that leave the canopy cover below 40 percent (see below for definition of gap), but would still allow the stand to function as dispersal habitat for the spotted owl.

The primary silviculture prescription would result in leaving variably spaced trees and a wider range of leave-tree diameters than a thinning that spaces trees equidistant from one another. The variable-spaced prescription generally removes smaller trees (between 8 to 16 inches dbh) and leaves larger trees (greater than 16 inches dbh). Thinning typically removes the most-abundant conifer species, while leaving less-abundant conifer and hardwoods in the stand. In some circumstances individual trees (less-abundant conifer or hardwood species) would be cut if they pose a safety hazard or for operational reasons, such as skid trails, yarding corridors, landings, and road locations that are needed to meet the management objectives of the proposed treatment. Leave trees are selected irrespective of tree condition, so those with deformities, cavities, broken or dead tops, breakage, double tops, crooks, heart rots, insect damage, mistletoe brooms, and other similar features of structural diversity are retained in the stand (Knowles 1996a). These trees may have wood volume loss which is not desirable as a commercial product, but such defects, disease, and infestations are ecologically desirable as they may kill some trees in the future, creating snags and coarse wood over time.

The REO provided general recommendations for variable-density thinning within LSRs that were deemed to "have a high likelihood of benefiting late-successional forest conditions" (Knowles 1996a, Knowles 1996b). The REO recommendations provide the basis for the general prescription proposed for the LSR stands, which would be a thinning from below with at least 10 percent of the stand area in skips (unthinned areas) and up to 10 percent of the area in a combination of areas of heavy thinning and gaps (small openings). The thinning treatment would reduce stand density to 30 to 40 percent of maximum stand density index, which is a level between maximizing growth at the stand level and maximizing individual tree growth (Drew and Flewelling 1979, Long 1985). Approximately 100 to 180 trees per acre would remain in the post-treatment stands with an estimated average canopy closure ranging from about 60 to 80 percent at the stand level.

The treatments proposed in AMA stands are similar to that of LSR stands except that canopy gap size, and cut tree diameter can be larger and fewer trees may remain. The thinning treatment would reduce stand density to 20 to 30 percent of maximum stand density index; a level below maximizing growth at the stand level but maximizing individual tree growth (Drew and Flewelling 1979, Long 1985). Thinning treatment (and subsequent creation of snags and coarse woody debris) will leave a range of approximately 50 to 100 trees per acre with an estimated average canopy closure between 40 and 60 percent at the stand level. Minor tree species would be retained; however, in locations designated for lower tree density following treatment, some minor species may be cut where they are in excess of needs while still maintaining tree species diversity in the overstory of the stand. Skips would be incorporated in the thinning treatment and total up to 20 percent of the stand area. Gaps up to 5 acres in size would be placed throughout the thinning unit which could represent up to 30 percent of the stand area.

At the stand level, dispersal habitat would not be degraded in quality to the point that it is no longer classified as dispersal habitat. In limited stands that are classified as lower quality foraging habitat for spotted owl, up to 500 acres would be temporarily downgraded to dispersal habitat over the course of the programmatic. Associated activities such as temporary road construction and reconstruction, and creation of log and helicopter landings, would include removal of spotted owl dispersal habitat. Under the proposed action, it is estimated that 100 acres of dispersal habitat designated as critical habitat would be temporarily removed for logging-associated activities over the course of the programmatic. Further description of road and landing impacts can be found in the "Associated Activities for all Vegetation Management Actions" section.

Over the 10-year term of this programmatic, 24,000 acres of commercial thinning will occur in stands younger than 80 years; 12,000 acres would be within LSR and 12,000 acres within AMA. Stands proposed for thinning within critical habitat for the marbled murrelet and spotted owl include all of these LSR acres and 70 percent (8,400 acres) of the AMA acres. A portion of the thinning and associated activities would be conducted during the spotted owl and marbled murrelet breeding and nesting seasons.

3.15.8.2 Treatment in LSR Stands over 80 Years of Age and/or greater than 20 inches in Diameter

Management objectives to thin stands in LSR that are older than 80 years of age are similar to those less than 80 years old. LSR stands over 80 years of age that will be thinned are generally found in overstocked stands on less productive sites or stands that were previously commercially thinned on more productive sites. In these situations, a review process is required for an exemption from the REO to approve thinning in LSR stands greater than 80 years of age, and/or removing trees greater than 20 inches dbh.

Over the 10-year term of this programmatic, 2,000 acres of commercial thinning in stands greater than 80 years of age would occur within an LSR. All LSR treatments would be within designated critical habitat for the spotted owl and marbled murrelet.

3.15.8.3 Treatment in AMA Stands, including over 80 Years of Age and/or greater than 20 inches in Diameter

The treatments proposed in AMA stands over 80 years of age are similar to that of younger stands in AMA. Thinning treatment (and subsequent creation of snags and coarse wood) will leave an average of approximately 50 to 100 trees per acre with an estimated average canopy cover ranging from 40 to 60 percent at the stand level. Minor tree species would be retained; however, in locations designated for lower tree density following treatment, some minor species may be cut where found in excess of needs while maintaining tree species diversity in the overstory of the stand. Skips would be incorporated in the thinning treatment and total up to 20 percent of the stand area. Gaps up to 5 acres in size would be placed throughout the thinning unit, which could represent up to 30 percent of the stand area, differing from the LSR standard of 10 percent. Over the 10-year term of this programmatic, 4,000 acres of commercial thinning in stands greater than 80 years of age would occur within the AMA allocation.

3.15.8.4 Treatment Specific to Alder-Dominated Stands

Pure conifer patches would be given a treatment corresponding to the land designation for the stand location (LSR or AMA) as described in previous sections. In red alder-dominated or mixed red alder/conifer stands and patches of stands, individual red alder trees would be removed to enhance the growth of existing conifers. Rather than the complete removal of red alder, individual red alder (generally greater than 8 inches dbh) would be removed from within a set distance (determined for each stand) of live conifers for release. Because these stands are currently dominated by hardwoods, they are not considered suitable marbled murrelet habitat or nesting habitat for the spotted owl. The work is generally conducted during late summer/early fall outside the early nesting season for the spotted owl, but within the murrelet nesting season. Over the course of this consultation, approximately 500 acres of alder-dominated stands would be treated.

3.15.8.5 Forest Health (Sanitation) in Forest Stands

After a disturbance event such as wind, fire, insects, or disease, stand conditions may call for live-tree removal from an area to protect future habitat quality and reduce stand vulnerability to subsequent disturbances. While salvage cutting is the removal and recovery of dead or dying trees after disturbance, sanitation is different in that live trees are removed to stop or reduce an actual or anticipated spread of insects and/or disease. Sanitation in forest stands would include the commercial removal of trees to reduce an excess of infested trees if they are expected to have negative effects on remaining trees and stands, and to protect stands from future disturbance. Trees removed would be greater than8 inches dbh. Tree selection is based on a specific diagnosis and prescription for stand health including wildlife habitat objectives for adequate amounts of snags and coarse wood over time. In general, stand size to be treated may range from 1 to 40 acres, but there may be events which are larger in size that will require Level 1 review.

Cutting of trees will be done outside the spotted owl and marbled murrelet nesting season unless the site is farther than the appropriate disruption distance from suitable habitat. Over the course of this consultation approximately 1,000 acres of stands would be treated.

3.15.8.6 Cut-tree Diameter Limits

For the majority of stands under 80 years of age in LSRs, trees greater than 20 inches dbh would not be cut as part of the thinning treatment. There will be some individual trees (live and standing dead) greater than 20 inches dbh that would need to be felled for safety or operational reasons and would remain on site as coarse wood (following REO guidance, Knowles 1996a). There may be stands in LSRs with a high density of large diameter (greater than 20 inches dbh) that are heavily stocked, and not considered spotted owl or marbled murrelet habitat that could benefit from silviculture treatment.

Within AMA stands under 80 years of age, there is no upper diameter limit on trees cut as a part of the thinning treatment. Typically, trees larger than 24-inch dbh would not be removed but, in some stands, they may be felled to meet stand objectives. If that is proposed, Level 1 review will occur during project planning or as soon as the need is identified. Depending on individual stand conditions, an upper diameter limit may be specified in some cases to maximize variability of the stand in the future. Trees considered suitable nest trees for either spotted owl or marbled murrelet would not be felled. In stands that have low density of standing dead and downed material, trees greater than 20 inches dbh may be converted to snags or coarse wood.

3.15.8.7 Skips (no-cut areas)

A skip, also known as a no-harvest area, is an area voided from commercial treatment due to possessing valuable characteristics that provide habitat for terrestrial wildlife, fish and botanical species or protection of unique features. Skips may also provide for the continued production of small-diameter snags through competition-induced tree mortality, or they may include patches of smaller trees. It provides thermal and visual cover for wildlife species, and protection for snags and coarse wood. The placement of skips offers protection of sensitive features within stands while increasing stand heterogeneity by adding an element of randomness.

Skip areas could include buffers for riparian areas, suitable nest trees, legacy trees and snags, and additional buffers designated in the PDC for protection or conservation of other species or features. Additionally, skips could include rock outcrops, concentrations of coarse wood, snag patches, brushy areas, vine maple clumps or other features that would benefit from protection. Absent of treatment, skip areas would continue to suppress the development of an understory and maintain a component of dense overstory lacking much understory vegetation that would benefit species preferring a closed canopy forest.

Within the thinning units, the size of skips in both LSR and AMA are similar and range from one-tenth acre to one-third acre.

Over the 10-year term of this programmatic, 3,000 acres of skips would be retained in LSR and AMA.

3.15.8.8 Heavy Thinning and Gaps

Patches of heavy thinning and gaps would be incorporated in the thinning treatment to increase structural and spatial complexity, obtain desired characteristics such as longer live crowns and larger live branches on individual trees, and encourage growth of understory trees and vegetation. Low tree density within heavy-thinning patches would allow the maximization of individual tree growth and the development of understory trees and vegetation. This will also promote growth and retention of larger branches lower on tree boles. Heavy thinning patches and gaps would be located to enhance existing desirable stand characteristics or to develop these characteristics in areas that lack these features.

In both AMA and LSR, prior to a thinning, a typical stand has about 300-400 trees greater than 5 inches dbh per acre. A heavy thin patch may be up to 1.5 acres and would leave about 20 to 50 trees per acre (Knowles 1996a, Muir et. al 2002). Heavy thinning would retain minor hardwood and conifer species. Even though the tree and canopy density would be less within the heavily thinned area, the overall objective in retaining an average of 40 percent canopy cover throughout the stand would be met. Possible locations for heavy thinning could include patches of leave trees with the potential to develop desired crown structure more quickly, locations designed to ensure the continued presence of minor tree species in the stand, and existing concentrations of understory trees or vegetation. In AMA, some stands may have larger heavy-thin patches (larger than 1.5 acres), while still meeting the 40 percent canopy cover average. There is no limit to the size of a heavy thin patch in AMA.

Gaps (small openings in the canopy) would allow the development of very large crowns and stems on edge trees that are able to occupy additional growing space and would allow the rapid introduction and development of a mid-level canopy of conifers and hardwood trees and shrubs. Gaps may also promote the development of very large crowns, branches, and stems on any residual trees in the center of such a gap. Typically in AMA gaps are 0.25 acre in size and could go up to 5 acres (for example in stands with root disease or when creating ungulate forage habitat). In LSR, gaps would be up to 0.25 acre in size and normally placed in areas protected from wind and away from roads and landings. In LSR, trees between 8 and 20 inches dbh would be removed, but gap creation would retain minor hardwood and conifer species.

Over the 10-year term of this programmatic, 1,500 acres of gaps would be created in LSR and AMA.

3.15.8.9 Associated Activities for all Vegetation Management Actions

3.15.8.9.1 Equipment for Removing Vegetation

Equipment used to remove vegetation for the majority of proposed activities would primarily be chainsaws. Other equipment may include mechanized machinery (e.g. feller buncher, harvester, dozer, etc.). These activities require the use of a variety of heavy equipment such as excavators, dozers, loaders, backhoes, and trucks. Hand-held equipment will include chainsaws and hand tools.

3.15.8.9.2 Yarding

The primary yarding systems to complete vegetation management activities include ground-based yarding, skyline (cable) yarding with full or one-end suspension, and helicopter yarding. Skyline and helicopter systems may be operated year-round. Skyline yarding uses a large cable, called a skyline that runs from the yarder and is attached to a tailhold. Ground-based yarding systems utilize loaders, dozers, skidders, or forwarders that bring the logs from where they are felled back to the landing. Ground-based logging is normally done year-round, except for instream work windows for listed fish species, or adjacent contiguous nesting habitat for either marbled murrelet or spotted owl.

Skid trails are designated to limit the overall amount of ground compacted. Helicopters are used for yarding trees to landings when road and landing construction is not feasible. Helicopters may be used during the marbled murrelet and spotted owl breeding season; however, the priority would be to schedule such activity outside the nesting season when adjacent to more-contiguous nesting habitat.

3.15.8.9.3 Road and Landings

To complete thinning operations, road and landing construction is needed. There are two types of roads: system roads and non-system roads. System roads are permanent roads used for multiple access needs on National Forest System lands. Non-system roads are referred to as temporary roads and are used to temporarily access timber sale units that cannot be reached by system roads. New road construction will include removing trees from the road bed, excavation, adding surface rock material, establishing ditches, adding cross-drain culverts, and installing culverts at streams.

Under this consultation, there would be no net increase in system roads after completion of project activities. All non-system roads will be decommissioned after completion of project activities. This includes removing stream crossings, decompacting the road surface, native plant seeding and planting, and blocking vehicle access.

Conventional landings are used as yarding collection points and for log truck loading. The size of a typical landing for ground-based operations is 0.25 acre and for cable logging is 0.10 acre. Landings can be current openings such as a roadside or a previous log landing, or will need to be created. If a new landings need to be developed, they are typically located within the thinning unit boundary. Landing numbers can vary depending on estimated volume in a stand, topography, type of logging equipment, type of material that needs sorting on site, contract restrictions on how logs are brought in, etc. Over the course of this programmatic consultation, the Forest Service estimates that 210 acres of ground-based landings and 360 acres of cable logging landings would be used. Of those 580 acres, 350 acres would be new construction. Normally a landing is located within forested stands that exhibit the same characteristics as stands to be thinned. Proposed landing locations require agreement by the Forest Service and purchaser. There will be no landings within Riparian Reserves.

A helicopter operation may include service, log, and emergency landings. Creation of emergency landings with helicopter logging may be needed if an existing landing or large opening is not within the required distance. USFS landings can be up to 1 acre in size to accommodate the fuel truck, log landings up to 3 acres to accommodate the arriving logs and necessary logging equipment, and an emergency landing would be 0.25 acre. Landing numbers can vary depending on estimated volume in a stand, topography, type of logging equipment, type of material that needs sorting on site, contract restrictions on how logs are brought in, etc.

Over the course of this programmatic consultation, the Forest Service estimates that 60 helicopter landings (service, log, emergency) would be used, of which 130 acres are in existing opening or non-habitat, and 60 acres of new construction are in stands similar to those thinned (dispersal habitat for spotted owl), for a total of 180 acres. During the 10-year term of the proposed action, it is anticipated that some spotted owl and murrelet SNTs will be removed (Table 4).

3.15.8.9.4 Hauling

Timber haul involves the transportation of logs, with large trucks, from a landing to a paved public road. Timber transport on forest roads can have adverse effects to streams and listed fish habitat. Timber haul may occur year-round or be seasonally restricted depending on road design, road conditions, and resource protection needs.

3.16 Transportation System Program

The transportation system program includes activities related to constructing, reconstructing, or repairing national forest roads. All vehicle traffic on forest roads is part of this proposed action and is consulted on by this Opinion.

When the ONF builds, rebuilds, repairs, or hauls on a segment of road, they are required to bring that road segment into compliance with a collective set of conditions referred to as the 'Forest Service Standard' in this Opinion. The Forest Service Standards are described in several different Forest Service publications, including but not limited to the list in Appendix J: *Forest Service Road Standards*.

3.16.1.1 Conservation Measures for the Transportation System Program

All Species:

1. If a road is decommissioned, effective access controls shall be employed to reduce motorized use and unauthorized activities on that road such as dumping of trash and cutting of legacy trees and other important habitat features.

Spotted Owls and Marbled Murrelets:

1. No blasts greater than 2 lbs. shall be allowed within disruption distances of suitable habitat during the spotted owl early nesting season or the entire murrelet nesting season.

Bull Trout:

(Culvert Replacement and Installation)

1. No new culvert installations or culvert replacements will occur in bull trout habitat within bull trout core areas as part of this proposed action.
2. The proposed replacement and installation of culverts greater than 36 inches in diameter in non-bull trout bearing streams, located within 0.5 mile of bull trout-bearing streams, shall be reviewed by Level 1 for consistency with this programmatic.

3. If culvert work is planned to occur immediately upstream from an incised channel (a streambed that has become eroded, deepened, and disconnected from its floodplain), the culvert inlet will be placed at the same elevation as the existing natural streambed. If this is not feasible, the project will be reviewed by Level I to determine consistency with this programmatic."

(Culvert Cleaning, Ditch Maintenance, and Road Blading)

4. To protect key bull trout spawning populations, road blading, ditch maintenance, and culvert cleaning shall not occur (except for emergency storm-related work) on the following roads between October 1 and April 1: South Fork Skokomish watershed Road 2361 and spurs, Road 2363 and spurs; Dungeness and Graywolf watersheds Roads 2860, 2870, 2880.

5. The vegetated ditchline shall be maintained, where functional, to help control soil erosion. Grasses and other non-woody vegetation shall be retained in ditches to reduce water velocity and trap sediment. When ditches are cleaned, sediment traps shall be installed and maintained until vegetation is re-established to prevent delivery of sediment to stream channels.

(Slope Stability)

6. New temporary roads shall not be constructed in areas with locally saturated or unstable soils or with fills greater than 30 feet in vertical height.

7. New temporary road construction will be analyzed to evaluate slope stability, potential erosion, and delivery to stream channels by Forest Service Soils scientist/hydrologist to ensure that impacts are within the range anticipated in this consultation.

(Sediment Disposal)

8. Excess material (spoils) shall be disposed of so it does not enter stream channels or other water bodies.

(Road Placement, Design, and Drainage)

9. Any proposed new permanent road construction, new temporary road construction, re-opening unclassified roads, or road reconstruction that rebuilds the road surface within 200 feet of stream channels will be reviewed by the Level 1 team to ensure that the anticipated effects are consistent with the scope of the effects described in this Opinion.

10. Stream-crossing locations on new permanent roads or temporary roads will be built at locations that minimize the length of road that lies within riparian areas to the maximum extent practicable.

11. Install cross-ditch drainage structures on new, temporary, reconstructed roads, in locations up-slope of stream crossings to minimize entry of ditch water and surface sediment into streams. Those drainage structures shall be located as close to the stream crossing as possible, while still allowing the outfall to deposit on stable portions of the forest floor and not continue directly into the stream system.

12. Cross-drain culverts on new, temporary, or reconstructed roads will be placed, when practicable, where they will drain onto stable, vegetated, low to moderate slopes with porous soils, allowing for water infiltration, and with low probabilities of erosion and formation of new channels that connect to existing streams.

13. Install a sufficient number of drainage structures on new, temporary, or reconstructed roads to minimize ditch scour, erosion at the drainage structure outlets, and prevent ditch overflow.

14. Drainage structures will be designed to avoid ditch and road surface erosion. The ONF will refer to Forest Service Handbook 7709.56 or an equivalent technical manual when designing drainage structures to meet site-specific conditions.

15. On steep slopes, or where a drainage structure outfall drains onto fill or other erodible material, or where there is not sufficient vegetation or rock for natural energy dissipation; install and maintain flumes, down spouts, and/or energy dissipaters to prevent erosion below the outfall.

16. When ditch line grades are steep enough that water could bypass or damage drainage structure inlets, the ONF will use Forest Service Handbook 7709.56 or an equivalent technical manual to determine if ditch-hardening or other measures are necessary to prevent ditch and road surface erosion.

17. Where practical, safe, and feasible, design new, temporary, or reconstructed roads with the road surface sloped toward the outside of the road (out-sloped). This type of design helps to prevent accumulation of water in the ditch line where it must be managed to minimize sediment delivery to the stream network.

(Large Wood)

18. Existing large wood in stream channels shall be left in place if feasible or replaced in the stream channel at the conclusion of the project, unless doing so would cause degradation of habitat or put a drainage structure at risk.

(Blasting)

19. Blasting in proximity to bull trout habitat in core watersheds, to be consistent with this programmatic, must be set back from the wetted width of adjacent bull trout habitat a distance determined by the protocol in Appendix D – or determined by the Level 1 team to be consistent with this Opinion.

3.16.2 New Road Construction

Rerouting existing roads to provide access around future storm damage sites may require some new road construction. New re-routed road sections would generally be less than 1,000 feet in length. The amount of road building varies widely. The roads included under this project type will remain open for use and become part of the permanent forest road network. The ONF proposes to construct 4 miles of new road during the 10-year term of the proposed action. These activities tend to occur during the breeding seasons of spotted owls and marbled murrelets because of construction constraints during wet-weather periods. Removal of as many as 30 acres of spotted owl dispersal habitat may occur with the building of new permanent roads. Some large-diameter trees deemed hazardous may be removed from the road right-of-way. During the 10-year term of the proposed action, spotted owl and murrelet SNTs will be removed (Table 4). Construction activities include the use of heavy earth-moving equipment, including backhoes, bulldozers, excavators, dump trucks, low boy tractor-trailers, rock crushers, and road graders. Work may also include hydromulching, hydroseeding, and blasting. No more than two sites would use explosives each year; this could include blasts with less than a 2-lb. charge. In some cases road work may continue for several weeks at a site. Instream work generally will be conducted from July through September (low-flow season); the timing of these projects will vary by watershed to meet allowable work windows for hydraulic projects according to the HPA MOU 2017.

As described in previous sections, additional new road construction will occur in association with commercial timber harvest activities. As stated, there would be no net increase in permanent roads from new road construction associated with commercial timber harvest, as new road construction will be offset by road decommissioning. Over the 10-year term of the proposed action the ONF proposes to construct up to 2 miles of permanent roads associated with commercial timber harvest.

3.16.2.1 Specific Conservation Measures for New Road Construction

In addition to the conservation measures applicable to All Activities and the conservation measures for all Transportation System activities, the following conservation measures apply for New Road Construction.

Spotted Owls and Marbled Murrelets:

1. No patches of suitable marbled murrelet nesting habitat or suitable spotted owl habitat will be removed for new permanent road building under this proposed action.

Bull Trout:

When the ONF builds, rebuilds, repairs, or hauls on a segment of road, they are required to bring that road segment into compliance with a collective set of conditions referred to as the 'Forest Service Standard' in this Opinion. The Forest Service Standards are described in several different Forest Service publications, including but not limited to the list in Appendix J: *Forest Service Road Standards*.

3.16.3 New Temporary Road Construction

All temporary roads constructed under this proposed action will be decommissioned and hydrologically stabilized following use (generally within 5 years or less of their construction). The ONF proposes to construct no more than 18 miles of temporary roads during the 10-year of the proposed action. Approximately one-half of the temporary roads would be constructed on old previously disturbed railroad grades or abandoned road beds that are no longer drivable. Approximately one half of the temporary roads would be new temporary roads built on previously undisturbed ground. New temporary road construction will generally be limited to short spur roads built off of existing roads needed to access landings for salvage sale projects, but construction of temporary roads on abandoned roadways or railroad grades may be over a mile in length. Construction of new temporary roads generally occurs in June through October because of construction constraints during wet-weather periods. Accordingly, an average of about 2 miles of temporary road per year may be constructed during the murrelet and owl breeding periods for the 10-year term of the proposed action. Some trees greater than 18 inches dbh may be removed from the road right-of-way, but these trees would generally not have achieved the structure of potential nest trees for murrelets or spotted owls. There could also be potential murrelet/spotted owl nest trees adjacent to the road prism that may be felled if identified as hazard trees (Table 4).

Temporary road construction activities include the use of heavy earth-moving equipment, including backhoes, bulldozers, excavators, dump trucks, low boy tractor-trailers, rock crushers, and road graders. In some cases road work may continue for several weeks at a site. Work may also include hydromulching, hydroseeding, and blasting. No more than two sites per year would use explosives during the 10-year term of the proposed action. Blasting with charges less than 2 lbs. may occur in the breeding season of the murrelet and the spotted owl. In-stream work will generally be conducted from July through September (low-flow season); although the timing of this work will vary by watershed to meet allowable work windows for hydraulic projects.

As described in previous sections, additional temporary road construction will occur in association with commercial timber harvest activities. Over the 10-year term of the proposed action the ONF proposes to construct up to 18 miles of temporary roads associated with commercial timber sales.

3.16.3.1 Specific Conservation Measures for Temporary Road Construction

In addition to the conservation measures applicable to All Activities and for all Transportation System activities, the following conservation measures apply specifically for Temporary Road Construction activities:

Spotted Owls and Marbled Murrelets:

1. No patches greater than one acre of suitable spotted owl or marbled murrelet nesting habitat will be removed for temporary road building.

2. When the temporary road is decommissioned, effective access controls will be employed to reduce motorized use and unauthorized activities, such as trash dumping and cutting of legacy trees.

Bull Trout:

When the ONF builds, rebuilds, repairs, or hauls on a segment of road, they are required to bring that road segment into compliance with a collective set of conditions referred to as the 'Forest Service Standard' in this Opinion. The Forest Service Standards are described in several different Forest Service publications, including but not limited to the list in Appendix J: *Forest Service Road Standards*.

3.16.4 Road Reconstruction

Road reconstruction is an activity within existing road prisms on permanent system roads to improve drivability or to bring the roads up to current standards. The ONF proposes to reconstruct approximately 100 miles of road during the 10-year term of the proposed action, unassociated with commercial thinning. This work will be done on permanent roads to upgrade road surfaces, improve safety, or replace aging structures. Approximately one-third of the road reconstruction work may be done during the early spotted owl nesting season, while most work will be scheduled to coincide with the summer dry season from July through September.

As described in previous sections, additional road re-construction will occur on existing road prisms from non-system roads and decommissioned roads in association with commercial timber harvest activities. Over the 10-year term of the proposed action the ONF proposes to reconstruct approximately 130 miles of roads associated with commercial timber sales.

Reconstruction activities include the use of heavy earth-moving equipment, including backhoes, bulldozers, excavators, dump trucks, low boy tractor-trailers, rock crushers, and road graders. Work may also include hydromulching, hydroseeding, and blasting. No more than five sites would have explosives used each year. In some cases, road work may continue for several weeks at a site.

Instream work for road reconstruction generally will be conducted from July through September (the low-flow season). The timing of this work will vary by watershed to meet allowable work windows for hydraulic projects (WDFW and USFS 2017).

3.16.5 Bridge Construction and Reconstruction

Bridges on forest roads are installed/reinstalled to provide passage of flood flows and associated bedload, for better fish passage, or because the current crossing structure has reached the end of its expected design-life and is becoming unsafe. Bridges that are being upgraded for fish passage should be covered under the joint Oregon-Washington Aquatic Restoration Biological Opinion (USFWS 2013). The extent of this activity varies, but generally it will be limited to previously disturbed locations. The ONF proposes to construct or reconstruct an average of 8 bridges per year during the 10-year term of the proposed action. Most in-stream bridge construction activities are likely to occur during the summer low-flow period to meet conditions of the Hydraulics Projects MOU (WDFW and USFS 2017). Road bridges could include designs as simple as prefabricated bridges set from one side of the stream onto spread footings (with no stream crossings by heavy equipment and no excavation) or as complicated as built-in-place steel or concrete structures that may include some stream crossings with equipment, excavation within the wetted perimeter for footings and/or rip-rap, and re-channeling of the water flow (for temporary diversions or permanent fill removal and regrading).

Placement of riprap, if any, will be less than 300 cubic yards (cy) per project and limited to the amount necessary to protect bridge abutments and footings. Treated timber will not be used for abutments or other structures within the bankfull channel. The equipment used for this type of work includes larger-tracked excavators and cranes, bulldozers, dump and concrete trucks, helicopters, and generators for pumps. Some of these activities are likely to occur during the early spotted owl or murrelet nesting seasons. Pile-driving and/or blasting may also might occur on about 32 bridges during the 10-year term of the proposed action. Blasting with charges of greater than 2 lbs. will not occur during the early spotted owl nesting season. No removal of patches of suitable habitat for the spotted owl or marbled murrelet will occur as a result of this activity. Removal of individual larger trees may be necessary for the purpose of minor realignment of the road, driving site distance maintenance, and approved clearing of construction limits. Generally, spotted owl and marbled murrelet SNTs anticipated to be cut by this program are considered danger trees (see Table 4).

For new bridge construction, only those bridges that fully span the bankfull stream channel are included in the proposed action covered by this Opinion. Construction of bridges that have supports or abutments within the bankfull channel are not covered under the proposed action covered by this Opinion.

Reconstruction of existing bridges that fully span the bankfull stream channel, and reconstruction activities of other bridges that does not involve any in-stream work, such as replacing bridge decking, are also included in the proposed action. Any reconstruction of existing bridge supports or abutments within the bankfull channel and other bridge work that would occur within the wetted width of bull trout habitat are excluded from the proposed action.

In-stream work on bridge construction/reconstruction generally will be conducted from July through September (the low-flow season). The timing of this work will vary by watershed to meet allowable work windows for hydraulic projects (WDFW and USFS 2017).

3.16.5.1 Specific Conservation Measure for Bridge Construction/Reconstruction

In addition to the conservation measures applicable to All Activities and for all Transportation System activities, the following conservation measures for bull trout apply specifically to Bridge Construction/Reconstruction:

1. Bridge construction and reconstruction actions occurring within the wetted width of bull trout habitat in core watersheds or critical habitat, with the exception of riprap placement as described by the following Conservation Measure # 2, are not covered under this programmatic action.

2. Replacement of riprap above water where riprap previously existed to protect the bridge is covered by this programmatic Opinion without Level 1 review. Placement of riprap in new locations above, below, or next to existing riprap or infrastructure (such as bridge abutments) shall be reviewed by the Level 1 team to ensure consistency with this programmatic consultation. Any in-water placement of riprap in bull trout habitat shall also be reviewed by the Level 1 team to ensure consistency with this programmatic consultation. When a riprap project that would have otherwise been evaluated by the Level 1 team for consistency is performed as an emergency action, the Level 1 team will instead review that project after-the-fact and determine if the effects were consistent with those consulted on this Opinion or if the action requires separate emergency consultation with the USFWS.

3.16.6 Transportation System Repair (Excluding Bridges)

Road system segments may be damaged or undermined by storm events or other natural events. Minor storm-related repairs such as cleaning blocked culverts, clearing roadways of trees and slide debris, and removing bank sloughs from ditch lines are covered under the Routine Road Maintenance portion of the proposed action addressed by this Opinion. Transportation System Repair covers repairs of more-severe storm damage to the road prism or drainage structures. Such situations may require placement of riprap and fill at failures, installation of new culverts or drainage devices, or realignment of road segments. The ONF proposes to repair up to 100 sites per year in the transportation system during the 10-year term of the proposed action. Placement of riprap, if any, will be less than 300 cy per project and limited to the amount necessary to protect existing structures (bridge abutments, footings, culvert inlets and outlets) and fill minor erosion sites. Most work will occur above the wetted width of the stream, but some riprap will be placed in the water.

Transportation-system-repair activities include the use of heavy earth-moving equipment for up to several weeks at a site. The equipment used may include backhoes, bulldozers, excavators, dump trucks, lowboy tractor-trailers, rock crushers, and road graders. Activities within this project type may include hauling of existing materials from rock sources for riprap, surfacing, or barriers. The use of explosives, jackhammers, and pile drivers could occur at several sites where bridges are constructed to replace culverts. Some of the work will be conducted during the early spotted owl or murrelet nesting seasons.

Some transportation repair projects that have the “overall goal of restoring hydrologic functions” have been or will be covered under the joint Oregon-Washington Aquatic Restoration Biological Opinion (ARBO II) (USFWS 2013) or its replacement. If the transportation system repair project is consistent with the project description and intent of the ARBO II, then that project will be covered by the ARBO II. All road repair projects occurring for the purpose of commercial thinning within bull trout core areas will follow the most current ARBO standards.

In-stream work on transportation system repair actions generally will be conducted from July through September (the low flow season), and will not occur within bull trout habitat in core watersheds for bull trout (with the exception of some in-water riprap placement). The timing of this work will vary by watershed to meet allowable work windows for hydraulic projects (WDFW and USFS 2017). Under the proposed action, repair work at about 20 sites per year may be initiated during the early spotted owl nesting and murrelet nesting seasons.

3.16.7 Specific Conservation Measures for Transportation System Repair Projects

In addition to the conservation measures applicable to All Activities and for all Transportation System activities, the following conservation measures for bull trout apply specifically for Transportation System Repair Projects:

1. Transportation system repairs occurring within the wetted width of bull trout habitat in bull trout core watersheds or critical habitat, with the exception of riprap placement as described by the following Conservation Measure # 2, are not included in the proposed action.

2. Replacement of riprap above water, where riprap previously existed to protect the bridge, is covered by this programmatic Opinion without Level 1 review. Placement of riprap in new locations above, below, or next to existing riprap or infrastructure (such as bridge abutments) or in new locations outside of the bankfull channel shall be reviewed by the Level 1 team to ensure consistency with this programmatic consultation. Any placement of riprap into the water in bull trout habitat shall also be reviewed by the Level 1 team to ensure consistency with this programmatic consultation. Riprap placement in the bankfull channel in entirely new locations (not adjacent to existing riprap or infrastructure) is not included the proposed action and is not covered by this Opinion. When a riprap project that would have otherwise been evaluated by the Level 1 team for consistency with this project is performed as an emergency action, the Level 1 team will instead review that project after-the-fact and determine if the effects were consistent with those consulted on this Opinion or if the action requires separate emergency consultation with the USFWS.

3.16.8 Rock Sources

Existing rock quarries are developed as source areas for rock and gravel to be used for surfacing and maintaining forest roads, including hauling timber, and improving and maintaining administrative and recreation sites such campgrounds and trails. Contractors may provide their commercial rock sources for a project, and those sites are not covered in this consultation. They are required to adhere to Forest Service standards and specifications. For this consultation, development and expansion of rock quarries/pits will be on National Forest System lands, and is done by contract.

The Forest Service has 190 existing (recorded) sites which may be active or inactive. They range in size of less than 1 acre to 15 acres; average size of a large pit is 9 acres. Quarries may be large enough to supply road surface materials for a network of roads or may be small and supply rock only for the roads associated with an individual timber sale or trail. Activities associated with the operation of existing rock sources may include blasting, excavating with heavy equipment, crushing operations, stockpiling rock material, and hauling material to project sites. Blasting at these sites may be accomplished with large in-the-hole charges that cause minimal sound disturbance. Occasionally, surface charges are detonated that cause greater sound. The ONF will attempt to limit blasting activities to existing quarries and other rock sources only. Activities associated with the development or expansion of a quarry can include removal of vegetation (understory herbs and shrubs, live and dead trees, and downed wood) and soil. Expansion of existing pits would include vegetation clearing of all vegetation material, including roots, within the development area, and for a reasonable setback from edge of slopes. It may also require excavation, drilling and blasting, crushing, sorting and piling of rock materials, stockpiling of rock material, loading, and hauling material in trucks to project sites. There may also be a need for construction or reconstruction of access roads and the work area. These activities require the use of a variety of heavy equipment such as drill rig, excavators, dozers, loaders, percussion hammers, backhoes, rock crushers, and trucks. Hand-held equipment may include chainsaws and hand tools.

Pits and quarries may be active for several days to several months, and work may be conducted at any time of day or night. Use may be intermittent or concentrated in a short time period. Both expansion and new pit development may require blasting. A site expansion or development will require multiple drill holes and multiple charges placed for each development entry. Sites may be opened in one entry, but likely will occur during multiple times over several years. Blasting at select quarry sites may be accomplished by either large in-the-hole charges, or surface charges. Detonation of in-the-hole charges cause minimal sound disturbance whereas detonation of surface charges cause greater sound.

The ONF proposes to operate 40 rock sources intermittently during the 10-year term of the proposed action. The ONF anticipates that blasting with charges 2 lbs. and less may occur at five sites per year, three of which would be during the early spotted owl nesting season. No blasting of charges heavier than 2 lbs. is anticipated under the proposed action. Additionally, under this programmatic, operation of 10 out of the 40 existing rock pits would include expansion. Typically, an expansion would include 2 acres of clearing outside of the current pit limit. New rock-pit development is similar to an expansion, but is between 2 and 10 acres in size. New development will permanently remove all vegetation. Under this programmatic, 5 new rock pits would be created. For new rock pit development and expansion within LSR, a review process is required for an exemption from the REO.

Over the 10-year term of this programmatic, 10 of the 15 proposed expansions/new development sites will occur within 0.25 mile of spotted owl and marbled murrelet suitable nesting habitat or critical habitat. The number of spotted owl and marbled murrelet SNTs anticipated to be cut as a result of the proposed implementation of this program during the 10-year term of the proposed action is presented in Table 4.

Development and expansion operations using blasting, drilling, and crushing will occur outside the nesting season for spotted owls or marbled murrelets. Other lower-impact operations such as digging and loading may occur during the nesting period. There would be no activity within Riparian Reserves or areas.

In addition to blasting, noise may be elevated above background levels by operation of heavy equipment, including transport of aggregate material to the project site. Quarry sites (outside of Riparian Reserves) that are no longer needed to supply rock for roads, can be used as waste areas for material removed from roads and ditches during road-maintenance operations.

3.16.8.1 Conservation Measures for Rock Source Projects (New and Expanded)

All Species:

1. Use of new sites for rock sources shall require Forest Service coordination with the Level 1 team to ensure that effects to listed species and critical habitats are consistent with those anticipated in this Opinion.

2. Alteration or removal of suitable habitat would occur outside of the spotted owl and murrelet nesting season, unless the site is considered low-quality habitat by the level 1 team.

3. For a full list of conservation measures applicable to rock sources, see Appendix L (PDCs).

3.17 Road Maintenance Program

The purpose of the ONF road-maintenance program is to provide safe vehicular access to the ONF by maintaining the existing road surfaces, culverts, ditches, and roadsides free of potholes, debris, brush, and other obstructions and to perform work necessary to minimize road-related erosion. All vehicle traffic on forest roads is part of this proposed action and is consulted on by this Opinion.

The proposed maintenance activities include cleaning, replacement, and installation of culverts; grading; removal of debris from landslides ; erosion control; brushing; removal of danger and downed trees; pavement repair; bridge maintenance; gate installation and maintenance; painting; and shoulder maintenance. The ONF maintains 2,200 miles of road in five maintenance levels (MLs) (the higher the number, the more developed the road). Road maintenance activities can occur year-round. The ONF proposes to maintain up to 2,200 miles of road per year during the 10-year term of the proposed action. The ONF proposed to maintain about 1,200 of these miles between March 1 and August 5 each year (500 miles in MLs 1 to 2 (450 miles-mechanized; 50 miles-non-mechanized), and 700 miles in MLs 3 to 5). From August 6 through September 30, 350 miles of road would be maintained (150 miles in MLs 1 to 2, 200 miles in MLs 3 to 5). From October 1 through March 1, 650 miles of road will receive maintenance; of those, 300 miles would be on ML 1 and 2 roads and 350 miles on ML 3 to roads.

In addition to this mobile-maintenance work, the ONF estimates that relatively immobile tasks such as culvert repairs and slide repairs would be done at an average of about 16 sites per year on ML 1 to 5 roads during the 10-year term of the proposed action. About 24 miles of helicopter surveys may be needed as part of the road-management program and this activity is included in the allocated total in the Administrative Tours and Remote Site Inspection section below. The following describes the amount of maintenance done at each maintenance level.

Maintenance Level 1: These roads have been closed to vehicular traffic but not decommissioned. Preventative maintenance generally is conducted with non-mechanized hand tools with minimal use of mechanized equipment. Approximately 29 percent of total road miles on the ONF are in ML 1.

Maintenance Level 2: These roads are maintained for high-clearance vehicles only and generally have low or infrequent use; however, some ML 2 roads are located in high-traffic situations and require maintenance on a year-round basis. Maintenance work includes cross ditching (10 per mile, work on 30 percent each year), ditch maintenance (work on 10 percent each year), culvert cleaning (10 per mile, work on 30 percent each year), brushing (every 4 years), and removals (slides, unstable fill slopes, etc. average 18 cy/mile). Approximately 53 percent of the total road miles on the ONF are in ML 2.

Maintenance Level 3: These gravel roads are maintained for standard cars and passenger vehicles and can have a wide range of use. Work includes blading (2.5 bladings/year), ditch maintenance (annual), culvert cleaning (10 per mile, 35 percent each year), brushing (every other year), and removals (debris from landslides, unstable fill slopes, etc. average 18 cy/mile). Approximately 13 percent of total road miles on the ONF are in ML 3.

Maintenance Levels 4 and 5: These roads generally receive high use from standard passenger cars and other vehicles. The proposed work on ML 4 and 5 roads includes ditch maintenance (annual), culvert cleaning (10 per mile, 35 percent per year), brushing (every other year), removals (slides, unstable fill slopes, etc. average 18 cy/mile), shoulder maintenance (annual), sweeping of roads (annual), paint striping (every 5 years), and chip sealing (every 8 years). Approximately 5 percent of total road miles on the ONF are in ML 4 or 5.

Road-maintenance activities such as grading, culvert cleaning, drainage maintenance, ditch cleaning, surfacing replacement, road closures, gate maintenance, and tree removal are usually done between March 15 and November 30 and are limited by snow during the winter months. Activities that require dry weather such as shoulder maintenance, painting, pavement skin patching/potholes, crack repairs, and bridge maintenance usually are done during August, but can occur anytime between June 1 and September 30 depending on the weather. Bridge maintenance has a longer time-window and might occur between April 1 and the end of October. Activities involving vegetation control such as brushing are done year-round, but are usually done in the spring through mid-summer (April 1 to June 30) when the sap is flowing because effects will last longer. Some danger tree removal may be required in conjunction with these maintenance activities.

Heavy run-off events or other natural disturbances may require road repairs to alleviate imminent resource damage or public safety issues at any time. In-stream work in response to these events generally will be conducted from July through September (the low-flow season). However, the timing of this work will vary by watershed to meet allowable work windows for hydraulic projects (WDFW and USFS 2017).

3.17.1 Specific Conservation Measures for Activities Conducted for the Road Maintenance Program

Bull Trout:

1. All conservation measures required under the Transportation System Program are also required under the Road Maintenance Program.

3.17.2 Culvert Replacement and Installation

This activity is normally done during the summer low-flow period on ML 1 through 4 roads. It includes replacement of existing culverts that have become damaged or are no longer functional and installation of new culverts needed to improve road drainage. Culvert replacements or installations under Road Maintenance are limited to ditch relief pipes and structures which convey intermittent channels or small, non-fish bearing streams where the new culvert is less than or equal to 36 inches in diameter.

Replacement of larger culverts and culverts on fish-bearing streams are discussed in the sections in this Opinion on Transportation System Repair and Fish Passage Improvement, respectively. Equipment used for culvert replacement and installation generally would include a backhoe or excavator and a dump truck. Culvert replacement can take 1 day or longer.

3.17.3 Grading

This activity is done year-round on roads of MLs 3 or 4, and includes cross ditches and some cleaning and removing ditches. Generally, a road grader is used to complete this work that can cover 4 to 6 lane miles/day depending on road location and condition.

3.17.4 Drainage Maintenance

This activity is usually performed in the fall and spring on roads of MLs 2 to 4. The equipment used to complete drainage maintenance work is usually a backhoe and sometimes a dump truck. About 15 culverts can be cleaned per day. Culverts infrequently need replacement, which requires a backhoe or excavator and can take a day or more. Pulling ditches (ditch cleaning) would also be completed. The equipment to be used includes a road grader, loader, dump truck, and chainsaw.

3.17.5 Brushing

Brushing is usually performed during the spring when it is more effective, and can cover 5 road-side miles per day depending on site conditions. Brushing normally is done on ML 4 roads every other year and may be done on ML 3 roads every third year. Brushing is done on ML 2 roads when needed for access, public safety, and drainage maintenance.

3.17.6 Downed Tree Removal

This activity involves removing windfalls (downed trees) from within the road prism using a chainsaw and takes about 0.5 hour to 1 hour per tree. Most of this work is done in early spring after the winter storms, but can occur anytime during the year when needed.

3.17.7 Danger Tree Removal

Removal of danger trees along ML 2 to 5 roads occurs annually. All conservation measures specified under the Danger Tree Removal Program will be applied to this road maintenance activity.

3.17.8 Pavement Repairs

Pavement repairs are usually performed in August through September using a dump truck, paver, and roller. Work normally goes fairly quickly, and is done about every 5 years. Individual potholes are filled annually using a dump truck or pickup.

3.17.9 Surfacing Replacement

Surfacing replacement is usually performed July through September using dump trucks, pavers, rollers, and graders. Work includes replacement of aggregate surfacing or chip sealing of asphalt surfacing.

3.17.10 Bridge Maintenance

Bridge cleaning is done every 2 to 3 years in the summer (usually July through September) using a compressor and a power washer. The High Steel Bridge (over the South Fork of the Skokomish River) takes 0.5 day to 1 day to complete. Twelve steel bridges on the ONF require periodic painting every 15 to 20 years, and two steel bridges require painting every 5 years. Routine bridge maintenance involves repair of bridge approaches with gabions or reinforced soil retaining walls, brushing of approaches, hazard/danger tree removal, removal of drift logs from the channel near bridge, asphalt patching and crack sealing, bridge and approach guardrail repair, skin patching of bridge deck, sign installation, replacement of deck running planks, flushing/cleaning of bridge decks, cleaning of all bridge bearing seats and bridge components, cleaning, sandblasting and spot painting of steel bridges with containment, removal of fill from contact with girders, in-place chemical treatment of timber bridge components, and periodic inspections with Under Bridge Inspection Trucks.

3.17.11 Gate Installation and Maintenance

On roads where public access is restricted, road gates, earthen berms, jersey barriers, ecology blocks, or boulders are installed to prevent vehicle access. A backhoe, boom truck, or similar machinery is typically used for such activities, with work completed in 1 day or less. Gate maintenance normally consists only of painting, but sometimes total replacement is required, which takes a backhoe up to 3 hours and a welder up to 2 hours to complete.

3.17.12 Painting

Stripe painting on paved roads is done every 5 years using a paint truck.

3.17.13 Shoulder Maintenance

This activity involves shaping the road shoulder so that it meets the edge of the pavement smoothly. It is accomplished with a road grader, and generally does not involve the ditchline portion of the road prism. A tractor with a rotary broom follows the grader and sweeps loose gravel off the paved surface. The activity is best accomplished from July to September, as dry conditions are needed to avoid mud on the road surface and possible movement of sediment into stream courses. About 5 miles per day can be accomplished depending on site conditions.

3.17.14 Road Daylighting

Trees within the road prism of Forest Service roads frequently produce debris like tops, branches, needles, and leaves which can obstruct ditches and plug culverts, leading to road failure. Another component to daylighting is to increase sun exposure on the road to allow the road to dry out faster and reducing damage to the road. These trees may not meet the definition of a hazard/danger tree.

The prescription includes removing an individual tree or clumps of trees that extend over the road within about 30 feet of the edge of the road prism. This includes both conifer and deciduous trees, and the stand is not classified as late-successional/old growth as defined by the 1994 NWFP. Most of the conifers would be less than 20 inches dbh. Tree removal along Forest Service system roads would follow the conditions and cut tree diameter limits given in sections for “Treatment Specific to LSR Stands” and “Treatment Specific to AMA Stands”.

A majority of these trees selected for removal are alder. The majority of these stands would not be classified as suitable habitat for either the spotted owl or marbled murrelet, but may be classified as spotted owl dispersal habitat.

This activity may be conducted simultaneously in preparation for timber sales and would only be necessary one time per road for the life of this document. This work is generally done to avoid heavy rainfall, from early June through early October, but can occur year-round. Work may be conducted in the breeding season for marbled murrelet and spotted owl, but activity adjacent to more-contiguous nesting habitat will be prioritized to occur outside the nesting season for either species.

Over the course of this consultation, up to 1,500 acres would treated.

3.18 Lands and Special Uses Program

The Special Use Program involves a variety of activities that require the issuance of permits, including occupancy of recreational residences and cabins, use and maintenance of facilities, and commercial operations. There are approximately 260 special use permits on the ONF. Of these,

~ 85 are under the recreation program and ~ 175 are considered non-recreational. New construction or operation of wind-power facilities are not covered under the proposed action or this Opinion and would require separate consultation.

3.18.1 Road Use and Access Permits

Road-use permits authorize haul, usually of timber and rock, to and from nonfederal lands over National Forest System roads. The ONF proposes to issue an average of approximately 20 road use permits per year during the 10-year term of the proposed action. This number includes the road construction/reconstruction permits described below. Under the 2001 USDA Interim Directive 7709.59-2001-1, road use permits that are issued for commercial use of existing roads that are available for public use, and suitable for the planned commercial use without reconstruction, do not trigger compliance with the requirements of the NEPA and the ESA. Most of the use permits issued by the ONF will fall under this context. Road use requests that require construction or reconstruction prior to use are subject to NEPA and ESA requirements. Accordingly, only road use and access permits in the latter category are included as part of the proposed action and covered by this Opinion.

As stated in USDA and USDI (1994b:C-19): "Access to non-Federal lands through LSRs will be considered and existing right-of-way agreements, contracted rights, easements, and special-use permits in LSRs will be recognized as valid uses. New access proposals may require mitigation measures to reduce adverse effects on LSRs. In these cases, alternate routes that avoid LSR habitat should be considered. If roads must be routed through a reserve, they will be designed and located to have the least impact on late-successional habitat." The number of spotted owl and marbled murrelet SNTs anticipated to be cut as a result of the proposed implementation of this program during the 10-year term of the proposed action is presented in Table 4.

Road Construction/Reconstruction Permits authorize the construction or reconstruction of a road across ONF lands to access non-Federal lands, usually for purpose of timber harvest with necessary machinery such as excavators, shovels, graders, dump trucks, and chainsaws. The amount of road building on ONF lands varies widely; requests range from 25 feet to 1 mile and average approximately 500 feet. Some roads may remain open permanently, whereas others will be temporary (less than 5 years) and will be restricted, closed, or decommissioned following use. Road construction may entail cutting of Federal timber. The ONF anticipates that an average of approximately five road construction/reconstruction permits per year will be issued for a total of 5 miles of new road construction/reconstruction on Federal land during the 10-year term of the proposed action. This activity generally is limited to spurs less than 1,000 feet in length. As many as 30 acres may be converted to road (assuming a 25-foot clearing width). The proposed action in this Opinion does not cover projects that remove patches of suitable habitat for spotted owls or murrelets.

Most of the requests for road use permits involve access to privately owned land for timber harvest. A section 10 permit is required under the ESA for activities on non-Federal lands that are likely to cause take of listed wildlife species unless a Federal nexus exists, such as a Forest Service road-use permit, that would facilitate coverage of these activities under an Opinion issued under section 7 of the ESA, provided the effects of the proposed action do not violate section 7(a)(2) of the ESA. Road use permits for actions on private lands that are likely to cause take of listed wildlife species are outside the scope of the proposed action covered by this Opinion.

Road construction/reconstruction activities include the use of heavy earth-moving equipment including backhoes, bulldozers, excavators, dump trucks, lowboy tractor-trailers, rock crushers, and road graders. Work may also include hydromulching, hydroseeding, and blasting. Blasting with charges less than 2 lbs. may be required in a few cases annually. In some cases, road work may continue for several weeks at a site. Instream work generally will be conducted from July through September (the low-flow season). The timing of in-stream work will vary by watershed to meet allowable work windows for hydraulic projects (WDFW and USFS 2017).

3.18.1.1 Specific Conservation Measures for Road Use and Access Permits Projects

All Species:

1. All conservation measures shall be applied on ONF lands as specified under the following programs in the proposed action covered by this Opinion: Road Construction/ Reconstruction projects in the Transportation System Program; the Road Maintenance Program; and the Hazard/Danger Tree Removal Program.

2. Road-use requests that require construction or reconstruction prior to use for roads longer than 1,000 feet will require Level 1 team review.

3. Road-use authorizations that involve hauling rock or timber on ONF roads or over ONF lands shall meet or exceed the road design and maintenance standards of the Forest Service and the standards for road use and access permits under the proposed action covered by this Opinion. Prior to hauling under any road-use authorization, a Forest Service engineer and an aquatic specialist will review the subject roads to ensure that adequate drainage and erosion-control measures are in place. During hauling under any road-use authorization, the ONF will monitor the subject roads again to ensure that Clean Water Act sediment standards are being met.

Spotted Owls and Marbled Murrelets:

1. Construction of new roads shall only occur in non-suitable or dispersal habitat for spotted owls, but may be within critical habitat for both the marbled murrelet and spotted owl. Removal of suitable spotted owl and marbled murrelet habitat, including that within critical habitat for both species for road construction (other than removal of individual hazard trees) is not covered by the proposed action and will require separate consultation.

2. Blasting with charges greater than 2 lbs. within a distance of 0.25 mile from suitable habitat shall only occur outside of the nesting seasons for spotted owls and marbled murrelets.

3.18.2 Road and Trail Easements

Road and trail easement agreements provide for joint use and management of the road system(s), exchange of easements where needed, and agreements on road access locations, construction standards, and maintenance levels, for the parties to the agreement. Roads and investments in roads become a shared responsibility between the parties, allowing for cost-effective cooperation in construction, maintenance, and repairs. The ONF currently administers up to 100 road and trail easements (including new trail construction easements) and proposes to issue an average of three new easements per year during the 10-year term of the proposed action. Activities may include minimal removal of timber (hazard/danger tree removal or right-of-way widening) and surface disturbance. Typical road right-of-way is 0.1 to 5.0 miles in length and 40 to 60 feet in width. Actual road prisms are 12 to 22 feet wide. These activities include the use of chainsaws and heavy earth moving equipment including backhoes, bulldozers, excavators, dump trucks, lowboy tractor-trailers, rock crushers, and road graders.

As stated in USDA and USDI (1994b, p. C-19), "Access to non-Federal lands through LSRs will be considered and existing right-of-way agreements, contracted rights, easements, and special-use permits in LSRs will be recognized as valid uses. New access proposals may require mitigation measures to reduce adverse effects on LSRs. In these cases, alternate routes that avoid LSR habitat should be considered. If roads must be routed through a reserve, they will be designed and located to have the least impact on late-successional habitat."

Joint Road Agreements are used between corporate and state entities where desired. Other landowners within or adjacent to the ONF, with similar long-term access needs of a lesser scope, would utilize other types of easements consistent with the Forest Road and Trail Act or Forest Land Policy Management Act together with Cooperative Road Maintenance Agreements, to perfect their right of access, obtain county building permits, provide for private driveways, and coordinate road use and maintenance with the ONF. In some instances, permits or easements may be required to resolve existing unauthorized uses such as residential/agricultural driveways or lost or unrecorded deeds.

In-stream work associated with road and trail easements generally will be conducted from July through September (the low-flow season). The timing of in-stream work will vary by watershed to meet allowable work windows for hydraulic projects (WDFW and USFS 2017).

3.18.2.1 Specific Conservation Measure for Road and Trail Easements Projects

All Species:

1. All conservation measures shall be applied on ONF lands as specified under the following Programs covered under the proposed action addressed by this Opinion: Road Construction/ Reconstruction projects under the Transportation System Program; the Road Maintenance Program; and the Hazard/Danger Tree Removal Program.

3.18.3 Tailhold and Guyline Anchor Permits

These permits authorize the use of trees on National Forest lands for tailholds and guyline anchors that enable cable logging on adjacent non-Federal lands. The ONF receives requests to use ONF trees for tower guyline anchors or tailholds when a log landing for a cable yarding operation on private land is located so near to the property boundary that there is not sufficient room on the private land to extend the guyline far enough out to provide support for the tower. Since cable landing locations are dictated by terrain, the operators usually do not have much choice in where the landing would be located, and are unable to move the landing farther away from the boundary.

Trees on National Forest lands will not be cut down or removed to place tailholds or guyline anchors without prior approval from the ONF. It is usually necessary to notch the trees at the base to prevent the cable from riding up the tapering bole, but often the tree can be left standing, and if the notches are replaced after use, the tree has a good chance of survival. Protective straps and tree plates will be used as necessary to minimize damage to trees. The largest trees that are in the most suitable location are preferred for use as guyline anchors or tailholds. There may be minor ground disturbance due to the cable touching the ground near the tree. There may also be some branches lost or removed from adjacent trees as a result of raising and lowering the cable. Chainsaws may be used on ONF lands; however, other motorized equipment may be used on the permittee's lands.

ONF proposes to issue an average of approximately 6 permits per year during the 10-year term of the proposed action, with each permit covering multiple trees (tailholds or guyline anchors) for an average of up to five trees per permit. Up to 400 trees would be used as tailhold or guyline trees over the 10-year duration of the programmatic. Each year, up to 7 spotted owl and/or murrelet SNTs may be used as a tailhold or guyline anchor. ONF anticipates less than 400 trees will be notched, including potential nest trees; however, no potential nest trees will be felled. Up to 50 trees not identified as an SNT may be felled. Table 4 presents the number of spotted owl and murrelet SNTs anticipated to be affected by this activity.

If the private action involving a tailhold and guyline anchor permit is likely to cause the incidental take of listed wildlife species, such take can be addressed through the habitat conservation plan process under section 10 of the ESA or through an individual section 7 consultation on the issuance of a tailhold and guyline anchor permit by the ONF. Tailhold and anchor permits for actions on private lands that are likely to cause take of listed wildlife are not part of the proposed action.

3.18.3.1 Specific Conservation Measures for Tailhold and Guyline Anchor Permit Projects

Spotted Owls and Marbled Murrelets:

1. Prior to the use or removal of a potential nest tree, ONF will require the permittee to prioritize the use of: (1) high quality stumps; (2) standing trees that do not have nest tree characteristics nor provide buffering of a nest tree; and (3) potential nest tree or tree that provides buffering of a nest tree.

2. The ONF shall require that permittees avoid, whenever possible, using spotted owl or murrelet SNTs for tailholds or guylines.

3. Protective straps and tree plates shall be used, as necessary and feasible, to minimize damage to trees used as tailholds and guyline anchors.

4. Notches shall be replaced on the tree after use.

3.18.4 Utilities

These activities include linear right-of-way operations and maintenance of lines for power, phone, cable, and pipelines. The right-of-way for power transmission lines (both above and below the ground) and telephone lines range from 0.1 to 20.0 miles in length and up to 200 feet in width and usually are confined within road rights-of-ways. The ONF has 14 power line permits, and 9 telecommunication line permits. An average of five permits per year will be issued or renewed for existing right-of-ways during the 10-year term of the proposed action. Maintenance activities include brushing below power lines or in ditches to keep vegetation low and during hazard/danger tree removal. Repair or replacement of damaged waterline segments and upgrading of lines to fiber optic cable are common permitted activities. This work may be conducted year-round. Vegetation management plans would be developed for specific projects that require removal of forested stands.

A number of these activities are projects conducted by other Federal agencies that have the lead for these activities, such as the Federal Energy Regulatory Commission or Bonneville Power Administration. Activities conducted by other Federal agencies (other than the ONF) or their contractors, permittees, licensees, lessees, grantees, or agents are not covered by this proposed action or Opinion, but will be addressed in separate consultations with those respective agencies. The Federal action of the ONF issuing an easement or right-of-way permit to facilitate the action by another Federal agency will be covered under that separate consultation.

3.18.4.1 Specific Conservation Measures for Utilities Projects

1. All conservation measures specified under the Road Maintenance Program and the Hazard/Danger Tree Removal Program discussed above in this Opinion shall also apply to utility projects.

3.18.5 Communication and Weather Sites

The Forest Service has three designated communication sites (North Point, Neilton Point, and Buck Mountain) where multiple government, commercial, and privately leased communication facilities are operated. Each site can support 5 to 20 towers. Leases generally are issued by the ONF for 20 years. The ONF also operates some radio repeater and weather stations for internal use. The ONF proposes to issue or amend leases, maintain, and/or upgrade six communication or weather sites per year during the 10-year term of the proposed action. This work is generally conducted in the spring through fall however operational maintenance can be done year-round. Maintenance activities include brushing and clearing of sites to keep vegetation low, structural maintenance and repair and replacement of facilities, road maintenance for access, removal of hazard trees, and fuels management activities, as described in the administrative site plans. Typical maintenance equipment includes chainsaws and motorized hand tools. Some earthwork may require heavy equipment.

For those sites with proposed tower installation, vegetation removal or topping within the line-of-sight (about one tree-crown widths) of receivers is needed to allow for signal transmission. Depending on the tower location and site projection (where receiver is located), tree removal could include a singular tree or multiple trees in clumps within a corridor. All three of the communication sites are on a ridgeline, and the line-of-sight removal would intersect other ridge tops. The line-of-sight for existing or proposed towers could be as wide as one tree crown, and could extend up to 5 miles; however, only trees that are exposed to the ridgeline would be topped or felled and would not be a continuous path of removal. New towers would likely require larger areas of vegetation removal to provide line-of-sight; existing towers generally need periodic vegetation maintenance. To minimize repeated cutting for immediate needs, larger groups of trees will be cut or topped to accommodate immediate and future requests. Communication sites are outside of riparian zones.

The existing vegetation surrounding communication sites is mainly thinned stands, including clear cuts, but some older stands are adjacent to the site. Under the proposal, there would be no removal of more than 1 acre of suitable nesting habitat per site for either spotted owl or marbled murrelet under this consultation. When individual suitable nest trees or clumps of suitable nest trees (smaller than 1 acre) are removed, work would occur outside the nesting season for both species. During the 10-year term of the proposed action it is anticipated there would be spotted owl and murrelet SNTs that would be removed (see Table 4).

Under this consultation, the Forest Service proposes to complete line-of-sight vegetation removal for up to 10 towers.

3.18.6 Research and Monitoring Permits

The ONF proposes to issue an average of 10 permits per year for miscellaneous research and monitoring activities during the 10-year term of the proposed action. Activities covered by these permits may include, but are not limited to collection of aquatic flora and fauna (including possible animal baiting, trapping, and banding), collection of physical riparian and instream habitat data, excavation of test pits for groundwater, collection of data concerning sedimentation or scouring in potential spawning habitat, possible limited cutting of trees and ground vegetation, establishment of temporary research plots, burial of sensors (which may require minimal ground disturbance), seismic testing, construction of tree-mounted data collection platforms, and installation of radio transmission antennas. Equipment used may include augers, chainsaws, equipment toters, power tools and hand tools. Research and monitoring activities may require permits from the USFWS, the National Marine Fisheries Service (NMFS), and/or the WDFW. It is likely that each permit may include as many as ten sites for activities during the 10-year term of the proposed action. This work generally is done during the summer, but can be year-round.

Due to the variable nature of these activities, the USFWS and the ONF will discuss project proposals that involve the use of heavy equipment or other motorized equipment which may generate high sound levels, visual disturbance, or cause the removal of murrelet nest platform trees, suitable spotted owl nest trees or trees that provide cover to platform trees to determine if a separate consultation is warranted. Research and monitoring activities for listed species will require ESA section 10(a)(1)(A) permits for those species and, therefore, separate section 7 consultations would be required for such activities. This consultation only addresses effects of such activities on listed species not covered under ESA section 10(a)(1)(A). The NWFP directs the Forest Service to consider whether there are equivalent opportunities available outside LSRs and whether such activities are consistent with LSR objectives.

3.18.6.1 Specific Conservation Measure for Permits for Research and Monitoring

Spotted Owls and Marbled Murrelets:

1. The Level 1 team shall review proposed project activities that include disturbance to spotted owls or murrelets, removal of SNTs, and trees that buffer murrelet nest trees to determine if a separate consultation is warranted.

3.18.7 Water Transmission and Withdrawal Permits

The proposed action addressed by this Opinion covers only the reissuance of existing water transmission and withdrawal permits and maintenance, not the issuance of new permits. Water pipeline corridors typically range between 200 feet and 1,000 feet in length and are about 6 feet in width. For domestic water supply, an applicant must obtain a water right from the Washington State Department of Ecology before applying for a Special Use Authorization from the ONF. There are approximately 26 existing operational waterline permits on the ONF. During the 10-year term of the proposed action, 13 of those permits will be subject to reissuance. Ten of these thirteen permits involve water transmission and withdrawal activities in bull trout core watersheds. The name, location, description, and withdrawal rate in cubic feet per second (cfs) for each permit to be reissued are presented in Table 5. Repair or replacement of damaged water-line segments are a common permitted activity. Repair and maintenance of existing water-transmission lines and systems can require the use of a backhoe, flatbed truck, boom truck, dump truck, chainsaw, and drilling rig.

Table 5. Water transmission/withdrawal permits in bull trout core watersheds on the ONF to be reissued during the 10-year term of the proposed action.

Permit Holder	Description of Use	Nearest BT Habitat	Waterbody cfs	Withdrawal cfs	Location
Lake Sutherland Water District	Community Water System with intake from unnamed tributary to Lake Sutherland. 2" water transmission line.	Elwha River	>300 cfs at summer low-flow	0.05 cfs	T30N R8W Section 28
David Christiansen	Private domestic waterline	Mouth of Ziegler Creek at confluence with Lake Quinault	N/A	< 0.02 cfs	T23N R9W Section 15
Dedmore	Private domestic waterline	Elwha River	>300 cfs at summer low-flow	< 0.1 cfs	T30N R7W Section 33
Fritz	Private domestic waterline from unnamed creek	Dungeness	>50 cfs at summer low-flow	< 0.1 cfs	T29N R3W Section 20
David Lutz	Private domestic waterline	Upper Quinault River	>500 cfs at summer low-flow	< 0.1 cfs	T23N R9W Section 16
Eldon Gebaroff	Private domestic waterline	Lower Quinault River	>500 cfs at summer low-flow	< 0.1 cfs	T22N R10W Section 22
Grays Harbor Water District #8	Community Water System	Lower Quinault River	>500 cfs at summer low-flow	1 cfs	T22 R9W Section 18
Black Diamond Water District	Community Water System	Little River (Elwha)	Not Provided	Not Provided	T30N R7W Section 36
U.S. Fish and Wildlife Service	48" water supply line to Quinault National Fish Hatchery	Lower Quinault River	>500 cfs at summer low-flow	Up to 45 cfs	T22N R10W Section 32

Table 5. Water transmission/withdrawal permits in bull trout core watersheds on the ONF to be reissued during the 10-year term of the proposed action.

Permit Holder	Description of Use	Nearest BT Habitat	Waterbody cfs	Withdrawal cfs	Location
Peterson, Mertes	Private domestic waterline	Jackson Creek		< 0.2 cfs	T26N R2W Section 14
Shoemake, Carol	Private domestic waterline	Solduck River		< 0.1 cfs	T30N R10W Section 19
Baur, York	Private domestic waterline			0.01 cfs	T30N R10W Section 20
City of Port Townsend Big Quilcene Waterline	Community Water System	Big Quilcene	Minimum instream flow of 27 cfs below diversion when natural flow above diversion ≥ 27 cfs	250 cfs	T27N R2W Section 31
City of Port Townsend Little Quilcene Waterline	Community Water System	Little Quilcene	Minimum of 6 cfs is maintained instream	Up to 9.56 cfs	T28N R2W Section 32

The following activities are associated with the maintenance and upkeep of existing water transmission lines and systems; use of backhoes, flatbed trucks, boom trucks, dump trucks, chainsaws, and/or drilling rigs: installation of new water pipelines, requiring excavation using backhoes or ditch witches; maintenance of access roads and trails (brushing, removal of hazard/danger trees, grading and shaping, surfacing); removal of hazard/danger trees near pumphouses, intake and filtration structures, and other improvements; upgrading facilities on existing sites to meet Washington State Department of Ecology standards, including installation of filtration buildings, replacement of water pipelines, relocation of intake sites, and construction of new drainfields to handle overflow at filtration sites; and drilling of additional wells on existing sites. This work is conducted year-round.

3.18.7.1 Specific Conservation Measures for Water Withdrawal Permits Projects

All Species:

1. All conservation measures specified for the following proposed actions: Road Construction/ Reconstruction projects in Transportation System Program; the Road Maintenance Program; and the Hazard/Danger Tree Removal Program also apply to Water Withdrawal Permit actions.

Bull Trout:

1. Any project involving placement/repair of instream diversion or withdrawal structures, or excavation within the bankfull stream channel within bull trout core watersheds shall be reviewed by the Level 1 Team to determine if a separate consultation is warranted.

2. The Black Diamond Water District Permit, and any other permit renewal not listed in Table 5, will be reviewed by the Level 1 Team to determine if it is consistent with the effects anticipated in the Opinion or if a separate consultation is warranted.

3.18.8 Outfitter Guide Permits

Outfitter-guide permits are granted to outfitters for backcountry trips (such as hunting, fishing, or sightseeing), mountain climbing, and trail-hiking guides, which may include the use of saddle and pack stock as part of the permit. There are typically four to six permits issued on the ONF per year, and each are usually 1 year in duration. The ONF proposes to issue an average of up to six permits per year during the 10-year term of the proposed action. Outfitter-guide permits provide the ONF with the opportunity to clearly state conditions for outfitter operations that will minimize user impacts on species of concern, and their habitats. These activities generally occur in the summer to late fall, but can occur year-round.

3.18.8.1 Specific Conservation Measures for Outfitter-Guide Permits

All Species:

1. Special Use Permits for outfitter-guide permits shall contain terms and conditions as necessary to avoid adverse impacts to listed species or their habitats. Permits will also include specific conditions for sanitation and cleanup of affected sites.

Marbled Murrelets:

1. Food and garbage shall be stored properly to prevent attraction of corvids.

3.18.9 Developed Facilities Permits

Developed facilities include structures and other improvements located on National Forest lands that are owned or leased by corporations, organizations, and individuals. The proposed action and this Opinion only covers the reissuance of existing permits for developed facilities. The

ONF proposes to reissue an average of seven permits for developed facilities per year during the 10-year term of the proposed action. The developed facilities can be commercial (resorts, cabins, campground concession, cabin rentals, stores, gas stations) or non-commercial (summer homes, organization camps) in nature. It also includes operational facilities such as the Quinault Sewer Treatment Plant that is operated under contract. The larger developed facilities, such as the Lake Quinault Lodge and Satsop Work Center, have master development plans to guide their use. Permits for many developed facilities are long-term commitments of National Forest land, generally for a period of 20 years. ONF authorization is not needed for normal facility maintenance unless the activity is ground or vegetation disturbing. Activities such as land clearing, installation of new structures, well-drilling, septic-system installation, and tree removal require prior ONF review and approval. Developed-facilities permits are administered primarily under the Recreation Special Uses program. New land clearing is not anticipated to exceed 5 acres of non-habitat adjacent to existing facilities during the 10-year term of the proposed action.

3.18.9.1 Specific Conservation Measure for Developed Facility Permits

All Species:

1. All conservation measures specified under the Hazard/Danger Tree Removal Program shall also apply to developed-facility permits.

3.18.10 Recreation Residence Maintenance

There are 64 recreational residences on the ONF, all of which are along Lake Quinault. Recreation residences are permitted homes on National Forest land that are maintained by the permittee. Approximately 64 permits will be reissued during the 10-year term of the proposed action. Maintenance activities such as washing windows and cleaning gutters and roofs do not require ONF permission prior to each activity. Cabin projects such as painting and roofing must be approved by the ONF to ensure they meet compliance standards. Prior ONF permission is required for ground-disturbing or vegetation-disturbing activities such as land clearing, installation of new structures, cutting of hazard/danger trees, and/or sewer hookups. It is likely that fewer than 15 sites per year would involve this type of activity. New land clearing is not anticipated to exceed 1 acre adjacent to existing facilities during the 10-year term of the proposed action; none of this clearing would be done in suitable habitat for spotted owls or marbled murrelets. Work related to the maintenance of recreation residences can be done year-round.

3.18.10.1 Specific Conservation Measures for Recreation Residence Maintenance Projects

All Species:

1. All conservation measures specified under the Hazard/Danger Tree Removal Program shall also apply to maintenance of recreation residences.

3.18.11 Permits for Other Special Uses

The ONF receives requests for special and group events such as search and rescue, military training operations, club meetings, weddings, recreation events, Native American gatherings, photography, commercial filming, group hikes, and apiaries. Under new direction for non-commercial group use, permits are required only when a group exceeds 75 people. The ONF proposes to issue approximately 10 'other' special use permits per year during the 10-year term of the proposed action. On a project-specific basis, requirements are developed to maintain and protect resource values. These requirements are expected to address the location, time of year, and sanitation measures. Non-commercial group use and other special uses can occur year-round.

3.18.11.1 Specific Conservation Measures for Permits for Other Special Uses

All Species:

1. Special use permits shall contain terms and conditions as necessary to avoid adverse impacts to listed species or their habitats. These permits also shall also include specifics requirements on sanitation and cleanup of affected sites.

Marbled Murrelets:

1. Food and garbage shall be stored properly to prevent attraction of corvids.

3.18.12 Land Line Survey and Boundary Adjustments Program

Activities associated with surveying land lines may include hand-brushing and use of chainsaws for traversing, tree-blazing, establishment of corner markers, and posting of boundary signs. Trees 6 inches dbh or less may be cut in dense stands. Boundary adjustments are performed to resolve existing encroachments, or when an ONF boundary is not precise. Boundary adjustments require a re-survey of the proper boundary line and proper documentation. These activities are not ground disturbing. About 3 miles of such surveys per year will occur over the 10-year term of the proposed action, with about 1 mile of survey work per year occurring in the early spotted owl nesting season or murrelet nesting season.

3.18.13 Administrative Tours and Remote Site Inspections Program

Periodic overflights and helicopter travel are conducted on the ONF. In order to demonstrate a number of projects or issue-sites to members of the Forest Service from Regional or National Headquarters, or other officials, it is often necessary to use fixed-wing aircraft for overflights or to travel via helicopter. The ONF expects to conduct several overflights each year during the 10-year term of the proposed action to display progress and issues as well as to track landscape conditions. Overflights are generally at least 500 feet above ground level and seldom are conducted below 300 feet. Smaller propeller aircraft generally are used for such flights and take-off and landing generally occur outside the ONF. The ONF expects to conduct an average of three helicopter tours each year, involving a total of about four stops each. Helicopter landing zones are located in existing clearings or landings.

3.18.14 Waste Cleanup Program

Because of their remoteness and easy access, forest roads often are used to discard garbage and other forms of waste materials. Non-hazardous materials are cleaned up on an intermittent basis, and generally involve hand work and a medium-sized truck or pickup-trailer combination. Power winches may be used to pick up and load larger items. Occasionally, hazards are discovered or are accidentally created on the ONF that need immediate attention due to health/safety risk. In the past, these discoveries have included fuel/petroleum-based product leaks/spills, and barrels of contaminants such as methylethylketones. These situations usually are treated as emergencies in accordance with existing laws and regulations. Intensity of the clean-up activity may vary widely. In other cases, abandoned vehicles that have been contaminated may have to be removed. In the case of a spill of liquid contaminants, substantial volumes of soil may have to be excavated and disposed of, utilizing heavy equipment such as backhoes, front-end loaders, and dump trucks. In addition, there usually are four to six incidents of hazardous waste disposal on the ONF per year. Theft of standing cedar trees is unfortunately common on the ONF; about 10 sites per year are found. It may take from 1 to 6 hours to clean up the debris from the area using power tools and non-motorized tools. Under the proposed action, a total of about 110 sites of all types are anticipated to be cleaned during the 10-year term of the proposed action, with about one-third of the 110 events involving heavy equipment.

3.18.15 Wildlife and Botany Habitat Management Program

Many activities described under the Silviculture program (e.g., upland and riparian thinning) can also be considered wildlife-habitat restoration. Other activities to improve habitat quality include prescribed fire for habitat restoration or enhancement, snag creation, installation of nest boxes, planting and seeding of native vegetation, pruning, cavity treatments, coarse wood treatments, and small-diameter tree removal for meadow-habitat restoration. Some of these treatments are included in a Knutson-Vandenberg plan for a timber sale, and would take place within timber sale area boundaries or adjacent to recently thinned stands. The ONF proposes up to 300 acres of habitat-restoration activities per year (outside the Silviculture Program) during the 10-year term of the proposed action.

Snag creation can include blasting or cutting off tops of trees with chainsaws, inoculation with local stem-decay fungi, or girdling. These activities generally will be conducted within areas designated for silvicultural treatment such as thinning’s, and must be consistent with the NWFP. Tree topping and girdling will usually done with chainsaws. If blasting is necessary, it will be conducted with charges of 2 lbs. or less.

Cavity treatments include creating habitat features in topped or live trees to benefit cavity-using wildlife. Habitat features include artificial cavities, cavity starts, lightning blazes, bat crevices, bat flanges, and sap wells. This work would be done with chainsaws or power tools and often requires climbing the tree.

Coarse wood treatments include falling trees in areas deficient in downed woody debris. Treatments could also include creating furrows in felled trees, piling fine or coarse downed wood, and bundling logs to create coarse-wood structures. The tree falling and log furrow creation would be done with chainsaws, and the piling and bundling would be done using hand tools and chainsaws.

Pruning treatments include thinning branches in dense tree crowns to provide raptor perch sites or pruning branches in tree crowns to accelerate the development of large vertical branches suitable for marbled murrelet nesting. Treatments may also include pruning understory shrubs or hardwood trees to increase availability of big game browse or suitability for shrub-nesting birds. Pruning treatments would be done with chainsaws or hand tools.

Some restoration silvicultural activities are designed to accelerate development of multi-storied stand characteristics by removing selected trees to promote growth of individual trees. Trees cut are left on the ground for coarse wood or may be used for other restoration activities. Select thinning (in plantations) involves work crews with chainsaws. ONF proposes approximately 40 acres of restoration thinning and release per year during the 10-year term of the proposed action.

Prescribed burning for habitat restoration and enhancement is used to remove encroaching conifers in natural openings or applied to areas identified as needing created openings or to reestablish native plant communities. Prior to the treatments, non-motorized hand tools and chainsaws are used to prepare the site for burning. No prescribed burning is proposed within 0.25 mile of suitable habitat during the spotted owl or murrelet nesting seasons unless the proposed project would have insignificant effects.

Forage seeding normally occurs with the use of hand seeders within areas of disturbance (natural and management caused) such as roadsides, skid trails, or openings. This activity usually is done in the spring or fall seasons when seed or plant survival is higher and generally involves only hand tools. Native and desired non-invasive non-native species are used depending on availability, site conditions, and desired future condition of the area. Usually, native seed would be collected from adjacent areas and then spread in the project areas. Transplanting of native vegetation would involve collecting plants or cuttings from adjacent areas and then planting them in desired areas. In some cases, cuttings or seed would be collected, grown into rooted plants in nurseries, and planted out in the project areas. The ONF proposes to plant or seed approximately 75 acres per year during the 10-year term of the proposed action.

3.18.15.1 Conservation Measures for Activities Conducted for the Wildlife Habitat Management Program

All Species:

1. Disturbed sites shall be revegetated with native vegetation when feasible, and preferably species endemic to the watershed. The use of approved non-invasive, non-native seed mixes may be considered if existing conditions require timely restoration that native species cannot fulfill.

2. Prescribed burn plans shall be evaluated by a wildlife biologist to consider the seasonal and spatial needs of listed species and their habitats before, during, and after implementation.

3. All temporary approaches used by motorized vehicles during prescribed-burn activities shall be closed or made impassable, and rehabilitated. Consideration for future access needs shall be planned to avoid or minimize resource impacts.

Spotted Owls and Marbled Murrelets:

1. Burning during the nesting seasons of spotted owls and marbled murrelets shall be conducted at least 0.25 mile away from suitable nesting habitats to minimize the chance that adults, nestlings, or fledglings are injured by being exposed to smoke.

Bull Trout:

1. To ensure adequate amounts of large wood in streams, any trees greater than 12 inches dbh to be felled within reach of a stream shall be felled or pushed toward the stream and left in place if feasible.

3.18.16 <u>Inventory and Monitoring of Aquatic and Terrestrial Habitat/Biota Program</u>

Under the proposed action, the ONF proposes to conduct numerous fish, wildlife, and botanical surveys. Activities may include physical stream and riparian surveys; spawning surveys; snorkel surveys; water quality and quantity monitoring; inventory of lakes; surveys of various mammals, mollusks, butterflies, and other invertebrates; aquatic and terrestrial amphibian surveys; bat surveys; raptor surveys; carnivore monitoring; and botanical surveys. Surveys may be by foot, vehicle, boat, or aircraft. Helicopters may be used to transport field crews to conduct salmon redd surveys, bald eagle surveys, or to collect other data, but helicopter use is not anticipated to exceed two uses per year; one of these helicopter use events may occur during the early spotted owl or murrelet nesting seasons.

Research and monitoring activities may require permits from the USFWS, the NMFS, and/or WDFW. Electrofishing, dip-netting and smolt trapping are activities which require a permit under section 10 of the ESA for the listed target species. If an ESA section 10 permit is required, a separate consultation will occur on that proposed action.

Established survey protocols for wildlife species are used to determine occupancy and use of an area by a particular species. Surveys may involve visual surveys, simulated vocalizations to elicit responses, remote audio recorders, remote cameras and hair snares, track surveys, and use of helicopter and fixed wing aircraft. Research and monitoring activities on the ONF are also implemented by Federal biologists and researchers, university staff, or state agencies.

3.18.16.1 Conservation Measures for Activities Conducted for the Inventory and Monitoring of Aquatic and Terrestrial Habitat/Biota Program

All Species:

1. Inventory and monitoring shall be carried out using protocols that minimize the disturbance to wildlife and are effective at obtaining the desired information.

2. All fish and wildlife surveys that involve capture, confinement, or collection of animals shall be done under appropriate State and Federal collection permits.

Bull Trout:

1. Walking on bull trout redds shall be avoided during stream surveys.

3.18.17 <u>Acquisition of Large Wood for Watershed Restoration Projects</u>

Collection, transport, and storage of large trees and root wads needed to implement in-stream structure projects are part of the proposed action. However, implementation of watershed restoration projects is not covered by this the proposed action of this Opinion; because those activities are covered by the USFWS's 2007 ARBO (USFWS 2007).

Large wood for aquatic restoration projects may be acquired from felled hazard trees, salvage of blowdown, or trees removed for road construction. In addition to the above sources, small groups of trees may be removed in patches up to 1 acre in size from within mid-seral stands (i.e., spotted owl dispersal habitat). Various techniques may be used, including removal of whole trees with rootwads by pushing trees over with heavy equipment, or felling trees with chainsaws to create small openings that are up to 1 acre in size. Large wood may be transported by helicopter to a project site. A total of up to 40 acres of spotted owl dispersal habitat in AMAs may be removed for large wood acquisition during the 10-year term of the proposed action. Group tree removals in LSRs or areas designated as spotted owl and marbled murrelet critical habitat are not covered by the proposed action or this Opinion and require separate analysis under section 7 of the ESA.

3.18.17.1 Specific Conservation Measures for Acquisition of Large Wood

Spotted Owl and Marbled Murrelets:

1. All tree removals will be coordinated with the wildlife and silviculture programs.

2. Removal of groups of trees is limited to gaps up to 1 acre in size from mid-seral stands that consist of non-suitable or dispersal habitat for spotted owls.

3. Removal of groups of trees for large wood acquisition is not permitted in LSR or designated spotted owl or marbled murrelet critical habitat.

4. Blowdown adjacent to harvested units or within 200 feet of roads are preferred sites for tree removal.

5. Removal of individual trees that contain suitable nesting structure for spotted owls or marbled murrelets (other than removal of hazard trees) is not permitted.

3.18.18 Fire Hazard Reduction Program

One purpose of the Forest Service fire management program on the ONF is to reduce the potential fire hazard, primarily along road corridors and other heavy human use areas. Another purpose of the fire-management program is to conduct prescribed fire projects for restoration of habitats, and to create a diversity of habitats on the landscape. Current activities include vegetation removal around administrative sites and prescribed piling and burning to reduce fire hazards. Additionally, prescribed fire and thinning projects are planned to restore meadows, prairies, balds, maintain forest openings, and to provide a safer fire environment around communities adjacent to ONF lands. On the ONF, the Hood Canal District typically piles material along roadsides and landings; however, the Pacific District historically has piled material throughout the project area. Each project will be assessed as to how thoroughly clean-up activities will be addressed. Dry piles that burn hotly produce a limited amount of smoke that dissipates quickly. Dry piles can burn completely within 3 hours, whereas wet conditions may result in a cooler burn that is not as complete. Equipment used during burning includes drip torches, chainsaws, pumps, and fire engines.

The ONF proposes to treat about 590 acres of all habitat types per year during the 10-year term of the proposed action. Approximately 200 acres would be treated when crews are available in June and July. The affected acreage is likely to occur on both sides of the road in many cases, and may occur along a continuous road system. Chainsaws and hand tools are generally used to remove small ladder fuels or downed and dead material from landings and road corridors. Hand-piling is sometimes performed and may be followed by burning. Burning generally is conducted in the fall (September through November) or spring (March through June).

The methods used for reducing fire hazards on the ONF are hand piling, machine piling, landing piling, chipping, lop and scatter, underburning, and slash pullback along roads. About 45 acres of fuels reduction using mechanized equipment (hand piling and chipping) are done annually during the nesting seasons for spotted owls and murrelets. Additional information on proposed measures to reduce fire hazards on the ONF over the 10-year term of the proposed action are as follows:

3.18.18.1 Hand Piling and Burning

This activity is done utilizing hand tools and minimal chainsaw use. With this method, the ONF treats 130 to 150 acres per year in relation to timber sales, and 5 to 10 acres per year in relation to other activities. Of this 135 to 160 acres, up to 20 acres would be hand-piled and burned each year during the 10-year term of the proposed action during the early spotted owl and entire marbled murrelet nesting seasons.

3.18.18.2 Machine Piling and Burning

Machine piling of slash created through the clearing of road rights-of-way is done with a tractor. The ONF treats 10 to 25 acres per year. Under the proposed action, a similar amount would be treated each year during the 10-year term of the proposed action.

3.18.18.3 Landing Piling and Burning

This activity is usually done by the mechanized loader working on site of a recent thinning operation. The ONF treats 10 to 50 acres per year. Under the proposed action, a similar amount would be treated each year during the 10-year term of the proposed action.

3.18.18.4 Chipping and Burning

Chipping of roadside debris is done with a chipping/mulching machine; the ONF currently treats 5 to 55 acres per year using this method. Under the proposed action, a similar amount would be treated each year during the 10-year term of the proposed action. Up to 25 acres would be chipped and burned annually during the early spotted owl and marbled murrelet nesting seasons.

3.18.18.5 Broadcast Burning and Under-burning

This activity is done using drip torches and other firing devices. This activity will normally be associated with habitat restoration and enhancement, but could be used for small areas of post activity clean-up. While these types of treatment have not been used much in recent years on ONF, they are a useful management tool for habitat restoration and may be applied in future. Timing for burning is very weather-dependent. Most of the burning is conducted during the fall, especially from mid-October through November, to take advantage of fall rains and safe burning conditions. Minimal burning is done during the spring through the end of July to finish areas not completed in the fall. Under the proposed action, the ONF may treat from 50 to 300 acres per year during the 10-year term of the proposed action.

3.18.18.6 Conservation Measures for Activities Conducted for the Fire Hazard Reduction Program

Spotted Owls and Marbled Murrelets:

1. Burning during the entire nesting seasons of spotted owls and marbled murrelets shall be conducted at least 0.25 mile away from suitable nesting habitats to minimize the chance that adults, nestlings, or fledglings are injured as a result of exposure to smoke.

Bull Trout:

1. Broadcast burning and under-burning projects shall be designed to protect natural woody material in streams, lakes, or wetlands. This may be achieved as a result of site conditions or by implementing active protection measures as necessary.

3.18.19 <u>Special Forest Products Program</u>

This program includes the harvest of salal (*Gaultheria shallon*) and bear grass (*Xerophyllum tenax*), transplanting of small conifers and shrubs, mushroom picking, Christmas tree cutting, cutting of small trees for posts and rails, firewood cutting, and collection of other forest products. Permits are required from the ONF for the collection of these products. The ONF expects to issue approximately 5,000 permits per year for these activities during the 10-year term of the proposed action. The ONF will complete one Project Consistency Evaluation Form annually to report the number of permits issued for each of these project types.

Commercial users desiring to camp are issued a permit by the ONF to do so; such permits limitations as to where they are allowed to camp. They are not allowed to camp in developed campgrounds and must camp at least 50 feet away from stream courses. The permit also specifies the length of stay permitted and is based on time to complete the authorized work. The permit specifies other requirements, including necessary sanitation and camp cleanup needs. Harvesting is not permitted in Wilderness, Special Botanical Areas, Research Natural Areas, developed recreation sites, and administrative sites.

3.18.19.1 Conservation Measures for Activities Conducted for the Special Forest Products Program

All Species:

1. Camp permits to commercial users shall include limitations as to where they are allowed to camp; they are not allowed to camp in developed campgrounds, and must camp at least 50 feet away from stream courses. The permit shall specify the length of stay permitted based on time to complete work, sanitation, and camp cleanup.

Marbled Murrelets:

1. Camp and collection permits will require that food and garbage be stored properly to prevent wildlife conflicts and attraction of corvids.

3.18.19.2 Salal Harvest

Annually, about 500 to 1,000 permits or contracts are issued to harvest salal on the ONF. Harvest is located on lower-elevation sites and generally within second-growth stands having a hemlock/salal plant association. Harvesting is accomplished by hand-picking when new growth of stems and leaves have hardened off in August. Picking continues into May if a suitable crop is still available. Salal is very common throughout the ONF, especially on the eastside, but heavier harvest occurs closer to brush-buying centers located in Forks and Shelton.

3.18.19.3 Bear Grass Harvest

This activity occurs on the southeast side of the ONF, generally in drier, high-elevation sites. Harvest occurs during the spring (April through June) and early fall (September and October). Permits stipulate only plants with 24-inch leaves may be used. Harvest is of limited duration and intensity, using three to five people in a site for a period of 1 or 2 weeks. Hand tools are used, with permits specifying areas for camping on site as needed.

3.18.19.4 Christmas-Tree Cutting

This activity generally occurs from early November through December 24. Areas closed to tree cutting are designated Wilderness areas, Research Natural Areas, Special Botanical Areas, riparian reserves, developed campgrounds, private/state-owned lands within National Forest boundaries, and some Administratively Withdrawn Areas as identified by each Ranger District. On the ONF, 1,000 to 2,000 permits are issued annually; that same pattern is expected each year during the 10-year term of the proposed action. The affected trees are less than 15 feet tall and harvested by handsaw. This activity generally occurs in regenerating timber harvest units.

3.18.19.5 Bough Cutting

Commercial use permits or contracts are issued by the ONF for bough cutting. The ONF has not offered bough permits or contracts for many years, but funding for planning and administration has improved as a result of botanical receipts. Under the proposed action, all bough cutting would take place after October 1, mainly in silver fir, cedar, and Douglas-fir plantations at low to middle elevations through December. Only tip-pruning is permitted, and boughs may only be cut from the lower half of the tree. Hand tools are used, with most cutting being done adjacent to open roads.

3.18.19.6 Cutting of Firewood, Posts, and Rails

Under the proposed action, approximately 1,000 permits each year for the 10-year term of the proposed action would be issued by the ONF for firewood cutting, which may occur year-round when other constraints are not present. Removal of downed wood for such things as firewood, shakes, fence posts, rails, or other uses is only permitted within 50 feet of roads. Firewood cutting may occur in most land allocations, provided NWFP standards and guidelines are met. Typically, wood removal is only from road prisms and old log landings. The ONF may offer some firewood permits that would allow wood-cutters to thin stands pre-marked by a silviculturist. Some permits will result in cutting at multiple sites and other permits will result in no new sites as they will cut where previous permittees have already cut. An average of two sites will be used per permit.

3.18.19.7 Specific Conservation Measures for Cutting of Firewood, Posts and Rails Projects

Bull Trout:

1. All natural woody material in streams, lakes, or wetlands shall be left in place.

2. No cutting of standing or downed trees shall be permitted within 100 feet of stream channels.

3.18.19.8 Mushroom Picking

This activity occurs across the ONF. It involves hand picking without motorized equipment for harvest. Commercial permits are issued with time limits. About 100 permits annually are issued for commercial use; a similar pattern is expected under the 10-year term of the proposed action. Chanterelles form the majority of harvested mushrooms and are generally found in fairly dense (closed canopy) and relatively young Douglas-fir stands categorized as stem-exclusion stage forests. A permit from the ONF is not required for personal use harvest of up to 1 gallon each of three species.

3.18.19.9 Disposition of Confiscated Materials

Theft of forest products is common. High economic value is placed on cedar and maple. These products can be removed in smaller portions than traditional logs and still marketed for a high price. This allows removal of these products with a chainsaw and a pick-up truck. Other products that are portable are also removed illegally. These actions often occur along roads. When such an infraction is encountered and even when enforcement/legal actions initiated, such materials do not remain in place for many days once the tree has been felled. When it is appropriate to do so, based upon enforcement actions, legal proceedings, levels of downed wood in adjacent stands, and other considerations, the ONF will attempt to properly dispose of such materials in a manner that discourages future illegal use of that material. In order of preference, the ONF generally uses such material to fill administrative needs, such as restoration projects. When there is not an administrative need, such materials may be made available to Native American Tribes to fill their ceremonial or traditional needs, or they may be sold or otherwise disposed of.

3.18.19.10 Other Forest-Product Requests

These requests include collection of brush including evergreen huckleberry (*Vaccinium ovatum*) and swordfern (*Polystichum munitum*), collection of conifer cones and seedlings, and collection of cedar bark for cultural use. These requests also include collection of plants used for medicines, pharmaceuticals, flavorings, weaving, and dying.

3.18.20 <u>Tribal Requests Program</u>

Traditionally, the ONF receives requests from Native American Tribes for various forest products that include firewood, and yew, western red cedar, and Alaska yellow cedar (*Cupressus nootkatensis*) logs for ceremonial, artistic, traditional, and other needs. Consequently, a few large or very large trees are expected to be removed during the 10-year term of the proposed action in response to such requests. Table 4 presents the number of spotted owl and murrelet SNTs anticipated to be removed for this activity. Prior to the removal of a cedar, the ONF will explore three prioritized options to locate the trees: 1) blown down, confiscated material, or trees identified as hazard/danger trees; 2) standing trees within the AMA allocation, areas outside designated Critical Habitat, and outside spotted owl and marbled murrelet suitable habitat; 3) standing trees in LSR, designated Critical Habitat, and suitable habitat for spotted owls and marbled murrelets.

3.19 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. Actions conducted under this consultation generally occur on National Forest lands although direct and indirect effects may occur in adjacent areas. Additionally, non-Federal lands extending 1 mile from the National Forest boundary are included in the action area due to above-ambient sound and sediment impacts. The ONF is located on the Olympic Peninsula in the northwest portion of Washington State.

The ONF administers approximately 632,000 acres of land in Clallam, Jefferson, Grays Harbor, and Mason counties. There are approximately 67,200 acres of private land and land administered by other government agencies within the boundary of the ONF, mostly on the west side. National Forest lands are administered under the direction of the Forest Service Supervisor headquartered in Olympia, Washington. The Supervisor is supported by a headquarters staff, and by personnel on two Ranger Districts based in Quilcene and Forks. The ONF includes lands in the Lower Chehalis, Grays Harbor, Queets-Quinault, Hoh-Quillayute, Crescent-Hoko, Dungeness-Elwha, Hood Canal, and Skokomish 4th-field watersheds.

4 BIOLOGICAL OPINION – Northern Spotted Owl Critical Habitat

5 STATUS OF THE SPECIES: Spotted Owl

The spotted owl was listed as a threatened species in 1990 because of widespread loss of habitat across the subspecies range and the inadequacy of existing regulatory mechanisms to conserve the species (55 FR 26114 [June 26, 1990]). Spotted owls have continued to decline, especially in the northern parts of the species' range, where populations have declined by as much as 77 percent since 1990 (Dugger et al. 2016, p. 71). Over the past two decades it has become apparent that competition from the barred owl (*Strix varia*) poses a significant threat to the spotted owl. 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, p. 58).

Past habitat loss and current habitat loss due to wildfires, timber harvest, and other disturbance continue to threaten the spotted owl (Davis et al. 2016, pp. 34-35). Range-wide nesting/roosting habitat declined from an estimated 9.09 million acres in 1993 to 8.95 million acres on Federal lands in 2012, a net loss of about 1.5 percent (Davis et al. 2016, p. 21). Across all lands (Federal and non-federal), habitat declined from approximately 12.5 million acres to 12.1 million acres, a net loss of about 3.4 percent (Davis et al. 2016, p. 22). Wildfire is the primary cause of habitat loss on Federal lands, while timber harvest is the primary cause of habitat loss on non-federal lands (Davis et al. 2016, pp. 21-22).

The *Revised Recovery Plan for the Northern Spotted Owl* (Recovery Plan) (USFWS 2011) identifies habitat loss and 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 and habitat loss. For barred owl competition, Recovery Actions include the 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, p. III-65, 67). The USFWS initiated an ongoing 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 preliminary assessment of the first two years of the removal experiment in Oregon and Washington was equivocal (Wiens et al. 2017, p. 16). 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), but it remains unknown whether similar results can be obtained in larger areas with different forest conditions and where barred owls are more abundant.

Range-wide, spotted owl populations are declining at an average rate of 3.8 percent per year since intensive studies began in the 1980s (Dugger et al. 2016, pp. 70-71), indicating the species is increasingly at risk of extirpation. The risk of extirpation is highest in the northern portion of the species range where barred owls have been present for the longest period and rate of population decline is steepest. If the current rates of decline continue the species will likely decline to extirpation in the northern portion of its range in the near future. The spotted owl population in British Columbia, Canada, was near extirpation when a captive breeding program was initiated in 2007 when less than 25 spotted owls were estimated to remain in the wild in British Columbia (Fenger et al. 2007, pp. 15, 20).

For a detailed account of spotted owl biology, life history, threats, demography, and conservation needs, refer to Appendix E: *Status of Northern Spotted Owl and Northern Spotted Owl Critical Habitat*.

6 STATUS OF DESIGNATED CRITICAL HABITAT: Spotted Owl

The final rule designating revised critical habitat for the spotted owl was published on December 4, 2012 (77 FR 71876-72068), and includes over 9.5 million acres in 11 units and 60 subunits in California, Oregon, and Washington. Critical habitat contains those areas that are essential to the conservation of the species. 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 71879). 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 populations are likely to persist within properly functioning ecosystems at the critical habitat unit and range-wide scales" (77 FR 71938).

The PCEs 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). 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 the effects of past timber harvest, wildfire, disease, and other disturbances. Based on the spotted owl habitat data developed for monitoring the NWFP (Davis et al. 2016), we estimate that approximately 51 percent of the lands within critical habitat currently contain suitable spotted owl nesting and roosting habitat (4.89 million acres).

For a detailed account of the status of the designated spotted owl critical habitat, refer to the 2012 final rule designating critical habitat (77 FR 71876) and Appendix E: *Status of Northern Spotted Owl and Northern Spotted Owl Critical Habitat*.

7 ENVIRONMENTAL BASELINE: Spotted Owl and Spotted Owl Critical Habitat

Regulations implementing the ESA (50 CFR 402.02) define the environmental baseline as the past and present impacts of all Federal, State, or private actions and other human activities in the action area. Also included in the environmental baseline are the anticipated impacts of all proposed Federal projects in the action area that have undergone section 7 consultation, and the impacts of State and private actions which are contemporaneous with the consultation in progress. The environmental baseline analysis for spotted owls also describes the relationship of the current condition and conservation role of the action area to spotted owl recovery units.

7.1 Current Condition of the Spotted Owl on the Olympic Peninsula

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 (Thomas et al. 1990, p. 61). 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.

Federal lands on the Olympic Peninsula include over 737,000 acres of spotted owl nesting/roosting (suitable) habitat, which represents about 6.1 percent of all suitable habitat on Federal lands range-wide (Davis et al. 2016, p. 21). Approximately 96 percent of the extant spotted owl habitat on Federal lands in the province is located in conservation reserves. Estimates of suitable owl habitat on the Olympic Peninsula vary depending on the data sources and the habitat models used to depict owl habitat. Table 6 presents two sources of information regarding spotted owl habitat on the Olympic Peninsula – one is derived from the NWFP effectiveness monitoring program (Davis et al. 2016), and the other is derived from the ONF vegetation database.

Table 6. Estimates of spotted owl habitat on the Olympic Peninsula.

Ownership	Land Ownership (acres)[1]	Spotted Owl Habitat (acres) based on Northwest Forest Plan monitoring data (2012)[2]	Spotted Owl Habitat (acres) based on ONF vegetation database (2001)[3]
Olympic National Forest	630,746	252,869	259,731
Olympic National Park	900,072	484,135	741,818
Other lands – State, Private, Tribal, etc.	1,500,106	121,598	263,606
Totals	3,030,924	858,602	1,265,155

Notes:

1 Land ownership acres are derived from the 2009 Land Use Allocation map for the NWFP (depicted in Davis et al. 2011, p. 25).

2 Spotted owl habitat estimates are approximate values derived from habitat maps developed for the NWFP 20-year monitoring report which depict conditions as they existed in 2012 (Davis et al. 2016)

3 Spotted owl nesting, roosting, and foraging habitat as reported by the ONF in the Biological Assessment (USFS 2009, pp. 12-14). Habitat acres are approximate values based on 2000 – 2001 vegetation data.

Thomas et al. (1990, p. 4) identified the Olympic Peninsula as an area of special concern for spotted owls due to the physical isolation of the spotted owl population on the Peninsula to other populations in adjacent provinces. Because of extensive timber harvest throughout much of the western Washington lowlands, spotted owls on the Olympic Peninsula are relatively isolated from other spotted owl populations located in the Washington Cascades and the Oregon Coast Range (Davis et al. 2011, p. 52).

Since 1993, spotted owl habitat losses have been relatively minor on Federal lands on the Olympic Peninsula from timber harvest, wildfire, insects, and other causes (~ 5,700 acres (0.7 percent)) (Davis et al. 2016, p. 21). Rangewide, total habitat losses (Federal and non-federal lands) from timber harvest, wildfire, and other disturbances is estimated at 47,100 acres for the period from 1993 to 2012 (Davis et al. 2016, p. 22). Barred owls are common on the Olympic Peninsula (Gremel 2007, pp. 8-9), and competition with barred owls poses a significant and complex threat to the spotted owl (USFWS 2011, p. 1-8).

The recovery criteria established in the revised spotted owl recovery plan (USFWS 2011, p. ix) call for a stable or increasing spotted owl population throughout the listed range, adequate distribution of viable spotted owl subpopulations, and a stable or increasing habitat trend within each recovery unit as demonstrated by a statistically reliable monitoring effort.

7.1.1 Status of Spotted Owl Habitat in the Action Area (Olympic National Forest)

There are approximately 250,000 to 285,000 acres of spotted owl habitat located on the ONF (Table 6). Much of the habitat on ONF is contiguous with large patches of late-successional forest within Olympic National Park, and the majority of spotted owl habitat on the ONF is located in the LSR allocation. An additional 149,000 acres are currently young forests that are classified as spotted owl dispersal habitat (ONF 2019). The majority of management actions on the ONF have focused on restoration thinning. From 2008 to present, the ONF has completed seven individual consultations for commercial thinning on over 12,000 acres of spotted owl dispersal habitat; none of these sales removed or downgraded suitable spotted owl nesting/roosting habitat. Since 2006, the USFWS has consulted on the removal of 6 acres of suitable nesting habitat associated with the Dosewallips Road Reconstruction project, but this project has yet to be implemented. Spotted owl habitat losses on the ONF from timber harvest, other wildfire, and windthrow have been minor since 1994 (~700 acres) (Piper, S. in litt. 2020b). Up to 1,239 acres of suitable habitat on the Forest may have been degraded due to a fire or fire suppression efforts on the Hood Canal Ranger District in 2018 (named the Maple Fire).

Other projects covered under the 2013 programmatic consultation have resulted in the removal of scattered individual suitable nest trees across the ONF. Since 2013, a total of 82 suitable nest trees for spotted owls have been removed as hazard trees or for other purposes.

7.1.2 Status of Spotted Owls in the Action Area (Olympic National Forest)

Surveys for spotted owls by ONF personnel have been conducted since the 1980s in cooperation with the WDFW, Olympic National Park, and Pacific Northwest Research Station (PNW). Demographic studies were conducted by PNW on the ONF from the mid-1980s to 2018. Historically, these surveys covered approximately 80 percent of the ONF. Due to a decline in funding, the ONF demographic study has concentrated surveys only in the northern half of the Olympic Peninsula since 2006. In the final years of the demography study, the PNW demography group monitored 40 sites on the ONF (21 in northern Hood Canal and 19 on the west side of Peninsula in Sol Duc valley) and the NPS demography group monitored 52 sites in

Olympic National Park. The ONF geographic information system (GIS) database includes a total of 114 historic spotted owl activity centers (i.e., sites with pairs or resident single spotted owls) located within the administrative boundary of the ONF.

Estimates of population change on the Olympic Peninsula indicate that the number of spotted owls declined at an average rate of 3.9 percent per year for the period from 1990 to 2013, indicating a total loss of about 60 percent of the population that existed in 1990 (Dugger et al. 2016, p. 70-72). Rates of spotted owl territory occupancy on the Olympic Peninsula declined from 81 percent in 1995 to 21 percent in 2013 (Dugger et al. 2016, p. 80). Since 2013, demographic monitoring on the Olympic Peninsula indicates spotted owls are now absent from about 90 percent of the historic territories monitored (Gremel 2018, p. 8, Lesmeister et al 2019, p. 3).

Reproduction (nesting) on the Olympic Peninsula typically follows a 2 year pattern, with most spotted owls initiating nesting in even-numbered years (e.g., 2004, 2006), and very few or no spotted owls nesting in odd-number years (Dugger et al. 2016, p. 83). Nesting success (defined as nest attempts that result in at least one fledgling) for spotted owls on the Olympic Peninsula in even years typically averages between 80 and 100 percent (Gremel 2018, p. 14, Lesmiester et al. 2019, p. 12). While average nesting success is high, because owls on the Peninsula typically only nest every 2 years, average fecundity is low (0.29) (Dugger et al. 2016, p. 80). Fecundity is defined as the number of female offspring produced per nesting female. With average low fecundity, it may take multiple nesting attempts for a nesting pair to replace themselves. As the spotted owl population on the Peninsula has declined, the number of pairs attempting to nest has also declined to the point that less than 10 percent of historic activity centers that are monitored support pairs.

The reduction in occupied spotted owl sites on the Peninsula has coincided with an increasing barred owl population over the past 20 years. Because barred owls favor low-elevation areas, the pattern of spotted owl displacement by barred owls began in the low-elevation areas along the coast and in valley bottoms, and has gradually progressed into the interior of the peninsula (Gremel 2005, p. 10). Spotted owls on the Olympic Peninsula are now largely confined to steep valley walls and higher elevation areas of habitat (Gremel 2018, p. 8). Assuming a 10 percent occupancy rate, we expect that out of the 114 historic spotted owl activity centers located on the ONF, only about 11 activity centers are likely occupied at this time, while the remaining territories are likely to be vacant or occupied by barred owls.

Previous consultations for spotted owl on the ONF have documented adverse effects to one spotted owl territory associated with habitat loss (Dosewallips Road Reconstruction), but this project has not been implemented.

7.2 Current Condition of Spotted Owl Critical Habitat

As discussed above, the action area is located within the Olympic Peninsula physiographic province. Spotted owl critical habitat in the Olympic Peninsula province includes over 500,000 acres located within the ONF. Critical habitat within this province is associated with the North Coast Ranges and Olympic Peninsula Critical Habitat Unit (Unit 1). Critical habitat within

Unit 1, along with other Congressionally-Reserved Areas (e.g., Olympic National Park) provides demographic support and connectivity for spotted owls on the Olympic Peninsula in Washington. At the provincial scale, approximately 42 percent of the area within the designated critical habitat is comprised of forests that are currently classified as nesting or roosting habitat for the spotted owl (210,986 acres).

7.2.1 Unit 1: North Coast Ranges and Olympic Peninsula

Unit 1 encompasses approximately 824,500 acres, including the Olympic Peninsula, and the northwestern portion of Oregon (77 FR 71920). Critical habitat within Unit 1 contains five subunits, three of which are located in Washington: NCO-1, NCO-2, and NCO-3. NCO-1 and NCO-2 include lands on the western and eastern side of the Olympic Peninsula, respectively. Subunit NCO-3 was exempted from final designation of critical habitat under Section 4(a)(3) of the ESA. Current estimates of suitable NRF habitat and dispersal habitat indicate the subunits within Unit 1 in Washington are currently highly capable for supporting dispersal, but have lesser amounts of nesting/roosting habitat, comprising about 42 percent of both subunits (Table 7).

Table 7. Summary of spotted owl habitat within Critical Habitat Unit 1: North Coast Ranges and Olympic Peninsula in Washington State.

CH Subunit	Total designated CH acres	Highly Suitable NRF acres	Marginal NRF acres	Unsuitable habitat acres	Percent of CH in NRF	Percent of CH in NRF and marginal
NCO-1	291,501	96,897	114,465	54,541	42 %	81 %
NCO-2	208,815	53,743	90,690	29,634	42 %	85 %

Notes: 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 20-year monitoring report which depict conditions as they existed in 2012 (Davis et al. 2016) prior to the 2018 Maple Fire in NCO-2.

7.2.2 Critical Habitat Subunit: North Coast Ranges and Olympic Peninsula 1 (NCO-1)

The NCO-1 subunit consists of approximately 293,539 acres in Clallam, Jefferson, Grays Harbor, and Mason counties, Washington, including lands managed by the ONF and the State of Washington. The ONF manages 230,966 acres (79 percent) as LSRs to maintain functional, interactive, late-successional and old-growth forest ecosystems, and 62,966 acres (21 percent) under the adaptive management area land use allocation. Threats in this subunit include current and past timber harvest, competition with barred owls, and isolation on a peninsula (along with NCO-2). At the time of listing, 94 percent of this subunit was covered by verified spotted owl home ranges and remaining areas were likely to have been occupied by non-territorial owls and subadults (77 FR 71920).

Spotted owl habitat suitability maps developed for the NWFP 20-year monitoring report indicated that approximately 42 percent of the area within subunit NCO-1 contained “highly suitable” or “suitable” NRF habitat in 2012. Approximately an additional 39 percent of the subunit contains “marginal” quality habitat, for a total of 81 percent “highly suitable,” “suitable,” and “marginal” habitat, indicating that the subunit is highly capable of supporting spotted owl dispersal (Table 7). The vast majority of subunit NCO-1 is located on federal lands, where habitat removal and degradation have been minor. While timber harvest, wildfire, and windthrow have led to some loss of NRF habitat, actions within federal lands have occurred mostly within dispersal habitat, or unsuitable habitat for spotted owls.

Subunit NCO-1 is considered essential for the conservation of the species to meet the recovery criterion that calls for the continued maintenance and recruitment of spotted owl habitat (USFWS 2011, p. ix). The increase and enhancement of spotted owl habitat is necessary to provide for viable populations of spotted owls over the long term by providing for population growth, successful dispersal, and buffering from competition with the barred owl (77 FR 71920).

7.2.3 Critical Habitat Subunit: North Coast Ranges and Olympic Peninsula 2 (NCO-2)

The NCO-2 subunit consists of approximately 213,633 acres in Clallam, Jefferson, Grays Harbor, and Mason counties, Washington, and comprises lands managed by the ONF. The ONF manages 173,682 acres as LSRs to maintain functional, interactive, late-successional and old-growth forest ecosystems, and 39,083 acres under the adaptive management area land use allocation. Threats in this subunit include current and past timber harvest, competition with barred owls, and isolation on a peninsula (along with NCO-1). At the time of listing, 95 percent of this subunit was covered by verified spotted owl home ranges and remaining areas were likely to have been occupied by non-territorial owls and subadults (77 FR 71920).

Spotted owl habitat suitability maps developed for the NWFP 20-year monitoring report indicated that approximately 42 percent of the area within subunit NCO-2 contained “highly suitable” or “suitable” NRF habitat in 2012. Approximately an additional 43 percent of the subunit contained “marginal” quality habitat, for a total of 86 percent “highly suitable,” “suitable,” and “marginal” habitat, indicating that the subunit is highly capable of supporting spotted owl dispersal (Table 7). The vast majority of subunit NCO-2 is located on federal lands, where habitat removal and degradation have been minor. The Maple Fire occurred within this subunit in 2018, leading to the degradation of up to 1,239 acres of suitable habitat during the fire and fire suppression efforts. This potential habitat loss represents a small portion (1.4 percent) of suitable habitat within critical habitat in subunit NCO-2. Prior to 2012, two other fires occurred within this subunit, including the Bear Gulch Fire in 2006 and Big Hump Fire in 2011. Habitat loss from these two fires is accounted for in the habitat suitability maps, and habitat acreages listed in Table 7.

Subunit NCO-2 is considered essential for the conservation of the species to meet the recovery criterion that calls for the continued maintenance and recruitment of spotted owl habitat (USFWS 2011, p. ix). The increase and enhancement of spotted owl habitat is necessary to provide for viable populations of spotted owls over the long term by providing for population growth, successful dispersal, and buffering from competition with the barred owl (77 FR 71920).

7.3 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 in the Pacific Northwest is ongoing, and is projected to continue for the coming decades, regardless of measures that may be taken to reduce or capture greenhouse gas (GHG) emissions. Air temperature warming is already underway, and is expected to continue, with the mid-21st century projected to be approximately four to six degrees Fahrenheit (°F) (2.2 to 3.3 degrees Celsius [°C]) warmer than the late 20th century (Mauger et al. 2015, p. 2-5; USGCRP 2017, pp. 196-197). Summer precipitation is expected to decrease, while winter precipitation is expected to increase (Mauger et al. 2015, p. 2-7; USGCRP 2017, p. 217). In particular, heavy rainfall events are projected to occur between two and three times as frequently and to be between 19 and 40 percent more intense, on average, in the late 21st century than they were during the late 20th century (Warner et al. 2015, pp. 123-124). Trends for the ONF are projected to be somewhat milder than those in the Pacific Northwest as a whole. With a business-as-usual scenario of GHG emissions and capture, air temperatures between now and 2045 are projected to warm approximately 2 to 5 °F (approximately 1 to 2.5 °C), relative to the late 20th century (LCD 2020). The majority of climate models project an increase in fall and winter rainfall (up to a 20 percent increase in winter rainfall) and a decrease in spring and summer rainfall (up to a 24 percent decrease in summer rainfall), though some models instead show very slightly wetter summers or very slightly drier falls and winters (LCD 2020).

Spotted owls in ONF are among the species ranked as highly sensitive to climate change (Halofsky et al. 2011, p. 107). Changing climate conditions may affect spotted owls in a variety of ways. Spotted owl survival and reproductive rates are related to temperature and rainfall conditions, so changes in these conditions may affect spotted owl fitness directly. Over the coming decades, climate change is also likely to influence the quantity and quality of spotted owl habitat in the ONF, via changes in the frequency of forest disturbances and in tree mortality rates. Changing conditions in spotted owl habitat may also affect spotted owl prey, and alter ecological interactions between spotted owls and their prey or their competitors.

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 or even 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, likely via effects to prey populations (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). Given the projected changes in temperature and seasonal rainfall within the action area, it is difficult to predict how climate change will affect spotted owl demography. It is likely that cold, wet winter and early spring seasons will occur less frequently, which may be beneficial for spotted owl survival, reproduction, and recruitment. On the other hand, summer temperature increases and more frequent drought are also likely, and could counteract any beneficial effect of warmer winters and springs.

Forested habitats in western Washington are affected by climate change mainly via changes in disturbances, including wildfire, insects, tree diseases, and drought mortality. These types of disturbances can all cause the loss of spotted owl habitat, though it is hoped that this loss will be offset by ingrowth as existing mid-successional forest matures. Following stand-replacing disturbances, climate conditions may not allow recruitment of the tree species that are currently present, leading to ecotype change (Halofsky et al. 2011, p. 100); however, the effect of this kind of ecotype change may not directly affect spotted owl habitat availability until many decades in the future.

Western Washington's fire regime has historically been typified by large, infrequent, stand-replacing fires (Halofsky et al. 2018a, pp. 3-4). For example, approximately half of the Olympic Peninsula burned around 1308; a large fire covered much of the northern and eastern Olympic Peninsula around 1701; and there were many other years with widespread fire on the Olympic Peninsula in the intervening 400 years (Henderson et al. 1989, pp. 13-19). However, fires of this nature have not occurred during the 20th-century period usually used for statistical analyses of fire behavior or projections of future fire, which extends only a few decades into the past (Littell et al. 2010, p. 150). For example, between 1993 and 2012, monitoring based on a database of large (at least 1,000 acres) fire perimeters detected the loss to fire of only 1,200 acres of stands 80 years old and older on federal lands on the Olympic Peninsula (Davis et al. 2015, p. 30). A model based on fire data collected in 1971 through 2015 classifies less than 1 percent of forested lands in the Coast Ranges of Washington and Oregon (including the Olympic Peninsula) as being currently "highly suitable" for large fires, and only the northern and eastern parts of the Olympic Peninsula are rated as having moderate or greater suitability for large fires (Davis et al.

2017, pp. 179-182). The fire regime in Western Washington, including on the Olympic Peninsula, has historically been sensitive to climate conditions (Henderson et al. 1989, pp. 13-19; Littell et al. 2010, p. 140; Weisberg and Swanson 2003, pp. 23-25).

The area burned in Western Washington is expected to increase in the coming decades, but there is great uncertainty about the magnitude of the increase, and it is likely to affect some areas more than others, even within the ONF. In the Coast Ranges of Washington and Oregon, the model based on fire data collected in 1971 through 2015 projects that the forested area highly suitable for large fires will more than double, to 2 percent, still a small fraction of the total area (Davis et al. 2017, p. 180). The area of moderate suitability for large fires is projected to expand to the west and south, but is still expected to be confined to the northern and eastern sections of the peninsula (Davis et al. 2017, p. 180). Before 2050, the ONF, like most of Western Washington, is projected by one study to be less vulnerable to climate-changed induced fire than many other parts of the Western United States (Buotte et al. 2018, pp. 5, 8). A different study found that forests west of the Cascade Crest are more vulnerable to fire than other western forests, because they will be sensitive to hotter, drier summers, but will not benefit from increased winter precipitation since soils are already saturated during winter months (Rogers et al. 2011, p. 6). All of these studies are based on the recent period in which fire frequency has been lower than it was prior to European settlement. Since the future projections do not account for the historical fire regime, the projections are more likely to be underestimates than overestimates, especially given that extreme fire weather that could trigger these fires is increasing in frequency (Halofsky et al. 2018a, p. 6; Littell et al. 2010, p. 149).

Two recent studies have modeled future fires based on projected climate and vegetation characteristics, rather than simply using statistical projections based on past rates of wildfire. These studies showed, respectively, a 1.5- to 5-fold increase between the historical period and the 21st century, and a 2- to 4-fold increase between the late 20th century and mid-century (Halofsky et al. 2018b, p. 10; Sheehan et al. 2019, p. 14). In both studies, the lower increases were associated with a model assumption that firefighting would continue to be effective. In one of these studies, the baseline annual percentage of area burned was based on information about pre-European settlement fire rotation in western Washington, and at 0.2 to 0.3 percent of the forest land base burned per year, is an much greater annual area burned than we have observed in the recent past; the late 21st-century annual area burned was expected to reach 0.3 to 1.5 percent of the forest land base per year, with extreme fire years burning 5 to 30 percent of the forest land base (Halofsky et al. 2018b, p. 10). The results of the other study, which also included Western Oregon, estimated an even larger annual percentage of area burned, starting at 0.47 to 0.56 percent per year in the late 20th century and increasing to 1.14 to 1.99 percent by the mid-21st century (Sheehan et al. 2019, p. 14).

Insects and disease also cause the loss of spotted owl habitat. On federal lands of the Olympic Peninsula, 1,200 acres of forest 80 years old or older were lost to insects and disease since 1993 (Davis et al. 2015, p. 30). The Forest Service and WDNR have worked together since 1981 to collect and distribute aerial survey data regarding the presence of insects, disease, and other damage agents in Washington's forests (WDNR and USFS 2018). This dataset indicates the identity of various insect and disease issues that have been recorded in the action area, including Douglas-fir beetle (*Dendroctonus pseudotsugae*), "dying hemlock," fir engraver (*Scolytus* *ventralis*), spruce aphid (*Elatobium abietinum*), Swiss needle cast (*Phaeocryptopus gaeumannii*), and balsam woolly adelgid (*Adelges piceae*). It is likely that various root diseases have also killed trees in the action area. During the aerial surveys, damage from root diseases is generally classified as bear damage, the most prevalent issue recorded in the action area (Clark et al. 2018, p. 31). Root diseases that may be present include annosus (*Heterobasidium annosum*), armillaria (*Armillaria ostoyae*), and black stain (*Leptographium wageneri*) root diseases, as well as laminated (*Phellinus weirii*), tomentosus (*Inonotus tomentosus*), and yellow (*Parenniporia subacida*) root rots (Goheen and Willhite 2006, pp. 72-87). These insects and diseases vary in the types of trees they affect, and in the severity of effect to the individual tree and to the stand. Some level of some diseases may be beneficial to spotted owl habitat values, for example, by creating potential nest cavities. Others may cause habitat loss. Douglas-fir beetle, in particular, is more likely to attack older trees, and can kill up to 80 percent of the older Douglas-fir trees in a stand (Goheen and Willhite 2006, pp. 30, 224).

Drought has not historically been a major factor in western Washington forests, because these forests are not typically water limited (Littell et al. 2010, p. 139). Nonetheless, nearly all of the Olympic Peninsula has been affected repeatedly by multi-year drought during the 1918-2014 period, with some areas experiencing up to five years of moderate-severity drought or three years of severe drought (Crockett and Westerling 2018, p. 345). In the Pacific Northwest generally, drought is associated with Douglas-fir canopy declines that can be observed via satellite imagery (Bell et al. 2018, pp. 7-10). In Western Washington, Oregon, and Southwestern British Columbia, tree mortality more than doubled (from around 0.5 percent per year to more than 1 percent per year) over the 30-year period between 1975 and 2005, likely due to increasing water stress (van Mantgem et al. 2009, pp. 522-523). Tree mortality may be caused by warm dry conditions in and of themselves (via xylem failure) or when hot, dry conditions compound the effects of insects, disease, and fire.

Some of the insects and pathogens already present in spotted owl habitat, such as Douglas-fir beetles, are likely to become more prevalent and cause greater mortality in the future. Douglas-fir trees stressed by heat and drought emit ethanol, which attracts Douglas-fir beetles, and have lowered chemical defenses, which is likely to increase the endemic levels of Douglas-fir infestation and could result in higher probability of epidemic infestation (Agne et al. 2018, p. 326-327). Future climate conditions are also hypothesized to promote other diseases, such as Armillaria root disease, that could affect spotted owl habitat (Agne et al. 2018, p. 326).

All climate models project increased summer warming for Western Washington, and most project decreased spring snowpack and summer precipitation, resulting in increasing demand on smaller amounts of soil water in the forest during the growing season. Most areas of the ONF are expected to experience increasing water deficits over the 21st century (McKenzie and Littell 2017, p. 31). These deficits will not be uniform, with the northern and especially eastern parts of the Olympic Peninsula projected to experience much greater hydrological drought, starting sooner than in the southern and western areas, while there are even projected reductions in water deficit for higher elevation areas adjacent to the action area in Olympic National Park (McKenzie and Littell 2017, p. 31). The projected future warm, dry conditions, sometimes called “hotter drought” or “climate change-type drought” in the scientific literature, are expected to lead to continued increases in tree mortality. Though projections of future drought mortality in Western

Washington are not available, the effects of the recent multi-year drought in California may provide some context about what to expect. Drought conditions in California during 2012 through 2015 led to an order of magnitude increase in tree mortality in Sierra Nevada forests (Young et al. 2017, p. 83). Although wetter regions, such as the Olympic Peninsula, are unlikely to have near-future impacts as severe as those already seen in California, eventually extreme climate conditions are likely to further increase drought stress and tree mortality, especially since trees in moist forests are unlikely to be well-adapted to drought stress (Allen et al. 2010, p. 669; Allen et al. 2015, pp. 19-21; Anderegg et al. 2013, p. 705; Crockett and Westerling 2018, p. 342; Prestemon and Kruger 2016, p. 262; Vose et al. 2016a, p. 10).

Blowdown is another forest disturbance that has historically caused extensive stand-replacing disturbances in western Washington. The effect of climate change on blowdown frequency, extent, and severity is unknown, and there are reasons to believe that blowdowns may become either more or less frequent or extensive. Hurricane-force winds hit the Washington coast approximately every 20 years during the 20th century (Henderson et al. 1989, p. 20). Blowdown events are often associated with extra-tropical cyclones, which are often associated with atmospheric rivers. Blowdown is influenced by wind speeds and by soil saturation. Destructive windstorms have occurred in the Pacific Northwest in 1780-1788, 1880, 1895, 1921, 1923, 1955, 1961, 1962, 1979, 1981, 1993, 1995, and 2006 (Henderson et al. 1989, p. 20; Mass and Dotson 2010, pp. 2500-2504). During the 20th century, the events in 1921, 1962, and 2006 were particularly extreme. Although there are some estimates of timber losses from these events, there are no readily available estimates of spotted owl habitat loss from particular events. In addition to habitat loss from these extreme blowdown events, a smaller amount of habitat is lost each year in "endemic" blowdown events. On federal lands of the Olympic Peninsula, remotely sensed imagery indicates that 2,600 acres of forest 80 years old or older was lost between 1993 and 2012 to non-wildfire, non-insect natural disturbances mainly consisting of blowdown (Davis et al. 2015, p. 30).

Because we did not locate any studies attempting to project spotted owl habitat or forest blowdown into the future, we looked to studies regarding the conditions associated with blowdown: wind, rain, and landscape configuration. There are indications that average wind speeds over the Pacific Northwest have declined since 1950, and average wind speeds are projected in most climate models to decline further by the 2080s (Luce et al. 2013, pp. 1361-1362). However, it is not clear how average wind speeds might be related to blowdown, since blowdown events usually happen during extreme wind events. Extreme extra-tropical cyclones are expected to become less frequent in the Northern Hemisphere in general, and perhaps in Washington in particular, but these predictions involve many uncertainties. Different models show local increases in storm frequency in different places (Catto et al. 2011, pp. 5344-5345). Also, how "extreme" events are categorized differs between studies, and the results vary depending on what definition of "extreme" is used (Catto et al. 2001, p. 5348; Ulbrich et al. 2009, p. 127). One recent model projects no change in the extreme ground-level winds most likely to damage nesting habitat, and an increase in the frequency of extreme high-altitude winds (Chang 2018, pp. 6531, 6539). Atmospheric rivers are expected to become wetter and probably more frequent. The frequency of atmospheric river days is expected to increase by 150 to 600 percent over the 21st century (Gao et al. 2015, p. 7185; Warner and Mass 2017, p. 2135), though some models project up to an 18 percent decrease in frequency (Payne and Magnusdottir 2015,

p. 11,184). The most extreme precipitation events are expected to be 19 percent wetter (Warner et al. 2015, p. 123). If increased rain causes greater soil saturation, it is easily conceivable that blowdown would become likely at lower wind speeds than would be needed to cause blowdown in less saturated conditions, but we did not find studies addressing this relationship. Since blowdown is more likely at forest edges, increasing fragmentation may lead to more blowdown for the same wind speed and amount of soil saturation, and decreases in fragmentation could reduce blowdown. Spotted owl habitat within the action area may become less fragmented over the next 30 years, as stands mature into suitable habitat conditions, or it may become more fragmented due to increases in the forest disturbances mentioned above. Thus, the likely extent of spotted owl habitat loss to blowdown within the ONF over the coming decades is highly uncertain.

Synergistic effects between drought, disease, fire, and blowdown are likely to occur to some extent, and could become widespread. Some forested area could be lost to winter flooding, as well (Halofsky et al. 2011, p. 100). If large increases in tree mortality do occur, interactions between these agents are likely to be involved (Halofsky et al. 2018a, pp. 4-5). The large recent increase in tree mortality in the Sierra Nevada has been caused in large part due to these kinds of synergistic interactions. As noted above, the ONF is unlikely to be as severely affected and severe effects are likely to happen later in time here than in other places (where such effects are already occurring). In fact, one study rates nearly all of Washington's forests as having low vulnerability, relative to other western forests, to drought or fire effects by 2049 (Buotte et al. 2018, p. 8). However, many other studies do indicate that there is a risk of one or more of these factors acting to cause the loss of some amount of spotted owl habitat over the next 30 years.

Even where spotted owl habitat remains, some elements of the habitat are likely to be altered by the changing ecological conditions described above, and these may affect interactions between spotted owls and other animals. For example, northern flying squirrels (flying squirrel) (*Glaucomys sabrinus*) eat fungi and lichens, and the availability of these moisture-associated foods is expected to decrease with the increasing drought conditions (Weigl 2007, p. 903). A reduction in food availability for flying squirrels will presumably result in a reduction in the availability of flying squirrels as spotted owl prey.

In summary, climate change is likely to further exacerbate some existing threats to the spotted owl such as the projected potential for increased habitat loss from drought-related fire, tree mortality, insects and disease, and increases in extreme flooding, landslides and windthrow events in the short-term (10 to 30 years), as well as affecting reproduction and survival during years of extreme weather. Some effects may be positive; for example, warmer, drier spring weather could create favorable conditions for nesting success. On balance, however, the effects of climate change are likely to cause habitat loss, and may limit habitat ingrowth and prey availability.

7.4 Conservation Role of the Action Area for Spotted Owls

ONF contains high-quality spotted owl habitat that currently supports a small breeding population of spotted owls and is considered essential for the long-term conservation of the species. Habitat within the ONF is essential for providing demographic support for the overall spotted owl population both within the Olympic Peninsula recovery unit and rangewide. Future recruitment and enhancement of spotted owl habitat on the ONF is considered essential to provide for population expansion, successful dispersal, and buffering from competition with the barred owl (77 FR 71920 [Dec. 3, 2012]).

8 EFFECTS OF THE ACTION: Spotted Owl

The proposed action will adversely affect spotted owls by exposing nesting owls to short-term indirect habitat degradation and disturbance effects associated with road and trail construction and maintenance, maintenance of administrative and recreation facilities, a variety of actions associated with special use permits, non-commercial forest treatments, timber harvest activities, rock source crushing and blasting. Timber harvest activities will also have long-term beneficial effects associated with future recruitment of spotted owl habitat in the action area.

Most actions (outside of designated Wilderness Areas) are carried out with the use of chainsaws, heavy equipment, or other motorized equipment. Many individual actions will occur within areas of suitable spotted owl nesting habitat. Actions can occur at any time during the year, but the majority will occur during spring and summer months during the spotted owl nesting season. Considering the range of actions covered in this programmatic consultation, the effects to spotted owls are related to potential noise and visual disturbance and limited habitat effects associated with individual tree removal. Access permits issued by the ONF would not result in adverse effects to any listed species on non-federal lands.

8.1 Insignificant and Discountable Effects of the Proposed Action on Spotted Owl

Effects to spotted owls may occur from actions that remove or degrade spotted owl nesting, roosting, and foraging habitat; or by actions that produce loud sound and activity in close proximity to nesting spotted owls, resulting in a potential disruption of spotted owl breeding and nesting behaviors. ONF management activities that meet the following criteria are considered to have insignificant effects (i.e., not likely to adversely affect) to the spotted owl:

1. Removal of understory vegetation (small trees and shrubs) within suitable spotted owl habitat outside the early spotted owl nesting season (July 16 to February 28). Small trees are defined as conifers less than or equal to 10 inches dbh.

2. Removal of scattered individual large trees or snags (suitable nest trees) within suitable spotted owl habitat outside the early spotted owl nesting season (July 16 to February 28) (Table 4). Large trees are defined as conifers greater than or equal to 18 inches dbh. Removal of known nest trees is not permitted.

3. Sound-generating activities that occur during the late breeding season (July 16 to September 30) within close proximity to unsurveyed suitable habitat or known nest sites (Table 8).

4. Sound-generating activities that occur at greater than the established disruption threshold distances from known nest sites or unsurveyed suitable habitat during the early breeding season (March 1 to July 15) (Table 8).

Management activities that meet the above criteria would not result in the loss of suitable nest trees or trees adjacent to suitable nest trees within suitable habitat during the early spotted owl breeding season. Removal of understory vegetation such as small trees or shrubs within suitable spotted owl habitat is considered to be a minor habitat modification, because key habitat elements such as large overstory trees, overstory canopy cover, and large snags are maintained. Spotted owls occupy large territories encompassing thousands of acres of suitable habitat. Loss of scattered, individual large trees or snags within a stand of suitable habitat is considered a minor habitat modification, as long as the individual tree removal occurs outside the early spotted owl nesting season. This minimizes the risk that an occupied nest tree could be felled during the nesting season.

The use of chainsaws, heavy equipment, and helicopters all introduce increased levels of sound and human activity which can disrupt spotted owl nesting behaviors if the activity occurs in close proximity to an active nest site (Table 8). Project activities that do not occur during the early nesting season, or do not occur within the disruption distance thresholds listed in Table8, are expected to have insignificant effects to spotted owls. For more details on disruption of spotted owl behavior due to disturbance, disruption distance thresholds, and the spotted owl nesting season, see Section *8.2 Effects to Spotted Owls from Disturbance*. Project activities that do not result in the loss of suitable habitat and occur outside of the spotted owl nesting season (October 1 to February 28) are generally considered to have insignificant, discountable, or no effects to spotted owls.

8.1.1 Revised Spotted Owl Critical Habitat (2012)

The USFWS published the final rule for revised spotted owl critical habitat in the December 4, 2012 Federal Register (77 FR 71876). The effective date of the revised critical habitat was January 4, 2013. The revised spotted owl critical habitat designation includes 11 critical habitat units and 60 critical habitat subunits, and encompasses over 9.5 million acres in Washington, Oregon, and California. 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). Effects analysis for spotted owl critical habitat evaluate how a proposed action will affect the capability of the PCEs to provide for spotted owl nesting, roosting, foraging, and dispersal (77 FR 71939).

8.1.1.1 Individual Tree Removal Including Removal of Suitable Nest Trees

As many as 750 “suitable nest trees” (SNTs) may be removed as part of the proposed action over ten years, all of which may be removed from within designated spotted owl critical habitat. SNTs are defined as trees or snags that contain a large cavity, broken top, external platform, or other structure that could provide a suitable nest structure for spotted owls. Approximately 1,000 trees at least 18 inches dbh (but without potential nesting structures) are also expected to be removed as part of this consultation. Removal of scattered, individual trees or snags from within the nesting, roosting, and foraging habitat PCEs are considered to be a minor habitat modification, because the loss of individual trees does not affect the functionality of a stand to provide these PCEs (77 FR 71940 [Dec. 4, 2012]). Key habitat elements such as large overstory trees, overstory canopy cover, and multiple canopy layers will be maintained at the stand scale. Therefore, the effects of individual tree removal to the spotted owl critical habitat PCEs are considered to be insignificant.

8.2 Effects to Spotted Owls from Disturbance

8.2.1 Background Information: Disturbance to Spotted Owls from Project Noise and Activity

In this analysis, we use the term "disturbance" to mean audio/visual stressors resulting from human activities within or adjacent to spotted owl nesting habitat. We use the term "disruption" to specify where we expect exposure to audio/visual disturbance will disrupt normal nesting behaviors such as incubation or feeding of young. In previous analyses of the potential for disturbance to spotted owls (USFWS 2013, pp. 74-89), we concluded that the noise and activity associated with the use of excavators, chainsaws, helicopters, and other motorized equipment can disrupt normal spotted owl nesting behaviors in some situations. In these analyses, 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) (Table 8). 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). Disruption of normal nesting behaviors during the early nesting season is significant due to the potential for reduced hatching success, fitness, or survival of nestlings.

8.2.1.1 Behavioral Responses to Disturbance

Noise and visual disturbance associated with forest management activities during the early spotted owl nesting season could result in flushing a spotted owl adult or juvenile away from a nest. Flushing from a nest site is considered a significant disruption of normal behavior because flushing a nesting owl increases the risk of predation to the eggs or nestlings. The greatest risk to spotted owls from disturbance is causing a pre-fledged juvenile to flush. It is common for pre-fledged owlets to leave the nest and perch on adjacent branches before they can fly (Forsman et al. 1984, p. 36). Owlets in this stage of development are vulnerable because if they fall to the ground before they are able to fly they have a high risk of mortality. Forsman et al. (1984, p. 36) notes that seven of nine owlets that fell or jumped from the nest prematurely were killed by the fall or disappeared before reaching the flying stage.

A flush response creates the likelihood of injury by increasing the risk of predation through the advertisement of the nest's location, advertisement of the adult and juvenile, or the premature departure of a nestling from a nest. Predation mortality of juvenile spotted owls is common, and is the leading cause of death of fledglings (Forman et al. 2002, p. 18). Spotted owls are preyed upon by great horned owls (*Bubo virginianus*) (Forsman et al. 1984, p. 38; 2002, p. 18), and they presumably are preyed upon by northern goshawks (*Accipiter gentilis*), and red-tailed hawks (*Buteo jamaicensis*) (Forsman et al. 2002, p. 27). It is likely that flushing a spotted owl from its nest or causing a nestling to flush from the nest prematurely would increase the chances of juveniles being predated. However, adult spotted owls are protective and have been observed defending themselves and their young from potential avian predators (e.g. hawks and ravens)

(Forsman et al. 1984, p. 36). Female spotted owls exposed to disturbance are reluctant to leave the nest during the early stages of the breeding cycle (Delaney et al. 1999, p. 71; Delaney and Grubb 2003, p. 22), so the risk of causing an incubating spotted owl to abandon a nest is considered to be discountable.

8.2.1.2 Physiological Responses to Disturbance

Spotted owls exposed to active forest management, including sound or visual disturbances may produce 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).

The implications of elevated GCs are unknown. There is correlational evidence that spotted owls exposed to high levels of road noise fledged fewer young than spotted owls near quiet roads, but there was no consistent relationship between elevated GCs and nesting success (Hayward et al. 2011, p. 11). 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). The application of an early season LOP avoids disturbance effects to spotted owls during this sensitive period in their life cycle, and may be effective in minimizing the physiological effects of disturbance (Wasser et al. 2005, p. 134).

8.2.1.3 Disturbance During the Late Nesting Season

The late nesting season extends from July 16 through September 30. In the late nesting season, juvenile spotted owls have fully fledged and are able to thermoregulate, fly short distances, and are no longer completely dependent upon the adults for daily feedings (Forsman et al. 1984, pp. 37-38). A brief flush response from either an adult or juvenile at this stage of development is not likely to reduce the juvenile owl's fitness or ability to survive. The biological effect of potential noise or visual disturbance that occurs during the late nesting season is considered to be insignificant. Spotted owl territories encompass thousands of acres of forest habitat which they range across searching for prey. It is likely that individual spotted owls that are foraging or roosting in close proximity to project activities may occasionally be flushed away from a foraging perch or a roosting site by project noise and activity. Such flush responses that occur away from an active nest site are considered to be insignificant, because the owls are simply moving away from the source of disturbance, rather than being forced to flush away from an active nest site.

Table 8. Disturbance, significant disruption and/or physical injury distance thresholds for Spotted Owls. Distances are to a known occupied spotted owl nest tree or suitable nest trees in unsurveyed nesting habitat.

Project Activity	**No Effect** (Mar 1 – Sep 30)	**NLAA** "may affect" disturbance distance **(Mar 1 – Sep 30)**	**LAA** early nesting season significant disruption distance **(Mar 1–Jul 15)**	**LAA** late nesting season significant disruption distance **(Jul 16–Sep 30)**	**LAA** direct injury and/or mortality **(Mar 1 – Sep 30)**
Light maintenance (e.g., road brushing and grading) at campgrounds, administrative facilities, and heavily-used roads	>0.25 mile	≤ 0.25 mile	NA[1]	NA	NA
Log hauling on heavily-used roads (FS maintenance levels 3, 4, and 5)	>0.25 mile	≤ 0.25 mile	NA[1]	NA	NA
Chainsaws (includes felling hazard/danger trees)	>0.25 mile	66 yards to 0.25 mile	≤ 65 yards[2]	NA	NA
Heavy equipment for road construction, road repairs, bridge construction, culvert replacements, etc.	>0.25 mile	66 yards to 0.25 mile	≤ 65 yards[2]	NA	NA
Pile-driving (steel H piles, pipe piles) Rock Crushing and Screening Equipment	>0.25 mile	120 yards to 0.25 mile	≤ 120 yards[3]	NA	≤ 5 yards (injury)[3]
Blasting	>1 mile	0.25 to 1 mile	≤ 0.25 mile[4]	NA	≤ 100 yards (injury)[4]
Helicopter: Chinook 47d	>0.5 mile	266 yards to 0.5 mile	≤ 265 yards[5]	≤ 100 yards[6] (hover only)	NA
Helicopter: Boeing Vertol 107, Sikorsky S-64 (SkyCrane)	>0.25 mile	151 yards to 0.25 mile	≤ 150 yards[7]	≤ 50 yards[6] (hovering only)	NA
Helicopters: K-MAX, Bell 206 L4, Hughes 500	>0.25 mile	111 yards to 0.25 mile	≤ 110 yards[8]	≤ 50 yards[6] (hovering only)	NA
Small fixed-wing aircraft (Cessna 185, etc.)	>0.25 mile	111 yards to 0.25 mile	≤ 110 yards	NA	NA
Tree Climbing	>66 yards	26 yards to 65 yards	≤ 25 yards[9]	NA	NA
Burning (prescribed fires, pile burning)	>1 mile	0.25 mile to 1 mile	≤ 0.25 mile[10]	NA	NA

NLAA = "not likely to adversely affect." **LAA** = "likely to adversely affect" ≥ is greater than or equal to, ≤ is less than or equal to.

Table 8 (Spotted Owl) Footnotes:

1. NA = not applicable. Based on information presented in Temple and Guttiérez (2003, p. 700), Delaney et al. (1999, p. 69), and Allwardt and Kerns (1992, p. 9), we anticipate that spotted owls that select nest sites in close proximity to open roads either are undisturbed by or habituate to the normal range of sounds and activities associated with these roads.
2. Based on Delaney et al. (1999, p. 67) which indicates that spotted owl flush responses to above-ambient equipment sound levels and associated activities are most likely to occur at a distance of 65 yards (60 m) or less.
3. Impulsive sound associated with pile-driving is highly variable and potentially injurious at close distances. A review compiled by Dooling and Popper (2007, p. 25) indicates that birds exposed to multiple impulses (e.g., pile driving) of sound at 125 dBA or greater are likely to suffer hearing damage. We have conservatively chosen a distance threshold of 120 yards for impact pile-driving to avoid potential effects to hearing and to account for significant behavioral responses (e.g. flushing) from exposure to loud, impulsive sounds. Based on an average maximum sound level of 110 dBA at 50 feet for pile-driving, exposure to injurious sound levels would only occur at extremely close distances (e.g., ≤ 5 yards).
4. Impulsive sound associated with blasts is highly variable and potentially injurious at close distances. We selected a 0.25-mile radius around blast sites as a disruption distance based on observed prairie falcon flush responses to blasting noise at distances of 0.3 to 0.6 mile from blast sites (Holthuijzen et al. 1990, p. 273). Exposure to peak sound levels that are greater than 140 dBA are likely to cause injury in the form of hearing loss in birds (Dooling and Popper 2007, pp. 23-24). We have conservatively selected 100 yards as an injury threshold distance based on sound levels from experimental blasts reported by Holthuijzen et al. (1990, p. 272), which documented peak sound levels from small blasts at 138 to 146 dBA at a distance of 100 m (110 yards).
5. Based on an estimated 92 dBA sound-contour (approximately 265 yards) from sound data for the Chinook 47d presented in Newman et al. (1984, Table D.1).
6. Rotor-wash from large helicopters is expected to be disruptive at any time during the nesting season due to the potential for flying debris and shaking of trees located directly under a hovering helicopter. The hovering rotor-wash distance for the Chinook 47d is based on a 300-ft radius rotor-wash zone for large helicopters hovering at < 500 above ground level (from WCB 2005, p. 2 – logging safety guidelines). We reduced the hovering helicopter rotor-wash zone to a 50-yard radius for all other helicopters based on the smaller rotor-span for all other ships.
7. Based on an estimated 92 dBA sound contour from sound data for the Boeing Vertol 107 the presented in the San Dimas Helicopter Logging Noise Report (USFS 2008, chapters 5, 6).
8. The estimated 92 dBA sound contours for these helicopters is less than 110 yards (e.g., K-MAX (100 feet) (USFS 2008, chapters 5, 6), and Bell 206 (85-89 dbA at 100 m)(Grubb et al. 2010, p. 1277).
9. Based on Swarthout and Steidl (2001, p. 312) who found that 95 percent of flush responses by spotted owls due to the presence of hikers on trails occurred within a distance of 24 m.
10. Based on recommendations presented in *Smoke Effects to Northern Spotted Owls* (USFWS 2008, p. 4).

8.2.2 Exposure of Spotted Owl Habitat to Noise and Visual Disturbance from Commercial Thinning and Associated Activities

Over the next 10 years, the ONF proposes commercial thinning of up to 30,000 acres within the action area. Other activities will be conducted associated with the commercial timber harvest, requiring the use of chainsaws and heavy motorized equipment, including other types of vegetation management (forest health treatments, maintenance of communication sites, viewshed management, expansion of trailheads and campgrounds), road construction and maintenance, landing construction, use of helicopters, and rock pit development and expansion. Commercial thinning treatments within historical spotted owl core areas will not occur during the early nesting season (March 1 – July 15). However, some associated activities, described above, may occur during the early nesting season. Using a 65-yard radius exposure zone, the ONF estimated that these activities will result in noise and visual disturbance within up to 5,265 acres of suitable spotted owl habitat over the 10-year duration of this consultation.

Because the timing of specific activities occurring over the next 10 years is unknown, we assume that disturbance within these 5,265 acres of suitable habitat is equally likely to occur within the early and late nesting season (Piper, S., in litt. 2020a). While this programmatic consultation covers 10 years of commercial thinning projects, and those projects will likely take multiple years each to implement, we do not expect all 5,265 acres of habitat to be exposed for the entire duration of the proposed action. We expect that actions associated with commercial thinning will be spread throughout the action area, and that these actions will not occur more than once within each forest stand. Likewise, we expect that other types of actions, such as maintenance of communication sites, viewshed management, etc. will not need to occur more than once at each location. As a result, any given habitat location exposed to disturbance due to these actions is not likely to be exposed for more than one nesting season.

8.2.3 Exposure of Spotted Owl Habitat to Noise and Visual Disturbance from All Other Action Categories

During the next 10 years, the ONF expects to continue to complete maintenance and reconstruction activities on the entire 2,020-mile road system and 290 miles of trails, and to complete various forest management activities at various sites throughout the ONF. Using GIS, we plotted a 65-yard disturbance-exposure zone along trails and 115-yard exposure zone along roads and campgrounds (adding 50 yards for the length of an average hazard tree). Based on past project implementation, the ONF estimated the number of individual programmatic actions that are likely to occur during the early spotted owl nesting season. These estimates are detailed in Appendix F: *Annual Disturbance Acres by Activity Type – Spotted Owl*, and the cumulative totals are summarized in Table 9.

Table 9. Estimated suitable spotted owl habitat acres exposed to visual and noise disturbance **annually** during the spotted owl early nesting season (March 1 to July 15) from other action categories.

Programmatic Category	Acres of suitable and non-suitable habitat exposed to potential disturbance	Acres of suitable habitat exposed to potential disturbance
Forest Roads (including all activities associated with the road system, campgrounds, administrative facilities, danger tree felling, and Special Use Permits)	7,507	1,905
Forest Trails (including all activities associated with forest trails such as trail maintenance, trail bridges, trail reconstruction)	961	481
Other Forest Actions (including pre-commercial thinning, utilities maintenance, habitat restoration, communication sites, etc.)	1,796	456
Totals	**10,264**	**2,842**
Acres of suitable habitat within 115 yards of roads, campgrounds and within 65 yards of trails	**47,160**	
Acres of suitable habitat exposed to potential disturbance	**2,842 (rounded to 2,840)**	
Percent of suitable habitat within 115 yards of roads, campgrounds and within 65 yards of trails exposed to potential disturbance	**6 %**	

Activity- and program-specific accounting of these acres is presented in Appendix F; as explained therein, we included habitat within 115 yards of roads or campgrounds and within 65 yards of trails.

Approximately 47,160 acres of suitable spotted owl habitat on the ONF are located in close proximity to roads, campgrounds, and trails. Approximately 6 percent (2,840 acres) of these acres will be exposed to annual noise and visual disturbance associated with programmatic actions during the early nesting season. This represents less than 1 percent of the total suitable habitat acres on the ONF.

Over 10 years, the cumulative amount of suitable habitat exposed to disruptive activity is approximately 28,400 acres. This is an estimate comprised of many small-scale projects scattered across the ONF and associated primarily with the road network. Most individual programmatic actions (e.g., felling a danger tree or trail bridge construction) will expose only a small of area of suitable habitat to disruptive activities (65-yard radius = 2.74 acres), while a few individual actions (e.g., sling operations with a large helicopter) could expose 45 acres or more of habitat to disruptive actions. Most disruptive activities are expected to be short in duration (e.g., hours to 1 day in any one location) with the exception of projects such as bridge replacement or road reconstruction, which could have a project duration of 2 weeks or more at one location.

8.2.4 Estimate of Individual Spotted Owls Exposed to Noise and Visual Disturbance

The general planning areas for the proposed commercial thinning projects over the next 10 years are known, and road and trail system on the ONF are essentially permanent features on the landscape where the majority of programmatic activities will occur. However, the locations of individual actions (e.g. stand treatments, danger tree felling, etc.) covered under this programmatic are unknown, so we rely on the estimated habitat acres exposed to provide the context for this analysis. As described above, we expect a cumulative total of approximately 5,265 acres of suitable spotted owl habitat will be exposed to noise and visual disturbance from activities associated with commercial thinning over 10 years, for an average of about 527 acres exposed annually. However, since commercial thinning projects will not occur every year throughout the duration of this programmatic, the actual number of acres exposed will vary from year to year. Additionally, we expect approximately 2,840 acres of suitable spotted owl habitat will be exposed annually within potential disruption distances for spotted owls from all other action categories.

To estimate the number of spotted owls that could potentially be exposed to disturbance from programmatic activities, we reviewed the ONF GIS database of spotted owl activity centers. The database includes a total of 114 spotted owl activity centers (i.e., sites with pairs or resident single spotted owls) located within the administrative boundary of the ONF. Demographic monitoring on the Olympic Peninsula indicates spotted owls are now absent from about 90 percent of the territories monitored (Gremel 2018, p. 8, Lesmeister et al 2019, p. 3). Assuming a 10 percent occupancy rate, we expect that out of the 114 historic spotted owl activity centers located on the ONF, only about 11 activity centers are currently occupied, while the remaining territories are vacant or occupied by barred owls.

Based on past activities, the ONF estimates that out of the 114 historic spotted owl activity centers, the core areas associated with up to 60 historic spotted owl activity centers will be exposed to disturbance effects from commercial thinning harvest or other activities. Because the exact locations of thinning treatments and associated activities are unknown, we are unable to determine exactly how many, and which of the historic spotted owl activity centers will be exposed to disturbance. However, based on current occupancy rates of spotted owl activity centers in 2018 (10 percent) we estimate that up to 6 occupied activity centers will be exposed to significant disturbance from activities associated with commercial thinning during the entire nesting season (March 1 – September 30). As stated previously, we assume that disturbance caused by these activities is equally likely to occur during the early and late spotted owl nesting season. Based on this assumption, we expect that only 3 occupied activity centers will be exposed to noise and visual disturbance from commercial thinning or other disturbance related activities during the early nesting season (March 1 – July 15) over the next 10 years.

As described above, we expect up to 3 spotted owl activity centers (3 nesting pairs and their young) to be exposed to noise and visual disturbance from activities associated with commercial thinning or other programmatic forest management activities over 10 years during the early nesting season. This is a conservative estimate, because we are relying on estimates of activities within historic spotted owl core areas as a surrogate measure for exposure to nesting pairs. This assumption is also based on the ONFs' conservation measures to avoid activities in the vicinity of known occupied spotted owl sites, and the fact that spotted owls on the ONF occur at very low densities relative to the total available suitable habitat. The majority of spotted owls on the ONF only nest in alternate years, which further reduces the likelihood of disrupting nesting behavior. Additionally, many of the programmatic activities would occur in areas that currently receive high levels of human activity such as along open roads where spotted owls are less likely to select nest sites.

8.2.5 Expected Response of Individual Spotted Owls Exposed to Disturbance

Programmatic actions that occur within the disruption distance of an active spotted owl nest are not always likely to result in a significant behavioral or physiological response. Many spotted owls exposed to experimental disturbance trials did not flush and spotted owls that were previously exposed to disturbance did not flush during subsequent exposures (Delaney et al. pp. 67-69). A flush response creates a likelihood of injury or mortality, but does not definitively result in these outcomes. Any injury or mortality caused by a flush response is a potential effect that may occur later in time, and is expected to be limited to juvenile spotted owls.

We do not expect any of the programmatic activities covered by this consultation to result in an outright nest failure, the abandonment of a nest by the adult pair of spotted owls, or reduced fitness or survival of adult spotted owls. In experimental disturbance trials with spotted owls, none of the spotted owls exposed to disturbance abandoned their nests, and there was no difference in the reproductive success between experimental and control groups (Delaney et al. 1999, p. 66; Delaney and Grubb 2003, p. 21). We consider potential disturbance effects to spotted owls to have a relatively low risk for resulting in reduced individual fitness or nesting success. However, considering the scale of the programmatic actions considered in this consultation, and the uncertainty associated with individual project location, timing, and duration, it is reasonable to assume that up to 3 nesting pairs and their young will be exposed to significant disturbance effects as a result of these actions.

Not all spotted owls potentially exposed to programmatic activities are likely to have their normal behaviors significantly disrupted. As described above under *8.2.1 Background Information: Disturbance to Spotted Owls from Project Noise and Activity*, most noise and visual disturbances that occur near spotted owl nest sites in the late nesting season are not expected to result in significant effects. Additionally, most spotted owls on the Olympic Peninsula nest every 2 years, with most nesting activity occurring during even-numbered years (e.g., 2008, 2010), with little or no nesting activity in odd-numbered years (e.g. 2009, 2011) (Forsman et al. 2011, pp. 22-23). Non-nesting spotted owls would not be expected to experience any significant effects from programmatic activities.

We anticipate that significant adverse effects from disturbance are limited to 3 nesting pairs and their young over the 10 years covered by this consultation. The potential effect is a flush response by an attending adult or a nestling resulting in a nestling fledging prematurely when it is more vulnerable to predation, or increased levels of stress-related hormones in nesting adults. ONF biologists have access to spotted owl demography survey information for some areas on the ONF, and have a conservation measure to avoid disruptive activities at known occupied sites. Conservation measures for murrelets that restrict work activities to daylight periods in suitable nesting habitat will also reduce potential disturbance effects to foraging spotted owls by avoiding work during night and dawn/dusk periods when spotted owls are most active.

8.2.6 Potential for Injury (Hearing Loss) from Blasting Noise

The ONF has identified the use of small blasts using 2 lbs. of charge or less for various projects including trails construction and road work. Spotted owls exposed to blast noise that exceeds 140 dBA are likely to suffer injury in the form of hearing loss because the intensity of the noise is sufficient to damage the delicate inner ear sensory hair cells (Dooling and Popper 2007, p. 24). A partial loss of hearing sensitivity has important implications for the survival and fitness of individual spotted owls. Spotted owls rely on both sight and hearing to locate and capture prey (Gutierrez et al 1995, p. 5), and vocalizations appear to serve an important social function for spotted owls (Gutierrez et al 1995, p. 9).

A total of up to 19 project sites may require blasting annually (Appendix F: *Annual Disturbance Acres by Activity Type – Spotted Owl*). The ONF has incorporated several minimization measures for blasting into their project description (Appendix C: *Guidelines for Blasting on Olympic National Forest*). These measures include limiting the size of charges to 2 lbs. or less; covering all shots with sandbags or fill; using time delays for shots with multiple blasts; and using noiseless, non-explosive blasting caps for detonation. These measures are expected to significantly reduce blasting noise levels, but we are unable to predict the effectiveness of these minimization measures.

Considering there are up to 19 project sites with blasting activities each year, we expect up to 123 acres will be exposed to potentially injurious sound levels annually (6.5 acres per site). Not all blasting sites are likely to be in suitable spotted owl habitat, so these estimates represent the maximum habitat area that could be exposed to these effects annually. Based on the analysis above, we conclude that exposure to blasting noise has the potential to cause direct injury to spotted owls in the form of impaired hearing. This injury can happen at any time during the year, and is not restricted to nest sites or the critical nesting season. The limited blasting covered by this consultation poses a relatively low risk of direct injury to spotted owls because spotted owls are rare and occur at very low densities relative to the total available suitable habitat on the landscape. The primary risk to spotted owls associated with blasting is exposure to noise disturbance during the nesting season. These effects are addressed above under *8.2.1 Background Information: Disturbance to Spotted Owls from Project Noise and Activity*.

8.2.7 Potential for Injury from Helicopter Rotor Wash

The proposed action plans for helicopter logging as part of commercial timber harvest activities. A research study with Mexican spotted owls (*Strix occidentalis lucida*), a closely related subspecies to northern spotted owls, evaluated the effects of military helicopter overflights to Mexican spotted owls (Delaney et al. 1999). This study found that Mexican spotted owls that were exposed to helicopter noise during the nesting season elicited alert responses (i.e., head turning towards noise) when helicopters were an average of 0.25 mile (400 m) away, but the owls did not flush from their roosts until the Sound Exposure Level (SEL; total sound energy over time) exceeded 92 dBA and occurred within a distance of less than 344 feet (105 m) (Delaney et al. 1999, p. 68).

Spotted owls that were previously exposed to helicopter overflights did not flush during subsequent exposures, suggesting some spotted owls have the ability to tolerate or habituate to helicopter noise (Delaney et al. 1999, p. 69). Distance was a better predictor of spotted owl response to helicopter flights than noise levels, because even when controlled for distance, noise levels from helicopters were variable (Delaney et al. 1999, p.72). The authors note that short duration, single pass, single aircraft overflights had little effect on spotted owls, and concluded that a 105-m (344-foot) radius protection zone should eliminate all spotted owl flush responses to helicopter overflights (Delaney et al. 1999, p. 74).

The authors suggest that spotted owls are more likely to respond to slow helicopter maneuvers such as hovering or landing than fast, by-pass maneuvers (Delaney et al. 1999, p. 72). If a helicopter is hovering in close proximity to a spotted owl nest, the owls would be exposed to high levels of noise, potential visual disturbance, and potentially rotor wash from the helicopter. Rotor wash is a column of high-velocity air forced downward by a helicopter's blade rotation. Helicopter rotor wash can cause saplings, decaying trees, and loose debris from treetops to fall, and can create hazardous conditions from dust and flying debris underneath the ship (WCB 2005, p. 19).

We consider the potential disruption zone for helicopter overflights to be 110 yards above suitable spotted owl habitat, or the estimated 92 dBA SEL sound contour, whichever is greater. The only helicopters that are expected to have 92 dBA sound contours that exceed 110 yards are large helicopters such as the Chinook 47D. Helicopter overflights that maintain a minimum altitude of 110 yards above suitable spotted owl habitat are not likely to disrupt spotted owl nesting behaviors or result in a flush response.

At helicopter landing zones, or locations where helicopter sling operations are occurring within suitable nesting habitat during the early spotted owl nesting season (March 1 to July 15), we consider the potential disruption zone to be a 110-yard radius around the landing zone, or the estimated 92 dBA SEL sound contour, whichever is greater. The conservation measures/PDCs restrict the use of helicopters associated with commercial thinning actions to after July 15 every year. Due to this timing restriction, exposure of spotted owl habitat to rotor wash from helicopters will occur only during the late nesting season. We expect helicopter use to disrupt normal spotted owl nesting behavior due to noise and visual disturbance. For a description of the effects of noise and visual disturbance on spotted owls, see Section *8.2.1 Background Information: Disturbance to Spotted Owls from Project Noise and Activity*.

For most types of helicopter, we consider a 50-yard radius around the helicopter landing zone or sling site to be the potential area where spotted owls, if present, could be directly injured from flying debris (Table 8). Exposure to helicopter noise and rotor wash also has the potential to cause a juvenile spotted owl to flush away from its natal area prematurely, therefore increasing its risk of starvation associated with premature dispersal.

Over the duration of this programmatic consultation, we expect up to 200 acres of forest adjacent to helicopter logging units and helicopter lands to be exposed to hazardous rotor wash during the late spotted owl nesting season, between July 16 and September 30. Since we do not have site specific information for projects that require helicopter use under this consultation, we assume that all 200 acres of exposure may occur within historical spotted owl territories, where rotor wash may increase the risk of direct injury or mortality to spotted owl pairs and juveniles. The use of helicopters will likely be part of multiple projects covered under this programmatic, so we expect that the exposure to rotor wash will be spread out throughout the action area, and the 10-year duration of this consultation.

Based on the analysis above, we conclude that exposure to hazardous rotor wash has the potential to cause direct injury to spotted owls, but this outcome is not reasonably certain to occur because spotted owls are rare and occur at very low densities relative to the total available suitable habitat on the landscape. The primary risk to spotted owls associated with helicopters is noise disturbance during the early nesting season. These effects are addressed above under *8.2.1 Background Information: Disturbance to Spotted Owls from Project Noise and Activity*.

8.2.7.1 Effects to Spotted Owls from Exposure to Smoke from Prescribed Fire Treatments

If prescribed burning and resulting smoke occurs in early spring, disruption of breeding efforts is likely to occur if an active spotted owl nest is directly exposed to dense smoke. Adult spotted owls have the mobility to move away from smoke and would most likely not be affected by smoke from prescribed fires. However, flightless spotted owl nestlings are likely to be adversely affected by the exposure to heavy dense smoke created by burning fuels with high moisture content in the spring of the year (USFWS 2008, pp. 2-3). The parental bond of adults staying with young during times of heavy smoke could negatively affect the health of adult spotted owls. In assessing the effects of smoke associated with proposed prescribed burning, it is assumed that heavy smoke at ground level and in forested stands may have negative effects, but light-to-moderate smoke that is mixing or venting well is of little consequence to spotted owls (USFWS 2008, pp. 2-3). Smoke may cause spotted owls to flush from nests and/or roosts, and may impair hunting opportunities through interfering with audio and visual methods of detecting prey. Based on the potential hazards associated with smoke, we consider burning within a distance 0.25 mile from an active nest during the early nesting season as likely to adversely affect spotted owls (USFWS 2008, p. 4). The ONF will implement a conservation measure that will ensure that smoke-generating activities will be conducted greater than 0.25 mile from suitable habitat for spotted owls, and will only occur during approved atmospheric conditions that lead to vertical smoke movement and quick smoke dissipation. Therefore, we consider the risk of exposure of spotted owl nests to smoke from prescribed fire treatments to be discountable.

8.3 Effects to Spotted Owl Habitat

The proposed action is expected result in degradation, downgrading, and removal of spotted owl habitat as a result of activities associated with 30,000 acres commercial timber harvest and vegetation management actions. Temporary road construction, landing construction, and other activities associated with commercial timber harvest vegetation management will result in the removal of up to 70 individual SNTs. Commercial timber harvest and associated activities will also result in stand-level effects to spotted owl habitat. Over the 10-year duration of the programmatic, commercial thinning is expected to affect dispersal habitat by degrading 20,000 acres, downgrading 5 acres to non-habitat, and removing 221 acres. Activities associated with commercial thinning will also remove 11 acres of suitable NRF habitat and downgrade (to dispersal) 910 acres of low quality foraging habitat. Removal of suitable NRF habitat will require Level 1 review during project planning and will occur outside of the nesting season. Application of the conservation measures and PDCs will ensure that commercial timber harvest only occurs within *low-quality* suitable foraging habitat that would benefit from thinning treatments, with the intent of accelerating the development of late-seral forest characteristics in the long term.

Additionally, over the course of this 10-year programmatic consultation, road construction, maintenance, and other activities will result in effects to individual trees, and dispersal habitat. The proposed action will result in the removal of up to 680 individual SNTs (in addition to the 70 individual SNTs removed for commercial timber harvest), and up to 1,000 individual large trees (at least 18 inches dbh). A total of up to 60 acres of spotted owl dispersal habitat may be removed for temporary road construction or converted to non-forested land due to road construction associated with right-of-way access to non-Federal lands, and up to 40, 1-acre patches of dispersal habitat may be removed for large wood projects.

8.3.1 Removal of Suitable Nest Trees

Individual tree removal includes felling of danger trees, and the occasional removal of individual trees for various projects or special uses, including the removal of SNTs. The majority of individual tree removals will occur within a distance of 150 feet from roads, campgrounds, administrative facilities, and trailheads. We broadly defined spotted owl SNTs to include all conifer trees and snags that are greater than or equal to 18 inches dbh that contain suitable structures (platforms, cavities, broken tops) used by spotted owls for nesting. Trees and snags that are greater than 18 inches dbh with potential nesting structures are common features in suitable spotted owl habitat.

Conservation measures for this programmatic include inspection of individual trees to determine if the tree is an SNT, inspection of SNTs for signs of use, and a nesting-season conservation measure requiring a biologist be on site during felling of SNTs. These conservation measures, coupled with the fact that most SNT removal will occur in roadside areas that have a low likelihood for spotted owl nesting, minimizes the potential risks to spotted owls associated with removal of SNTs. The ONF estimated they may remove as many as 750 spotted owl SNTs under this 10-year consultation (70 associated with commercial timber harvest, 680 associated with all other activities). No more than 111 of these SNTs (an average of 11 annually) would be removed during the spotted owl nesting season.

Felling of SNTs during the early nesting season creates a potential risk of direct injury or mortality to spotted owl nestlings or eggs (e.g., an SNT containing 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 in an area that was being logged has been documented (Forsman et al. 2002, p. 18). The potential risk for spotted owls to be struck and killed or injured by falling trees during timber harvest is highest in the area relatively close to the nest tree. During timber harvest, non-breeding adult spotted owls can reasonably be expected to move away from the area and avoid injury. However, nesting spotted owls during incubation or brooding of nestlings may be reluctant to leave the area (Delaney et al. 1999, p. 71), and therefore, may be vulnerable to such injury. Fledglings, whether in or out of the nest, may also be at risk of direct mortality due to the effects of tree falling, or might disperse prematurely in response to the disturbance and thus be subject to predation or starvation outside of the nest grove.

We consider the risk of direct injury to spotted owls from hazard tree felling to be discountable, because all trees with suitable nest structure will be examined for signs of active use by spotted owls prior to felling and no known occupied nest tree may be felled. Active spotted owl nest/roost sites can be readily identified by the presence of owl pellets, feathers, and whitewash on the ground (Gremel 2007, p. 12). The risk of direct injury to spotted owls from tree felling would be greatest if an action involved clear-cutting an occupied nest grove. The scattered tree removal covered by this consultation poses little risk of direct injury to spotted owls. SNTs felled outside of the early breeding season pose little risk of injury to spotted owls, because after July 16, juvenile spotted owls would have fledged and would be able to fly and escape any potential harm.

If an undocumented nest tree was inadvertently felled outside the nesting season, the spotted owl pair in question would need to relocate to a new nest site. Spotted owls on the Olympic Peninsula commonly use different nest trees within their territory over subsequent years (Gremel 2007, pp. 10-11). Hershey et al. (1998, p. 1408) found evidence that selective or single-tree harvesting had occurred in 31 percent of the nest sites within their study area. In the majority of the sites, less than 10 “large” trees had been removed. This suggests that minor losses of individual trees within a nest stand do not necessarily reduce its functionality or use. Spotted owl territories encompass thousands of acres of suitable habitat and potentially contain numerous SNTs. Therefore, we assume that the loss of a nest tree outside the nesting season would result in the pair selecting another nest tree within the same territory, without a significant disruption of nesting behavior.

Individual tree removal will create small gaps in the forest canopy with only minor effects to suitable spotted owl habitat. Removal of individual hazard trees is not expected to result in a loss of habitat that measures in acres at any one site, and these impacts would not be detectable at the home range landscape scales. Therefore, there is no anticipated loss of suitable habitat acreage within any spotted owl home range as a result of individual SNT removal.

Considering the conservation measures associated with individual tree removals and the dispersed nature of these activities, we do not consider the habitat effect associated with individual tree removal to create a likelihood of injury to spotted owls. The potential for direct injury of spotted owls from SNT removal is expected to be discountable. The primary risk to spotted owls associated with removal of SNTs is exposure to chainsaw noise and disturbance during the early nesting season (discussed above under *8.2.1 Background Information: Disturbance to Spotted Owls from Project Noise and Activity*).

8.3.2 Removal of Large Trees that are Not Suitable Nest Trees

In addition to the removal of 750 SNTs, the ONF is anticipating the removal of approximately 1,000 trees at least 18 inches dbh that do not have nesting structures. There are millions of such trees in the ONF, so the loss of these large trees without nesting structure would not be expected to measurably affect spotted owls or measurably degrade the quality of spotted owl habitat. As described above, we consider the potential for direct injury of spotted owls from individual tree removal to be discountable. The primary risk to spotted owls associated with removal of these 1,000 large trees is exposure to chainsaw noise and disturbance during the early nesting season (discussed above under *8.2.1 Background Information: Disturbance to Spotted Owls from Project Noise and Activity*).

8.3.3 Small Patch Removal of Dispersal Habitat

A total of up to 60 acres of spotted owl dispersal habitat may be removed for temporary road construction or converted to non-forested land due to road construction associated with right-of-way access to non-Federal lands. In addition, up to 40, 1-acre patches of dispersal habitat may be removed for large wood projects. The majority of habitat removal would be in small, dispersed patches associated with temporary road construction in various locations on the ONF. For example, a 0.25-mile long temporary road would remove approximately 1 acre of dispersal habitat in a narrow, linear strip that is approximately 30 to 40 feet wide. Once the use of a temporary road is completed, these roads will be closed, decommissioned, or otherwise allowed to become reforested over time, so we do not expect long-term loss of forest habitat associated with these actions.

Dispersal habitat is not considered to have the same value to spotted owls as “suitable” spotted owl habitat, which is capable of supporting nesting, roosting, and/or foraging. Dispersal habitat is young, mid-seral forest that spotted owls use temporarily when transiting between patches of suitable old-forest habitat. Although large areas of non-forested habitat (e.g., the Willamette Valley) appear to act as barriers to dispersal, spotted owls regularly disperse through highly fragmented landscapes that are typical in western Washington and western Oregon (Forsman et al. 2002, p. 22). Spotted owls are known to cross highway corridors such as Interstate 5 in Oregon and Interstate 90 in Washington (Forsman et al. 2002, p. 22).

Both dispersal and suitable spotted owl habitats are well-distributed within Federal lands on the Olympic Peninsula (Davis et al. 2011, p. 51). Due to the linear nature of temporary road corridors, and the small sizes of forest openings associated with these roads, and the 1-acre limit on removal of patches of dispersal habitat for large wood projects, the removal of up to 100 acres of dispersal habitat over 10 years is not expected to measurably affect spotted owl dispersal behavior or success on the ONF. The effects of limited dispersal habitat removal to spotted owl dispersal are therefore anticipated to be insignificant.

8.3.4 Commercial Thinning and Associated Activities

The proposed action is expected result in degradation, downgrading, and removal of spotted owl dispersal and NRF habitat, as a result of activities associated with 30,000 acres commercial timber harvest. Of the proposed thinning activities, about 16,000 acres will occur on AMA lands, and about 14,000 acres will occur within LSR. Over the 10-year duration of the programmatic, commercial thinning and associated activities are expected to affect dispersal habitat by degrading (but maintaining) 20,000 acres, and removing or downgrading 226 acres to non-habitat. The proposed action will also remove an estimated 11 acres of suitable NRF habitat (associated with forest health treatments, road construction and reconstruction, rock pit expansion and development, and communication tower site operations and management) and downgrade 910 acres of low-quality foraging habitat to dispersal habitat (associated with commercial thinning).

Radio-telemetry studies of spotted owl habitat use in Washington have clearly demonstrated that spotted owls consistently select late-successional and old-growth forests over other forest cover types (Hayes et al. 1989, p. 19, Forsman et al. 2005, p. 372, Hamer et al. 2007, p. 764). Where spotted owls do select younger forests for roosting or foraging, they tend to select areas that have high densities of large snags or large, remnant trees, and high over-story canopy cover (≥ 60 percent) (North et al. 1999, p. 526, Sovern et al. 2015, p. 259). These features are important because they provide denning and resting sites for flying squirrels (Carey 1995, p. 648), the spotted owl's primary prey species on the Olympic Peninsula (Forsman et al. 2001, p. 144).

The majority of commercial thinning treatments covered by this consultation will occur within dispersal habitat for spotted owls. These stands currently lack large snags or remnant old trees, and have little or no understory vegetation. Such stands likely support very low densities of flying squirrels (Carey 1995, p. 648), and are marginal for spotted owl habitat use other than as dispersal habitat used by spotted owls to fly between patches of suitable NRF habitat.

The effects of thinning on spotted owls in Washington are unclear and not well documented in the published literature. Research in the Oregon Cascades indicates that the intensity of thinning treatments has a strong influence on whether spotted owls used stands for foraging in the first two years following commercial thinning (Irwin et al. 2015). This study found that in some areas, spotted owls will select thinned stands (in proportion to their availability) that retain a relatively high amount of basal area (109-153 ft^2/acre) in mid-story conifers (4 - 26 inches dbh) (Irwin et al. 2015, p. 238). The authors further suggest that fuels reduction projects that remove small understory trees (5 - 7.5 inches dbh) may improve spotted owl foraging habitat (Irwin et al. 2015, p. 238), by stimulating the development of understory shrubs and forbs important for spotted owl prey species. No spotted owls in this study abandoned their territories in response to thinning, even in situations where the thinning occurred over 58 percent of the core territory area, or when thinning occurred in close proximity to nest trees (e.g., within 45 ft) (Irwin et al. 2015, pp. 236, 239). This is not entirely unexpected, because spotted owls are strongly territorial.

Many of the thinning stands in the study area were not selected for foraging by spotted owls either before or after thinning treatments, and most thinning treatments had no detectable effect on spotted owl habitat selection, presumably because the young stands being thinned were either too dense or lacked spotted owl prey species (Irwin et al. 2015, p. 239). Meiman and others (2003, p. 1260) tracked the response of a single male spotted owl following commercial thinning in young Douglas-fir stands in the Oregon Coast Range. The data collected in this study indicated that commercial thinning resulted in significantly reduced use of the thinned area during and after harvest, and a shift in use away from the thinned stands (Meiman et al. 2003, p. 1260). In the central Washington Cascades, Hicks and others (1999, p. 23) documented spotted owls using partially-harvested stands for roosting within approximately 6 months after thinning, suggesting that use of thinned stands by spotted owls may occur rapidly following treatment in some areas.

Based on the above information, we expect that spotted owls will avoid areas while they are being actively thinned. After harvest activities are completed, we expect spotted owls will eventually resume use of thinned areas for roosting or dispersal where the thinning treatments maintain the components of spotted owl habitat (e.g., overstory canopy cover, snags, down logs, prey species abundance). The thinning prescriptions included in this proposed action are expected to maintain spotted owl dispersal habitat within most of the treated areas. The expected loss of up to 226 acres of dispersal habitat represents a small portion (less than 0.1 percent) of dispersal-capable forest within the action area. The removal and downgrade of these 226 acres are expected to be spread out throughout the action area. While some of these dispersal habitat losses may have limited local effects on spotted owl dispersal, we expect the effects of this limited loss of dispersal habitat will likely have insignificant effects on dispersal capability of the action area.

As stated previously, commercial thinning and associated activities will also affect suitable NRF habitat by removing 11 acres of suitable NRF habitat and downgrading 910 acres of low quality foraging habitat to dispersal habitat. This habitat removal and downgrade can directly affect spotted owls by reducing the total amount of suitable old-forest habitat available for foraging 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.

Due to low occupancy rates in historic spotted owl territories, we are not reasonably certain that individual spotted owls will be adversely affected by NRF habitat removal or downgrading. However, we consider the loss and degradation of suitable NRF habitat within the action area to be an adverse effect to spotted owls in general, due to the decreased capacity of the local landscape to provide both demographic (breeding) and dispersal (recruitment) support for spotted owls. At the scale of the action area, the loss of 11 acres of NRF habitat and downgrading of 910 acres of foraging habitat reduces the capacity of the affected locations to support spotted owls. Some of the 921 acres of NRF downgrading and removal may occur within historical spotted owl home ranges and core areas. Because the NRF downgrading and removal will occur as part of multiple commercial thinning projects, we expect these effects to NRF habitat to be spread out across multiple of the 60 historical home ranges and core areas, and across the duration of the programmatic.

At the scale of the Olympic Peninsula, the estimated loss and degradation of spotted owl habitat represents a minor loss in the context of existing conservation reserves on Federal lands. While the habitat loss associated with this action is expected to be measurable, it does not represent a significant reduction in landscape capacity to support spotted owl conservation and recovery at the scale of the Olympic Peninsula recovery unit. As noted in the Environmental Baseline, about 50 percent of the land area and 86 percent of the existing NRF habitat on the peninsula is located on Federal lands. While habitat losses on non-federal lands have continued to outpace habitat gains on the peninsula over the past 20 years, the area of habitat in Federal reserves is expected to increase over the next few decades as previously harvested forests mature (Davis et al. 2016, pp. 21, 35). There has been a net gain of approximately 36,900 acres in dispersal habitat on Federal lands (3.3 percent) on the peninsula over the past 20 years, indicating that habitat capacity is gradually increasing on Federal lands as young forests transition to mature forest (Davis et al. 2016, p. 31).

Thinning in both dispersal habitat and foraging habitat stands can also affect spotted owls indirectly by increasing the risk for negative competitive interactions with barred owls, and by reducing the abundance of prey species for the spotted owl (refer to Sections *8.3.5 Barred Owl Competition* and *8.3.6 Prey Resources*).

8.3.5 Barred Owl Competition

Barred owls began expanding their range westward in the early 1900s and have been found in Washington State since 1965. The current range of the barred owl now almost completely overlaps with that of the spotted owl (Pearson and Livezey 2003, p. 266). Because barred owls compete with spotted owls for habitat and resources for breeding, feeding, and sheltering, ongoing loss of habitat has the potential to intensify the competition by reducing the total amount of these resources available to the spotted owl and bringing barred owls into closer proximity with the spotted owl (USFWS 2011, p. I-9).

Both species are known to nest in second-growth conifer stands, but only where there are remnant large trees and snags that provide nest sites. A recent comparative study in Oregon found that both species use patches of older conifer forest for roosting and foraging, both species relied on similar prey associated with these forest types, and the survival of both species was associated with the amount of old forest in their home ranges (Weins et al. 2014, p. 37). These findings highlight the significance of old forest as a potential limiting factor in the competitive relationship between the two species. In order to reduce or not increase this potential competitive pressure while the threat from barred owls is being addressed, the Northern Spotted Owl Recovery Plan now recommends conserving and restoring older, multi-layered forests across the range of the spotted owl (USFWS 2011, p. I-8).

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 (Dugger et al. 2011, p. 2463), indicating that as suitable habitat decreases within a home-range, the likelihood for negative competitive interactions between the two species increases.

The proposed action is expected to degrade and remove suitable habitat for spotted owls, some of which may be located within historical spotted owl territories. This habitat degradation has the potential to increase negative interactions between the two species, which is considered an adverse effect to spotted owls. However, the amount of habitat loss (11 acres of NRF habitat) and degradation (910 acres of low-quality foraging habitat) expected to occur on the scale of the action area is minor, as it represents less than 0.4 percent of the suitable habitat within the action area. After the action is completed, most of what is currently suitable habitat will remain suitable habitat. Additionally, while the action may result in some localized effects within historical spotted owl territories due to short-term habitat degradation, application of the conservation measures and PDCs allows only for commercial timber harvest within low-quality suitable foraging habitat that would benefit from thinning treatments, and accelerate the development of late-seral forest characteristics in the long term.

The proposed action is also expected to degrade spotted owl dispersal habitat in the action area, much of which consists of younger forests. Although both owl species are known to use younger, less structurally complex forests for limited foraging and roosting opportunities, such forests are not a significant factor in either adult survival or reproductive rates for either spotted owls or barred owls (Dugger et al. 2005, p. 863, Weins et al. 2014, pp. 35-36).

8.3.6 Prey Resources

Flying squirrels comprise more than 50 percent of the biomass in spotted owl diets on the Olympic Peninsula (Forsman et al. 2001, p. 145). In general, two forest conditions can support relatively high numbers of flying squirrels: (1) closed-canopy forest (old or young) with high stem density, and (2) classic multi-layered old forest, with the latter generally providing the highest abundances (Wilson 2010, pp. 112-113). Important habitat components associated with flying squirrel abundance are all associated with above-ground protective cover (e.g., high stem density, deep crowns, live crowns in the mid-story layer, with few canopy gaps across the stand) (Wilson and Forsman 2013, p. 82). These components provide sufficient protection for squirrels from predators to attain and sustain relatively high population levels. Even with relatively high predation rates (e.g., during spotted owl breeding years), enough female flying squirrels can survive each year in these forests to quickly restore populations to a relatively high level. In contrast, when there are too many gaps, too many large gaps, lack of a mid-story canopy layer, or overall low stem density, flying squirrels succumb to predation pressure and few squirrels survive to reproduce (Wilson and Forsman 2013, p. 82).

There is growing evidence that thinning can have a negative effect on flying squirrels. Several studies have shown declines in flying squirrel abundance following thinning or generally higher squirrel abundance in unthinned stands compared to thinned stands (Wilson and Forsman 2013, p. 81). A study in western Oregon found that flying squirrel densities dropped in thinned stands relative to thinning intensity for at least 11 to 13 years after treatment (Manning et al. 2012, p. 115). They found that flying squirrel density was significantly greater in unthinned control stands (mean 2.02 squirrels/hectare (ha).) than in thinned stands (0.39/ha.), and significantly greater in the light thin and gap treatments (0.5/ha.), than in heavy thin treatments (0.17/ha.) (Manning et al. 2012, p. 120). Under the proposed action, up to about 30,000 acres of forest will be thinned, including heavy and lighter thinning treatments, similar to those discussed in the study (Manning et al. 2012, p.117).

Most thinning prescriptions reduce canopy cover and canopy complexity in a way that appears to leave flying squirrels more vulnerable to predators than before thinning (Wilson and Forsman 2013, p. 83). This effect may be further compounded once the understory begins to develop in response to thinning, as the abundance of forest-floor small mammals can quickly increase and, in turn, attract additional predators to the area that may opportunistically prey on flying squirrels (Wilson and Forsman 2013, p. 83). The proposed standard and heavy thinning treatments are likely to result in a local reduction of flying squirrels in thinned stands due to the reduction in live tree canopy cover, and these effects can persist for many years after thinning has been completed (Manning et al. 2012, p. 115; Wilson and Forsman 2013, p. 79). Heavy thinning would likely nearly exclude flying squirrels from these stands for more than 12 years and possibly decades. Canopy cover in thinned stands increases at a rate of 1 to 2 percent per year (Chan et al. 2006, p. 2696), so it may take 15 to 20 years for heavily thinned stands to recover sufficient canopy cover to support flying squirrels. Standard (moderate) thinning would reduce tree density, but based on the study by Manning et al. (2012), flying squirrels would likely still be able to use these stands at reduced densities. However, it could also be decades before the density of flying squirrels return to pre-thinning levels.

Other important spotted owl prey species on the Olympic Peninsula include bushy-tailed woodrats (*Neotoma cinerea*) and snowshoe hare (*Lepus americanus*) (Forsman et al. 2001, pp. 144-145). Population studies have shown early and positive responses to thinning by some small forest-floor mammals (primarily mice, voles, and shrews (*Sorex* spp.) (Wilson and Forsman 2013, p 79). Thinning results in increased understory vegetation and plant species diversity on the forest floor, providing food, shelter, and protective cover for forest-floor associated mammals (Wilson and Forsman 2013, p 79).

The available evidence suggests that the effects to spotted owl prey species from thinning treatments are complex. Flying squirrel abundance will decline within the treated portions of thinned stands, but other potential prey species such as deer mice (*Peromyscus maniculatus*) and chipmunks (*Tamias* spp.) are likely to increase in response to thinning treatments (Carey and Wilson 2001, p 1019). Wildfire and prescribed burning appear to have similar effects on small mammal species as thinning treatments, with responses varying between different species, according to their habitat preferences for early- or late-successional forest habitat (Roberts et al. 2008, Fisher et al. 2005, Converse et al. 2006). The proposed action would affect about 22,000 acres of spotted owl foraging and dispersal habitat, which is less than 9 percent of the available habitat in the action area that is likely to support flying squirrels and other spotted owl prey.

Since treatments will occur in patches distributed over the project area and duration, and the amount of total suitable habitat downgraded and removed is minor, the short-term effects to spotted owl prey populations at the scale of the action area would be minor. There would be no change to flying squirrel habitat in adjacent untreated old-forest stands, and unthinned skips and riparian buffers within thinning units will maintain some canopy for connectivity and refugia habitat for flying squirrels and other prey species within stands affected by the action. The proposed action is expected downgrade currently suitable spotted owl foraging habitat, which will likely reduce prey availability in the action area. We consider this reduction in prey availability an adverse effect to spotted owls. Since reductions in prey populations in the action area are difficult to measure, we use habitat acres as a surrogate measure of adverse effects to spotted owls. As discussed above, the proposed action is expected to result in up to 11 acres of suitable NRF habitat removal, and 910 acres of foraging habitat degradation, which will have minor effects to the capacity of the action area to support flying squirrels, but may result in localized adverse effects to prey availability for spotted owls.

9 EFFECTS OF THE ACTION: Spotted Owl Critical Habitat

The PCEs identified in the final 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). Effects analyses for spotted owl critical habitat evaluate how a proposed action will affect the capability of the PCEs to provide for spotted owl nesting, roosting, foraging, and dispersal at a scale that is relevant to the spotted owls' life history needs (77 FR 71939).

9.1 Effects to PCE 1 – Forest types in early-, mid-, or late-seral stages that support the spotted owl

All of the proposed commercial thinning is located in forest types that contain PCE 1 and are "habitat capable" of developing into dispersal or suitable NRF habitat. Additionally, some road construction and maintenance, recreation site management, rock pit expansion, and other activities may occur within PCE 1. Natural forest types in the action area include western hemlock, western red cedar, and Douglas-fir plant associations that are capable of developing late-successional forest habitat.

The project includes pre-commercial thinning in young, mid-seral conifer plantations that do not meet the minimum criteria for spotted owl dispersal habitat or nesting/roosting/foraging habitat. The proposed action includes about 30,000 acres of commercial thinning, of which less than 9,000 acres will occur in non-suitable habitat. All of these treatments within non-suitable habitat may occur within critical habitat. These stands contain PCE 1 – forest types that support the spotted owl. At the scale of individual stands, thinning treatments designed to increase stand diversity and enhance stand development are considered to have wholly beneficial effects to critical habitat (77 FR 71939). All temporary roads, landings, and canopy gaps within critical habitat will be reforested following timber harvest, and will eventually develop late-successional forest characteristics. There would be no permanent reduction in habitat capable acres in the action area due to commercial thinning treatments.

Some permanent removal of PCE 1 may occur in association with rock pit development and expansion. Rock pit developments will permanently remove all vegetation within their footprints, totaling up to 35 acres across five sites over the 10-year duration of this programmatic. As the location of these rock pits developments is unknown, we assume that all of these five sites may be located within critical habitat for the spotted owl. These permanent removals represent localized adverse effects to PCE 1. At the scale of the action area, and subunits NCO-1 and NCO-2, the effects to the function of PCE 1 due to the proposed action are minor.

9.2 Effects to PCE 2 – Nesting and Roosting Habitat

A total of up to 11 acres of nesting and roosting habitat may be removed under this consultation, all of which may be located within critical habitat for the spotted owl. These effects to PCE 2 are associated with forest health treatments near campgrounds, road construction and reconstruction for access to commercial thinning stands, rock pit expansion and development, and the operation and maintenance of communication tower sites. Because the removal of spotted habitat will be maintained for as long as the rock pits and communication tower sites are in use, we consider this removal of PCE 2 to be permanent. Removal of PCE 2 from forest health treatments and temporary road construction are temporary, but may require decades to recover the habitat function removed, and is considered an adverse effect to critical habitat.

The removal of 11 acres of nesting and roosting habitat will be dispersed across the action area, around multiple campgrounds, road construction sites, up to 15 rock pit expansions and developments, and up to 10 communication tower sites on the ONF. As a result, all of the nesting and roosting habitat removals occurring during the course of this programmatic consultation will be in small (less than 1 acre) patches. It is unknown which of the project locations will require removal of nesting and roosting habitat. Assuming all of these removals will occur at one location, within one historical spotted owl home range and core area, the removal of 11 acres of nesting and foraging habitat in small patches may lead to localized adverse effects on the function of PCE 2. However, at the scales of the action area, and subunits NCO-1 and NCO-2, the effects to the function of PCE 2 due to the removal of nesting and roosting habitat are minor, and represent a very small (less than 0.1 percent) portion of suitable habitat in the subunits.

9.3 Effects to PCE 3 –Foraging Habitat

The effects to suitable spotted owl habitat considered in this consultation include 910 acres of suitable spotted owl foraging habitat downgraded to dispersal habitat due to commercial thinning treatments. This may occur where thinning reduces overstory canopy cover from greater than 60 percent down to 40 percent. Downgrading suitable habitat will result in localized reductions in the total area of suitable foraging habitat in the action area, and is considered an adverse effect to critical habitat. Effects to this PCE include short-term degradation, and long-term successional effects associated with thinning, burning, and fuel reduction treatments.

The proposed commercial thinning treatments within foraging habitat will promote the long-term development of roosting and foraging habitats in treated stands. A primary effect of thinning is an increase in growing space that allows the largest trees in the stand to continue their rapid juvenile growth in diameter, height, and crown (Chan et al. 2006, p. 2696; Harrington et al. 2005, p. 97). Another effect of thinning is the development of a mid-canopy of shade intolerant trees. The availability of growing space, both in the thinned areas and gaps, will allow shade tolerant seedlings and saplings to develop into larger trees, that will result in a varied and multi-layered forest canopy most commonly associated with late-successional forest (Chan et al. 2006, pp. 2708-2709).

Development of large trees with deep crowns, multiple canopy layers, and understory vegetation would be accelerated, resulting in long-term beneficial effects to the future development of spotted owl nesting, roosting, and foraging habitat.

9.4 Effects to PCE 4 – Dispersal Habitat

Within designated critical habitat, the proposed action includes about 20,400 acres of stand treatments and vegetation management in stands currently classified as dispersal habitat. This dispersal habitat includes both complex native stands that have become degraded due to disturbance events, and younger forest plantation stands. We evaluate effects to spotted owl dispersal habitat at the stand scale based on the expected tree density and overstory canopy cover that will remain in the stand post-treatment.

9.4.1 Dispersal Habitat Maintained

Standard thinning treatments in stands currently classified as dispersal habitat that maintain a minimum overstory canopy cover of at least 40 percent are considered dispersal habitat maintained. Dispersal habitat would be degraded somewhat due a short-term loss of existing small snags, destruction of down logs, and reductions in overstory canopy cover. However, the PDCs and conservations measures limit the destruction of snags and down logs. Additionally, in young plantation stands these effects would be short-term since the overstory is expected to close back in at a rate of about 1 to 2 percent per year (Chan et al. 2006, p. 2696). In complex mature stands, trees may take longer to regenerate canopy cover, though the action does plan for replanting in areas where regeneration is expected to be low. Reduction in overstory canopy cover creates marginal conditions for dispersal use, but stands with greater than 40 percent canopy cover are still capable of supporting the transience phase of spotted owl dispersal (Miller et al. 1997, p. 145). Up to 20,000 acres of dispersal habitat will be degraded over the duration of the action, all of which may occur within critical habitat. At the scale of individual stands, the action area, and subunits NCO-1 and NCO-2, thinning treatments that maintain minimum dispersal habitat are considered to have insignificant effects to the dispersal habitat PCE (77 FR 71939).

9.4.2 Dispersal Habitat Downgraded to Non-suitable Habitat and Removed

Heavy thinning treatments in stands currently classified as dispersal habitat that reduce overstory canopy cover to 30 to 40 percent are considered "dispersal habitat downgraded to non-suitable habitat." These stands are expected to recover dispersal habitat function within 10 to 20 years after thinning, and are likely to result in long-term beneficial effects in terms of accelerating development of late-successional forest structure. The proposed project includes 5 acres of dispersal habitat downgraded to non-suitable within critical habitat. At the scale of individual stands, thinning treatments that result in a short-term loss of dispersal capability are considered to be an adverse effect to critical habitat, even if the treatments are likely to result in long-term beneficial effects (77 FR 71940). At the scale of the action area, and subunits NCO-1 and NCO-2, the effects to the function of PCE 4 due to the degradation of dispersal habitat are minor.

The proposed action will also result in the temporary and permanent removal of up to 221 acres of dispersal habitat within critical habitat. Most of these acres are expected to be temporary removal of dispersal habitat, resulting from landings and temporary roads associated with commercial thinning. Stands with temporary removal of dispersal habitat will take more than 20 years to recover dispersal habitat function after the activities have been completed. Additionally, permanent removal of dispersal habitat will occur as a result of rock pit expansion and development, totaling 35 acres. We do not expect these stands to support spotted owl dispersal again in the future. At the scale of individual stands, these effects are considered an adverse effect to critical habitat. At the scale of the action area, and subunits NCO-1 and NCO-2, the effects to the function of PCE 4 due to the removal of dispersal habitat are minor.

9.4.3 Small Patch Removal of Spotted Owl Dispersal Habitat

A total of up to 60 acres of the spotted owl dispersal habitat PCE may be removed for temporary road construction or road reconstruction or road realignment projects. A minor amount of dispersal habitat is likely to be converted to non-forested lands due to road construction associated with right-of-way access to non-Federal lands, or rerouting sections of storm-damaged roads. The majority of dispersal habitat removals would be in small (less than 1 acre), dispersed patches associated with road construction in various locations within critical habitat. In addition, up to 40, 1-acre patches of dispersal habitat may be removed for large wood projects.

Regeneration harvest in stands currently classified as dispersal habitat that reduce overstory canopy cover to less than or equal to 20 percent are considered dispersal habitat removed. These stands will require 40 to 50 years to recover dispersal habitat function after treatment, and ultimately delay the development of suitable NRF habitat within the critical habitat. The conservation role of critical habitat within the action area is to maintain existing habitat and recruit additional habitat. At the scale of individual stands, patch-removal for LWD acquisition that result in the removal of the dispersal habitat PCE are considered to be an adverse effect to critical habitat (77 FR 71940).

Dispersal habitat losses associated with temporary roads and large wood acquisition projects are not considered to be a permanent removal of habitat. Once the use of a temporary road is completed, these roads will be closed, decommissioned, or otherwise allowed to become reforested over time, but it may take decades for regeneration to restore habitat conditions. Minor losses due to conversion for new permanent road segments are expected to be balanced through road decommissioning and other ongoing restoration projects across the ONF. The relatively small, temporal impact to dispersal habitat is not expected to significantly impact the ability of the critical habitat unit to provide for the future development of critical habitat PCEs.

9.5 Effects to Dispersal Habitat Connectivity in Subunits NCO-1 and NCO-2

Early conservation strategies for the spotted owl recommended maintaining at least 50 percent of the landscape with forests capable of supporting spotted owl dispersal (i.e., trees averaging greater than or equal to 11 inches dbh with greater than 40 percent canopy cover) (Thomas et al. 1990, p. 310). Subunits NCO-1 and NCO-2 encompass a total of about 500,000 of the Olympic Peninsula, almost all of which are located within the action area. Approximately 83 percent of this landscape currently supports suitable nesting, roosting, foraging (42 percent) or dispersal habitat (41 percent). The proposed action will result in a net loss of 327 acres of habitat capable of supporting dispersal within the subunits NCO-1 and NCO-2. The amount of habitat available in the action area and subunits NCO-1 and NCO-2 would decrease by less than 0.01 percent.

Although large areas of non-forested habitat appear to act as barriers to dispersal, spotted owls regularly disperse through highly fragmented landscapes (Forsman et al. 2002, p. 22). Although it is clear from this study that spotted owls disperse across fragmented forest landscapes, we do not know if survival rates of dispersing owls are influenced by the amount of forest fragmentation or the amount of suitable habitat encountered along the dispersal path. While there is uncertainty regarding the forest conditions required for successful spotted owl dispersal, it is assumed that dispersal success is better when the dispersal habitat more closely resembles nesting, roosting, and foraging habitat (i.e., suitable habitat) (77 FR 71906). At the scale of subunits NCO-1 and NCO-2, approximately 83 percent of the landscape will remain capable of supporting spotted owl dispersal, even after the implementation of the proposed action.

Both suitable old-forest habitat and young forest dispersal habitat are generally abundant and well-distributed across the action area. This indicates that dispersal habitat is likely not a limiting factor in this landscape. Considering the information presented above, a short-term net loss of up to 327 acres of dispersal capable habitat is not expected to measurably affect spotted owl dispersal connectivity or success at the scale of the action area or subunits NCO-1 and NCO-2.

9.6 Effects on the Ability of NCO-1 and NCO-2 to Provide Demographic Support for Spotted Owls

As described above, the proposed action will result in degradation and removal of up to 921 acres of spotted owl NRF habitat within critical habitat subunits NCO-1 and NCO-2, 1 acre of which is permanent. This habitat degradation represents only a small portion of the available spotted owl habitat present in the subunits, and is dispersed over a large area. Overall, less than 0.5 percent of the suitable spotted owl habitat in the critical habitat subunits will be degraded or removed due to the proposed action. The degradation and removal of up to 911 acres of suitable NRF habitat may lead to minor localized reductions in the ability of some historical spotted owl activity centers to support spotted owls. As a result, we expect only a slight reduction in short-term capacity to support territorial spotted owls within the action area and subunits NCO-1 and NCO-2.

10 CUMULATIVE EFFECTS: Spotted Owl and Spotted Owl 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.

10.1.1 Forest Practices

Non-Federal lands (State, Tribal, private) occur both within and adjacent to the administrative boundary of the ONF. Non-Federal lands in the action area are managed primarily for timber production. Adjacent state lands managed by the WDNR, and adjacent private lands managed by Simpson Timber Company (now managed by Green Diamond Company) have completed Habitat Conservation Plans (HCP) for their forest management activities. Forest management on Tribal lands are generally funded by the Bureau of Indian Affairs and are therefore subject to section 7 consultation. Because these effects have already been addressed through section 7 consultation, they are not considered as cumulative effects.

Private timber harvest in the area must comply with the Washington Forest Practices Act (RCW 76.09) as well as the Washington Administrative Code (WAC) with respect to the Washington Forest Practices Rules (WAC 222). In the absence of a federally approved HCP or a State-approved special wildlife management plan, suitable spotted owl habitat on non-Federal lands is only 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 occupied suitable spotted owl habitat. However not all suitable spotted owl habitat on non-Federal lands is included within designated SOSEAs. Under the Washington Forest Practices Rules, a landowner in Washington could be in full compliance with the Washington Forest Practices Rules and have some risk of causing adverse impacts to spotted owls if their forest practices activity resulted in the loss of occupied spotted owl habitat.

Some non-Federal lands in the action area are not located within a SOSEA, or in an area with a federally-approved HCP for spotted owls. Outside of SOSEA boundaries, there are no restrictions on the harvest of suitable spotted owl habitat. Therefore, a landowner could harvest timber (habitat) without a pre-harvest survey, potentially resulting in the loss of a spotted owl site center or suitable habitat within an occupied spotted owl territory. On the Olympic Peninsula, virtually all suitable spotted owl habitat that existed on non-Federal lands has been previously harvested. The small patches of suitable habitat that remain on these lands are primarily associated with potentially unstable slopes or stream riparian areas, which are protected under the Washington Forest Practices Rules. Based on the limited amount of suitable habitat remaining on private lands in the action area, we conclude that the risk to spotted owls for significant adverse cumulative effects associated with forest practices is very low.

Future non-Federal timber harvest in the action area may affect adjacent designated spotted owl critical habitat. 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.

11 INTEGRATION AND SYNTHESIS OF EFFECTS: Spotted Owl and 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) reduce the value of designated critical habitat for the conservation of the species.

11.1 Summary of the Current Status and Conservation Needs of the Spotted Owl

Spotted owl populations are declining, especially in the northern parts of the species' range, where populations have declined by as much as 77 percent from 1990 to 2013 (Dugger et al. 2016, p. 71). The factors that influence spotted owl demography are not fully understood, but habitat quality and quantity, annual weather patterns, and the presence of barred owls are all factors that affect spotted owl survival, reproduction, and local population trends (Forsman et al. 2011, p. 75).

Over the past two decades, it has become apparent that competition from the barred owl poses a significant threat to the spotted owl. 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, p. 58). Past habitat loss and current habitat loss are also threats to the spotted owl, even though loss of habitat due to timber harvest has been greatly reduced on Federal lands for the past 2 decades (USFWS 2011, p. vi). Conservation strategies for the spotted owl emphasize the importance of maintaining large blocks of suitable habitat to support clusters of spotted owl territories and by providing for demographic exchange (dispersal) between these local populations (USFWS 2011, p. II-3), and reducing impacts associated with barred owl competition (USFWS 2011, p. II-4).

Spotted owl habitat in the ONF currently supports a small breeding population of spotted owls and is considered essential for the long-term conservation of the species. Many areas on the ONF support large habitat blocks that are contiguous with adjacent habitat in the Olympic National Park, and are considered essential for both spotted owl demographic support and dispersal connectivity on the Olympic Peninsula. Spotted owl habitat losses on Federal lands on the Olympic Peninsula since 1993 from timber harvest, wildfire, insects, and other causes have been relatively minor (~ 5,700 acres (0.7 percent)) (Davis et al. 2016, p. 21). The most pressing threats to spotted owls on the ONF are the increasing population of barred owls, demographic isolation from spotted owl populations in other provinces, and the low numbers of spotted owls remaining on the Olympic Peninsula.

11.2 Summary of the Effects of the Proposed Action, and Cumulative Effects

The ONF will implement restoration thinning treatments in up 30,000 acres over 10 years. The ONF estimated that a cumulative total of approximately 5,265 acres of suitable spotted owl habitat that is located directly adjacent to thinning units will be exposed to noise and visual disturbance from commercial thinning and associated activities over 10 years, for an average of about 527 acres exposed annually. However, since commercial thinning projects will not occur every year throughout the duration of this programmatic, the actual number of acres exposed will vary from year to year. The ONF also estimated that up to 2,840 acres of suitable spotted owl habitat will be exposed to noise and visual disturbance associated with other programmatic forest management activities (roads, trails, recreation facilities, special uses, etc.) annually.

As a result of commercial thinning activities, we also expect up to 200 acres of forest adjacent to helicopter logging units and helicopter landings to be exposed to hazardous rotor wash during the spotted owl late nesting season, between July 16 and September 30. Exposure to rotor wash may increase the risk of direct injury to spotted owl fledglings, due to falling and flying debris. However, given the rarity of spotted owls on the landscape, we are not reasonably certain that direct injury from rotor wash will occur. The estimated 200 acres of exposure to rotor wash will occur spread out over the action area and the 10-year duration of this programmatic.

Individual tree removal associated with activities other than commercial thinning may remove up 750 suitable nest trees and approximately 1,000 trees at least 18 inches dbh (but without nesting structures). Individual tree removal will create small gaps in the forest canopy with only minor effects to suitable spotted owl habitat, but may result in noise and visual disturbance effects to nesting spotted owls. This disturbance is accounted for in the estimated 2,840 acres of habitat exposed to disturbance annually from activities other than commercial thinning.

Over the 10-year duration of the programmatic, commercial thinning and associated activities are expected to affect dispersal habitat by degrading (but maintaining) 20,000 acres, and removing or downgrading 226 acres to non-habitat.

The proposed action will remove 11 acres of suitable NRF habitat and downgrade 910 acres of low-quality suitable foraging habitat to dispersal habitat (associated with commercial thinning). We consider the removal or downgrading of these 921 acres to be an adverse effect to spotted owls that rely on these areas for foraging. Habitat loss reduces the total area available to spotted owls for foraging, reduces prey species abundance, and increases the risk for competition with barred owls.

The loss of up to 100 acres of dispersal habitat in small (less than one acre) patches is not expected to measurably affect spotted owl dispersal connectivity or success at the scale of individual project sites or at the scale of the Olympic Peninsula.

The ONF anticipates up to 19 project sites will have blasting annually. The maximum area potentially exposed to injurious blast noise would be approximately 123 acres annually (6.5 acres per site). While exposure to blasting noise creates a potential for direct injury to spotted owls, given the low density of spotted owls remaining on the landscape, we are not reasonably certain that the limited blasting proposed by ONF will result in direct injury to individual spotted owls.

Spotted owls on the Olympic Peninsula have declined dramatically in response to increasing densities of barred owls. Approximately 10 percent of the 114 historic spotted owl activity centers on the ONF are likely to be occupied. Based on the low density of spotted owls remaining on ONF, we estimate that only 3 undocumented spotted owl activity centers (nesting pairs and their young) are likely to be exposed to disruptive activities over 10 years. The effect of this disturbance is expected to include a flush response during brooding of nestlings that creates a likelihood of injury by increasing the risk of nestling predation or the premature departure of the nestlings from a nest. We do not expect outright nest failure or the abandonment of the nest, because spotted owls in experimental studies have demonstrated an ability to tolerate short-term disturbances without nest abandonment or reproductive failure.

The majority of remaining spotted owl habitat on non-Federal lands in the action area occurs on lands managed under existing HCPs. Based on the limited amount of suitable habitat remaining on private lands in the action area, significant cumulative effects associated with non-Federal forest practices are not anticipated.

11.3 Effects to Spotted Owl Survival and Recovery

In spotted owl demography studies, apparent survival is an estimate of the probability that an individual will survive from one year to the next (Anthony et al. 2006, p. 10). An overall decline in apparent survival rates is the most significant factor driving the declining population trends across the range of the species (Forsman et al. 2011, pp. 63-64). There is now strong evidence that barred owls have negatively affected spotted owl populations, primarily by decreasing apparent survival and increasing rates of territory abandonment (Dugger et al. 2016, p. 58).

Demographic modeling indicates only about 10 percent of juvenile spotted owls survive to be recruited into the breeding population (Glenn et al. 2010, p. 2547). Because spotted owls are long-lived birds with relatively low reproductive output with low survival rates for juvenile owls, it may take several years of nesting for a pair to successfully replace themselves in the breeding population. The spotted owl's long reproductive life span allows for some eventual recruitment of offspring, even if recruitment does not occur each year (Franklin et al. 2000, p. 576).

On the Olympic Peninsula, spotted owl territory occupancy rates declined from 81 percent in 1995 to 21 percent in 2013 (Dugger et al. 2016, p. 80). The presence of barred owls in spotted owl territories appears to be the most apparent cause for the decline, because there have been only minor losses of habitat due to timber harvest or natural disturbances on federal lands within the Olympic demographic study area. Given the current low numbers of spotted owls remaining on the Olympic Peninsula, and the increasing population of barred owls, it is likely that current population declines will not be reversed, and spotted owls will eventually become extirpated from the Olympic Peninsula. While the proposed action has the potential to result in adverse effects to individual spotted owls through small areas of habitat loss or degradation, or exposure to noise or visual disturbance, we conclude that the magnitude and distribution of these stressors are not expected to influence spotted owl population trends on the Peninsula either positively or negatively.

Commercial thinning and associated activities under the proposed action will result in the degradation of approximately 20,000 acres of dispersal habitat. However, this dispersal habitat will continue to support dispersing spotted owls. Additionally, the proposed action will result in the removal or downgrade of 226 acres of dispersal habitat, the downgrade of 910 acres of foraging habitat, and the removal of 11 acres of foraging habitat. This habitat degradation will result in localized adverse effects to spotted owl dispersal and foraging, and may locally decrease prey populations and increase the potential for competitive interactions between barred owls and spotted owls. However, at the scale of the action area, these habitat impacts represent a very small portion of available habitat (less than 0.1 and 0.4 percent of dispersal and foraging habitat, respectively).

The risk of direct injury or mortality of spotted owls is not reasonably certain. There is a risk that spotted owl nestlings associated with three nest sites could suffer an increased risk of predation, but the likelihood of an outright nest failure due to disturbance is considered to be very low. After 25 years of intensive monitoring of spotted owls, no one has ever documented nest failure in spotted owls as a result of noise or visual disturbance, and there has been no documentation that thinning treatments in dispersal habitat within a spotted owls home range result in reduced survival or nesting success. In the long term, commercial thinning projects are expected to have beneficial effects on spotted owl habitat, as they will accelerate the development of late-successional habitat features within treated stands.

The proposed action will maintain all high-quality habitat within historic spotted owl home-ranges. Therefore, there will be no effect to apparent survival rates of adult spotted owls exposed to programmatic actions, so there would be no discernible effects to spotted owl population trends on the Olympic Peninsula. Apparent survival in spotted owls is most strongly correlated with the total amount of suitable old-forest habitat in the home range, and whether or not barred owls are present in the home-range (Weins et al. 2014, p. 37). Considering the scale of habitat effects and the short-term disturbance associated with programmatic actions, we do not expect a measurable reduction in spotted owl numbers, reproduction, or distribution at the scale of the action area, province, or listed range of the species.

Federal lands within the ONF contain over 250,000 acres of suitable spotted owl habitat, including large stands of high-quality old-growth forest that are contiguous with Olympic National Park. The majority of spotted owl habitat on the ONF is located in reserved land use allocations. Considering the minor habitat effects associated with ongoing programmatic forest management activities, the essential conservation role of the ONF to support long-term survival and recovery for spotted owls would not be reduced or diminished by the effects of the proposed action.

At the scale of the Olympic Peninsula, the estimated loss and degradation of spotted owl habitat represents a minor loss in the context of existing conservation reserves on Federal lands. While the habitat loss associated with this action is expected to be measurable, it does not represent a significant reduction in landscape capacity to support spotted owl conservation and recovery at the scale of the Olympic Peninsula recovery unit. As noted in the Environmental Baseline, about 50 percent of the land area and 86 percent of the existing NRF habitat on the peninsula is located on Federal lands. While habitat losses on non-federal lands have continued to outpace habitat gains on the peninsula over the past 20 years, the area of habitat in Federal reserves is expected to increase over the next few decades as previously harvested forests mature (Davis et al. 2016, pp. 21, 35). There has been a net gain of approximately 36,900 acres in dispersal habitat on Federal lands (3.3 percent) on the peninsula over the past 20 years, indicating that habitat capacity is gradually increasing on Federal lands as young forests transition to mature forest (Davis et al. 2016, p. 31).

11.4 Effects to Designated Spotted Owl Critical Habitat

The broad conservation role of designated critical habitat is to provide for a well-distributed and self-sustaining spotted owl population (77 FR 71941). At the scale of the subunits NCO-1 and NCO-2, critical habitat is considered essential for the continued maintenance and recruitment of spotted owl habitat to provide for viable populations of spotted owls over the long term by providing for population growth, successful dispersal, and buffering from competition with the barred owl (77 FR 71925).

Critical habitat on the ONF is essential for providing habitat for both demographic support (nesting/roosting/foraging) and connectivity habitat for successful spotted owl dispersal on the Olympic Peninsula. As described in the Status of the Species, and in the Environmental Baseline, spotted owl nesting/roosting/foraging and dispersal habitats are generally abundant and well-distributed across subunits NCO-1 and NCO-2, and within the action area. Despite past management practices and historical habitat loss, more than 40 percent and more than 80 percent of the two subunits are still suitable NRF and suitable dispersal habitat, respectively.

In the 2011 revised recovery plan for the spotted owl, the USFWS identified thinning in young forests as Recovery Action 6:

> "*In moist forests managed for spotted owl habitat, land managers should implement silvicultural techniques in plantations, overstocked stands and modified younger stands to accelerate the development of structural complexity and biological diversity that will benefit spotted owl recovery"* (USFWS 2011, p. III-19).

The primary goal of the Revised Recovery Plan for the Olympic Peninsula portion of the spotted owl's range is to conserve stands that support spotted owl occupancy or contain high value spotted owl habitat (USFWS 2011, p. III–17), and to implement silvicultural treatments where such treatments may accelerate the development of young stands into future spotted owl nesting habitat, even if doing so temporarily degrades existing dispersal habitat (77 FR 71941).

The proposed action will result in the degradation and removal of up to 921 acres of NRF habitat, including 910 acres of low-quality foraging habitat downgraded to dispersal habitat and 11 acres of NRF acres removed in small (less than one acre) patches. The 910 acres of foraging habitat impacts will only occur within habitat that is not considered to be "high-quality" due to stand composition and age. Additionally, the proposed action will affect dispersal habitat by degrading but maintaining about 20,000 acres, downgrading up to 5 acres to non-suitable habitat, and removing up to 221 acres. The proposed action is generally consistent with the following USFWS recommendations for management within critical habitat:

- *Conserve older stands that contain the conditions to support spotted owl occupancy or high-value spotted owl habitat as described in Recovery Actions 10 and 32 (USFWS 2011, pp. III–43, III–67). On federal lands this recommendation applies to all land-use allocations* (77 FR 71909).

- *Management emphasis needs to be placed on meeting spotted owl recovery goals and long-term ecosystem restoration and conservation. When there is a conflict between these goals, actions that would disturb or remove the essential physical or biological features of spotted owl critical habitat need to be minimized and reconciled with long-term ecosystem restoration goals* (77 FR 71909).

- *Continue to manage for large, continuous blocks of late-successional forest* (77 FR 71909).

- *In areas that are not currently late-seral forest or high-value habitat and where more traditional forest management might be conducted (e.g., matrix), these activities should consider applying ecological forestry prescriptions as described in the 2011 Revised Recovery Plan (USFWS 2011, pp. III–14, III–17 to III–19)* (77 FR 71908).

Commercial thinning under the proposed action avoids treatments in high-quality spotted owl NRF habitat, and does not include regeneration harvest. Vegetation treatments are dispersed across a large landscape within subunits NCO-1 and NCO-2. The proposed action is consistent with these special management considerations by emphasizing restoration thinning treatments, and is consistent with the standards and guidelines established in the NWFP.

The proposed action will lead to localized minor reductions in the capacity of the critical habitat to provide for demographic support of spotted owls within the action area, but this reduction will not diminish the capability of the critical habitat to provide for connectivity and successful dispersal of spotted owls within the action area or at the scale of subunits NCO-1 and NCO-2. Therefore, the proposed action would not diminish the conservation and recovery role of the critical habitat for providing well-distributed nesting, roosting, foraging and dispersal habitats at the scale of the critical habitat subunit.

For the reasons described above, the proposed action, taking into account any cumulative effects, is not expected to affect the function of critical habitat at the scale of the Olympic Peninsula physiographic province or rangewide, or the current ability for the PCEs to be functionally established in areas of currently unsuitable but capable habitat, to serve its intended recovery role for the spotted owl.

12 CONCLUSION: Spotted Owl and Spotted Owl Critical Habitat

After reviewing the current status of the spotted owl, the environmental baseline for the action area for the spotted owl, the effects of the proposed action and the cumulative effects, it is the USFWS's opinion that the activities covered in this 10-year programmatic consultation, as proposed, are not likely to jeopardize the continued existence of the spotted owl and is not likely to destroy or adversely modify designated critical habitat.

13 BIOLOGICAL OPINION - Marbled Murrelet and Murrelet Critical Habitat

14 STATUS OF THE SPECIES: Marbled Murrelet and Marbled Murrelet Critical Habitat

14.1 Summary of the Status of Murrelets

The murrelet was listed as a threatened species in Washington, Oregon, and California in 1992 under the federal ESA. The primary reasons for listing included extensive loss and fragmentation of old-growth forests which serve as nesting habitat for murrelets and human-induced mortality in the marine environment from gillnets and oil spills (57 FR 45328 [Oct. 1, 1992]). Although some threats such as gillnet mortality and loss of nesting habitat on federal lands have been reduced since the 1992 listing, the primary threats to species persistence continue (USFWS 2019, p. 65).

The 1997 *Recovery Plan for the Marbled Murrelet* (USFWS 1997) identified six Conservation Zones throughout the listed range of the species: Puget Sound (Conservation Zone 1), Western Washington Coast Range (Conservation Zone 2), Oregon Coast Range (Conservation Zone 3), Siskiyou Coast Range (Conservation Zone 4), Mendocino (Conservation Zone 5), and Santa Cruz Mountains (Conservation Zone 6). The Conservation Zones are considered to be the functional equivalent of recovery units as defined by USFWS policy (USFWS 1997, p. 115). Monitoring of murrelet habitat and population trends is reported by Conservation Zones and by state (Table 10).

The most recent population estimate for the entire NWFP area in 2018 was 22,500 murrelets (95 percent confidence interval [CI]: 17,500 to 27,600 birds) (McIver et. al 2020, p. 3). The long-term trend derived from marine surveys for the period from 2001 to 2018 indicate that the murrelet population across the entire NWFP area has increased at a rate of 0.5 percent per year (McIver et. al 2020, p. 4). While the overall trend estimate across this time period is slightly positive, the evidence of a detectable trend is not conclusive because the confidence intervals for the estimated trend overlap zero (95% -0.6 to 1.6 percent) (McIver et. al 2020, p. 4) (Table 10).

Table 10. Summary of murrelet population estimates and trends (2001-2018/2019) at the scale of Conservation Zones and states.

Zone	Year	Estimated number of murrelets	95% CI Lower	95% CI Upper	Average density (at sea) (murrelets /km$^{2)}$	Average annual rate of population change (%)	95% CI Lower	95% CI Upper
1	2018	3,843	1,937	6,901	1.099	-4.8	-7.3	-2.4
2	2019	1,657	745	2,752	1.004	-2.2	-5.8	+1.5
3	2018	8,414	6,026	12,033	5.274	+1.4	-0.4	+3.3
4	2019	6,822	5,576	11,063	5.885	+3.5	+1.6	+5.5
5	2017	868	457	1,768	0.983	+7.3	-4.4	+20.3
Zones 1-5	2018	22,521	17,482	27,559	2.564	+0.5	-0.6	+1.6
Zone 6	2019	404	272	601	na	na	na	na
WA	2018	5,551	2,795	8,307	1.08	-3.9	-5.6	-2.1
OR	2018	11,063	7,610	14,515	5.34	+2.2	+0.8	+3.6
CA Zones 4 & 5	2018	5,741	3,894	7,588	3.88	+4.6	+2.7	+6.5

Sources: (McIver et al. 2020, pp. 8-17, Felis et al. 2020, p. 7).

Murrelet population size and marine distribution during the summer nesting season is strongly correlated with the amount and pattern (large contiguous patches) of suitable nesting habitat in adjacent terrestrial landscapes (Raphael et al. 2016, p. 109). The loss of nesting habitat was a major cause of murrelet decline over the past century and may still be contributing as nesting habitat continues to be lost to fires, logging, and wind storms (Miller et al. 2012, p. 778). Currently, only about 11 percent of habitat-capable lands contain potential nesting habitat for the murrelet (Table 11). About 60 percent of the estimated habitat is located within federal reserves (e.g., National Parks, Late-successional Reserves, Wilderness, etc.), while about 34 percent of habitat is located on state or private ownerships (Table 11).

Table 11. Estimates of higher-quality murrelet nesting habitat by State and major land ownership within the area of the *Northwest Forest Plan* – derived from 2012 data.

State	Habitat capable lands (1,000s of acres)	Habitat on federal reserved lands (1,000s of acres)	Habitat on federal non-reserved lands (1,000s of acres)	Habitat on non-federal lands (1,000s of acres)	Total potential nesting habitat (all lands) (1,000s of acres)	Percent of habitat capable land that is currently in habitat
WA	10,851.1	822.4	64.7	456	1,343.1	12 %
OR	6,610.4	484.5	69.2	221.1	774.8	12 %
CA	3,250.1	24.5	1.5	82.9	108.9	3 %
Totals	20,711.6	1,331.4	135.4	760	2,226.8	11 %
Percent		60 %	6 %	34 %	100 %	-

Source: (Raphael et al. 2016, pp. 66-69).

Monitoring of murrelet nesting habitat within the NWFP area indicates nesting habitat has declined from an estimated 2.53 million acres in 1993 to an estimated 2.22 million acres in 2012, a total decline of about 12.1 percent (Raphael et al. 2016, p. 72) (Table 12).

Table 12. Distribution of murrelet nesting habitat (acres) by Conservation Zone, and summary of net habitat changes from 1993 to 2012 within the Northwest Forest Plan area.

Conservation Zone	1993	2012	Change (acres)	Change (percent)
Zone 1 - Puget Sound/Strait of Juan de Fuca	829,525	739,407	-90,118	-10.9 %
Zone 2 - Washington Coast	719,414	603,777	-115,638	-16.1 %
Zone 3 - Northern to central Oregon	662,767	610,583	-52,184	-7.9 %
Zone 4 - Southern Oregon - northern California	309,072	256,636	-52,436	-17 %
Zone 5 - north-central California	14,060	16,479	+2,419	+17.2 %
Totals	2,534,838	2,226,882	-307,956	-12.1 %

Source: (Raphael et al. 2016, p. 80).

The largest and most stable murrelet subpopulations now occur off the Oregon and northern California coasts, where the population trends are positive, while subpopulations in Washington declined at a rate of approximately -3.9 percent per year for the period from 2001 to 2018 (McIver et al. 2020, p. 4) (Table 12, above). Rates of nesting habitat loss have also been highest in Washington, primarily due to timber harvest on non-federal lands (Raphael et al. 2016, p. 37), which suggests that the loss of nesting habitat continues to be an important limiting factor for the recovery of murrelets.

Factors affecting murrelet fitness and survival in the marine environment include: reductions in the quality and abundance of murrelet forage fish species, harmful algal blooms, toxic contaminants; murrelet by-catch in net fisheries; murrelet entanglement in derelict fishing gear; oil spills, and human disturbance in marine foraging areas (USFWS 2019, pp. 29-61). While these factors are recognized as stressors to murrelets in the marine environment, the extent that these stressors affect murrelet populations is unknown. As with nesting habitat loss, marine habitat degradation is most prevalent in the Puget Sound area where anthropogenic activities (e.g., shipping lanes, boat traffic, shoreline development) are an important factor influencing the distribution and abundance of murrelets in nearshore marine waters (Raphael et al. 2016, p. 106).

14.2 Summary of the Status of Designated Murrelet Critical Habitat

In 1996 the USFWS designated critical habitat for the murrelet within 32 Critical Habitat Units (CHUs) encompassing approximately 3.9 million acres across Washington, Oregon, and California (61 FR 26256 [May 24, 1996]). In 2011, the USFWS issued a revised final rule which removed approximately 189,671 acres in northern California and southern Oregon from critical habitat designated under the 1996 final rule based on new information indicating that these areas did not meet the definition of critical habitat (76 FR 61599:61604 [October 5, 2011]). No changes were made for critical habitat designations in Washington.

In 2016, the USFWS issued a final determination which confirmed that critical habitat for the murrelet as designated in 1996 and revised in 2011, meets the statutory definition of critical habitat under the ESA of 1973, (81 FR 51348 [August 4, 2016]). The revised critical habitat designation for murrelets encompasses over 3.69 million acres in Washington, Oregon, and California (76 FR 61599 [Oct. 5, 2011]).

In Washington, the critical habitat designation includes over 1.2 million acres, located primarily in LSRs on National Forests. The PCEs of critical habitat represent specific physical and biological features that are essential to the conservation of the species and may require special management considerations or protection. The PCEs of murrelet critical habitat include (1) individual trees with potential nesting platforms and (2) forested areas within 0.8 kilometer (0.5 mile) of individual trees with potential nesting platforms that have a canopy height of at least one-half the site potential tree height. This includes all such forest, regardless of contiguity (76 FR 61604).

The conservation role of critical habitat is to support successful nesting and reproduction of murrelets, and to maintain viable murrelet populations that are well distributed across the listed range of the species (76 FR 61609). Much of the area included in the critical habitat designation includes young forest and previously-logged areas within LSRs that are expected to provide buffer habitat to existing old-forest stands, and future recruitment habitat to create large, contiguous blocks of suitable murrelet nesting habitat.

For a detailed account of the status of marbled murrelets and designated marbled murrelet critical habitat, refer to Appendix G: *Status of the Species and Designated Critical Habitat - Marbled Murrelet*.

15 ENVIRONMENTAL BASELINE: Marbled Murrelet and Marbled Murrelet 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 (45016 FR 84 [Aug. 27, 2019]).

15.1 Murrelet Conservation Zones

The environmental baseline analysis for the murrelet describes the relationship of the current condition and conservation role of the action area to murrelet recovery units. In Washington, there are two Conservation Zones: Puget Sound (Conservation Zone 1) and Western Washington Coast Range (Conservation Zone 2) (USFWS 1997, p. 114). Murrelet suitable nesting habitat and population estimates for the Conservation Zones are summarized in Table 10 and Table 12 (above).

The ONF includes portions of both Conservation Zones 1 and 2. National Forest lands in the Hood Canal and eastern Straits of Juan de Fuca area are located in Conservation Zone 1, while lands on the western Olympic Peninsula are located in Conservation Zone 2.

While the Conservation Zones in Washington represent large geographic regions that the USFWS uses to describe recovery areas for murrelets, the Conservation Zones do not represent discrete populations of murrelets. Radio-telemetry studies conducted in Washington have documented movements of individual murrelets using marine foraging areas in both Zones 1 and 2 during the same season, suggesting all of Washington could be considered a single Zone for conservation planning purposes (Bloxton and Raphael 2006, p. 162). Because murrelets in Washington are known to move across large areas of marine habitat during the summer nesting season (Lorenz et al. 2017, p. 313), we do not attempt to attribute murrelets counted in a specific marine area to specific areas of inland nesting habitat.

15.1.1 Conservation Role of the Action Area

Lands considered essential for the recovery of the murrelet within Conservation Zones 1 and 2 are: (1) any suitable habitat in a LSR; (2) all suitable habitat located in the Olympic Adaptive Management Area; (3) large areas of suitable nesting habitat outside of LSRs on federal lands, such as habitat located in the Olympic National Park; (4) suitable habitat on State lands within 40 miles off the coast; and (5) habitat within occupied murrelet sites on private lands (USFWS 1997). The conservation role of the action area is the same as it is rangewide on NWFP lands, namely 1) protection of nesting habitat by maintaining and protecting occupied habitat, and 2) minimizing the loss of unoccupied but suitable habitat (USFWS 1997, p. 119). More specifically, the short-term actions necessary to stabilize populations include maintaining occupied habitat, maintaining and enhancing buffer habitat, and minimizing nest disturbances to increase reproductive success (USFWS 1997, pp. 138-142).

15.1.2 Current Condition of the Species in the Action Area

The Action Area for this analysis includes ONF, and other lands located within a distance of one mile from the ONF administrative boundary. Most of the land area located adjacent to ONF (within one mile) is within Olympic National Park, while the remainder is comprised of state, private, and tribal ownerships. Due to the complex nature of the ownership patterns within the action area, we draw information from several sources to describe the environmental baseline, including information from NWFP monitoring reports regarding murrelet habitat conditions and trends across ownerships, and local information regarding current conditions on ONF. These sources vary slightly in their quantification of suitable murrelet habitat on the ONF, but each source provides the best available information for a specific purpose. The habitat model associated with the NWFP monitoring report (Raphael et al. 2016) is the best available habitat model that provides information across state, federal, and private lands, but is based on mapping that is most suitable for analyses at a landscape scale, and is less accurate at the stand scale (Pierce et al. 2009, p. 1912). The ONF's own habitat model is more suitable for stand-scale analyses, but covers only ONF lands.

15.1.3 Murrelet Habitat in the Action Area

The Olympic Peninsula contains the largest contiguous areas of murrelet nesting habitat remaining in Washington, and provides nesting habitat for murrelet populations in both Conservation Zone 1 and Conservation Zone 2. Landscape models of murrelet nesting habitat developed for the NWFP (Raphael et al. 2016) indicate over 221,000 acres of suitable murrelet nesting habitat are located within the boundaries of the ONF (Table 13).

The habitat estimates presented below in Table 13 are approximate values based on provincial scale modelling completed for the NWFP. These data provide context for the relative amount and distribution of suitable murrelet nesting habitat on the Olympic Peninsula across all ownerships. The ONF also maintains a GIS database of vegetation classes and forest stand inventory data. The ONF relies on its own databases to generate project-specific estimates of suitable habitat. Based on the forest stand inventory data, there are approximately 206,512 acres of suitable murrelet nesting habitat on the ONF.

Table 13. Summary of ownership and distribution of suitable murrelet nesting habitat on the Olympic Peninsula. Estimates in this table have been rounded to the nearest 10.

Land Ownership	Total land area (acres)	Murrelet nesting habitat (acres)	Percent of murrelet nesting habitat on Olympic Peninsula
Olympic National Forest	630,750	221,470	29 %
Olympic National Park	900,070	322,990	43 %
Other lands: State, Tribal, Private	1,500,100	211,400	28 %
Totals:	3,030,920	755,860	100 %

Note: Marbled murrelet habitat estimates represent approximate conditions in 2012, as depicted by map data developed for the NWFP monitoring program, moderate (class 3) and highest (class 4) suitability (Raphael et al. 2016, p. 72).

The NWFP (USDA and USDI 1994) established a large network of LSRs on National Forest lands for the specific purpose of maintaining and recruiting late-successional and old-growth forests. These areas, along with National Parks and congressionally designated wilderness areas, are all considered federal reserves. On the ONF, about 87 percent of suitable marbled murrelet nesting habitat is located in federal reserves (Table 14).

Table 14. Summary of potential murrelet nesting habitat in reserved and non-reserved land use allocations on the Olympic National Forest.

Land Use Allocation	National Forest lands (acres)	Suitable murrelet nesting habitat (acres)	Percent of habitat acres in reserved or non-reserved status
Federal reserved (LSR, CR)	507,724	192,070	87%
Federal nonreserved (AMA, matrix)	123,487	29,400	13%
Totals	631,211	221,470	100%

Notes: LSR = Late-successional Reserves, CR = Congressionally Reserved, AMA = Adaptive Management Area. Marbled murrelet habitat estimates represent approximate conditions in 2012, as depicted by map data developed for the NWFP monitoring program, moderate (class 3) and highest (class 4) suitability (Raphael et al. 2016, p. 72).

Federal reserves are expected to provide the primary role for the conservation and recovery of the murrelet in most areas (USFWS 1997). Murrelet habitat in conservation reserves on federal lands is expected to increase over the next 50 years as young forests transition to more mature forests and the quality of current habitat increases through a reduction of past habitat fragmentation and edge effects (Raphael et al. 2016, p. 114).

Under the NWFP, the focus of forest management on the ONF shifted from regeneration timber harvest in the 1970s and 1980s to a program of restoration thinning, implementing between 1,000 and 2,000 acres of restoration thinning projects annually. These projects are focused on managed plantations, rather than murrelet nesting habitat, but adjacent murrelet habitat is affected indirectly. Under the NWFP, murrelet nesting habitat losses on federal lands on the Olympic Peninsula since 1993 from timber harvest, wildfire, insects, and other causes is estimated at about 3 percent (~ 16,761 acres) (Raphael et al. 2016, p. 78).

Net habitat losses across all lands on the peninsula (federal and non-federal lands) is estimated at over 101,000 acres for the period from 1993 to 2012 , a net loss of approximately 11.9 percent of the habitat that was present in 1993 (Raphael et al. 2016, p. 79).

15.1.4 Forest Practices on Non-federal Lands in the Action Area

Non-federal lands (State, Tribal, private) occur both within and adjacent to the administrative boundary of the ONF. Although effects to murrelets occurring on these lands might usually be considered as cumulative effects, nearly all activities occurring on these lands include a federal nexus and were subject to section 7 consultation. Therefore, these effects are considered to be part of the baseline. Non-federal lands in the action area are managed primarily for timber production. Forest management on Tribal lands is generally funded by the Bureau of Indian Affairs and are therefore subject to section 7 consultation. State and private lands within the action area are managed in accordance with two HCPs, which have undergone section 7 consultation.

State lands in the action area are managed under the 1997 WDNR Habitat Conservation Plan (HCP), which includes provisions for the protection of murrelet occupied sites and murrelet nesting habitat within designated murrelet Special Habitat Areas (WDNR 2019). The murrelet provisions of the HCP are expected to mitigate for the effects of forest management activities on WNDR-managed lands in Washington, and contribute to the recovery of murrelets through the protection of existing occupied habitat, and increased recruitment of habitat in strategic locations for murrelet conservation (USFWS 2019, p. 146). Because these activities have been previously evaluated under section 7 of the ESA, cumulative effects, as defined above, are not anticipated.

In the absence of a federally approved HCP or a State-approved special wildlife management plan, suitable murrelet habitat on non-federal lands is only protected by the Washington Forest Practices Rules where protocol surveys document an occupied murrelet site. Due to specific exemptions within the Washington Forest Practices Rules, a landowner in Washington could be in full compliance with the Forest Practices regulations and have some risk of causing adverse impacts to murrelets if their forest practices activity resulted in the loss of occupied murrelet habitat. These situations include:

1. Timber harvesting or road construction in suitable murrelet habitat that occurs outside murrelet detection areas. Outside murrelet detection areas, only habitat that has a high probability of murrelet occupancy (i.e., ≥ 5-7 nest platforms/acre, depending on the location) is required to be surveyed prior to harvest (WAC 222-16-080(j)(iii) and (iv)). Murrelet habitat with fewer than 5-7 platforms per acre has a lower probability of

occupancy. However, lower platform density does not ensure that the habitat is unoccupied by murrelets. Timber harvest that removes suitable murrelet habitat without pre-harvest protocol surveys can potentially result in the loss of occupied habitat and direct injury/mortality of murrelets.

2. Timber harvesting or road construction in suitable murrelet habitat that occurs where a landowner owns less than 500 acres and the land does not contain a known occupied murrelet site (WAC 222-16-080(j)(vi). Landowners with less than 500 acres are not required by the Washington Forest Practices Rules to conduct pre-harvest murrelet surveys. Therefore, if a small landowner has suitable murrelet habitat on their property that is not part of a known occupied site, this habitat could be harvested without a State Environmental Policy Act review or pre-harvest surveys, potentially resulting in the loss of occupied habitat and direct injury/mortality of murrelets.

3. Timber harvesting along federal boundary areas with suitable murrelet habitat. Unless there is an occupied murrelet site documented on the adjacent federal lands to trigger the protections of the Washington Forest Practices Rules for murrelets, a landowner could harvest timber (non-habitat) up to the federal boundary, potentially resulting in a significant disruption of murrelet breeding if the harvest occurs during the nesting season (disturbance). Clearcut harvest could also result in long-term adverse effects to the suitable habitat on adjacent federal lands associated with exposed clearcut boundaries. There are few occupied murrelet sites documented on federal lands, so the Washington Forest Practices Rules that require seasonal restrictions to avoid disturbance, and managed buffers to avoid edge effects to occupied murrelet sites may not be applied to federal boundary areas.

The above situations represent the greatest risk to murrelets associated with private forest practices in the action area. Other situations that have the potential to result in adverse cumulative effects to murrelets include: (1) harvesting suitable murrelet habitat that occurs in stands less than 7 acres in size; and (2) harvesting occupied murrelet habitat that has been surveyed to protocol, but the surveys failed to detect murrelets (i.e., survey error).

In summary, the Washington Forest Practices rules provide a high level of protection for known occupied murrelet habitat in Washington. However, habitat that is not currently occupied, or does not meet the minimum habitat definitions provided in WAC 222-16-010 is likely to be harvested. The greatest risks for adverse to occur are through harvest of small remnant habitat patches (less than 7 acres in size), and habitat areas that do not meet minimum platform density criteria to trigger a survey.

The USFWS completed a formal consultation on the Washington State Forest Practices Rules HCP for aquatic species in 2006 and anticipated that essentially all suitable murrelet habitat located on private timber lands that is not associated with occupied sites or other protected areas (e.g., riparian buffers) will eventually be lost due to timber harvest (USFWS 2006, p. 477). We did not exempt incidental take of murrelets in this consultation. We identified the areas where compliance with Washington Forest Practices rules could result in impacts to murrelets. Because the consultation was focused on aquatic species, the State (WDNR) did not request an Incidental

Take Permit for murrelets. Therefore, the situations identified above represent a risk of cumulative effects to murrelets. In our consultation on the Washington Forest Practices Rules for aquatic species, the USFWS determined that ongoing forest practices on private lands "may affect, and is likely to adversely affect" murrelets. However, we concluded that these effects are not likely to jeopardize the continued existence of murrelets (USFWS 2006, p. 482). This conclusion was based on the protection of the occupied murrelet sites provided by the Forest Practices Rules, which is consistent with the murrelet recovery plan which calls for the protection of occupied habitat on private lands (USFWS 1997, p. 133).

Murrelet habitat on private timber lands is estimated to have declined by 39 percent in Washington from 1993 to 2012 (Raphael et al. 2018, p. 315). The loss of habitat on private lands emphasizes the importance of continued conservation of habitat on federal lands managed under the NWFP. In our review of the Washington Forest Practices Rules, we concluded that the loss of surveyed, unoccupied habitat on private forest lands posed a low risk of directly impacting murrelets, but the cumulative loss of unoccupied habitat ultimately curtails the opportunity for improving habitat distribution and supporting the long-term recovery of murrelets on private lands. The continued conservation of existing habitat on federal lands, coupled with future recruitment of habitat within LSRs and other federal-reserves will be essential for the long-term conservation and recovery or murrelets within the action area.

15.1.4.1 Occurrence of Murrelets on Olympic National Forest

Surveys for marbled murrelets were conducted on the Olympic Peninsula opportunistically by ONF and WDFW personnel in limited areas from 1987 to 1991. More extensive surveys were carried out using the intensive survey method described in the Pacific Seabird Group protocol between 1992 and 1999. These surveys were primarily in response to proposed activities. Large portions of the ONF remain unsurveyed or not surveyed to current protocol for murrelets (Evans Mack et al. 2003). No effort has been made to delineate or classify murrelet occupied sites on the ONF beyond the initial designation of 5,842 acres of Late-Successional Reserves (mapped as LSR3s) within Adaptive Management Areas under the NWFP.

Given there are up to 221,470 acres of murrelet nesting habitat on ONF, this constitutes 1.9% of the acres of nesting habitat in Washington. We could therefore assume that two percent of the total Washington population is associated with ONF. The actual percentage may be higher, given that most of ONF is relatively close to marine waters. If we assume two percent of the population nests on or is otherwise connected with the ONF, we estimate that at least 111 individual murrelets (two percent of the approximately 5,551 murrelets in Conservation Zones 1 and 2 in 2018, the most recent year for which data are available) are associated with ONF. This includes nesting and non-nesting adults, subadults, and fledglings, so the number of adults nesting on ONF lands will be smaller. Current population trends are consistent with an assumption that 40 percent of the population consists of breeding adults (Peery and Jones 2019, pp. 14, 25-26), which would result in an estimate of approximately 44 breeding adults and 22 nests on the ONF. On the other hand, it is very likely that more than two percent of the Washington population of murrelets is associated with the ONF, given the proximity of ONF lands to several areas of marine foraging habitat, as well as the relative contiguity of suitable habitat on the Olympic Peninsula, compared with many other areas of Washington. Therefore, the number of nests on the ONF is likely to be larger than 22 and the number of individuals associated with ONF is likely to be larger than 111.

In an alternative approach, Raphael and others (2002, p. 340) calculated an average density of more than 370 acres of nesting habitat per murrelet detected via radar in their study on the Olympic Peninsula, but acknowledged that murrelets likely occur at higher densities in some locations. Simultaneously active nests have been documented within a distance of 30 to 100 m from each other (Nelson 1997, p. 13). In the radar study, each murrelet detected potentially represented one nesting pair, though some could have been non-breeding birds flying inland for other purposes. At a density of one nest per 370 acres, and referring to the ONF's habitat map (which is similar to the map used for the radar study) showing 206,512 acres of suitable habitat, we calculate that ONF suitable habitat has the capacity to host up to 558 nesting murrelet pairs. This is likely a high overestimate of the current number of nests on ONF, given that the population is smaller now than it was in 1998 through 2000, when the radar surveys were completed. In 2001, the first year for which population monitoring information is available, 558 nesting pairs would have included 1,116 nesting adults, which alone would have been more than ten percent of the estimated 10,545 murrelets in Washington (McIver et al. 2020, p. 10). Some additional number of juveniles, subadults, and non-breeding adults would also have been associated with habitat on the ONF. With 1,116 breeding adults, if breeding adults made up 40 percent of the population (as discussed above), there would be 2,790 (1,116 divided by 40 percent) murrelets associated with the ONF, in total, approximately one quarter of the 2001 Washington murrelet population. If the same population were currently associated with the ONF, it would make up approximately half of the Washington murrelet population.

Population monitoring indicates murrelets in Washington have been declining since monitoring began in 2001. The factors most likely responsible for this are low rates of breeding and low nesting success rates. A low propensity for breeding may indicate that some adult murrelets in the population may have been displaced from the breeding population due to loss of nesting habitat (Lorenz et al. 2017, p. 317). Poor marine foraging conditions also affect breeding success. Murrelets in Washington have the largest recorded marine home ranges documented for the species, with some individuals flying over 100 km (62 miles) one way from nest sites to preferred marine foraging areas (Lorenz et al. 2017, p. 317).

It is not clear whether or not the population of murrelets associated with the ONF has declined at the same rate as the Washington murrelet population as a whole, because population trend data from marine surveys cannot be assigned to specific terrestrial nesting habitat areas. If the population trend on the ONF has varied from the larger population trend, it seems more likely that the decline has been slower on ONF than that it has been faster, compared with the statewide population. This conclusion is based in part on the slower rate of habitat loss on federal lands than on non-federal lands (Raphael et al. 2016, p. 72), and on potentially shorter commutes between ONF nesting habitat and marine foraging habitat, as compared with nesting habitat in the Washington Cascades (see Lorenz et al. 2017, p. 314, for example). If the murrelet population on ONF declined at a lower rate than the rest of the murrelet population, ONF may now be associated with substantially more than 25 percent of the Washington murrelet population. The number of nests associated with ONF likely falls between the low estimate of 22 nests and the high estimate of 558 nests, but may be closer to the high estimate, if murrelet populations associated with the ONF have declined more slowly than those in other parts of Washington. Therefore, for the purposes of our analysis, we assume that murrelet nests are present on the ONF at a density of one nest per 370 acres of suitable habitat.

It should be noted that not every adult murrelet in an area will initiate nesting in a given year. A radio-telemetry study of murrelets captured at sea off Washington located 14 nest sites on the Olympic Peninsula, including one nest site on the ONF (Lorenz et al. 2019, p. 159). Nesting murrelets tracked with radio telemetry had very low breeding rates (5 to 20 percent of tagged adults attempted to nest annually). Nest success ranged from 0 to 50 percent in any given year, with an average success rate of 20 percent (Lorenz et al. 2017, p. 312). These estimates are likely biased low due to the methodology used in this study, employing radio equipment that may have altered the behavior of murrelets, but studies in other locations using similar methods have observed higher rates of nesting and nest success. Direct causes of nest failure were found to be because eggs failed to hatch, eggs were abandoned during incubation, or the chick died at the nest due to accidental death or other causes (Lorenz et al. 2019, p. 160).

At other times and places, radio-telemetry and demographic modeling indicate that the proportion of adults breeding in a given year may vary from 5 to 95 percent (Lorenz et al. 2017, p. 312; McShane et al. 2004, p. 3-5). In other words, in some years, very few marbled murrelets attempt nesting, but in other years, almost all breeding-age adults initiate nesting. As noted above, murrelet population declines in Washington are consistent with an average of 60 percent of adults, or 40 percent of the total population, breeding in each year (Peery and Jones 2019, pp. 14, 25-26). In Washington as a whole, breeding propensity and nesting success are not high enough to sustain populations, but due to the small sample size of nests that have been monitored, it is not clear how breeding propensity and nesting success may vary in different terrestrial areas, such as the ONF.

15.2 Status of Marbled Murrelet Critical Habitat in the Action Area

Murrelet critical habitat is designated in 10 subunits that encompass 411,989 acres located within the ONF. Murrelet nesting habitat within the designated critical habitat subunits is fragmented from historical timber harvesting, and currently only about 162,000 acres are estimated to be in suitable nesting habitat (Table 15). Only minor losses of suitable murrelet habitat have occurred within reserved federal lands on the Olympic Peninsula over the past two decades (~ 15,806 acres (Raphael et al. 2016, p. 78). All LSR in the ONF is designated critical habitat.

Table 15. Summary of murrelet critical habitat subunits located on the Olympic National Forest.

Critical habitat subunit name	Total acres in subunit	Suitable murrelet nesting habitat (acres)	Percent of subunit acres that contain nesting habitat	Ownership
WA-01-a	60,477	25,391	42%	Olympic NF - LSR
WA-01-b	8,172	5,566	68%	Olympic NF - LSR
WA-02-a	15,955	11,429	72%	Olympic NF - LSR
WA-02-b	1,982	1,017	51%	Olympic NF - LSR
WA-02-c	46,342	23,515	51%	Olympic NF - LSR
WA-02-d	412	238	58%	Olympic NF - LSR
WA-03-a	97,847	43,665	45%	Olympic NF - LSR
WA-03-b	65,027	17,330	27%	Olympic NF - LSR
WA-06-a	71,539	23,499	33%	Olympic NF - LSR
WA-06-b	44,236	15,445	35%	Olympic NF - LSR
Totals	411,989	167,095	41%	

Notes: Murrelet habitat estimates are approximate values that represent conditions in 2012, as depicted by Raphael et al. (2016) map data, moderate (class 3) and highest (class 4) suitability.

During the time period covered by a previous ONF programmatic (2003 to 2011), up to 247 PCE 1s were removed (it is unknown how many PNTs removed were PCE 1)(USFWS 2003). Under the 2013-2023 programmatic consultation with the ONF (USFWS 2013), a total of 35 SNTs for murrelets were removed between 2013 and 2019. Twenty-eight of the 35 SNTs were in critical habitat, and therefore constituted removal of PCE1 (Holtrop, K. in litt. 2020). It should be noted that up to 1,239 acres of the 206,512 acres of suitable habitat on the ONF may have degraded due to a fire or fire suppression efforts on the Hood Canal Ranger District in 2018 (named the Maple Fire). Most of the area affected by the Maple Fire is within murrelet critical habitat ((Holtrop, K. in litt. 2020).

The project action area contains both State and private lands. Non-federal lands in the action area are managed primarily for timber production, but almost all forest that was potential murrelet nesting habitat on these lands has been previously harvested. Private timber harvest in the area must comply with the Washington Forest Practices Act (RCW 76.09) as well as the WAC with respect to the Washington Forest Practices Rules (WAC 222). The USFWS completed formal consultation on the Washington State Forest Practices Rules in 2006 and anticipated that there would be adverse effects to murrelet critical habitat PCEs from forest practices activities, but concluded that these effects are not likely to adversely modify murrelet critical habitat (USFWS 2006, p. 483). Because of this federal nexus, we consider these effects as a part of the baseline rather than cumulative effects.

We anticipate there will be some minor habitat loss and degradation associated with edge effects (windthrow, micro-climate, and fragmentation) to designated murrelet critical habitat PCEs that are located within a distance of 328 ft (100 m) of recently harvested areas on adjacent private timber lands. Suitable murrelet nesting habitat within federally-designated critical habitat is likely to be degraded through a reduction in the number of platform trees (PCE 1) located along clearcut edges, and a reduction in the total available platforms, and these effects can persist for decades after harvest has occurred (van Rooyen et al. 2001, p. 558).

Areas of critical habitat exposed to private timber harvest edge effects are dispersed along a small portion of the outer boundaries of the critical habitat subunits, and represent a degradation of a small fraction of the total available habitat within CH subunits. Windthrow and edge effects from private timber harvest along the ONF boundary are not expected to significantly reduce the capability of designated critical habitat to provide for a well-distributed and self-sustaining murrelet population at the scale of the CH subunits. The conservation role of critical habitat to provide for large blocks of nesting habitat to support successful murrelet reproduction will not be significantly reduced by the ongoing effects of forest management on adjacent private lands on the Olympic Peninsula.

15.2.1 Climate Change

Climate change is expected to affect murrelets within the ONF. Changes in temperature and precipitation are altering ecological processes within forests, and these changes are expected to continue and to increase in magnitude over the next 50 years. As discussed in Section 7.3, these changes are expected to result in forest stand disturbance and development patterns that differ from those of the past. In turn, changes in forest stands will affect the structure, suitability, and availability of murrelet nesting habitat. In addition, changes in the terrestrial environment may have a direct effect on murrelet reproduction, for example due to reduced energy expenditure on thermoregulation, but little is known about whether or how such direct effects may occur. Changes in the marine environment, outside of the action area, are also expected to affect the survival and reproduction of murrelets within the action area; see Appendix G for a discussion of these effects.

16 EFFECTS OF THE ACTION: Marbled Murrelet

Effects of the action are all consequences to listed species 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. (See § 402.17).

The analysis of the effects of the proposed action is based on an evaluation of the effects to murrelet nesting habitat. A habitat-based approach is a common practice of the USFWS in biological opinions. A habitat-based approach to evaluating the effects of the proposed action on murrelets is appropriate due to the difficulty in locating actual murrelet nest sites, the variation in the number of murrelets that actually breed each year, and the patchy distribution of murrelets in nesting habitat. The murrelet was federally listed as a threatened species in Washington, Oregon, and California, primarily due to the loss and fragmentation of nesting habitat, and numerous studies have demonstrated that murrelet numbers are strongly correlated with the amount of available nesting habitat at the scale of local watersheds (Burger et al. 2002, Raphael et al. 2002; entire). For these reasons, quantifying effects to murrelet nesting habitat is a scientifically credible approach to evaluating the effects of the proposed action on murrelets.

16.1 Summary of the Proposed Action

The proposed action will adversely affect murrelets by exposing nesting murrelets to short-term indirect habitat degradation and disturbance effects associated with road and trail construction and maintenance, maintenance of administrative and recreation facilities, a variety of actions associated with special use permits, non-commercial forest treatments, commercial thinning activities, rock source crushing and blasting. Timber harvest activities will also have long-term beneficial effects associated with future recruitment of murrelet habitat in the action area. Most actions (outside of designated Wilderness Areas) are carried out with the use of chainsaws, heavy equipment, or other motorized equipment. Many individual actions will occur within areas or adjacent to suitable murrelet nesting habitat. Actions can occur at any time during the year, but the majority will occur during spring and summer months during the murrelet nesting season.

We expect the conservation measures described in the section *3 Description of the Proposed Action* section will significantly reduce the effects to murrelets during the nesting season. However, some of the proposed actions adjacent to suitable habitat will still overlap with the murrelet nesting season in Washington, which the USFWS defines as April 1 to September 23 (USFWS 2012, p. 5).

16.1.1 Insignificant or Discountable Effects

Effects to murrelets may occur from actions that remove or degrade murrelet nesting habitat; or by actions that generate loud noises and activity in close proximity to nesting murrelets, resulting in a potential disruption of murrelet breeding and nesting behaviors. ONF programmatic management activities that meet the following criteria are considered to have insignificant effects (i.e., not likely to adversely affect) to the murrelet:

1. Removal of understory vegetation (small trees and shrubs) within or immediately adjacent to suitable murrelet habitat outside the murrelet nesting season (from September 24 to March 31). Small trees are defined as conifers less than or equal to 10 inches dbh.

2. Sound-generating activities that are not located within the established disruption threshold distances from known nest sites or unsurveyed suitable habitat during the murrelet nesting season (from April 1 to September 23) (Table 16).

3. Smoke-generating activities conducted greater than 0.25 mile from suitable habitat for murrelets that only occur during approved atmospheric conditions that lead to vertical smoke movement and quick smoke dissipation.

Management activities that meet the above criteria would not result in the loss of potential nest trees or trees adjacent to potential nest trees within suitable habitat during the murrelet nesting season. In addition, these actions would not be likely to disturb nesting murrelets during the nesting season. Project activities that do not result in the loss of suitable habitat and occur outside of the murrelet nesting season (September 24 to March 31) are generally considered to have insignificant, discountable, or no effects to murrelets.

If programmatic forest management activities occur within close proximity to an active nest or unsurveyed suitable habitat during the nesting season (April 1 to September 23), murrelet nesting behaviors may be disrupted by sight and sounds of management activities, potentially causing missed feedings or the adults to flush leaving young susceptible to predation and weather. Table 16 below provides a summary of common management activities and their associated disruption threshold distances. Short-term disruptions to murrelets associated with spring road maintenance, campground opening, and other programmatic activities are covered by this consultation in the Opinion.

16.1.2 Noise and Visual Disturbance

16.1.2.1 Exposure of Murrelet Nesting Habitat to Audio/Visual Disturbance

In this analysis, we use the term "disturbance" to mean audio/visual stressors resulting from human activities within or adjacent to murrelet nesting habitat. We use the term "disruption" to specify where we expect exposure to audio/visual disturbance will disrupt normal nesting behaviors such as incubation or chick provisioning. The USFWS has previously completed analyses for noise and visual disturbance to murrelets (Appendix H). In these analyses, we concluded that normal murrelet nesting behaviors are likely to be disrupted by loud noises that occur in close proximity to an active nest or when the activity occurs within the line-of-sight of a nesting murrelet.

For chainsaws, heavy equipment, and most ground-based activities we use a distance threshold of 0.25 mile to represent the area where disturbance "may affect" murrelets, and we use a threshold distance of 328 ft (100 m) (from an active nest, or suitable nesting habitat) where most ground-based activities are likely to disrupt murrelet nesting behaviors (USFWS 2015, p. 14). For helicopter overflights, we also use a minimum disruption distance threshold of 328 ft, or the distance to a sound exposure level of 92 decibels (A-weighted), whichever is greater (USFWS 2015, p. 14). Using these criteria, we reviewed the ONF programmatic activities and developed a summary table to display disruption distances for various activities which serve as the basis for estimating the area of nesting habitat exposed to disturbance (Table 16).

The intensity, frequency, duration, and magnitude of a disturbance event are all important factors the USFWS considers in the evaluation of disturbance effects. In general, we consider low intensity, short-duration actions (e.g., less than 1 day at a site) to be of much lower risk for disrupting murrelet nesting when compared to prolonged actions that require several days or weeks at a site to complete.

Table 16. Disturbance, significant disruption, and/or physical injury distance thresholds for murrelet during the nesting season (April 1 to September 23). Distances are to a known occupied marbled murrelet nest tree or suitable nest trees in unsurveyed nesting habitat.

Project Activity	**No Effect**	**NLAA** "may affect" disturbance distance	**LAA –** significant disruption distance	**LAA** – direct injury and/or mortality
Light maintenance (e.g., road brushing and grading) at campgrounds, administrative facilities, and heavily-used roads	>0.25 mile	≤ 0.25 mile	NA[1]	NA
Log hauling on heavily-used roads (FS maintenance levels 3, 4, and 5)	>0.25 mile	≤ 0.25 mile	NA[1]	NA
Chainsaws (includes felling hazard/danger trees)	>0.25 mile	111 yards to 0.25 mile	≤ 110 yards[2]	Potential for mortality if trees felled contain platforms
Heavy equipment for road construction, road repairs, bridge construction, culvert replacements, etc.	>0.25 mile	111 yards to 0.25 mile	≤ 110 yards[2]	NA
Pile-driving (steel H piles, pipe piles) Rock Crushing and Screening Equipment	>0.25 mile	121 yards to 0.25 mile	≤ 120 yards[3]	≤ 5 yards (injury)[3]
Blasting	>1 mile	0.25 to 1 mile	≤ 0.25 mile[3]	≤ 100 yards (injury)[4]
Helicopter: Chinook 47d	>0.5 mile	266 yards to 0.5 mile	≤ 265 yards[5]	≤ 100 yards[6] (injury/mortality)
Helicopter: Boeing Vertol 107, Sikorsky S-64 (SkyCrane)	>0.25 mile	151 yards to 0.25 mile	≤ 150 yards[7]	≤ 50 yards[6] (injury/mortality)
Helicopters: K-MAX, Bell 206 L4, Hughes 500	>0.25 mile	111 yards to 0.25 mile	≤ 110 yards[8]	≤ 50 yards[6] (injury/mortality)
Small fixed-wing aircraft (Cessna 185, etc.)	>0.25 mile	111 yards to 0.25 mile	≤ 110 yards	NA
Tree Climbing	>0.25 mile	111 yards to 0.25 mile	≤ 110 yards[9]	NA
Burning (prescribed fires, pile burning)	>1 mile	0.25 mile to 1 mile	≤ 0.25 mile[10]	NA

NLAA = "not likely to adversely affect." **LAA** = "likely to adversely affect" ≥ is greater than or equal to, ≤ is less than or equal to.

Table 16 (Marbled Murrelet) Footnotes:

1. NA = not applicable. We anticipate that marbled murrelets that select nest sites in close proximity to heavily used roads are either undisturbed by or habituate to the sounds and activities associated with these roads (Hamer and Nelson 1998, p. 21).
2. Based on recommendations from murrelet researchers that advised buffers of greater than 100 meters to reduce potential noise and visual disturbance to murrelets (Hamer and Nelson 1998, p. 13, USFWS 2012, pp. 6-9).
3. Impulsive sound associated with pile-driving is highly variable and potentially injurious at close distances. A review compiled by Dooling and Popper (2007, p. 25) indicates that birds exposed to multiple impulses (e.g., pile driving) of sound at 125 dBA or greater are likely to suffer hearing damage. We have conservatively chosen a distance threshold of 120 yards for impact pile-driving to avoid potential effects to hearing and to account for significant behavioral responses (e.g. flushing) from exposure to loud, impulsive sounds. Based on an average maximum sound level of 110 dBA at 50 feet for pile-driving, exposure to injurious sound levels would only occur at extremely close distances (e.g., ≤ 5 yards).
4. Sound associated with blasts is highly variable and potentially injurious at close distances. We selected a 0.25-mile radius around blast sites as a disruption distance based on observed prairie falcon flush responses to blasting noise at distances of 0.3 to 0.6 mile from blast sites (Holthuijzen et al. 1990, p. 273). Exposure to peak sound levels that are greater than140 dBA are likely to cause injury in the form of hearing loss in birds (Dooling and Popper 2007, pp. 23-24). We have conservatively selected 100 yards as an injury threshold distance based on sound levels from experimental blasts reported by Holthuijzen et al. (1990, p. 272), which documented peak sound levels from small blasts at 138 to 146 dBA at a distance of 100 m (110 yards).
5. Based on an estimated 92 dBA sound-contour (approximately 265 yards) for the Chinook 47d (Newman et al. 1984, Table D.1).
6. Because murrelet chicks are present at the nest until they fledge, they are vulnerable to direct injury or mortality from flying debris caused by intense rotor wash directly under a hovering helicopter. Hovering distance is based on a 300-ft radius rotor-wash zone for large helicopters hovering at less than< 500 above ground level (from WCB 2005, p. 2, logging safety guidelines). We reduced the hovering helicopter rotor-wash zone to a

   50-yard radius for all other helicopters based on the smaller rotor-span for all other ships.
7. Based on an estimated 92 dBA sound contour from sound data for the Boeing Vertol 107 the presented in the San Dimas Helicopter Logging Noise Report (USFS 2008, chapters 5, 6).
8. The estimated 92 dBA sound contours for these helicopters is less than 110 yards (e.g., K-MAX (100 feet) (USFS 2008, chapters 5, 6), and Bell 206 (85-89 dbA at 100 m)(Grubb et al. 2010, p. 1277).
9. Based on recommendations from murrelet researchers that advised buffers of greater than 100 meters to reduce potential noise and visual disturbance to murrelets (Hamer and Nelson 1998, p. 13, USFWS 2012, pp. 6-9).
10. Based on recommendations presented in *Smoke Effects to Northern Spotted Owls* (USFWS 2008, p. 4).

Over the course of the next 10 years, the ONF expects to continue to complete maintenance and reconstruction activities on the entire 2,020- mile road system and 290 miles of trails, and complete various forest management activities at various sites throughout the ONF. Additionally, the ONF expects that commercial thinning harvest and associated activities will result in a cumulative total of approximately 3,765 acres of noise and visual disturbance to suitable habitat for murrelets over 10 years.

For actions related to the road and trail system maintenance and all other actions unrelated to commercial thinning, using GIS, we plotted a 110-yard disturbance-exposure zone along trails and a 160-yard exposure zone along roads and campgrounds (adding 50 yards for the length of an average hazard tree) to estimate area of exposure. The ONF does not maintain a separate GIS layer for murrelet nesting habitat, so for this analysis we used the data for suitable spotted owl habitat to represent suitable murrelet nesting habitat. Spotted owls use a broader range of forest habitats than murrelets do, so the spotted owl data likely overestimates murrelet nesting habitat on the ONF. Based on past project implementation, the ONF estimated the number of individual programmatic actions that are likely to occur during the murrelet nesting season. These estimates are detailed in Appendix I: *Annual Acres and Percent of Marbled Murrelet Habitat Exposed To Disturbance Annual Disturbance*, and the cumulative totals are summarized in Table 17.

For actions related to maintenance and reconstruction activities on the entire 2,020- mile road system and 290 mile trail system of trails, we estimate that approximately 65,173 acres of suitable murrelet habitat are located in close proximity to roads, campgrounds, and trails. Approximately 6,950 acres of these acres will be exposed annually to noise and visual disturbance associated with programmatic actions during the nesting season. This represents about 3.3 percent of the total murrelet habitat (206,512 acres) on the ONF. The total acres of murrelet habitat exposed to disturbance is greater than our estimate for spotted owl habitat exposed because the minimum disruption distances are greater for murrelets and the critical nesting season for murrelets is 28 percent longer (137 days in early spotted owl nesting season vs. 176 days in the murrelet nesting season). This is an estimate comprised of many small-scale projects scattered across the ONF and associated primarily with the road network. Most individual programmatic actions (e.g. felling a danger tree or trail bridge construction) will expose only a small of area of suitable habitat to disruptive activities (a 110-yard radius = 7.85 acres); while a few individual actions (e.g., sling operations with a large helicopter or blasting) could expose 125 acres or more of habitat to disruptive actions. Most disruptive activities are expected to be short in duration (e.g., hours to 1 day in any one location) with the exception of projects such as bridge replacement or road reconstruction, which could have a project duration of two weeks or more at one location. However, it is not possible to estimate for certain, in advance, how many activities exceed what we consider to be a short-duration activity that would not result in a significant effect to nesting murrelets that occupy suitable habitat within 110 yards of those activities. It is also not possible to estimate for certain how often or how many activities that are short-duration in nature would overlap and result in multiple short-duration exposures to the same nesting habitat.

Table 17. Estimated suitable murrelet habitat acres exposed to visual and noise disturbance annually during the entire nesting season (April 1 to September 23) for all activities other than Commercial Thinning and associated activities.

Programmatic Category	Estimated acres of suitable and non-suitable habitat exposed to potential disturbance	Estimated acres of suitable habitat exposed to potential disturbance annually
Forest Roads (including all activities associated with the road system, campgrounds, administrative facilities, danger tree felling, Special Use Permits, etc.)	19,189	4,986
Forest Trails (including all activities associated with forest trails such as trail maintenance, trail bridges, trail reconstruction, etc.)	1,825	894
Other Forest Actions (including pre-commercial thinning, utilities maintenance, habitat restoration, communication sites, etc.)	4,103	1,066
Totals	25,117	6,946 (rounded up to 6,950)
Total Acres of suitable habitat located within 160 yards of roads and campgrounds and within 110 yards of trails	65,173	
Percent of suitable habitat within 160 yards of roads and campgrounds and within 110 yards of trails exposed to potential disturbance	10.7%	

Note: Activity- and program-specific accounting of these acres is presented in Appendix I. As explained therein, we included habitat within 160 yards of roads or campgrounds and within 110 yards of trails.

For actions related to commercial thinning, the ONF analyzed past project monitoring data to project estimated acreage of suitable habitat that will be exposed to noise and visual activity. The proposed action includes directly- and indirectly-related activities required to accomplish timber management including: tree falling, yarding, timber transport, road and landing construction, road reconstruction and maintenance, and rock pit operations. Over the course of this programmatic consultation, the Forest proposes to commercially thin up to 30,000 acres in LSR (14,000 acres) and AMA (16,000 acres). Up to 3,765 acres of suitable habitat will be exposed to noise and visual disturbance from commercial thinning and associated activities over the ten year period of this consultation during the nesting season. The amount of habitat the ONF estimates will be exposed to noise and visual disturbance during the nesting season is delineated by project type, as described in Table 18.

Table 18. Summary of exposure of murrelet suitable habitat to noise and visual disturbance from commercial thinning and associated activities during the nesting season (April 1-September 23) for the 10-year duration of the programmatic.

Action Category	Acres Exposed
Silviculture Treatment Specific to LSR and AMA Stands Less Than 80 Years of Age	1,500
Silviculture Treatment in LSR Stands over 80 Years of Age and >20"Diameter	300
Silviculture Treatment Specific to AMA Stands, including over 80 Years of Age and >20" Diameter	400
Silviculture Treatment Specific to Alder-Dominated Stands	50
Forest Health (Sanitation) in Forest Stands[1]	0
Forest Health (Sanitation) in Campgrounds and Administrative Sites[1]	0
Road Daylighting	500
Communication Site Vegetation Removal	100
Expansion of Trailheads and Campgrounds	15
Landing Construction	400
Rock Pit Expansion and Development	500

1. The ONF expects that these activities will occur only outside the marbled murrelet nesting season, or further than the appropriate disruption distance from suitable habitat.

Over 10 years, the cumulative amount of murrelet habitat exposed to disruptive activity is approximately 69,500 acres for all activities not associated with commercial thinning and 3,765 acres for all activities associated with commercial thinning, for a total of 73,265 acres or an average of 7,327 acres annually.

The road and trail system on the ONF are essentially permanent features on the landscape where the majority of programmatic activities will occur. However, the locations of individual actions (e.g. danger tree felling) covered under this programmatic are unknown, so we rely on the estimated habitat acres exposed to provide the context for this analysis. As described above, we expect an average of approximately 7,327 acres of murrelet nesting habitat will be exposed annually within potential disruption distances for murrelets, with an estimated cumulative total of 73,265 acres over 10 years. Some of these acres may be exposed to multiple actions, and are counted once for each exposure, so, for example, the same 10-acre area exposed to disturbances by five separate activities would be counted as 50 acres out of the 73,265-acre total.

The number of murrelets that will be exposed to noise and visual disturbance is unknown, and will not be detectable during or after the disturbances. There are no reliable data from which to estimate the number of murrelets in nesting habitat at the scale of an individual project site or an individual stand of suitable nesting habitat. However, to estimate the effects of programmatic activities over a large area, it is appropriate to use average nest densities to estimate an expected number of murrelets that will be exposed to the all of the proposed activities, collectively, on an annual basis. Raphael and others (2002, p. 331) used radar to count numbers of murrelets flying inland within 10 river drainages on the Olympic Peninsula. Murrelets were detected in each of the drainages monitored, and the total number of murrelets counted was strongly correlated with the total amount of nesting habitat in the watershed. Raphael et al. (2002, p. 340) calculated an average density of more than 370 acres of nesting habitat per murrelet detected in their study on the Olympic Peninsula (each bird detected represents a potential nesting pair), but acknowledged that murrelets likely occur at higher densities in some locations. Simultaneously active nests have been documented within a distance of 30 to 100 m from each other (Nelson 1997, p. 13).

We anticipate that up to 7,327 acres of murrelet nesting habitat in the ONF would be subjected to disturbance from programmatic activities annually. Based on the documented history of murrelet occupancy behaviors in all major watersheds on the Olympic Peninsula, we assume that all suitable murrelet nesting habitat likely to be exposed to disturbance in the action area is occupied habitat. Dividing the total acreage potentially exposed each year by the average density of one murrelet nest per 370 acres of suitable nesting habitat, this translates to approximately 20 nests per year would be potentially exposed to noise and visual disturbance. This is a reasonably conservative analytical approach that will help the ONF to insure that its actions are not likely to jeopardize the murrelet. Below, we further describe the effects of activities that result in noise and visual disturbance in their severity and duration to estimate whether and how exposure results in significant adverse effects to individuals.

16.1.2.2 Background Information: Murrelet Responses to Audio/Visual Disturbance

Murrelet responses to audio/visual stressors can include delay or avoidance of nest establishment, flushing of an adult from a nest or branch within nesting habitat, aborted or delayed feeding of juveniles, or increased vigilance/alert behaviors of adults and chicks at nest sites with implications for reduced individual fitness and reduced nesting success (USFWS 2015, pp. 13-14). Disturbances that cause a murrelet to flush can advertise the nest's location, thereby creating a likelihood of predation of the eggs or nestlings. When an adult is flushed, it can alert a predator to its location and the location of its egg or chick, thereby facilitating predation. These behavioral disruptions create a likelihood of injury by increasing the risk of predation, reducing the fitness of nestlings as a result of missed feedings, and/or increasing energetic costs to incubating adults. Due to the asynchronous nature of murrelet nesting behavior, it is possible for project activities to coincide with nest establishment, incubation, or chick rearing phases of nesting.

16.1.2.2.1 Effects During the Nest Initiation Phase

Murrelet nesting is asynchronous and spread over a prolonged season. In Washington, the murrelet breeding season extends from April 1 to September 23. Egg laying and incubation occur from April to early August and chick rearing occurs between late May and September, with all chicks fledging by late September (USFWS 2012) (Table 19).

Table 19. Murrelet nesting dates in Washington [1]

Percent of nests	Egg laying	Egg hatching	Fledging
Early (5%)	April 20 - April 30	May 20 - May 30	June 19 - June 29
Typical (90%)	May 5 - June 23	June 4 - July 24	July 4 - August 23
Late (5%)	June 29 - July 24	July 29 - August 23	August 28 - Sept 22
Averages from all nests in sample (n = 137)	June 1	June 30	July 30

[1] Dates in this table are based on known murrelet nests from Washington, northern Oregon and southern British Columbia (USFWS 2012).

Due to the asynchronous nature of murrelet nesting behavior (See Appendix A – Marbled Murrelet Nesting Season and Analytical Framework), it is possible for project activities to coincide with nest establishment, incubation, or chick rearing phases of nesting. As established in previous analyses, we expect that adult murrelets will respond negatively to human disturbance when they are establishing nest sites, completing adult incubation exchanges, and during prey deliveries (See Appendix H–Revised Disturbance Analysis for Marbled Murrelet).

During the nest initiation phase, noise and visual disturbance coupled with habitat modification from thinning is likely to cause murrelets to vacate the nesting habitat and either abandon nesting for that year, or seek a nest site in another location. Either response would represent a significant disruption of normal nesting behavior.

16.1.2.2.2 Effects to Incubating Adults

The incubation period for murrelets lasts from 28 to 30 days, with both adults sharing incubation duties (Nelson 1997, p. 17). During incubation, adult murrelets exchange incubation duties every 24 hours at dawn. The normal behavior of the adults during incubation is to remain motionless at the nest and avoid detection from predators. Adult murrelets are not likely to flush during incubation unless they are confronted at the nest directly by a predator such as a raven (Singer et al. 1991, p. 333), or direct approach by human researchers (Long and Ralph 1998, p. 16). The observed responses of adult murrelets exposed to brief disturbance trials have been increased vigilance and alert behaviors, without flushing from the nest (Hebert and Golightly, 2006, pp. 35-36).

The normal behavior of incubating adults is to rest and remain motionless during the day. Prolonged disturbance disrupts this normal behavior by causing the adults to remain vigilant and alert during a time when they are normally resting. Because adult murrelets exchange incubation duties each day, we assume that each adult can tolerate exposure to audio/visual stressors for a 1-day cycle without consequence to individual fitness or increased predation risk to the egg. Incubating adults exposed to prolonged noise/visual disturbance (multiple days or weeks) are likely to experience increased energetic stress due to increased vigilance, and are at increased risk of abandoning the egg during incubation. Adult murrelets exposed to disturbance effects are not expected to have significantly reduced survival rates, because evidence suggests that murrelets will abandon the egg during the incubation if they are stressed by lack of food or exposed to direct disturbance at the nest site (e.g., by the direct approach of a predator) (Lorenz et al. 2019, p. 162).

Therefore, exposure of incubating adults to audio-visual disturbance over periods of longer than 2 days creates a likelihood of injury to murrelet eggs or nestlings, due to the increased risk that the adults will abandon the nest.

We note that commercial thinning activities in any one timber harvest planning area may take multiple years to fully implement, but the overall duration of project implementation is not expected to change the intensity of the effects or the number of individuals affected because each stand would only be thinned once, regardless of the time it takes to thin all stands.

16.1.2.2.3 Effects to Nestlings

Observations of murrelet nestlings exposed to disturbance trials indicate nestlings appear to be mostly unaffected by brief exposures to ground-based visual or noise disturbance, with no significant behavioral responses detected (Hebert and Golightly 2006, p. 36). The greatest risk to murrelet chicks from exposure to audio/visual stressors is the potential for missed feedings. Adult murrelets appear to be most sensitive to audio/visual stressors when they are approaching a nest site or delivering fish to a nestling. There are several documented instances where ground-based activities caused adult murrelets to abort or delay feedings of nestlings, caused adults to divert their flight paths into nesting habitat, or caused murrelets to vacate suitable habitat (Hamer and Nelson 1998, pp. 8-17).

After egg-hatching, the adult murrelets will brood the chick for one or two days, and then leave the chick unattended at the nest except during brief periods of chick provisioning. During chick rearing, feedings may take place at all times of the day and evening, but typically over 90 percent of chick provisioning events occur during dawn and dusk hours (Nelson 1997, p. 18, Lorenz et al. 2019, p. 161). Chicks receive between one and eight meals per day (average = 3.2 $\pm$1.3) and fledge within 27 to 40 days after hatching. Chick growth and development to fledging varies depending on food availability and quality (Nelson 1997, p. 18, De Santo and Nelson 1995, p. 46). Food limitation during chick-rearing can result in poor growth, delayed fledging, increased mortality of chicks, and nest abandonment by adults.

We assume that adult murrelets that are approaching a nest for chick provisioning are likely to flush away from the nest and abort feeding attempts when exposed to intensive noise and visual disturbance. The implications of missed feedings due to noise or visual disturbance are significant, because each missed feeding represents a delay in the development of the chick, prolonging the time to fledging and increasing the risk of predation, accidental death from falling off the nest, or abandonment by the adults. If the disturbance at a nest site is prolonged (e.g., greater than 2 days), each successive day of disturbance represents an increasing risk that multiple missed feedings will trigger a significant delay in their growth and development processes, cause permanent stunting, or result in the mortality of a nestling due to malnourishment or abandonment.

16.1.2.2.4 Application of Limited Operating Periods

The application of daily limited operating periods is an important minimization measure for reducing disturbance effects to individual murrelets. A daily limited operating period means that implementation of project activities is limited to the period beginning two hours after official sunrise, to two hours before official sunset each day during the murrelet nesting season (April 1 to September 23). All incubation exchanges between nesting adults occur at dawn, and typically over 90 percent of chick provisioning events occur during dawn and dusk hours (Lorenz et al. 2019, p. 161). Under the proposed action, ONF will apply a daily limited operating period to most covered activities that occur within the disruption distance defined in Table 16 (disturbance distances, above). Only log hauling on existing system roads will occur during the dawn and dusk periods, and a subset of log loading at landings will occur during the dawn period.

Application of daily limited operating periods (LOP) greatly reduces the potential to disrupt murrelets during feeding and incubation exchanges, but it does not ensure that all chick provisioning events will be protected from disturbance. Activities that occur during the mid-day hours will result in the disruption of adult nesting behaviors (increased vigilance, and increased risk of nest abandonment), or result in occasional disrupted feedings of nestlings during mid-day hours. While most feedings occur during dawn and dusk, murrelets do occasionally provision chicks during the day (USFWS 2012, p. 5; Lorenz et al. 2019, p. 161; and see Table 20 below).

In summary, the application of daily limited operating periods is an important minimization measure, which ensures that incubation exchanges and most chick provisioning will occur uninterrupted by audio/visual stressors. However, projects with a duration of more than two days that employ daily limited operating periods still create a likelihood of injury due to a significant disruption of normal nesting behaviors associated with chick provisioning during mid-day hours (USFWS 2012, p. 5). Similarly, when two or more projects occur close enough together in space to affect the same area of suitable nesting habitat, and within the same 30-day period, even if the individual projects are short in duration, the cumulative exposure to multiple projects during the same nesting period also creates a similar likelihood of injury. Projects that do not adhere to daily limited operating periods greatly increase the risk of murrelet nesting failure, especially when those projects operate for more than one day.

16.1.2.3 The Effects of Disturbance to Murrelets on Olympic National Forest

16.1.2.3.1 Effects to Incubating Adults

We expect that most forestwide programmatic activities will implement a daily LOP. This daily LOP protects the morning and evening incubation exchange and chick provisioning, and therefore, we do not anticipate adverse effects to incubating adults or their nestlings, for any activities with a daily LOP that have a duration of 2 days or less. For a small subset of activities related to commercial thinning, exposure risk exists during the morning and evening period. These activities include log hauling on established system roads and log loading at landings.

Hauling along existing system roads is not subject to a daily LOP. We do not expect hauling to result in significant disruptions in murrelet nesting behavior, because we anticipate that marbled murrelets that select nest sites in close proximity to heavily used roads are either undisturbed by or habituate to the sounds and activities associated with these roads (Hamer and Nelson 1998, p. 21).

Most log loading will be subject to a daily LOP, or will occur at landings more than 110 yards from suitable habitat. In these situations, log loading will not result in an adverse effect to murrelets. In some circumstances, log loading at landings will be permitted during the morning period. The ONF estimates that 30 percent of conventional landings would log load in the morning period, resulting in 120 acres of suitable habitat being exposed to noise and visual disturbance over a ten year period. Generally, at any one landing, log loading will occur over a 4- to 6-day period. This creates a likelihood of injury associated with disruption of incubation exchange. The nesting murrelets and eggs exposed to these activities are reasonably certain to experience an increased likelihood of injury associated with increased risk of predation and nest abandonment. Adults exposed to these activities will also expend more energy, resulting in an increased likelihood of injury.

16.1.2.3.2 Evaluation Criteria for Estimating the Effects of Disturbance to Nestlings

Murrelets in the project area are most likely to follow a typical pattern of dawn and dusk nest attendance. Therefore, we assume that murrelet chicks will receive an average of 3.2 feedings per day, for an average period of 30 days, with most feedings occurring in the morning (Table 20). Daily feedings directly affect the rate of nestling development. A single missed feeding would represent a loss of 33 percent of a nestling's daily food and water intake. Missing a cumulative total of 3.2 feedings would prolong nestling development for a minimum of one day. Each successive day of missed feedings increases the risk of nest failure because adult murrelets do not compensate for missed feedings, and the rate of daily provisioning becomes inconsistent towards the end of nestling development (Barbaree 2011, p. 130).

Table 20. Summary of average daily feeding times and rates for murrelets nestlings.

	Morning feedings - 1 hour before sunrise to 2 hours after sunrise	**Mid-day feedings - 2 hours after sunrise to 2 hours before sunset**	**Evening feedings: 2 hours before sunset to 1 hour after sunset**	**Average total feedings per day**
1-day of feedings	2	0.2	1	3.2
30-day total feedings	60	6	30	96
Percent of total feedings	62.5%	6.3%	31.3%	100%

Source: Based on average feeding rates reported by Nelson (1997, p. 18).

The following outlines our general findings regarding severity of disturbance based on the best available science presented above. These are general in nature but relate to the total time to chick development, which is dependent on both quality and quantity of food received during development (Kuletz 2005, pp. 43-44; 85):

- A less than 1 percent reduction in cumulative feedings may create a likelihood of injury, because we consider a single missed feeding due to disturbance to be missed nutrition and water essential to chick growth and fledging. A significant effect to chicks occurs when an action results in greater than a 0.5 percent reduction in food intake, delaying nesting by up to 0.15 days.
- A 1 to 3.33 percent reduction in cumulative feedings creates a likelihood of injury by reducing daily food and water intake and increasing time to fledge by less than or equal to 1 day.
- A 3.34 to 32 percent reduction in cumulative feedings results in physical injury due to malnourishment that significantly increases the length of chick development. This level of reduction would increase days to fledging from 1 to 10 days, but is still within the range of chick development for murrelets (up to 40 days). Probability of mortality due to malnourishment or abandonment by adults increases incrementally, and especially so for consecutive missed feedings.
- A more than 32 percent reduction in cumulative feedings is likely to result in mortality due to malnourishment or abandonment by adults. Chick development would be prolonged to more than 40 days, which is beyond the observed range for murrelets.

16.1.2.3.3 The Effects of the Action to Nestlings

Under this programmatic consultation, the majority of individual project areas exposed to disruptive activities are small (less than 8 acres), and the duration of the exposure is expected to be brief (hours to 1 day) at any one location (e.g., removal of blowdown from trails, construction of small trail bridges, small-scale road repairs, etc.). These individual projects present a relatively low risk to murrelets with insignificant effects due to the short duration of the activities.

It is possible that individual nests could be exposed to multiple actions over the course of a nesting cycle, increasing the likelihood and magnitude of adverse effects. If multiple projects, each lasting a single day, introduce disturbance to the same patch of nesting habitat during the same 30-day nesting period, the additive effect of all of the individual projects is the same as the effect of a single project lasting multiple days (see below). However, we are unable to assess this additive risk sufficiently to identify where and when these situations will occur.

Aside from commercial thinning and associated activities, there are a limited number of projects that will have a duration of several days to weeks. These include road bridge construction (four sites annually, 7.85 acres of suitable habitat exposed per site, 31.4 acres per year total), trail bridge construction (five sites annually, 7.85 acres of suitable habitat per site, 39.25 acres per year total), and road construction or reconstruction projects (159.3 acres of suitable habitat exposed annually due to an annual expectation of 3 miles of road reconstruction using heavy equipment and 5 sites of road reconstruction using chainsaws [refer to Appendix I]). Because these projects are subject to a daily LOP, most nestling feedings will occur without disturbance. This is because most murrelet feedings occur during dawn/dusk hours when project activities are not permitted. However, if mid-day feedings coincide with project activities, these feedings are likely to be disrupted, resulting in a reduction of the nestling's intake of water and nutrients. At an average nest, mid-day feedings occur only once every few days, so projects that take several days are likely to result in one missed mid-day feeding, whereas projects that take two weeks would be expected to result in around three missed mid-day feedings. Even a single missed meal reduces the chick's daily intake of water and nutrition, and creates a likelihood of injury. As the number of missed meals increases, the likelihood and potential severity of injury increase. We expect a total of 230 acres (31.4 acres exposed from road bridge construction, 39.25 acres from trail bridge construction, and 159.3 acres from road reconstruction) of suitable habitat will be exposed to these aforementioned longer-duration projects, annually. The exposure to noise and visual disturbance will affect the mid-day feeding period for a duration of days to weeks. Continuing exposures for multiple days are expected to result in at least one missed feeding, and multiple missed feedings for longer-duration exposures. The disruption of feedings will create a likelihood of injury by reducing daily food and water intake and increasing time to fledge. As such, we expect that, given a nest density of one nest per 370 acres of suitable habitat, a total of approximately seven nestlings (230 acres x 10 years / 370 nests per acre per year) over ten years are reasonably certain to experience an increased likelihood of injury from missing meals over the duration of cumulative project activities.

Log loading at landings, associated with commercial thinning, will also occur over longer durations, and will result in significant adverse effects to chicks, especially where LOPs are not applied. We expect that daily LOPs will be applied to the majority of log loading, but during a 10-year period, 120 acres of suitable habitat will be exposed to log loading during the dawn period.

Disruption of chick provisioning during early morning and mid-day hours, associated with the disturbance of 120 acres of suitable habitat due to log loading at landings, is reasonably certain to result in physical injury to chicks. This injury is in the form of malnourishment due to up to a cumulative loss of about 13.75 percent of the required feedings for normal chick development (2.2 missed feedings over 6 days for any given nest) (refer to Table 20. Summary of average daily feeding times and rates for murrelets nestlings). We estimate that this level of malnourishment would increase the time to fledging for an affected nest by an additional 4.125 days. The proposed action is expected to occur over a period of 10 years, so the average amount of disturbance in the form of injury due to noise and visual disturbance would be approximately 12 acres per year. Over the term of the programmatic, given a nest density of one nest per 370 acres of suitable habitat, we are reasonably certain that one nestling will experience injury in the form of malnourishment due to log loading at landings without a morning LOP, in combination with mid-day timber harvest activity in close proximity.

Logging that implements daily LOPs (3,645 acres) would allow murrelets to complete morning and evening feedings and reduces, but does not eliminate, the likelihood of injury.

The duration of logging at any harvest stand varies depending on the size of the harvest stand and the complexity of the logging systems required. Based on the monitoring report for Nisqually Project timber sales (USFS 2017) that have been completed, we assume that most thinning stands will require an average of about 1 day per acre for commercial thinning to be completed (Table 21). For murrelet nest sites located along a thinning unit boundary, the average duration of exposure to disturbance stressors would be about 4 days, based on the disruption distance threshold of a 110-yard radius.

Table 21. Summary of days to complete commercial thinning based on monitoring data provided for the Nisqually Thin timber sale project (USFS 2017) [1]

Sale name	Unit #	Unit acres	Start date of logging	Completion date of logging	Total days	Acres/day
T-Bird	4	28	1/19/2016	2/16/2016	29	1.0
T-Bird	4A	16	7/26/2016	8/10/2016	16	1.0
T-Bird	3	13	8/10/2016	8/26/2016	17	0.8
Berry	8	3	9/16/2016	9/28/2016	13	0.2
Berry	13A	27	10/13/2016	11/8/2016	27	1.0
Bear	35	22	2/9/2017	2/26/2017	18	1.2
Berry	14	15	2/23/2017	2/28/2017	6	2.5
Totals		124			126	1.0

[1] Total days includes weekends and/or holidays when logging operations would be closed. Source: Implementation monitoring report for the Nisqually Thin Project (USFS 2017).

In large thinning stands, logging activities may occur over a period of several weeks, but the duration of activity within a 110-yard radius (7.8 acres) of any point along a thinning stand boundary will likely average about 4 days, because about half of the area within the 110-yard disruption distance (~4 acres) would be within the thinning stand boundary.

On average, timber harvest (felling, yarding) will only affect a given nest site for four days. Duration may be longer if a landing site is located on a road adjacent to nesting habitat. Because mid-day feedings are less frequent than morning and evening feedings, and on average do not occur daily, four days of mid-day disturbance is likely to equate to a single missed mid-day meal, or approximately one percent of all feedings during the nestling period. Even a single missed meal reduces the chick's daily intake of water and nutrition, and creates a likelihood of injury.

We anticipate that up to 3,765 total acres of murrelet nesting habitat in the action area would be subjected to noise and visual disturbance during implementation of commercial thinning and associated activities. If murrelets are present, this is reasonably certain to cause an increased likelihood of injury to all life stages. Based on estimates of murrelet density stated in the Environmental Baseline (1 nesting pair per 370 acres), we anticipate that 11 nests are likely to be present in proximity to commercial thinning units over the 10-year term of the action. However, the probability of exposure and the severity of adverse effects to murrelets is not uniform across those 3,765 acres. We calculate that 10 nestlings, associated with 3,645 acres of commercial thinning with a daily LOP, will experience an increased likelihood of injury over the course of ten years. One nestling is reasonably certain to experience injury in suitable habitat adjacent to landings (120 acres) without a morning LOP.

16.1.2.3.4 Summary of Noise and Visual Disturbance Effects

In summary, we anticipate that nesting murrelets are likely to be exposed to noise and visual disturbance, and that these disruptions could result in failed nesting attempts due to nest abandonment, predation of nestlings, or through reduced fitness of nestlings caused by missed feedings. We do not expect disturbance effects will always result in direct nest failure. It is likely that some nesting murrelets exposed to disturbance will nest successfully. Most of the programmatic activities would occur in areas that currently receive high levels of human activity. Although relatively few murrelet nest sites have been found near open roads or campgrounds, murrelets do occasionally nest successfully in such areas and appear to habituate to the normal range of sounds and activities associated with these areas (Hamer and Nelson 1998, p. 21, Bloxton and Raphael 2009, pp. 11-12).

We expect murrelets exposed to noise and visual disturbance during the nest initiation phase or incubation may delay or halt nest initiation or incubation. During chick provisioning phase, murrelet chicks are likely to experience injury or an increased likelihood of injury due to missed feedings. Due to the asynchronous nature of nesting phases in the murrelet nesting season, we assume that any of these outcomes is equally possible.

We anticipate that an average of approximately 7,327 acres of murrelet nesting habitat in the ONF will be subjected to noise and visual disturbance from programmatic activities annually. We expect that many of these disturbances will be brief enough in duration (one day or less) or will be outside of established disruption threshold distances from suitable habitat that they will result only in insignificant effects to murrelets. However, activities that are expected to have a duration of multiple days to weeks are expected to result in injury or an increased likelihood of injury, as shown in Table 22 below. Murrelets associated with 2,300 acres of suitable habitat will be exposed to noise and visual disturbance over the ten-year term of this consultation from trail bridge and road bridge construction, and road reconstruction for a duration that results in an increased likelihood of injury. We anticipate this will affect seven nests over the period of this consultation. Additionally, murrelets associated with 120 acres of nesting habitat on the ONF will have a significant behavioral response to noise and visual disturbance that results in injury over the ten-year period of this consultation, due to mid-day commercial thinning in combination with log loading during the dawn feeding period. This will affect one nest over the period of this consultation. And finally, due to mid-day commercial thinning activities, including mid-day log loading, we expect that 3,645 acres of habitat will be exposed to disturbance that will result in an increased likelihood of injury to nestlings, due to missed feedings and an increased risk of nest abandonment or disruption of nest initiation. This is expected to affect 10 nests associated with those acres over the period of this consultation.

Table 22. Summary of programmatic activity and expected effects over ten years due to noise and visual disturbance

Activity type	Effect severity and brief description of effect	Acres exposed to noise and visual disturbance over ten years	Number of nests affected over ten years (rounded up to next larger whole number)
Trail bridge, road bridge, and road construction and reconstruction (duration of more than two days and up to weeks)	Increased likelihood of injury to nestlings, due to missed feedings and increased risk of nest abandonment	Trail bridge construction: (39.27 acres/year) = 393 Road bridge (31.4 acres per year) = 314 Road reconstruction and reconstruction heavy equipment and chainsaw = 159.3 acres per year =1,593 Total = 2,300	7
Short-Duration Activities (less than 2 days) with a daily LOP	Insignificant effects, unless multiple projects affect the same nest	69,460 – (1,593 + 393 + 314) = 67,160	182
Log Loading without morning LOP	Injury to nestlings due to multiple missed feedings	120	1
Commercial thinning activities with LOP	Increased likelihood of injury to nestlings, due to missed feedings and increased risk of nest abandonment, or disruption of nest initiation	3,645	10
	TOTAL	73,265	200

16.1.3 Direct Injury and Mortality

16.1.3.1 Potential for Injury (Hearing Loss) from Blasting Noise

The ONF has identified the use of small blasts using 2 lbs. of charge or less for various projects including trails construction, road work, and rockpit development and expansion. The noise associated with blasting is highly variable and depends on the size of the charge, the material being blasted, and whether noise minimization techniques are employed (MM&A 2008, p. ii). Holhuijzen et al. (1990, p. 272) reported sound levels for small, experimental blasts using 0.37 lb. charges of Kinestek and 1.1 lb. charges of dynamite. Surface (uncovered) charges were detonated at a distance of 100 m (328 ft) from the sound measuring equipment in an open area. Peak noise levels averaged 140 dBA rms (range = 138 to 141 dBA) for Kinestek and 145 dBA (range = 144-146 dBA) for dynamite at 100 m. A review by Dooling and Popper (2007, pp. 23-24) reports that birds exposed to noise levels 140 dBA or greater are likely to suffer hearing damage (injury). The blasts described above would be potentially injurious to birds at distances of at least 100 m (330 feet).

Using a standard sound attenuation rate of -6 dBA, a blast using 1.1 lbs. of dynamite that registers 145 dB at 100 m would have a sound level of approximately 185 dBA at 1 m from the source. If we apply a standard "soft-site" attenuation rate of -7.5 dBA to account for a forested environment, the same blast with a sound level of 185 dBA at 1 m from the source would attenuate to 140 dBA at approximately 64 m (210 ft). These estimates indicate that a "surface shot" of 1.1 lbs. of uncovered dynamite could generate injurious sound levels at distances of over 200 feet from the blast site.

Murrelets exposed to blast noise that exceeds 140 dBA are likely to suffer injury in the form of hearing loss because the intensity of the noise is sufficient to damage the delicate inner ear sensory hair cells (Dooling and Popper 2007, p. 24). A partial loss of hearing sensitivity has important implications for the survival and fitness of individual murrelets. Vocal communication between murrelets is an important aspect of murrelet foraging behavior in the marine environment, and vocalizations also appear to serve an important social function at inland nesting sites (Nelson 1997, pp. 9-11). Hearing ability also has important implications for predator avoidance in both marine and terrestrial habitats.

The ONF has incorporated several minimization measures for blasting into their project description (Appendix C – *Guidelines for Blasting*). These measures include limiting the size of charges to 2 lbs. or less; covering all shots with sandbags or fill; using time delays for shots with multiple blasts; and using noiseless, non-explosive blasting caps for detonation. These measures are expected to significantly reduce blasting noise levels, but we are unable to predict the effectiveness of these minimization measures. Additionally, rockpit development and expansion operations using blasting, drilling and crushing will occur outside the nesting season for murrelets.

For the purpose of this analysis, we assume a potential injury distance of 300 feet (100 yards) for blasts of 2 lbs. or less. This is a conservative estimate that accounts for blasts with charges greater than those analyzed above, and also accounts for the fact that sound levels measured in the forest canopy are higher than sounds measured at ground level for the same activity (Delaney and Grubb 2004, p. 26). We will adjust this injury distance threshold accordingly if monitoring data from small blasting projects support a different distance threshold.

The ONF has identified various programmatic activities associated with trails, roads, and hazard tree felling that require the use of explosives. Up to 19 project sites may require blasting annually (Appendix I- *Annual Disturbance Acres by Activity Type – Marbled Murrelet*). For blasting, we expect that murrelet behavior will be significantly disrupted at distances of up to 0.25-mile from the blast site to represent the zone where a murrelet flush response is likely to occur, and an injury threshold distance of 100 yards where hearing loss may occur. Each blast site has the potential to expose approximately 126 acres to noise disturbance (i.e. a 0.25-mile radius = 126 acres), and up to 6.5 acres to potentially injurious sound levels (i.e., a 100-yard radius = 6.5 acres). The primary risk to murrelets associated with blasting is exposure to noise disturbance during the nesting season. These effects are addressed above under *The Effects of Disturbance to Murrelets on Olympic National Forest*. However, exposure to blasting noise also presents a potential for direct injury to murrelets in the form of hearing loss.

Considering there are up to 19 project sites with blasting activities each year, we expect up to 124 acres will be exposed to potentially injurious sound levels annually. Not all blasting sites are likely to be in suitable murrelet habitat, so these estimates represent the maximum habitat area that could be exposed to these effects annually. Blasting projects with the greatest likelihood to expose murrelets to injurious noise levels would be trail blasting along trails in suitable nesting habitat, or felling hazard trees with explosives in suitable nesting habitat. Hazard tree felling with explosives likely has the greatest potential for noise injury, because charges set on trees are likely more difficult to stem or cover to minimize the blast noise.

We cannot say it is reasonably certain that a murrelet nest would be located close enough to a blasting event for nesting murrelet adults or nestlings to be killed by in-air sound pressure or flying debris from blasting. However, murrelets exposed to blast noise that exceeds 140 dBA are likely to suffer injury in the form of hearing loss because the intensity of the noise is sufficient to damage the delicate inner ear sensory hair cells (Dooling and Popper 2007, p. 24). A partial loss of hearing sensitivity has important implications for the survival and fitness of individual murrelets. Vocal communication between murrelets is an important aspect of murrelet foraging behavior in the marine environment, and vocalizations also appear to serve an important social function at inland nesting sites (Nelson 1997, pp. 9-11). Hearing ability also has important implications for predator avoidance in both marine and terrestrial habitats.

Based on the analysis above, we conclude that exposure to blasting noise is reasonably certain to cause direct injury to murrelet adults or nestlings during the breeding period (April 1 to September 23). It is much more likely that murrelets will be exposed to noise and visual disturbance rather than direct injury from blasting noise. However, because this action involves blasting at up to 19 sites annually and will expose 124 acres of suitable habitat annually during the nesting season, it is reasonably certain that murrelets will be exposed to blast noise. Over the 10-year span of this consultation, that equates to 1,240 acres of habitat exposed. With a given nesting density of one nest per 370 acres, we expect that four nests would be affected over 10 years. For each nest affected, we expect that one adult and one nestling will experience hearing injury as a result of blasting, since it is unlikely that both adults will be at the nest at the same time. In total, we expect direct injury from blasting to affect four adults and four nestlings over the 10-year span of the programmatic consultation.

16.1.3.2 Potential for Direct Injury or Mortality from Tree Felling

16.1.3.2.1 Removal of Suitable Nest Trees

Individual tree removal will occur due to programs that remove or alter SNTs, including trail and trail bridge construction/reconstruction for native log stringers; hazard and danger tree removal for public safety; road use and access permits that allow for road construction across federal land to access non-federal land; commercial thinning and associated activities, including creating landings and road building/reconstruction; forest health within campgrounds; communication site development; rock pit expansion and development; tailhold and guyline anchor permits; road decommissioning during watershed restoration; bridge removal; and requests by Native American Tribes for ceremonial trees. The majority of individual tree removals will occur within a distance of 150 feet from major roads, campgrounds, administrative facilities, and trailheads.

We broadly defined murrelet SNTs to include conifer trees that are greater than or equal to 18 inches dbh that contain one or more suitable platforms that could be used by murrelets for nesting. Trees that are greater than or equal to 18 inches dbh are common features in suitable murrelet nesting habitat, but we expect few trees that are this size will contain suitable platforms. In tree species other than western hemlock, suitable platforms are most common in trees greater than or equal to 29 inches dbh, but western hemlock can contain platforms at smaller dbhs (Raphael et al. 2011, p. 11).

Conservation measures for this programmatic include inspection of individual trees to determine if the tree is an SNT, inspection of SNTs for signs of use, and a nesting-season conservation measure requiring a biologist be on site during felling of SNTs. Every effort will be made to avoid felling SNTs during the nesting season, but some situations (e.g., hazard trees) may require an SNT to be felled during the nesting season. These conservation measures reduce the potential risks to murrelets associated with removal of SNTs, but they do not ensure that murrelets will be protected from disturbance or direct injury under all circumstances. The ONF estimated they may remove as many as 930 murrelet SNTs under this 10-year consultation. No more than 200 of these SNTs (an average of 20 annually) would be removed during the murrelet nesting season. Felling SNTs or other trees within nesting habitat during the nesting season can result in noise and visual disturbance to murrelets, not only from chainsaw noise, but also from the loud noise and damage that felled trees can cause when they crash to the ground. These effects are addressed above under *The Effects of Disturbance to Murrelets on Olympic National Forest*.

Felling of SNTs during the murrelet nesting season creates a potential risk of direct injury or mortality to murrelets nestlings or eggs (e.g., an SNT containing an undocumented nest could be felled, or a felled tree could strike an adjacent tree with a nest). In a worst-case scenario, tree felling could result in direct mortality of a murrelet egg or nestling. When an adult murrelet is present during incubation or nestling feeding, we assume the adult would flush and be able to escape direct injury from tree felling. We consider the likelihood of direct injury to murrelets from hazard tree felling to be very low, given the small number of trees to be felled during the nesting season, but we cannot discount the possibility that an occupied tree could be felled. Murrelet nests are difficult to detect, and relatively few active nests have ever been found. Audio-visual surveys at an SNT during dawn hours could result in detecting a nest, but such observations are rare because murrelets are generally secretive in proximity to nest sites, approaching directly, quietly, and generally below canopy during low light levels (Nelson et al. 2006, p. 11). SNTs would have to be climbed, and each platform branch examined in order to determine if an active nest is present. Tree-climbing is possible in some situations, but it is an action that presents a risk to active nests. It is also unlikely that ONF staff would risk climbing any SNT that is identified as a hazard tree.

The number of SNTs per acre varies widely depending on stand characteristics. Hamer (1995, p. 171) assessed stand characteristics at occupied murrelet sites in Washington and noted that large trees (greater than or equal to 30 inch dbh) occurred at densities ranging from 72 to 220 trees per acre, and large platform densities (greater than or equal to 7 inch diameter) ranged from 25 to 450 per acre at occupied sites. There are over 200,000 acres of suitable murrelet habitat on the ONF, including many areas with large patches of high-quality old-growth habitat. At the scale of the ONF, there are likely hundreds of thousands of SNTs.

The risk of direct injury to murrelets from tree felling would be greatest if an action involved clear-cutting an occupied nest stand. The scattered individual tree removal covered by this consultation poses a relatively low risk of direct injury to murrelets, because active murrelet nests are rare and occur at very low densities relative to the total available nesting habitat on the landscape. It is much more likely that murrelets would be exposed to noise and visual disturbance rather than direct injury from felling an occupied SNT. Because this action involves the removal of up to 200 SNTs over the course of 10 nesting seasons, we cannot discount the possibility that an occupied tree could be felled, but this possibility is so low as to not be reasonably certain to occur. Given multiple SNTs per acre of suitable habitat, and more than 200,000 acres of suitable habitat, the 200 SNTs represent a tiny proportion of the available SNTs in the action area. We conclude that felling of 200 SNTs during the nesting season is not reasonably certain to result in direct injury or mortality of murrelet eggs or nestlings over the 10-year span of the programmatic.

16.1.3.2.2 Removal of Large Trees that are Not Suitable Nest Trees

In addition to the removal of 930 SNTs, the ONF is anticipating the removal of approximately 1,000 trees at least 18 inches dbh that do not have nesting structures. As with removal of SNTs, the removal of scattered individual trees will create small gaps in the forest canopy that are not expected to result in the loss of stands of suitable nesting habitat. Nesting habitat can be degraded at the site scale from individual tree removal if the trees felled provide direct canopy cover to adjacent SNTs (see Section 20 *EFFECTS OF THE ACTION: Marbled Murrelet Critical Habitat*). Felling trees within or adjacent to nesting habitat during the nesting season creates a risk for direct injury or mortality if the felled tree were to strike an adjacent occupied nest tree, but we consider the risk for direct injury to be so low as to not be reasonably certain to occur. The primary risk to murrelets associated with removal of these 1,000 large trees is exposure to chainsaw noise and disturbance during the nesting season. These effects are addressed above under *The Effects of Disturbance to Murrelets on Olympic National Forest*.

16.1.3.3 Potential Injury or Mortality to Murrelets from Large Helicopter Rotor Wash

The primary risk to murrelets associated with helicopter operations is for noise and visual disturbance during the nesting season. These effects are addressed above under *The Effects of Disturbance to Murrelets on Olympic National Forest*. However, large helicopters hovering near canopy level during sling operations can create a potential for direct injury or mortality to murrelets from the rotor wash underneath the helicopter.

Rotor wash is a column of high velocity air forced downward by a helicopters blade rotation (Slijepcevic and Fogarty 1998, p. 1). Helicopter rotor wash can cause saplings, decaying trees, and loose debris from tree tops to fall, and can create hazardous conditions from dust and flying debris underneath the ship (WCB 2005, p. 19). The intensity of rotor wash is influenced by helicopter flight (height above ground and forward speed), helicopter mass, and rotor span (Slijepcevic and Fogarty 1998, p. 2). For example, a Bell 205A helicopter that is hovering at 50 feet above ground level (AGL) generates rotor wash wind speeds of approximately 60 mph at the surface. The same ship hovering at a 100 feet above the ground would generate a rotor wash of approximately 35 mph at ground level (Slijepcevic and Fogarty 1998, p. 11).

Large helicopters, such as the Chinook-47D, can generate rotor wash in excess of 120 mph directly under the ship. Because the intensity of rotor wash varies significantly based on mass, speed, and the height of a ship AGL, we are not able to accurately predict the severity of rotor wash. Helicopter logging safety guidelines developed in British Columbia recommend a 300 foot-radius safety zone for timber fallers working underneath ships that are hovering below 500 feet AGL (WCB 2005, p. 2). This safety zone is recommended to avoid exposing timber fallers to overhead hazards created by rotor-wash, and we believe it represents a reasonable worst-case approach to analyzing risk for injury to murrelets.

Published literature regarding helicopter impacts on wildlife focus on noise and visual stimuli, rather than potential injuries caused by rotor wash; however, we cannot discount that effects from rotor wash may occur. The close approach of the helicopter to a drop site creates multiple stressors for murrelets that must be considered, including noise and/or visual disturbance and severe rotor wash, both of which could cause an incubating adult murrelet to flush off a nest. In a worst-case scenario, rotor wash could cause an egg or chick to fall off a nest branch or prematurely fledge, or cause direct injury to an egg or chick from flying debris or falling branches.

The ONF anticipates the use of large, heavy-lift helicopters (e.g. Chinook 47d or Boeing Vertol) associated with road and trail bridge construction projects and the acquisition of large wood for watershed restoration projects (Appendix I– *Annual Acres And Percent Of Marbled Murrelet Habitat Exposed To Disturbance*). The duration of helicopter use for this type of project implementation is relatively brief, and is estimated as multiple flights at each project site for a period of 1 to 2 days.

We assume a 300 foot-radius circle around each helicopter sling site (6.49 acres per site) is exposed to hazardous rotor wash conditions, recognizing that the sling site will be in an open area that is at least an acre in size to safely accommodate the helicopter sling operation.

The ONF anticipates up to 8 project sites unrelated to commercial thinning will have heavy-lift helicopter sling operations annually (2 trail bridge sites, 2 road bridge sites, and up to 4 large wood acquisition sites). The maximum area exposed to hazardous rotor wash conditions would be approximately 52 acres annually, although it is not known if all project sites will occur within or adjacent to murrelet habitat. Large wood acquisition sites pose a low risk to murrelets, because these sites are restricted to young forest stands that are not suitable as murrelet nesting habitat. Trail bridge sites likely pose the greatest risk for exposure to murrelets because approximately 50 percent of trails occur in suitable murrelet habitat. Helicopters will generally hover no closer than 250 feet AGL when performing sling operations, due to the standard use of a 250 foot-long cable for sling operations. However, if a ship is hovering at 250 feet AGL, the adjacent forest canopy could be exposed to rotor wash sufficient to break branches and physically damage trees. Because the intensity of rotor wash reduces significantly with increasing forward speed (Slijepcevic and Fogarty 1998, p. 2), we do not anticipate hazardous rotor wash conditions while the helicopters are in transit between pick up and drop sites.

Additionally, the proposed action plans for helicopter logging as part of commercial timber harvest activities, as described in the description of the proposed action. During the murrelet nesting season, helicopters shall maintain an altitude and distance from suitable habitat as described in Tables 8 and 15 except when they are on direct approach or departure from landing zones and during emergencies. Additionally, to the extent feasible, the number of overflights shall be minimized and use of the same flight paths shall be maximized over suitable habitat during the nesting season and the smallest, quietest helicopters that can accomplish the task efficiently and safely shall be used.

Over the duration of this programmatic consultation, we expect up to 200 acres of forest adjacent to helicopter logging units and helicopter lands to be exposed to hazardous rotor wash during the murrelet nesting season, between June 1 and September 23 over the ten year period of this consultation (20 acres annually). Since we do not have site-specific information for projects that require helicopter use under this consultation, we assume that all 200 acres of exposure may occur within murrelet suitable nesting habitat, where rotor wash may increase the risk of direct injury or mortality to murrelet adults and nestlings. The use of helicopters will likely be part of multiple projects covered under this programmatic, so we expect that the exposure to rotor wash will be spread out throughout the action area, and the 10-year duration of this consultation.

Based on the above analysis, we conclude that exposure to rotor wash is reasonably certain to cause direct injury or mortality of murrelet eggs, chicks, or fledglings throughout the breeding period (April 1 to September 23). Although there will be a relatively small amount of nesting habitat (20 acres) exposed to rotor wash each year we consider the probability of a direct injury to a murrelet chick to be reasonably certain to occur over the course of 10 years of implementation and the likelihood that there will be multiple trips per day at each site.

Because active murrelets nests are rare and occur at very low densities relative to the total available nesting habitat (one nest per 370 acres) on the landscape, it is reasonably certain that one murrelet egg or nestling will be directly killed as a result of helicopter rotor wash over the 10-year span of the programmatic.

16.1.3.4 Summary of Direct Injury and Mortality

In summary, we anticipate that nesting murrelets are likely to be exposed to potential injury or mortality due to program activities.

We anticipate that an average of approximately 1,440 acres of murrelet nesting habitat in the ONF will be subjected to potential sources of direct injury or mortality from programmatic activities annually. These sources include individual tree felling (including SNTs and other large trees), blasting, and large helicopters hovering less than 500 feet AGL. The felling of individual trees is not reasonably certain to lead to injury or mortality. However, blasting and large helicopter use involving hovering less than 500 feet AGL are expected to result in injury or mortality, as shown in Table 23 below. Murrelets associated with 1,440 acres of suitable habitat will be exposed to potential injury or mortality over the ten-year term of this consultation. In total, this is expected to affect 5 nests associated with those acres over the period of this consultation. We expect mortality of one murrelet egg or nestling from large helicopters hovering within 500 feet AGL. We also expect direct injury from blasting to affect four adults and four nestlings over the ten-year period of this consultation.

Table 23. Summary of programmatic activity and expected effects over ten years due to activities that may cause direct injury or mortality

Activity type	Effect severity and brief description of effect	Suitable Habitat Acres exposed to potential direct injury or mortality over ten years	Number of nests affected over ten years (rounded up to next larger whole number)
Blasting	Direct injury (hearing loss) from blasting	1,240	4
Large Helicopters Hovering < 500 feet AGL	Injury or mortality due to being struck by a limb or other flying debris	200	1
Tree Felling (individual SNTs or other individual large trees)	Direct injury or mortality due to crushing is possible, but not reasonably certain to occur	n/a	0
	TOTAL	1,440	5

16.1.4 Effects to Marbled Murrelet Nesting Habitat

16.1.4.1 Increased Risk of Predation adjacent to Campgrounds and Dispersed Camping Sites

The relationship between human activities and predators, and their potential impact on murrelet nesting success, has been identified as a significant threat to murrelets (75 FR 3424:3432 [Jan. 21, 2010], Peery and Henry 2010, p. 2414). Research in the Pacific Northwest has identified up to 15 mammalian and avian species that potentially prey on murrelet nests (Marzluff and Neatherlin 2006, p. 308). The risk of predation on murrelet nests by avian predators (especially corvids) appears to be highest in close proximity to forest edges (including roads), campgrounds, and settlements (Raphael et al. 2002; Marzluff and Neatherlin 2006). Corvid populations are elevated within 1 km of campgrounds and settlements, in comparison with populations of the same species more than 5 km from the same human developments, and sources of human food may attract individual corvids from more than 30 km away (Marzluff and Neatherlin 2006, p. 312). The most significant increase in nest predation occurs within 50 m (55 yards) of the campground edge (Raphael et al. 2002, p. 230). Even small campgrounds bolster corvid fledging success (Neatherlin and Marzluff 2004, pp. 715-716).

Under the proposed action, the existing ONF campgrounds will continue to be managed for recreational use, and some 1,405 dispersed campsites will continue to be expected for recreational use. Research on the Olympic Peninsula has demonstrated that nest predation risk can increase in close proximity to campgrounds, even in isolated settings due to the presence of refuse, food scraps, and the deliberate feeding of wildlife by recreationists. Marzluff and Neatherlin (2006, p. 311) state that the quality of nesting habitat adjacent to campgrounds may be compromised because of the increased risk of corvid predation.

The ONF provided information, using GIS analysis, about the suitable habitat available within 55 yards of suitable habitat (Table 24). This equates to approximately 13 acres of suitable habitat.

Table 24. ONF Permanent Campgrounds and suitable habitat within 55 yards of Murrelet Suitable Habitat

ONF Campground	Murrelet Suitable Habitat acreage (rounded up to next largest 0.1 acre)
Dungeness Forks	2
Klahanie	2
Falls Creek	1.4
Willaby	2
Campbell Tree Grove	2
Gatton Creek	2
Lena Lake	1.4

The location of dispersed sites has not been mapped, and changes from year to year. Therefore, the ONF was unable to provide a current estimate of suitable habitat adjacent to these dispersed sites. The ONF states that most dispersed campsites are along roads. If we assume that dispersed campgrounds are distributed randomly across the forest, we can expect that 41 percent of dispersed sites are adjacent to suitable habitat, given that 41 percent of the ONF is suitable habitat. Most of these sites are also located along roads. Dispersed campsites vary in size, but the average size is estimated to be about 0.25 acres. For analysis, if we assume that each dispersed site is a circle, this circle would have a radius of 20 yards, and adding an additional 55-yard radius to the 0.25-acre circle would make a circle with a 75-yard radius, 17,500 square yards or 3.6 acres (π*[75 yards]^2 = 17,500 square yards = 3.6 acres. We subtract 0.25 acre for the dispersed site itself, and another 0.25 acre for the adjacent road, leaving 3 acres of suitable habitat within 55 yards of each dispersed site adjacent to suitable habitat. In total, then, we estimate that approximately 576 dispersed sites (41 percent of 1,405 sites) will each affect 3 acres of suitable habitat on an annual basis, for a total of 1,728 acres of suitable habitat affected each year. Some specific sites are expected to be consistently present from year to year, while other sites will begin or cease to be used over the course of the 10-year term of the action. Although campgrounds degrade the suitability of murrelet nesting habitat in surrounding areas through human presence and increased corvid densities, the presence of a campground does not preclude the use of the area by murrelets. In Olympic National Park, Hall (2000, p 6.) found that campgrounds had similar rates of murrelet occupancy detections when compared to wilderness areas. While murrelets nesting near campgrounds likely have an increased risk of nest predation, murrelets have been documented successfully nesting in a major campground in Olympic National Park (Bloxton and Raphael 2009, p. 11).

These areas will continue to cause an increased level of predation risk for murrelets. Short of closing these areas to public access, there is relatively little that can be done to prevent these effects, other than to manage garbage to reduce wildlife access to human garbage. Under the proposed action, the effects associated with increased predation risk adjacent to roads and campgrounds will continue to occur. Continued management of campgrounds under the current practices creates a likelihood of injury to nesting murrelets due to increased predation risk. The effects of increased predation risk associated with developed areas are currently reflected in the declining murrelet population trends on the Olympic Peninsula.

If murrelet nests are present in suitable habitat within 55 yards of campgrounds, we expect an increased risk of injury due to predation. Given the 1,741 acres around campsites (1,728 acres of suitable habitat within 55 yards of dispersed sites and 13 acres within the same distance of permanent campgrounds), we are reasonably certain that nests will be present, and therefore we are reasonably certain that campgrounds will result in increased predation risk to murrelets. Given a nest density of one nest per 370 acres of suitable habitat, we expect five nesting pairs, eggs, or murrelet chicks will experience an increased likelihood of injury from predation on an annual basis.

16.1.4.2 Potential Displacement from the Loss of Suitable Nest Trees

Individual tree removal will occur due to programs that remove or alter SNTs. These programs include the following: 1) trail and trail bridge construction/reconstruction for native log stringers; 2) hazard and danger tree removal for public safety; 3) road use and access permits that allow for road construction across federal land to access non-federal land; 4) commercial thinning and associated activities, including creating landings and road building/reconstruction; 5) forest health management activities within campgrounds; 6) communication site development; 7) rock pit expansion and development; 8) tailhold and guyline anchor permits; 9) road decommissioning during watershed restoration; 10) bridge removal; and 11) requests by Native American Tribes for ceremonial trees.

The ONF estimated they may remove as many as 930 murrelet SNTs over the course of this 10-year consultation. No more than 200 of these SNTs (an average of 20 annually) would be removed during the murrelet nesting season.

The majority of individual tree removals will occur within a distance of 150 feet from major roads, campgrounds, administrative facilities, and trailheads. Additionally, the majority of SNTs will be felled during the non-nesting season when murrelet eggs and young are not present at nest sites, and the risk for disturbance or direct injury to murrelets is discountable. However, felling a tree that murrelets have previously used for nesting would potentially displace the murrelet pair that would have returned to the same tree the following year. Nesting murrelets on the Olympic Peninsula have been documented using the same nest platform in subsequent years (Bloxton and Raphael 2009, pp. 11-12). A recent study on the re-use of nest trees in British Columbia reported that 26 of 143 nest trees (18 percent) showed evidence of re-nesting (Burger et al. 2009, p. 217). Fidelity to individual trees for nesting was more common in landscapes that had highly fragmented nesting habitat, and less common in landscapes with large tracts of suitable nesting habitat (Burger et al. 2009, p. 222).

Prospecting for nest sites is a well-documented behavior in murrelets. Prospecting involves pairs and individuals flying near and landing on tree limbs in the early spring and midsummer. Murrelets also visit nesting areas during the winter and may select nest sites during this time (Nelson 1997, p. 7). Research in Oregon (Meyer et al. 2002, p. 110) and in British Columbia (Zharikov et al. 2006, p. 117) indicates that murrelets do not immediately abandon fragmented or degraded habitats. Murrelets are likely to maintain fidelity to their nesting sites as long as the habitat stands retain some suitable nesting structures and the birds are able to successfully nest at the site (Divoky and Horton 1995, pp. 83-84). The removal of individual SNTs will create small gaps in the forest canopy and will reduce the total number of suitable nest platforms at the stand scale, but is not expected to result in the loss of stands of suitable nesting habitat or substantially reduce nesting opportunities for murrelets (see Section 20 *EFFECTS OF THE ACTION: Marbled Murrelet Critical Habitat*).

Because murrelets in some areas have demonstrated fidelity to the same nest trees, we consider the felling of SNTs to be an adverse effect, because even if the tree is felled outside the nesting season, the murrelets returning to that tree in the following season would be forced to locate an alternate nest site. In areas where nesting habitat is highly fragmented or otherwise limited, relocating to a new nest site could result in a delay in the onset of breeding, nest site abandonment, or failed breeding due to increased predation risk at a marginal nesting location (Divoky and Horton 1995, p. 83; Raphael et al. 2002, p. 232). These effects are most likely to manifest in areas where entire stands of suitable habitat are lost due to timber harvest, or in areas where SNTs are extremely limited (e.g., less than one SNT per acre). Many locations on the ONF support large, contiguous stands of high-quality nesting habitat, while other areas contain highly fragmented habitats or low densities of SNTs. We expect the effects of SNT removal would be most significant in areas with few remnant SNTs. Such areas have a much lower likelihood of murrelet occupancy, but nesting in stands with few remnant trees has been documented (Grenier and Nelson 1995, p. 196).

The number of SNTs per acre varies widely depending on stand characteristics. Hamer (1995, p. 171) assessed stand characteristics at occupied murrelet sites in Washington and noted that large trees (greater than or equal to 30 inch dbh) occurred at densities ranging from 72 to 220 trees per acre, and large platform densities (greater than or equal to 7 inch diameter) ranged from 25 to 450 per acre at occupied sites. There are over 200,000 acres of suitable murrelet habitat on the ONF, including many areas with large patches of high-quality old-growth habitat. At the scale of the ONF, there are many hundreds of thousands of SNTs.

Based on the above information, we consider the loss of SNTs to be an adverse effect to murrelets, due to the fidelity that murrelets have demonstrated for individual trees and the potential for displacement of murrelets. Because there are large stands of suitable nesting habitat within the ONF and in the adjacent Olympic National Park, we expect the loss of individual trees during the non-breeding season would not result in a significant disruption of murrelet breeding behavior in subsequent years, as long as SNTs remain at high enough densities within the stand, because the nesting pair would likely respond to the loss of a previously-used nest tree by selecting another SNT within the stand. However, this may be more difficult for a nesting pair if their nest tree is removed from an area where SNTs occur at low densities of less than one SNT per acre. Removal of SNTs in areas with low densities of SNTs is likely to result in a significant disruption of normal nesting behaviors due to the effects of displacement. Where nest tree availability is limited, the loss of a nest tree will either prevent a pair from breeding following the tree removal, or will cause the pair to expend additional time and energy locating a new nest site.

We lack specific information regarding how often SNTs will be removed from areas with high or low SNT density. Because many areas with large patches of high-quality old-growth habitat are present on the ONF, we assume that more SNTs are located in areas with high SNT density than with low SNT density. Therefore, all other things being equal, it is more likely that SNTs will be removed from areas where SNTs are abundant. There are likely to be hundreds of thousands of SNTs present on the ONF, with at most a few hundred being used as nest trees in any given year, so any given SNT has a low likelihood of being recently used for nesting. Even if one of the 930 SNTs to be removed is a recently used nest tree, the chance of this occurring in an area with low SNT density is low and not reasonably certain to occur.

16.1.4.3 Effects to Murrelets from the Removal of Non-nesting Habitat Due to All Activities Except Commercial Thinning

As many as 100 acres of non-suitable, forested habitat may be converted to non-forested land due to road construction associated with the Road Use and Access Permits program, or through small gap clearings for acquisition of logs for watershed restoration projects. Most projects will result in the removal of small patches of young forest habitat up to one acre in size that would have no direct significant effect to murrelet nesting habitat unless trees were removed directly adjacent to SNTs. As discussed below, nesting habitat can be degraded at the site scale from tree removal if the trees felled provide direct canopy cover to adjacent SNTs (see Section 20 *EFFECTS OF THE ACTION: Marbled Murrelet Critical Habitat*). The primary risk to murrelets associated with removal of these small patches is exposure to chainsaw noise and disturbance during the nesting season. These effects are addressed above under *The Effects of Disturbance to Murrelets on Olympic National Forest*.

16.1.4.4 Effects to Murrelet Habitat from Commercial Thinning

In this section, we present our analysis of the effects of felling trees adjacent to suitable nest trees, hazard tree removal, and other effects to suitable murrelet nesting habitat (which include microclimate effects, windthrow, and increased predation risk).

16.1.4.4.1 Effects to Suitable Marbled Murrelet Nesting Habitat (Edge Effects)

Although murrelets are generally associated with old-forest habitat, the most basic unit of murrelet nesting habitat is an individual tree with suitable nest platforms. A platform is defined as a relatively flat surface at least 10 cm (4 inches) in diameter and 10 m (33 feet) high in the live crown of a coniferous tree. Platforms can be created by a wide bare branch, moss, or lichen covering a branch, mistletoe, witches brooms, and other deformities. Any forested area with a residual tree component, small patches of residual trees, or one or more platforms could be suitable murrelet nesting habitat (Evans Mack et al. 2003, p. 3).

Although the treated stands are not anticipated to support nesting murrelets directly, many of the stands do provide a "buffer habitat" function to adjacent old-forest stands that are suitable murrelet nesting habitat. The proposed action includes a conservation measure to retain a buffer of trees with interlocking canopies where a thinning stand boundary is bordered by suitable habitat. This buffer will protect individual platform trees in adjacent stands by maintaining interlocking canopies that provide canopy cover for platforms in those adjacent trees. Based on the very low density of suitable platforms within the thinning stands, and the retention of trees with interlocking canopies adjacent to old-forest edges, we do not anticipate a measurable loss of murrelet nesting habitat from within the thinning stands, with the possible exception of a few, scattered individual trees with platforms that were either smaller than the diameter limits described in the conservation measures or removed for safety reasons, as described above.

While we do not expect a measurable loss of contiguous murrelet nesting habitat, we do anticipate some temporary, adverse effects to adjacent suitable murrelet nesting habitat. These effects include changes in microclimate, and increased windthrow and predation risk. Those effects, and long-term beneficial effects, are described below.

16.1.4.4.2 Microclimate Effects

Clearcut edges are exposed to higher winds, increased solar radiation, lower humidity, and reduced moss cover on branches, which can reduce the suitability of a stand as murrelet nesting habitat. Exposed clearcut edges alter light, moisture, and temperature gradients in adjacent old-forest stands for distances of up to 240 m (Chen et al. 1993, p. 291, 1995, p. 74), and these effects can result in the loss and degradation of murrelet nesting habitat in edge-influenced stands. A study in British Columbia found that murrelet habitat located within 55 yards of a hard edge had fewer trees with suitable murrelet nest platforms relative to adjacent interiors, and hard-edged patches had reduced epiphyte (moss) cover overall, which reduced the number of available platforms in the affected habitat (van Rooyen et al. 2011, p. 549). This study documented that the availability of suitable nesting platforms is significantly decreased at edges, through the loss of trees with platforms, the loss of moss as a result of wind damage, and microclimate effects that reduce the growth, survival, and colonization of mosses. These negative effects persist for 20 to 30 years, and diminish as adjacent forests regenerate (van Rooyen et al. 2011, p. 558).

We do not expect that that thinning treatments and road construction/reconstruction, as proposed, will alter the microclimate conditions in adjacent murrelet nesting habitat stands to the same extent as a clearcut edge, but we recognize that there will be some short-term habitat degradation along old-forest edges where thinning treatments or other actions reduce canopy cover to below 60 percent. Heavy thinning treatments that will leave 20 to 50 trees per acre (tpa), depending on tree diameters, and an average post-harvest canopy cover of at least 40 percent will result in very open canopy conditions within thinned stands, which will alter the microclimate along the edges of adjacent old-forest stands. We expect that these effects will occur within 55 yards of the edge, in keeping with the less intensive end of the effects of hard edges discussed above.

Conservation measures that preclude harvest and creating gaps immediately adjacent to old-forest edge will minimize the magnitude of microclimate changes in adjacent stands, but the reduction in canopy cover in some stands is likely to alter microclimate conditions in the adjacent stands for up to a decade or more until canopy cover in the thinned stands recovers to 60 percent or more. Canopy cover in thinned stands is expected to increase at a rate of about 1 to 2 percent per year (Chan et al. 2006, p. 2696), so any microclimate effects associated with proposed thinning should diminish over a period of 10 to 15 years. Although nesting habitat along thinned edges may be degraded by increased exposure, there is no evidence to indicate that the presence of even high-contrast edges deters the use of an area for nesting by murrelets (Raphael et al. 2002, p. 226). Rather, the most significant effect to murrelets associated with managed forest edges is increased predation risk (discussed below).

16.1.4.4.3 Windthrow

Timber harvest often results in an increased risk of windthrow along the edges of clearcuts. Old-growth stands along managed-forest edges generally have reduced densities of tpa, and elevated rates of tree mortality, as measured by standing dead and down trees (snags and logs) compared to interior, unmanaged forest (Chen et al. 1992, p. 387). 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 per 100 m along clearcut edges, compared to an average of 0.7 trees per 100 m in partial cut harvests. The windthrow rate in the partial harvest units was similar to that found in unmanaged control sites. On the Olympic Peninsula, variable density thinning resulted in a blowdown rate of about 3 tpa in thinned stands. The overall level of wind damage was similar to unthinned stands (Roberts et al. 2007, p. 285). Internal edges created by gaps, skid hails, and unthinned patches did not inherently increase wind damage risk; however, where gaps were located in topographically vulnerable positions, greater wind damage did occur (Roberts et al. 2007, p. 285).

Based on these studies, it appears that the risk of windthrow within or adjacent to thinned stands is relatively low compared to clearcut areas, and that the rate of windthrow adjacent to thinned stands is comparable to that found in unmanaged stands. However, due to the intensity of the proposed thinning treatments, we expect there will likely be some loss of scattered, individual trees with platforms along old forest edges. We expect these effects, where they occur at all, to be most likely within 55 m of the thinned area. Windthrow is a major source of stand-replacing disturbance in the action area, but conservation measures leaving a buffer between suitable habitat and thinned areas will minimize thinning-related increases in suitable habitat loss via windthrow. In this Opinion, we consider the adverse effects of windthrow in combination with microclimate and predation risk, and refer to these effects cumulatively as edge effects.

16.1.4.4.4 Predation Risk due to Commercial Thinning

Research on murrelet nest predation has focused on edge effects adjacent to clearcuts, but the effects of thinning on murrelet predation risk have not been explicitly studied, and it is not clear whether the “edge” of a heavy thinning stand would cause the same effects as a clearcut. Malt and Lank (2009, p. 1276) studied murrelet nest predation on a gradient of forest regeneration, and found significant differences in predation rates between “hard” edges (recent clearcuts), “soft” edges (regenerating stands 17 to 39 years old), and “natural” edges (e.g., landslides, riparian edges). Murrelet nests located within 55 yards of high contrast edges created by recent clearcuts are 2.5 times more likely to be disturbed by predators relative to nests located in adjacent interior forest; “soft” edges had less than half the predation of interior forests, and “natural” edges were indistinguishable from interior forests (Malt and Lank 2009, pp. 1278-1279). The increased predation risk along the edges of recent clearcuts is associated primarily with Steller’s jays (*Cyanocitta stelleri*) because they are habitat generalists that respond positively to forest fragmentation and preferentially use forest edges due to the abundance of berries and insects in recent clearcuts (Malt and Lank 2009, pp. 1283-1284). This study suggests that regenerating forests 20 to 40 years old provide relative safety from avian predators at both patch and landscape scales. Regenerating stands of this age typically have simple structure and little understory vegetation, and therefore offer few resources to attract potential nest predators (Malt and Lank 2009, p. 1282).

The proposed thinning will alter existing closed-canopy "soft" edges between thinning stands and the adjacent old-growth forest in a subset of the proposed stands, and would affect up to half of the 3,765 acres (1,883 acres) of murrelet habitat located within 110 yards of programmatic activities associated with commercial thinning. The exact acreage is not known due to uncertainties in unit boundaries and geometry. The maximum acreage area that the 55-yard distance (50 m) buffer would occupy within the area of a 110-yard buffer is fifty percent of the 110 yard buffer of a thinning or clearing stand edge, in this case, up to 1,883 acres. This effect would continue for a duration of 10 to 15 years. We assume that these same acres of suitable habitat would be subject to these edge effects each year for 10 years, and that any nests present within that timeframe would be affected. Nests associated with the same nesting pair may be affected over multiple years. In a review of murrelet nest studies, murrelet nests along managed forest edges had an average success rate of 38 percent, compared to 54 percent in interior forest (McShane et al. 2004, p. 4-89). We do not expect that the proposed thinning treatments will increase predation risk to the same extent as a clearcut edge, but we recognize that there is likely to be a short-term increase in predation risk along old-forest edges where adjacent thinning treatments reduce canopy cover to less than 60 percent. Conservation measures that preclude creating gaps, permanent roads, and most temporary roads immediately adjacent to an old-forest edge will reduce the adverse effects associated with "hard" edges. Canopy cover in thinned stands is expected to increase at a rate of about 1 to 2 percent per year (Chan et al. 2006, p. 2696), so any increased predation risk associated with proposed thinning should diminish over a period of approximately 10 to 15 years after the proposed action.

The proposed action is not likely to result in increased densities of avian predators in the action area but, as described above, there is a likelihood of a shift in habitat use by resident corvids in thinned stands, along roads, or at new trailheads. Increased densities of corvids are generally associated with "rural development, farms and pastures, towns… developed campgrounds with moderate to high (> 500 campers per month) seasonal (May to September) camping activity" (Marzluff and Neatherlin 2006, pp. 304), and "campgrounds and small human settlements" (Raphael et al. 2002, pp. 229). We infer that the results of these studies are not comparable to the temporary presence of logging and road crews associated with commercial thinning primarily because of an existing trash management BMP and the difference in the quantity of accessible food scraps and predictability/consistency of human presence. The anticipated edge effects associated with commercial thinning represent a significant habitat modification that is likely to impair essential murrelet breeding behaviors due to increased predation and resulting reduced nesting success. Murrelets nesting in these 1,883 acres of adjacent suitable habitat will experience lower rates of nest success each year for 10 years, though this does not imply that all nests in these acres will fail each year, but simply that the likelihood of failure will be greater than it would be without the adjacent thinning.

Based on estimates of murrelet density stated in the Environmental Baseline (one nesting pair per 370 acres of suitable habitat), we calculate that five nesting pairs will experience reduced rates of nest success each year for 10 years. This effect will continue annually each year, resulting in 50 total nests subjected to edge effects (diminishing over 10 to 15 years).

16.1.4.5 Summary of Effects to Suitable Marbled Murrelet Nesting Habitat

The proposed action will not result in the direct loss of any stands of suitable murrelet nesting habitat in the action area, although a small number of nesting platforms may be lost due to windthrow. We anticipate there will be some habitat degradation associated with edge effects from changes in microclimate, windthrow, and increased predation risk, but these effects are expected to diminish with recovery and regeneration of forest canopy in the thinned stands. We anticipate there will be 1,883 acres of short-term habitat degradation associated with edge effects adjacent to thinning stands, which should diminish over a period of approximately 10 to 15 years after thinning. The anticipated edge effects represent a significant habitat modification that is likely to impair essential murrelet breeding behaviors due to reduced likelihood of nesting success to murrelets associated with 1,883 acres of habitat, scattered over space and time. This represents less than 1 percent of the total available nesting habitat within the ONF. Given an average density of approximately one nest per 370 acres of suitable habitat, we expect approximately five nests each year for ten years to experience reduced nesting success rates as a result of edge effects (totaling 50 nests).

Although nesting habitat along thinned edges may be degraded by increased exposure to the above stressors, there is no evidence to indicate that the presence of high-contrast edges deters the use of an area for nesting by murrelets (Raphael et al. 2002, p. 226). The proposed thinning prescriptions are designed to promote tree growth and crown development, as well as the development of a multi-storied canopy structure in thinned stands. The USFWS recognizes the potential benefits of thinning as an important recovery action to increase the rate at which murrelet habitat develops in younger forests (USFWS 1997, p. 144). We anticipate the proposed action will result in short-term habitat degradation effects and an increased likelihood of predation, as well as long-term beneficial effects towards recruiting future habitat in the action area.

16.1.5 Summary of Habitat Effects

In summary, the proposed action will affect stands of suitable murrelet nesting habitat in the action area. We anticipate there will be habitat degradation associated with increased predation risk due to close proximity to campgrounds due to the presence of refuse, food scraps, and the deliberate feeding of wildlife by recreationists. Additionally, we anticipate edge effects from changes in microclimate, windthrow, and increased predation risk, but these effects are expected to diminish with recovery and regeneration of forest canopy in commercially thinned stands and associated activities.

As shown in Table 25, we anticipate effects to 1,741 acres of suitable habitat adjacent to campsites annually. In many cases, this will affect the same habitat patches year after year, but changes in usage patterns of dispersed campsites may lead to annual variation in the location of these acres. We anticipate there will be 1,883 acres of short-term habitat degradation due to edge effects adjacent to commercially thinned stands and associated activities over the period of the consultation. These effects are expected to diminish over a period of approximately 10 to 15 years after the thinning occurs. We expect that murrelets associated with 5 nests will experience these effects annually for ten years, resulting in a total of 50 nests adversely affected. We also acknowledge that the proposed thinning prescriptions are designed to promote tree growth and crown development, as well as the development of a multi-storied canopy structure in thinned stands. The USFWS recognizes the potential benefits of thinning as an important recovery action to increase the rate at which murrelet habitat develops in younger forests (USFWS 1997, p. 144). We anticipate commercial thinning will result in short-term habitat degradation effects and an increased likelihood of predation, as well as long-term beneficial effects towards recruiting future habitat in the action area.

The anticipated increased predation risk from campgrounds and edge effects from commercial thinning represent a significant habitat modification that is likely to impair essential murrelet breeding behaviors due to reduced nesting success to all murrelets associated with 3,624 acres of habitat annually. We also anticipate insignificant effects from removal of non-nesting habitat due to all activities other than commercial thinning. Additionally, we expect that significant impairment of essential behaviors due to SNT removal, while an adverse effect, is not reasonably certain to occur.

In total, we expect that 100 nests will experience a significant impairment of essential breeding and sheltering behavior due to edge effects, resulting in reduced nest success due to an increased risk of nest predation.

Table 25. Summary of programmatic activity and expected effects over ten years due to activities that result in habitat modification

Activity type	Effect severity and brief description of effect	Acres exposed to potential direct injury or mortality over ten years	Number of nests affected over ten years (rounded up to next larger whole number)
Commercial Thinning	Significant disruption of breeding and sheltering behavior, due to edge effects (reduced nesting success)	1,883 x 10 years = 18,830	50
Campgrounds	Significant disruption of breeding and sheltering behavior, due to increased nest predation risk (reduced nesting success)	17,410 (may be the same 1,741 acres affected annually for ten years, though some dispersed campgrounds may move)	50
SNT Removal	Significant disruption of nesting behavior is possible where a recently used nest tree is removed from an area with low SNT density, but this effect is not reasonably certain to occur.	n/a	0
Removal of Non-nesting Habitat Due to All Activities Other Than Commercial Thinning	Insignificant effects	n/a	0
	TOTAL	36,240	100

16.1.6 Summary of Effects to Murrelets

In summary, the proposed program of activities is expected to affect murrelets via the introduction of smoke, noise and visual disturbance into suitable habitat; by the motion of trees, limbs, and air pressure gradients created by helicopter use with the potential to injure marbled murrelets; by reductions in the availability of nest trees; and by edge effects where suitable habitat borders thinning units. Some of these effects are expected to be insignificant, whereas others are expected to reduce nesting success of affected murrelets, and others will directly injure or kill individual murrelets (Table 26).

Insignificant effects due to noise and visual disturbance are expected to result from short duration activities (less than 2 days) conducted during the nesting season with a daily LOP, unless those activities overlap an area with a nest in the same season over consecutive days. These short-duration activities will occur throughout 67,160 acres of suitable nesting habitat during the nesting season over ten years, affecting 182 nests. All sound- and smoke-generated activities carried out during the nesting season located farther than the established disruption threshold distances from suitable habitat are also expected to have insignificant effects. Some insignificant effects to habitat are expected to result from removal of non-nesting habitat due to activities other than commercial thinning, and from removal (outside of the nesting season) of small trees and shrubs within or immediately adjacent to suitable habitat.

Table 26. Summary of programmatic activities and corresponding significant effects that are reasonably certain to occur to murrelets over ten years of program implementation.

Activity type and Stressors	Effect severity and brief description of effect	Acres exposed to effect over ten years	Number of nests affected over ten years (rounded up to next larger whole number)
Trail bridge, road bridge, and road construction and reconstruction (duration of more than two days and up to weeks) (Noise and Visual Disturbance)	Increased likelihood of injury to nestlings, due to missed feedings and increased risk of nest abandonment	2,300	7 (7 eggs or nestlings)
Log Loading without morning LOP (Noise and Visual Disturbance)	Injury to nestlings due to multiple missed feedings	120	1 (1 nestling)
Commercial Thinning activities with LOP (Noise and Visual Disturbance and Habitat Effects, within 55 yards of activity)	Significant disruption of breeding and sheltering behavior, due to edge effects (reduced nesting success)	18,830 (1,883 acres will experience significant diminishing edge effects for 10 years)	50 (5 nests each year for ten year)
Commercial thinning activities with LOP	Increased likelihood of injury to nestlings, due to missed feedings and increased risk of nest abandonment, or	3,645 - 1883 = 1,762	10 - 5 = 5 (5 eggs or nestlings)

Table 26. Summary of programmatic activities and corresponding significant effects that are reasonably certain to occur to murrelets over ten years of program implementation.

Activity type and Stressors	**Effect severity and brief description of effect**	**Acres exposed to effect over ten years**	**Number of nests affected over ten years (rounded up to next larger whole number)**
(Noise and Visual Disturbance only, 55-110 yards)	disruption of nest initiation		
Blasting (air pressure)	Direct injury from changing air pressure levels	1,240	4 nests
Large Helicopters Hovering < 500 feet AGL (rotor wash)	Injury or mortality due to being blown off the nest or being struck by a limb or other flying debris	200	1 (1 egg or nestling)
Campgrounds (Habitat Effects)	Significant disruption of breeding and sheltering behavior, due to increased nest predation risk (reduced nesting success)	17,410	50 (50 eggs or nestlings)
	TOTAL	41,862	118

Many stressors associated with the proposed program of activities are expected to reduce nesting success. Trail bridge and road bridge construction, road construction and reconstruction, and commercial timber harvest will increase the likelihood of injury to murrelet nestlings. Even with the application of the daily LOP, the addition of noise and visual disturbance, over a period of several days, is likely to disrupt one or more mid-day feeding attempts or increase the likelihood of nest abandonment. These activities are expected to affect 406 acres per year (176.2 for commercial thinning and 230 for trail bridge/road bridge/road reconstruction), and 12 murrelet nests (12 eggs or nestlings) over the 10-year duration of the action. Note that the acreage of noise and visual disturbance associated with commercial thinning with the daily LOP listed above does not include the area where this stressor overlaps with edge effects. Additionally we expect one nest (1 nestling) will experience injury due to malnourishment from disturbance-related effects for log loading without an LOP.

Timber harvest and the ongoing use of campgrounds, including dispersed campsites, are expected to alter habitat conditions in adjacent stands, disrupting essential breeding and sheltering behavior and therefore leading to increased predation risk. In suitable habitat along thinning unit boundaries, additional edge effects are also expected, including changes in microclimate and increases in windthrow. Edge effects are expected to affect 3,624 acres per year and 100 murrelet nests (100 eggs or nestlings) over the 10-year duration of the action. The edge effects associated with thinning are expected to continue for at least ten years after the thinning is completed, and therefore a given patch of habitat will be affected for ten years in a row, potentially extending beyond the end of the term of the action. Edge effects associated with campgrounds are likely to affect nearly the same areas of habitat every year for ten years, but affected areas may change slightly with changes in usage patterns of dispersed campsites. We also note that the area affected by edge effects associated with thinning (55 yards from the edge of the thinning unit) is entirely contained within the area affected by noise and visual disturbance associated with thinning (110 yards from the edge of the unit). To avoid double-counting the effects to these acres, we subtracted the acres where edge effects are expected from the total area where noise and visual disturbance is expected to result from commercial thinning with a daily LOP.

Direct injury and mortality is anticipated from large helicopters hovering less than 500 feet AGL and blasting. These effects are expected to occur within 144 acres per year (20 acres for large helicopters and 124 acres for blasting). We anticipate that one nest (one egg or nestling) will be killed by rotor wash from helicopter use. We anticipate four nests will be exposed to blasting noise, and at each affected nest, hearing injuries will result for 1 nestling, or 1 adult, or both.

In total, we expect that murrelets associated with 41,862 acres of suitable habitat on the ONF will be exposed to stressors that are reasonably certain to significantly disrupt normal behavior or significantly impair essential behavior. A total of 118 nests, representing between 118 to 122 eggs, nestlings, and adult murrelets, will experience these effects.

17 CUMULATIVE EFFECTS: Marbled Murrelet

Cumulative effects include the effects of future state or private activities, not involving federal activities 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. As discussed in the environmental baseline, forest management activities on state and private lands within the action area are associated with HCPs, and therefore do not result in cumulative effects.

Cumulative effects in the action area may occur at home sites or from other non-forest management activities at just outside of ONF, or in inholdings. The effects likely to result from typical home site activity and other non-forest management activities include possible noise disturbance (for example, occasional use of chainsaws to manage individual trees or other vegetation near houses), which we assume is often likely to last less than two days and therefore will result in insignificant effects to individual murrelets. A more serious effect of human settlement and other human activity is the accidental or deliberate delivery of food subsidies to corvids and other murrelet nest predators. This has the effect of increasing populations of nest predators and therefore increasing nest predation. Elevated densities of nest predators associated with cumulative effects are likely a contributing cause to the low nest success rates that have been observed in Washington, including on the Olympic Peninsula. Low nesting success, in turn, is a primary driver of murrelet population declines in Washington.

18 INTEGRATION AND SYNTHESIS OF EFFECTS: Marbled Murrelet

18.1 Effects to Murrelet Numbers, Reproduction, and Distribution

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 cumulative effects to the environmental baseline and, in light of the status of the species and critical habitat, formulate the USFWS's opinion as to whether the action is likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat.

18.1.1 Overview of Baseline Murrelet Population Demography and Habitat Relationships

Murrelets are long-lived birds, with high adult survival, low annual fecundity, and delayed maturity (McShane et al. 2004, p. 3-34). It may take a breeding pair several successive years of nesting attempts to replace themselves in the population. Murrelet demography studies and population viability modeling indicate that murrelet populations are most sensitive to changes in adult survival and fecundity (reproductive success) (McShane et al. 2004, pp. 3-53 to 3-58). Although adult annual survival rates are relatively high in murrelets (estimated at 83 to 92 percent), it is likely that recruitment rates throughout the species listed range are too low to reverse the current population decline.

The USFWS convened a Recovery Implementation Team in 2011 that concluded that the primary cause of population declines is sustained low recruitment. Sustained low recruitment can be caused by nest failure, low numbers of nesting attempts, and/or low juvenile survival rates due to 1) terrestrial habitat loss, 2) nest predation, 3) changes in marine forage base that reduce prey resources, and 4) cumulative effects of multiple smaller impacts (USFWS 2012). Recent monitoring efforts in Washington indicated that only 20 percent of monitored murrelet nesting attempts were successful, and only a small portion of the 158 tagged adult birds actually attempted to nest (13 percent) (Lorenz et al. 2017, p. 312). The low number of adults attempting to nest is not unique to Washington. Some researchers suspect that the portion of non-breeding adults in murrelet populations can range from about 5 percent to 70 percent depending on the year, but most population modeling studies suggest a range of 5 to 20 percent (McShane et al. 2004, p. 3-5). Recent modeling work in Washington suggests that current population declines are consistent with 60 percent of adults breeding each year, on average (Peery and Jones 2019, pp. 14, 25-26).

Murrelet population size and marine distribution during the summer nesting season is strongly correlated with the amount and pattern (large contiguous patches) of suitable nesting habitat in adjacent terrestrial landscapes (Falxa and Raphael 2016, p. 109). The largest and most stable murrelet subpopulations now occur off the Oregon and northern California coasts, where the population trends are positive, while subpopulations in Washington declined at a rate of approximately -3.9 percent per year for the period from 2001 to 2018 (McIver et al. 2020, p. 4). Rates of nesting habitat loss have also been highest in Washington, primarily due to timber harvest on non-federal lands (Falxa and Raphael 2016, p. 37), which suggests that the loss and fragmentation of nesting habitat continues to be an important limiting factor for the recovery of murrelets.

Although there are strong correlations between the amount and distribution of nesting habitat and the total numbers of murrelets at a regional scale (Raphael et al. 2011, p. 45), there are no corresponding data that allow us to accurately enumerate the number of murrelets at the scale of individual stands of murrelet nesting habitat beyond general landscape-scale assessments. Raphael et al. (2002, p. 340) used radar survey data to estimate an average density of more than 370 acres of nesting habitat per murrelet detected in their study on the Olympic Peninsula, indicating very low densities of nesting murrelets at a regional scale in Washington. At the watershed scale, murrelet nest densities estimated from radar range from 0.0027 to 0.033 nests per acre (1 nest per 30 to 370 acres of nesting habitat), while nest densities at the nest patch scale estimated from tree climbing efforts have ranged from 1 nest per 1.7 to 20 acres of nesting habitat (McShane et al. 2004, p. 4-60).

In summary, the number of murrelets present in nearshore marine waters during the nesting season is strongly associated with the amount of nesting habitat in adjacent landscapes. Given the tremendous variability in the density of murrelets at inland nesting sites, we rely on broader landscape-scale habitat relationships to provide an index of habitat effects to murrelet populations. Because we are able to reliably quantify habitat effects, we can reasonably infer how effects to habitat may influence murrelet population dynamics at both local and regional scales. To conclude, there are several key facts that we draw upon in our analysis of effects to murrelet populations:

1. Adult murrelets are long-lived, have high annual survival rates, and have very low reproductive rates. In any given year, a significant portion of the adult population does not nest or attempt to nest. Murrelet population trends are most sensitive to the loss of breeding adults.

2. Breeding rates and reproductive success is very low, and is currently insufficient in Washington to sustain a stable population. Loss and fragmentation of nesting habitat and poor marine foraging conditions are implicated as the primary causes.

3. Murrelet density at inland nesting sites is highly variable. At a regional scale, murrelets occupy nesting habitat at very low densities in Washington (hundreds of acres of nesting habitat per murrelet) but densities can be as high one nest per 1.7 acres at a nest patch scale. Loss of nesting habitat continues to be an important factor limiting murrelet recovery at a regional scale.

In summary, the species' inherently low annual reproductive potential, coupled with a suite of environmental stressors that limit the species productivity, leads us to conclude that the species will continue to experience local population declines in Washington. Protection of existing nesting habitat and reducing past habitat fragmentation effects through the recruitment of new habitat are key to the conservation and recovery of murrelets.

18.1.2 Summary of the Effects of the Action

In addition to insignificant effects, the action is expected to lead to a variety of significant behavioral disruptions to individual murrelets, mainly resulting from edge effects near commercial thinning units and campgrounds, as well as noise disturbance from commercial thinning and other activities. A few activities, such as blasting and low-elevation hovering with large helicopters, are expected to result in direct injury or mortality.

The proposed action is expected to result in direct injury to individuals associated with approximately five nests (one from helicopter rotor wash, and four from blasting), associated with 1,440 acres of suitable habitat exposed to these stressors at close distances, over a period of ten years. At the nest affected by rotor wash, we expect that only the nestling would be affected, as the adult would presumably flush in order to preserve its own life and future reproductive possibilities. At the nests affected by blasting, if an adult is present at the time of the blast, it is possible that both one adult and one nestling could be affected simultaneously.

Individual nestlings affected by helicopter rotor wash are likely to die outright, either from being struck by a blown limb or by being flung from the nest. Less serious injuries are also possible, for example, contusions occurring due to smaller pieces of vegetation being flung into the murrelet nest, but without knocking the nestling off of the platform. However, we assume that nest failure resulting from the death of the nestling is the most likely outcome if a murrelet nest is exposed to rotor wash.

Hearing injuries from blasting are likely to be less serious, because the hearing damage occurs via hair cell loss, and birds are known to regenerate hair cells, which restores the lost hearing capability. It is not known how quickly or completely hearing may be restored, however, and during the period of reduced hearing capabilities, murrelets are likely to be less able to communicate with conspecifics and coordinate activities such as care for nestlings and foraging. The ability to detect and avoid predators may also be affected. Therefore, hearing damage likely confers at least a temporary reduction in the likelihood of survival and reproductive success for the affected birds.

All other effects of the action, which are expected to affect 113 nests, will have the consequence of reducing nesting success. Nest failure is not expected to result in every case, but the risk of nest failure will be increased. Noise and visual disturbance lasting longer than a day during the nesting season will disrupt nest establishment, increase the probability of nest abandonment, and result in missed feedings for the nestling, all decreasing the likelihood of successful fledging, for approximately 13 nests associated with 4,062 acres, over the course of 10 years. Edge effects associated with commercial thinning and campgrounds will increase nest predation risk, and edge effects of commercial thinning will also result in changes in microclimate and loss of individual nest trees to windthrow. Annually, these stressors are expected to affect approximately 5 nests associated with 1,741 acres near campgrounds and dispersed campsites, and 5 nests associated with 1,883 acres adjacent to thinning units. Because these effects are expected to continue for ten years, they are expected to affect a total of 100 nests over 10 years. All of these edge effects will also decrease the likelihood of successful fledging.

The proposed action includes the vast majority of activities that are likely to occur on the ONF over the next ten years, and that may have an adverse effect to murrelets. Conservation measures incorporated through coordination between the Forest Service and the USFWS help to minimize what would otherwise be much greater effects to murrelets on the ONF.

18.1.3 Effects to Reproduction, Numbers, and Distribution at the Scale of the Action Area

As discussed above, most of the effects of the action involve reductions in nesting success. Except in the case of nestling mortality from helicopter rotor wash, this does not mean that nests will definitely fail, but that the chance of successful fledging, which is already likely to be low, will be reduced further by the effects of the action. For example, a previous review of literature has found that in general, murrelet nest success in interior forest stands was 54 percent, whereas nest success along managed forest edges was 38 percent (McShane et al. 2004, p. 4-89). True nest success rates in the action area are not known, since the only data comes from a radio telemetry study that may be biased toward lower nest success rates. However, given that the nest success rates measured by radio telemetry were as low as 20 percent (Lorenz et al. 2017, p. 312), true nesting success in the action area may well be far lower than 54 percent even in the most intact and undisturbed blocks of interior habitat. Noise and visual disturbance and edge effects near commercial thinning units and campgrounds reduce nesting success further.

Over the next ten years, an average of approximately 11 or 12 murrelet nests are expected to be affected by reduced nesting success annually, and in one additional case, nest failure is the expected outcome. This estimate assumes the worst case scenario that all commercial thinning will occur during the first year of implementation, and that edge effects from commercial thinning continue for ten years. Realistically, the number of nests affected is likely to be lower, but effects will continue for up to ten years following the end of the term of the action, because edge effects resulting from commercial thinning in the latter years of the action are expected to linger for 10 years after that. Also, to conduct a reasonable worst case analysis, this estimate is based on the assumption that murrelet nests will occur at high densities of one per 370 acres in each of the 10 years of the action.

Assuming that murrelet nests occur at a density of one per 370 acres, the 11 or 12 murrelet nests affected with reduced nesting success each year make up around two percent of the 558 murrelet nests present in the action area. If we assume a lower density of nests, we would expect a proportionately lower number of murrelets to be affected. For example, in the environmental baseline, we estimated a minimum number of 22 nests present on the ONF, though we concluded that the true number was probably greater. If we assumed that only 22 nests were present annually on the ONF, then we might anticipate effects to a total of 5, rather than 113, murrelets over 10 years. This is because the nest density would then be less than one nest per 9,364 acres.

The proposed action, for the most part, represents a continuation of the current program of activities carried out by the ONF. To the extent that this is true, the reduction in nest success resulting from the action is already reflected in the current low nest success rates. The proposed action does incorporate a 25 percent increase in commercial thinning, as compared with the last 10 years. Commercial thinning is expected to reduce the success of approximately 56 nests over 10 years, and if this represents 125 percent of previous commercial thinning effects, then the reduced success at 11 or 12 of these nests would not have been reflected in the baseline low levels of nesting success. This amounts to one or two additional nests affected each year, and a one percent increase in the overall effects of the action on reproductive success, relative to those effects already represented in the baseline rates of nest success.

Reductions in nest success, along with direct mortality, reduces the number of murrelets associated with the action area. Although we do not know true nest success rates, we can use the comparison between 54 percent success rates in interior forest and 38 percent success rates along managed forest edges as an example of how this effect to numbers will work. For illustration, assume that all 558 nests in the action area would have 54 percent nest success rate if all of the ONF programmatic activities were to cease, producing 301 fledglings per year (558 * 54 percent). If we consider a year when the single anticipated helicopter rotor wash mortality occurs along with 10 other nest exposures to disturbance and edge effects, we would expect 547 nests to have 54 percent nest success rates, 10 nests to have 38 percent success rates, and one nest to certainly fail. In this case, nests in the action area would produce 299 fledglings (547 * 54 percent plus 10 * 38 percent plus 1 * 0 percent). Over a ten-year period, on average, 3,013 murrelets would fledge in the action area without the effects of the action, and 2,995 murrelets would fledge in the action area with the effects of the action, a difference of 18 fledglings, or less than one percent. Considering that post-fledging mortality is higher than adult mortality, the difference in the number of surviving adults produced in the action area over ten years, with and without the effects of the action, is negligible. Additionally, as noted above, nearly all of the effect to numbers is already reflected in the baseline population trend, because these activities are already occurring, except for a portion of the proposed commercial thinning.

Again, these estimates are based on a high estimate of murrelet nest density on the ONF, and hypothetical nest success rates that are likely higher than the true nest success rates. Estimates based on lower nest density and lower nest success rates would likely portray a smaller effect to murrelet numbers on the ONF, at least in absolute magnitude, because the maximum number of fledglings that could be produced would be much smaller. In percentage terms, we would expect the effects to be similar to those outlined above.

We do not expect that the proposed action will affect the distribution of murrelets within the action area for the following reasons: 1) although the project will result in some limited, local degradation of murrelet nesting habitat through the loss of individual trees, the project would not result in the loss of any stands of murrelet nesting habitat; and 2) we do not expect murrelet occupancy at the scale of individual stands to be reduced over time as a result of the proposed action. Effects are expected to be concentrated near the system of roads and trails, but this is not expected to change patterns of murrelet usage of nest sites. The road and trail system already exists, and any effects it might have on murrelet distribution are already included in the baseline.

18.1.4 Integration of Effects to the Murrelet Populations in Conservation Zones 1 and 2

The ONF occurs in both Conservation Zones 1 and 2, and murrelets cannot be reliably assigned to Zone 1 or Zone 2 based on the location of their nesting habitat. Populations in Zone 1 and Zone 2 have declined over the past two decades, though only the Zone 1 decline was statistically significant at the 95 percent confidence level. The murrelet population in Conservation Zone 1 in 2018 was estimated at 3,843 murrelets (95 percent confidence interval = 1,937– 6,901). The murrelet population in 2019 in Conservation Zone 2 was estimated at 1,657 murrelets (95 percent confidence interval = 745 – 2,752) (McIver et al. 2020, pp. 8-17, Felis et al. 2020, p. 7). The combined Washington population included an estimated 5,551 murrelets in 2018 (95 percent confidence interval = 2,795 – 8,307) (McIver et al. 2020, p. 16). Due to the nature of the survey protocol and seasonal variation in the distribution of murrelets, there is a high level of variation in the annual population estimates. Despite this annual variation, the monitoring surveys indicate the murrelet population in Conservation Zone 1 declined at an average rate of 4.8 percent per year for the period from 2001 to 2018 (McIver et al. 2020, p. 18). This trend is statistically significant, with confidence limits that do not overlap zero (-7.3 to -2.4 percent decline per year). Conservation Zone 2 declined at an average annual rate of 2.2 percent for the period from 2001 to 2019 (McIver et al. 2020, p. 18), but the confidence interval overlaps zero (-5.8 to 1.5), indicating that there is substantial uncertainty as to whether the Zone 2 population is declining, stable, or increasing. In combination, the two Washington Conservation Zones showed a statistically significant decline of 3.9 percent per year between 2001 and 2018 (95 percent confidence interval = -5.6 to –2.1) (McIver et al. 2020, p. 18).

As described above in the Environmental Baseline, there are currently over 206,500 acres of suitable murrelet nesting habitat on the ONF, and we expect ONF lands could provide nesting habitat for 29 percent of the total murrelet population nesting on the Olympic Peninsula and 1.9 percent of the total estimated habitat in Washington State. Habitat on National Forest lands is considered essential for the long-term recovery of murrelets (USFWS 1997), and we expect that the conservation provided by reserved land use allocations designated under the NWFP will continue to provide a high level of protection to the majority of the species' habitat on the ONF.

The habitat on the ONF may have a disproportionate conservation value for Washington murrelets, relative to murrelets in other parts of the state. This is because estimates of murrelet nesting density on the Olympic Peninsula around 20 years ago, in combination with Washington murrelet population estimates from the same timeframe, imply that around a quarter of Washington's murrelets may have been associated with the ONF at that time. Given that some stressors affecting murrelets, such as habitat loss and distance from marine waters, are lower on the ONF than they are elsewhere, this disproportionate association of murrelets with the ONF is likely to have continued or perhaps even magnified in the intervening years.

18.1.4.1 Murrelet Reproduction

As described above, we expect the effects of the programmatic actions are likely to result in an incremental reduction in murrelet nesting success and reproduction in the action area. We consider any loss of murrelet reproduction to be significant, because the murrelets current reproduction rates are far below levels needed for a stable population. Murrelet populations in Washington are declining rapidly because nesting rates for breeding age adults are low and nest failure rates are high. Although we expect there will likely be some reduced nesting success, the level of lost reproduction due to programmatic actions is not expected to have a discernible effect on the likelihood or persistence at the scale of the populations in Conservation Zones 1 and 2.

As described above, the current murrelet population estimate for Conservation Zones 1 and 2 is approximately 5,551 murrelets. The total number of adult murrelets that attempt to nest in any given year is variable, and the overall nest success rates are variable and generally very low. Considering the variable response of murrelets to noise and visual disturbance and increased predation (i.e., disturbance is not expected to lead directly to failure of most exposed nests) and limited areas exposed to disturbance (approximately two percent of the available habitat on the ONF, annually), the incremental loss of reproduction anticipated will not be detectable and is not expected to increase the present rates of observed population declines in Conservation Zones 1 and 2.

The programmatic actions covered in this consultation are ongoing, routine management actions associated with the existing footprint of the ONF road and trail system, and a 25 percent increase in commercial thinning in plantations that do not provide suitable habitat. Therefore, current low rates of nesting success already capture most of the effect of the action on reproduction. Similarly, the cumulative effects associated with increased corvid populations near human settlements represent an ongoing effect that is reasonably certain to continue, and therefore the cumulative effects to reproduction are already reflected in current low levels of reproduction.

Although the actions are likely to result in an incremental loss of reproduction, these losses are not anticipated to appreciably reduce the likelihood of survival and recovery through a significant reduction in murrelet reproduction. This conclusion is supported by our finding that no direct mortality to adult breeding murrelets is anticipated; therefore, there would be no reduction in the existing potential breeding population at the scale of the action area and Conservation Zones 1 and 2, or rangewide.

18.1.4.2 Murrelet Numbers

In the above analysis, we estimated an annual total of approximately 4,186 acres of murrelet nesting habitat will be exposed stressors, such as noise and visual disturbance and edge effects that will lead to significant effects. This represents about two percent of the total available murrelet habitat on the ONF, and less than one percent of the available murrelet habitat on the Olympic Peninsula. This is a cumulative total comprised of many small-scale actions distributed primarily along the existing network of roads and trails. Most of these effects are expected to result in the disruption of normal nesting behaviors, but are not expected to result in direct nest failures. Therefore, most effects to murrelet numbers will be mediated through effects to reproduction.

We also anticipate direct mortality of one nestling due to helicopter rotor wash. Any mortality of murrelets is of serious concern because murrelet populations across the listed range of the species are declining rapidly. Although adult murrelets have high annual survival rates, murrelets suffer high rates of nest failure due to nest predation and starvation of young, even in pristine habitats located far from human disturbance. The current murrelet population estimate for Conservation Zones 1 and 2 is approximately 5,551 murrelets. The direct loss of a nestling is similar in effect to the reduction in nesting success, but rather than nesting success being reduced incrementally, in the case of the nest exposed to rotor wash, success will be reduced to zero for the year.

Our analysis of the effects of the action to numbers within the action area indicates that the effects of the action are likely to reduce the number of fledglings produced on the ONF by at most 18 individual fledglings over 10 years, and the change in the number of fledglings is expected to be less than one percent. As noted above, many of these fledglings would not have survived to adulthood regardless, so the difference in adult population resulting from the action will be smaller still. Any reduction in Washington's murrelet populations resulting from this action will not be detectable using currently available population monitoring techniques, given that the confidence intervals are far wider than any potential change in population.

18.1.4.3 Murrelet Distribution

We do not expect that the proposed action will affect the distribution of murrelets within either the action area or Conservation Zones 1 and 2 for the following reasons: 1) although the project will result in some limited, local degradation of murrelet nesting habitat through edge effects and the loss of individual trees, the project would not directly result in the loss of any stands of murrelet nesting habitat; and 2) we do not expect murrelet occupancy at the scale of individual stands to be reduced over time as a result of the proposed action. The essential conservation role of the ONF to provide for murrelet survival and recovery will not be reduced or diminished by this action. Therefore, the proposed action is not expected to affect the distribution of murrelets in the action area, Conservation Zones 1 and 2, or within the listed range of the species.

Given the above analysis, we conclude that the adverse effects to murrelets that would result from the proposed actions will not contribute to an appreciable reduction in the likelihood of survival and recovery of the murrelet in the wild by reducing murrelet numbers, reproduction, or distribution, at the scale of the ONF, Conservation Zones 1 and 2, or within the listed range of the species.

19 CONCLUSION: Marbled Murrelet

After reviewing the current status of the marbled murrelet, the environmental baseline for the action area for the marbled murrelet, the effects of the proposed action and the cumulative effects, it is the USFWS's opinion that the activities covered in this 10-year programmatic consultation, as proposed, is not likely to jeopardize the continued existence of the marbled murrelet.

20 EFFECTS OF THE ACTION: Marbled Murrelet Critical Habitat

Effects of the action are all consequences to 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. (See § 402.17).

When the USFWS evaluates the effects of a proposed action within critical habitat, we analyze the impacts to individual CHUs in light of their overall contribution to the survival and recovery of murrelets within the individual Conservation Zones, and within the overall range of the murrelet in Washington, Oregon, and California. We do this by analyzing the effects projects are likely to have on the PCEs of the critical habitat, which represent specific physical and biological features that are essential to the conservation of the species and may require special management considerations or protection. The PCEs of murrelet critical habitat include (1) individual trees with potential nesting platforms and (2) forested areas within 0.8 kilometer (0.5 mile) of individual trees with potential nesting platforms that have a canopy height of at least one-half the site potential tree height. This includes all such forest, regardless of contiguity (76 FR 61604).

As described in the *Environmental Baseline*, there are approximately 411,989 acres of murrelet critical habitat in the ONF, with an estimated 167,095 acres of this currently suitable murrelet nesting habitat. If we assume that all critical habitat that is currently categorized as suitable habitat meets the definition of PCE2, at least 41 percent of critical habitat contains PCE2. In addition, non-suitable forested habitat within 0.5 mile of SNTs also meets the definition of PCE2, and given the distribution of SNTs throughout areas of critical within the action area, much more than 41 percent of the critical habitat is likely to contain PCE2.

The ONF proposes to remove a total of 930 SNTs that meet the definition of PCE 1 and up to 1,000 large trees that are not SNTs within PCE 2. According to the 2019 BA, the ONF proposes to thin 16,000 acres of forest stands within designated critical habitat. Approximately 900 acres containing PCE 1 are within or immediately adjacent to thinned stands. Up to 8,405 acres of proposed thinning treatments are in stands that meet the definition of PCE 2 within critical habitat (USFS 2019 [BA], pp.14-15).

20.1.1 <u>Direct Effects – Felling of Trees with Potential Nesting Platforms</u>

20.1.1.1 Removal of PCE 1s

The ONF has identified that about 930 PCE 1 (SNTs) will be removed over the life of the programmatic consultation. There are multiple programs that will result in the removal of SNTs. However, the vast majority of SNTs to be removed during the life of this programmatic will be associated with the hazard/danger tree program (Table 27).

Removal of a PCE 1 is an adverse effect to critical habitat due to the loss of trees with platforms suitable for murrelet nesting. Loss of suitable nest trees eliminates opportunities for future nesting in these trees and represents a significant reduction in the conservation value of the habitat for murrelet recovery, at the forest stand scale, given that murrelets have high fidelity to stands containing SNTs, or even to individual SNTs themselves. Nesting murrelets on the Olympic Peninsula have been documented using the same nest platform in subsequent years (Bloxton and Raphael 2009, pp. 11-12). A recent study on the re-use of nest trees in British Columbia reported that 26 of 143 nest trees (18 percent) showed evidence of re-nesting (Burger et al. 2009, p. 217). Fidelity to individual trees for nesting was more common in landscapes that had highly fragmented nesting habitat, and less common in landscapes with large tracts of suitable nesting habitat (Burger et al. 2009, p. 222).

Table 27. Number of PCE 1s anticipated to be removed, by program, during this 10-year programmatic consultation.

Program	Approx. trees per 10 years
Trail Bridge/Foot Log Construction, Reconstruction, and Removal	30
Expansion of Trailheads and Campgrounds	30
Hazard/Danger Tree Removal	500
Commercial Thinning	100
Road Construction/Reconstruction and Landings for Commercial Thinning	100
Forest Health including Campgrounds	35
Storm-proofing and Road Drainage Upgrading	30
Road Use and Access Permits	20
Communication Site Permits	15
Rock Pit Expansion and Development	20
Lands and Special Use Permits, Tailhold Permits	30
Tribal Requests	20
Total	930

The ONF is unable to predict the location of SNTs that will need to be felled; therefore, our reasonable worst-case assumption is that all SNTs may be removed from critical habitat. Many hazard trees that meet the definition of SNTs are likely to provide reduced value for murrelet nesting due to their close proximity to campgrounds and roads, in terms of nesting success rates, but this does not mean that murrelets will not use these SNTs. Another ameliorating factor is the expectation that the majority of PCE 1s to be removed will be individual trees and not entire stands. Suitable nesting habitat on the ONF contains hundreds of thousands of SNTs. The number of SNTs per acre varies widely depending on stand characteristics. Hamer (1995, p. 171) assessed stand characteristics at occupied murrelet sites in Washington and noted that large trees (greater than or equal to 30 inch dbh) occurred at densities ranging from 72 to 220 trees per acre. Therefore, it is unlikely that removal of individual PCE 1s will measurably reduce the conservation value of critical habitat at the action area or unit scales.

20.1.1.2 Effects to PCE 1 from Removal of PCE 2

In addition to the removal of 930 SNTs, the ONF will remove trees within PCE 2. We assume that all 1,000 of the non-platform trees at least 18 inches dbh, and the 60 acres of trees removed under the Road Use and Access program, and 5 acres of forest stands that will be affected by commercial thinning and associated activities would be removed within PCE 2, given that the locations of these trees are not currently known and a large proportion of the landscape meets the definition of PCE 2. In addition, an unknown number of trees less than 18 inches dbh may be felled within PCE 2. Also, 8,405 acres of PCE 2 will be thinned or are located immediately adjacent to thinned stands.

The ONF anticipates 60 acres of land will be converted from forest to road under the Road Use and Access Permit program over the life of the programmatic. In addition, 5 acres of PCE 2 associated with commercial thinning and associated activities would be removed. Approximately 20 permits per year are anticipated. The likelihood and magnitude of adverse effects to PCE 1s from the conversion of PCE 2 to roads is difficult to assess programmatically. A reasonable worst case assumption is that of all PCE 2 removal (65 acres) will be close enough to PCE 1s to adversely affect critical habitat through microclimate changes to nest platforms, and removal of visual cover required for predator protection. However, it is unlikely that the removal of individual trees or small patches of PCE 2 from actions in this programmatic will measurably reduce the conservation value of critical habitat at the action area, subunit, CHU, or rangewide scales.

As described in detail under the *Effects to Murrelets*, we anticipate there will be some habitat degradation associated with edge effects from changes in microclimate conditions, scattered windthrow, and predation risk adjacent to commercial thinning stands.

Activities associated with commercial thinning will alter existing closed-canopy edges between thinning stands and the adjacent old-growth forest, degrading 3,765 acres containing PCE 1 located adjacent to commercial thinning activities. We do not expect that the thinning treatments proposed in this project will increase edge effects to the same extent as a clearcut edge. Conservation measures that include avoiding placement of gaps, permanent roads, and most temporary roads immediately adjacent to old growth forest or potential nest trees will minimize the magnitude of created "hard" edges in thinning stands within critical habitat. However, we recognize that there is a potential for a short-term increase in predation risk, microclimate changes, and some scattered windthrow along old-forest edges where adjacent thinning treatments reduce canopy cover to less than 50 percent. Canopy cover in thinned stands is expected to increase at a rate of about 1 to 2 percent per year (Chan et al. 2006, p. 2696), so edge effects associated with proposed thinning should diminish over a period of approximately 10 to 15 years.

20.1.1.3 Effects to PCE 2 – Forested Areas Adjacent to Trees with Potential Nesting Platforms

The ONF proposes to thin 8,405 acres of young forest stands (PCE 2) in critical habitat that provide closed-canopy microclimate and visual cover required for predator protection within 0.5 mile of PCE 1. Forest canopy cover would be reduced to no less than 40 percent. As described above, we anticipate there will be some habitat degradation associated with edge effects from changes in microclimate conditions, scattered windthrow, and predation risk adjacent to commercial thinning stands. The most significant effects to critical habitat function occur where thinning reduces canopy cover to less than 50 percent within a distance of 55 yards from old-forest edges. The proposed thinning will alter existing closed-canopy edges between thinning stands and the adjacent old-growth forest within murrelet critical habitat where the "buffer" function provided by adjacent forest is reduced.

Conservation measures that include avoiding placement of gaps, permanent roads, and most temporary roads immediately adjacent to old-forest edge will minimize the magnitude of microclimate changes in adjacent stands (which also meet the definition of PCE 2), but the reduction in canopy cover is likely to degrade habitat conditions in the adjacent stands for up to a decade or more until canopy cover in the thinned stands recovers to 60 percent or more. The USFWS recognizes the potential benefits of thinning in younger forests as an important recovery action to increase the rate at which murrelet habitat develops (USFWS 1997, p. 144). We anticipate the proposed action will result in minor short-term habitat effects, and long-term beneficial effects related to recruitment of future habitat in the action area.

20.1.1.4 Effects to Marbled Murrelet Critical Habitat Subunits

As stated in the Environmental Baseline, the ONF contains multiple Critical Habitat Subunit (CHSUs) encompassing 411,989 acres. About 41 percent of these acreage within CHUs (167,095 acres) is currently categorized as suitable habitat, as calculated using landscape-scale habitat models developed for the NWFP (Raphael et al. 2016). The proposed action includes 16,000 acres of thinning treatments in critical habitat that will promote the development of large trees and multi-storied stand structure in the treated stands. This represents less than four percent of the total area in the CHSUs. As described above, we anticipate there will be a minor degradation of murrelet habitat adjacent to thinning stands. In the context of forest successional processes, these effects will be short-term (10 to 15 years), and will rapidly diminish as thinned stands recover.

The USFWS recognizes the potential benefits of thinning in younger forests as an important recovery action to increase the rate at which murrelet habitat develops (USFWS 1997, p. 144). We anticipate the proposed action will result in minor short-term habitat effects, and long-term beneficial effects related to recruitment of future habitat in the action area, which is a subset of the larger CHUs. The conservation role of these CHUs to provide large blocks of nesting habitat will be maintained in the short-term, and will be improved in the long-term by promoting development of late-successional forest in the CHUs.

21 CUMULATIVE EFFECTS: Marbled Murrelet Critical Habitat

Cumulative effects include the effects of future state or private activities, not involving federal activities 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. As discussed in the environmental baseline, forest management activities on state and private lands within the action area are associated with HCPs, and therefore do not result in cumulative effects.

Cumulative effects in the action area may occur at home sites or from other non-forest management activities at just outside of ONF, or in inholdings. Human settlement and other human activity often provides food subsidies to corvids and other murrelet nest predators. This has the effect of increasing populations of nest predators and therefore increasing nest predation, and this effect spreads from the settled areas to nearby forested landscapes. Elevated densities of nest predators associated with cumulative effects reduce the conservation value of nearby critical habitat.

22 INTEGRATION AND SYNTHESIS OF EFFECTS: Marbled Murrelet Critical Habitat

We established in the environmental baseline that during the time period covered by a previous programmatic (2003 to 2011), up to 247 PCE 1s were removed (it is unknown how many PNTs removed were PCE 1), according to monitoring reports submitted the USFWS from the ONF. We are unable to calculate the acreage of PCE 2 that was removed during this time period. Under the 2013-2023 programmatic consultation with the ONF (USFWS 2013), a total of 35 SNTs for murrelets were removed between 2013 and 2019. Twenty-eight of the 35 SNTs were in critical habitat, and therefore constituted removal of PCE1 (Holtrop, K. in litt. 2020).

The Murrelet Critical Habitat Database (real-time database) indicated that only 17 acres of suitable habitat (with an unknown number of PCE 1s) and 46 acres of PCE 2 outside of suitable habitat have been removed in all of Conservation Zones 1 and 2 on federal land since implementation of the database (May 15, 2020).

Under the proposed action, we estimated that 930 individual SNTs, up to 60 acres of forested stands containing PCE 2 associated with the Road Use and Access Permit program would be removed, 5 acres of PCE 2 associated with commercial thinning and associated activities would be removed, and the proposed action includes 16,000 acres of thinning treatments in critical habitat. Approximately 900 acres containing PCE 1 are within or immediately adjacent to thinned stands. Up to 8,405 acres of proposed stand treatments meet the definition of PCE 2.

Our reasonable worst case assumption is that all 930 SNTs are within CH, and therefore are PCE 1s, and all removal of forested stands (65 acres) will be within CH and close enough to PCE 1s to meet the definition of PCE 2. Furthermore, we assume that all PCE 2 to be removed will be close enough to PCE 1s to create adverse effects to critical habitat through microclimate changes to nest platforms, and removal of visual cover required for predator protection.

We anticipate there will be some minor habitat loss and degradation associated with edge effects (windthrow, micro-climate, and fragmentation) to designated murrelet critical habitat PCEs that are located within a distance of 328 ft (100 m) of recently harvested areas on adjacent private timber lands.

We do not expect the proposed removal or degradation of PCEs would impair the ability of the CHUs to provide for the conservation of the murrelet. The ONF contains multiple CHSUs encompassing 411,989 acres. About 41 percent of this acreage within CHUs (167,095 acres) is currently categorized as suitable habitat, as calculated using landscape-scale habitat models developed for the NWFP (Raphael et al. 2016). The 167,095 acres of murrelet critical habitat on the ONF currently categorized as suitable habitat contain hundreds of thousands of PCE1. The 65 acres of critical habitat PCE2 removed represents less than 0.1 percent of the total critical habitat on the ONF and a significantly smaller percent of the critical habitat available in CHSUs in Washington. The expected removal of 930 SNTs, which we assume are all PCE1, similarly represents significantly less than 1 percent of the hundreds of thousands of PCE1 available on the ONF. CHUs for the murrelet encompass approximately 3.9 million acres across Washington, Oregon, and California (61 FR 26256 [May 24, 1996]). The scale of effects associated with the actions covered by this programmatic, taking into account ongoing effects of other, previously consulted-upon actions and the cumulative effects, are not expected to reduce the conservation value of critical habitat at the CHU or rangewide scales, given the amount and condition of critical habitat on the ONF.

Additionally, the USFWS recognizes the potential benefits of thinning in younger forests as an important recovery action to increase the rate at which murrelet habitat develops (USFWS 1997, p. 144). We anticipate the proposed action will result in minor short-term habitat effects, and long-term beneficial effects related to recruitment of future habitat in the action area.

Critical habitat within this Conservation Zone, and all other Conservation Zones would remain functional or retain its current ability to become functional to meet the conservation needs of the species.

23 CONCLUSION: Marbled Murrelet Critical Habitat

After reviewing the current status of the marbled murrelet critical habitat, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the USFWS's opinion that the activities covered in this 10-year programmatic consultation, as proposed, are not likely to destroy or adversely modify designated marbled murrelet critical habitat.

24 BIOLOGICAL OPINION – BULL TROUT AND BULL TROUT CRITICAL HABITAT

25 STATUS OF THE SPECIES: Bull Trout

25.1 Status of the Species Rangewide

The bull trout was listed as a threatened species in the coterminous United States in 1999. Throughout its range, the bull trout is threatened by the combined effects of 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 [Nov. 1, 1999]). 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, 2015b, p. iii).

The 2015 recovery plan for bull trout identifies six recovery units of bull trout within the listed range of the species (USFWS, 2015b, p. 34). Each of the six recovery units are further organized into multiple bull trout core areas, which are mapped as non-overlapping watershed-based polygons, and each core area includes one or more local populations. Within the coterminous United States we currently recognize 109 currently occupied bull trout core areas, which comprise 600 or more local populations (USFWS, 2015b, p. 34). 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.

The USFWS has also identified a number of marine or main-stem riverine habitat areas outside of bull trout core areas that provide foraging, migration, and overwintering (FMO) habitat that 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, 2015b, p. 35).

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

25.1.1 Coastal Recovery Unit

The Coastal Recovery Unit (RU) 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 life history form, unique to the Coastal RU. The Coastal RU 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 RU, 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 RU 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 bull trout population and has been used as a donor stock for re-establishing the Clackamas River population (USFWS, 2015a, p. A-6).

25.1.2 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]). 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). In the Elwha River core area (Strait of Juan de Fuca), internal connectivity is being restored. Most core areas in this region still have their headwater habitats within relatively protected areas (Olympic National Park and wilderness areas), though the steep geomorphic structure of the Olympic Peninsula creates numerous natural waterfall barriers to some of these headwater habitats (USFWS, 2015a, p. A-7).

25.1.3 Changes in Status of the Olympic Peninsula Region

For core areas connected to the Strait of Juan de Fuca and Hood Canal, the recently completed regional salmon recovery plan under the Shared Strategy for Puget Sound and plan implementation by watersheds under the Puget Sound Partnership has resulted in general habitat improvements for bull trout in core areas. However, actions to date (e.g., land acquisition, floodplain restoration, culvert removal, riparian revegetation, levee setbacks, and road removal) have generally been focused on Puget Sound Chinook salmon. The Washington Forest Practices HCP has provided additional fish habitat protections in forested upland habitats, with improved forestry practices and road maintenance (FFR 1999; WFPB 2001).

Within the Elwha River core area, the Elwha and Glines Canyon Dams had blocked upstream anadromous salmonid access to 70 miles (113 km) of bull trout habitat on the Olympic Peninsula for nearly 100 years. In 2014, with the nearly completed removal of the Glines Canyon Dam, bull trout (potentially anadromous) began to return to the upper watershed with the reopening of migratory corridors and flushing of accumulated sediments (The News Tribune, in litt. 2014). The relicensing agreement with Tacoma Power for the Cushman Hydroelectric Project in 2010 (Skokomish River core area) is expected to significantly improve connectivity for upstream and downstream migrating bull trout as well as conserve important habitats for this species once license articles are fully implemented. In addition, the restoration of fish passage will reintroduce anadromous salmon into the upper North Fork Skokomish River Basin.

In addition, active, ongoing partnerships such as the Puget Sound Partnership (PSP 2014) and Puget Sound Nearshore Ecosystem Restoration Project, as well as the USFWS's own Coastal Land Acquisition program are contributing to bull trout recovery through identification and implementation of projects that protect and restore important nearshore marine FMO habitats used by bull trout or their preybase (e.g., salmon, surf smelt, and herring) in this region.

26 STATUS OF DESIGNATED CRITICAL HABITAT: Bull Trout

Bull trout critical habitat was designated in the coterminous United States in 2010. 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. Overall bull trout abundance is "stable" range-wide (USFWS, 2015b, 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, 2008a, p. 22; USFWS, 2015a, p. 2). In addition, 23 core areas have declining populations, with 66 core areas having insufficient information (USFWS, 2008a, p. 22; 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 contribute to degraded the PCEs, 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. 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; 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 K: Status of Bull Trout Critical Habitat.

26.1 Conservation Role and Description of Bull Trout Critical Habitat

The Olympic Peninsula and Puget Sound CHUs are essential to the conservation of amphidromous bull trout, which are unique to the Coastal-Puget Sound population segment. These CHUs contain marine nearshore and freshwater habitats, outside of core areas, that are used by bull trout from one or more core areas. These habitats, outside of core areas, contain PCEs that are critical to adult and subadult foraging, overwintering, and migration.

26.1.1 Primary Constituent Elements of Bull Trout Critical Habitat

The final revised rule designating bull trout critical habitat (75 FR 63898 [October 18, 2010]) identifies nine Primary Constituent Elements (PCEs) essential for the conservation of the species. The 2010 designation of critical habitat for bull trout uses the term PCE. The new critical habitat regulations (81 FR 7214) replace this term with physical or biological features (PBFs). This shift in terminology does not change the approach used in conducting our analyses, whether the original designation identified PCEs, physical or biological features, or essential features. In this letter, the term PCE is synonymous with PBF or essential features of critical habitat.

Within the designated critical habitat areas, the PCEs 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 following PCEs are essential for the conservation of bull trout.

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 (36 °F to 59 °F), 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.

27 ENVIRONMENTAL BASELINE: Bull Trout And Bull Trout Critical Habitat

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

The proposed program of actions in this consultation mostly occurs outside of the wetted width of bull trout habitat and critical habitat, but some actions are anticipated to have indirect effects to bull trout and bull trout critical habitat. On land, the action area includes all of the 632,300 acres of lands managed by the Forest Service located within the administrative boundary of the ONF, which include the Pacific and Hood Canal Ranger Districts located entirely on the Olympic Peninsula in northwestern Washington. In bull trout habitat, the action area includes 132.1 miles of known occupied bull trout habitat within ONF's boundaries, plus all main-stem bull trout habitat downstream of ONF boundaries to a sediment sink such as the Pacific Ocean or a large lake (such as Lake Quinault). The distribution of bull trout habitat within and adjacent to the ONF is presented in Table 28. In core areas, the critical habitat designation is the best available information for known occupied bull trout distribution. In non-core areas, the best available information for the distribution of bull trout is from areas identified as key bull trout recovery habitat in the bull trout recovery plan (USFWS, 2015). In bull trout critical habitat, the action area includes 86.2 miles of bull trout critical habitat within ONF's boundaries, and all main-stem bull trout habitat downstream of ONF boundaries to a sediment sink such as the Pacific Ocean or a large lake (e.g., Lake Quinault). The distribution of bull trout critical habitat within and adjacent to the ONF is presented in Table 29.

Table 28. Distribution of bull trout habitat on the Olympic Peninsula and on the ONF.

Core Area 4th Field Watershed	Total miles on the Olympic Peninsula[1]	Miles on the ONF[1]
Dungeness River	39.8	19.1
Elwha River	67.7	1.4
Hoh River	98.1	1
Queets River	146.6	21.8
Quinault River	92.0	5.2
Skokomish River	73.9	30
Total	**518.1**	**78.5**
Non-Core Watershed (FMO[2] only)		
Morse, Siebert, Ennis Rivers	15.9	0
Raft River	9.0	0
Humptulips River	103.6	37.1
Wishkah River	56.6	0
Wynoochee River	50.9	5.6
Satsop River	55.1	3.8
Dosewallips River	47.9	7.1
Total	**338.9**	**53.6**
Grand Total	**857.0**	**132.1**

[1] Shorelines of lakes and reservoirs were included in the calculation for total miles but were not included in the calculation for miles on the ONF because the analysis in this Opinion is focused on streams.

[2] 'FMO' is an abbreviation for foraging, migration, and over-wintering.

Table 29. Distribution of designated critical habitat (CH) for bull trout on the Olympic Peninsula and in ONF.

4th Field Watershed	Total miles of CH[1]	Miles of CH on ONF[1]
Dungeness River	39.8	19.1
Elwha River	67.7	1.4
Hoh River	98.1	1.0
Queets River	146.6	21.8
Quinault River	92.0	5.2
Skokomish River	73.9	30
Wynoochee River	50.9	5.4
Satsop River	43.7	2.3
Total	**612.7**	**86.2**

[1] Shorelines of lakes and reservoirs were included in the calculation for total miles but were not included in the calculation for miles on the ONF because the analysis in this Opinion is focused on streams.

27.1 Status of Bull Trout Critical Habitat in the Action Area

In bull trout critical habitat, the action area includes 86.2 miles of bull trout critical habitat within ONF's boundaries, and all main-stem bull trout habitat downstream of ONF boundaries to a sediment sink such as the Pacific Ocean or a large lake (e.g., Lake Quinault). That action area includes most of the Coastal RU. The Coastal RU is essential to the conservation of bull trout because populations are significantly different at the mitochondrial DNA level from the four RUs east of the Cascade Range and at the microsatellite DNA level from the Klamath RU; in the Olympic Peninsula and Puget Sound areas, they are almost completely isolated from other RUs and are partially isolated from other RUs in the lower Columbia River; some populations within this RU exhibit amphidromous (move to and from salt water from fresh water) life history form; they co-occur with Dolly varden (*Salvelinus malma*) in the northern portion of the RU and coastal populations of anadromous salmonids elsewhere; they occur in a coastal climate and vegetative condition west of the Cascade Range, 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. The most current information on the status of bull trout critical habitat in the Coastal RU, and therefore the action area, is included in the Bull Trout Final Critical Habitat Justification (USFWS, 2010b). Other information on the status of habitat in the action area is included in the Status of Bull Trout in the Action Area section, below.

27.2 Status of Bull Trout in the Action Area

For purposes of analyzing the current condition of the bull trout and the factors influencing that condition in the action area, we are relying upon assessments of these factors for the Coastal RU of the bull trout that was described and discussed in the USFWS's 2015 recovery plan for the bull trout. This analysis represents the best available information on bull trout status on the Olympic Peninsula in general and the ONF in particular. The Environmental Baseline analysis in this Opinion is excerpted or adapted from text in the *Recovery Plan for the Conterminous United States Population of Bull Trout (Salvelinus confluentus)* USFWS, 2015).

The Coastal RU is one of six recovery units, encompassing the Olympic Peninsula, Puget Sound, and Lower Columbia River regions. The only core areas currently supporting anadromous populations of bull trout are located within the Puget Sound and Olympic Peninsula regions. Although bull trout in the Lower Columbia River region share a genetic past with the Puget Sound and Olympic Peninsula regions, it is unclear whether Lower Columbia River core areas supported the anadromous life history to any significant degree in the past, or could in the future.

The Olympic Peninsula region includes selected rivers and tributaries to Hood Canal, the Strait of Juan de Fuca, and the Pacific Ocean coastal area north of Willapa Bay, Grays Harbor, and the Chehalis River. Although data and records regarding the historical distribution of bull trout in the Olympic Peninsula region are limited, observations indicate that mainstem reaches and many tributaries within the Quinault, Queets, Hoh, Elwha, Dungeness, and Skokomish Rivers are occupied or used by bull trout at various life stages. Other information indicates that bull trout from several of these rivers migrate into saltwater to forage and travel along the coast and into coastal tributaries, bays, or estuaries to reach additional foraging and overwintering sites. 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 never been documented on the Olympic Peninsula (USFS 2009).

27.3 Bull Trout Core Areas

The Olympic Peninsula Bull Trout Recovery Planning Team has identified the Quinault, Queets, Hoh, Elwha, Dungeness, and Skokomish River basins, which contain the only known bull trout core populations in the management unit, as six separate core areas (Figure 1, Table 30). The combination of 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 comprises a core area. The status of the bull trout and its habitat at the core area scale is the basis for assessing the extent of bull trout recovery in a recovery unit. As discussed above, 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 considered to be 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. A core area may include many local populations.

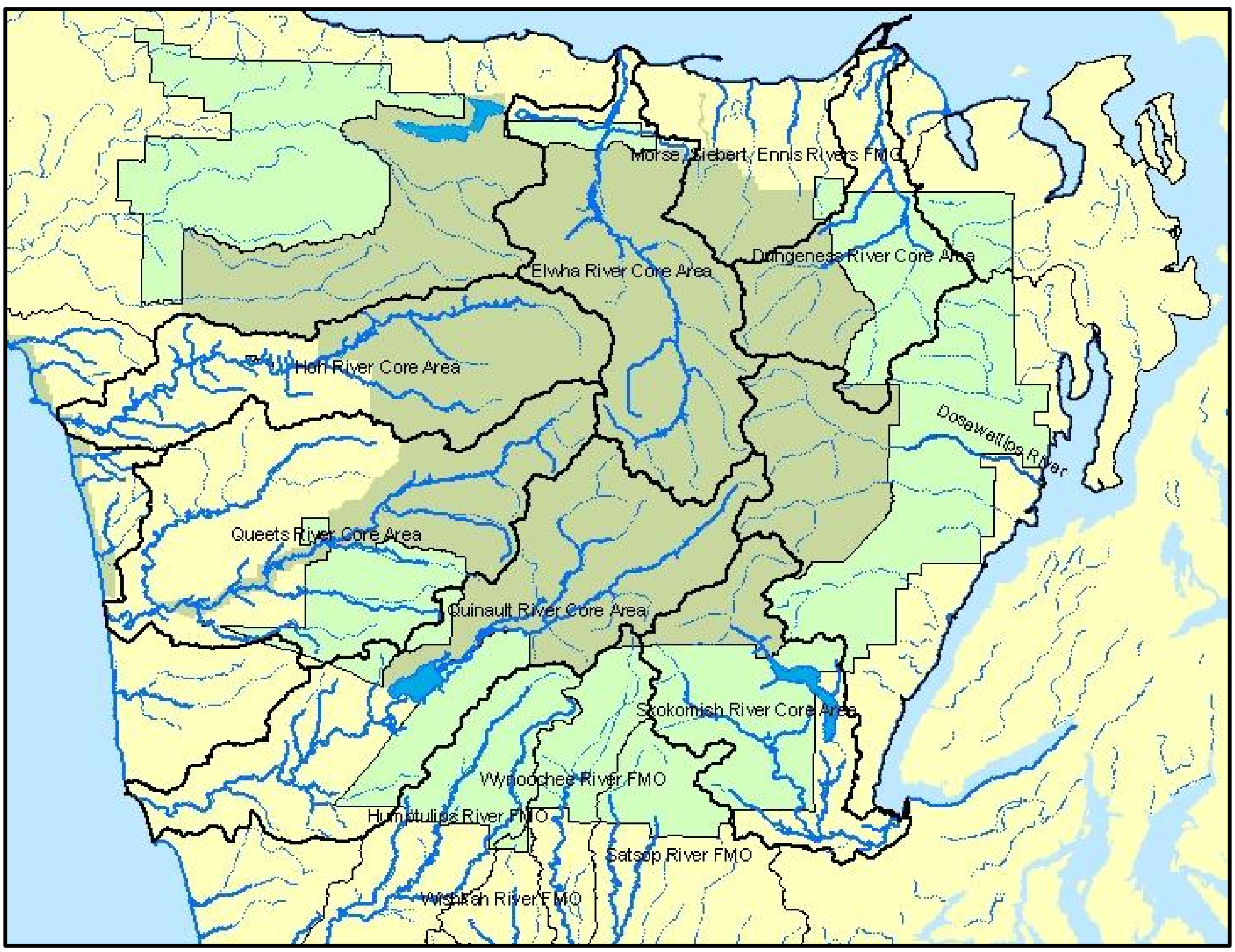

Figure 1. Bull trout core areas on the Olympic Peninsula.
Note: Light green areas in this figure represent the ONF. Lakes and streams depicted in dark blue represent the current known and presumed distribution of bull trout on the Olympic Peninsula identified in the draft bull trout recovery plan (USFWS, 2004). Core areas are outlined in black and labeled.

Table 30. Summary of bull trout core areas and non-core area FMO watersheds on the ONF.

Bull Trout Core/FMO Area	Total Acres in Core/FMO Area	Extent of Core/FMO Area (in acres) on the ONF	Percent of Core/FMO Area on the ONF	Total Extent of Bull Trout Streams/ Shorelines in Core/ FMO Area (in miles)	Extent of Bull Trout Streams/ Shorelines in Core/ FMO Area on the ONF (in miles)	Percent of Total Bull Trout Streams/ Shoreline in Core/FMO Area on the ONF
Dungeness River Core Area	130,886	56,004	42.8%	49.4	20.5	41.5%
Elwha River Core Area	205,663	11,180	5.4%	104.9	9.3	8.9%
Hoh River Core Area	191,088	413	0.2%	142.4	1.8	1.3%
Queets River Core Area	288,409	53,373	18.5%	169.0	28.2	16.7%
Quinault River Core Area	279,795	45,983	16.4%	154.6	19.7	12.7%
Skokomish River Core Area	152,990	81,505	53.3%	116.3	47.4	40.8%
Core Area Totals	**1,248,831**	**248,458**	**19.9%**	**736.5**	**126.9**	**17.2%**
Morse, Siebert, Ennis Rivers FMO	100,494	3,960	3.9%	15.9	0	0
Raft River FMO	71,824	1,051	1.5%	9.0	0	0
Humptulips River FMO	157,873	56,295	35.6%	103.6	37.1	35.8%
Wishkah River FMO	65,801	1,599	2.4%	56.6	0	0
Wynoochee River FMO	125,454	42,055	33.5%	50.9	5.6	11.0%
Satsop River FMO	189,529	34,017	17.9%	55.1	3.8	6.9%
Dosewallips River FMO	74,355	21,975	29.6	47.9	7.1	14.8%
Non-Core FMO Area Totals	**785,330**	**160,952**	**20.5%**	**338.9**	**53.6**	**15.8%**
ONF Totals	**2,034,161**	**409,410**	**20.1%**	**1075.4**	**180.5**	**16.8%**

Acres and stream miles listed for the ONF are gross estimates that include inholdings within the ONF administrative boundary. Lake shoreline areas (e.g., Cushman or Aldwell reservoirs) are included in the stream length estimates. This table was created using ONF and USFWS GIS (geographic information system) data. Areas identified as key bull trout recovery habitat was used to map bull trout distribution within the ONF (USFWS, 2015). Due to inherent inconsistencies in GIS analyses, the figures reported here may differ slightly from figures reported elsewhere.

Ten local populations of bull trout have been identified within the six core areas in the Olympic Peninsula Management Unit. Where specific spawning location information was lacking, the Olympic Peninsula Recovery Planning Team used best professional judgment and local expertise to identify some local populations 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 considered to be occupied by bull trout (USFWS, 2015).

27.3.1 Status of Bull Trout within the Olympic Peninsula Geographic Region of the Coastal Recovery Unit

The Coastal RU is divided into three geographic regions: Puget Sound, Olympic Peninsula, and the Lower Columbia River. The Puget Sound and Olympic Peninsula geographic regions are entirely within Washington and the Lower Columbia River geographic region is within Washington and Oregon. The Puget Sound geographic region contains eight core areas, the Olympic Peninsula geographic region contains six core areas, and there are two core areas within Washington in the Lower Columbia geographic region (Lewis River and Klickitat core areas). Within the Washington core areas, there are 71 local populations, 4 potential local populations, 2 local populations located in both Canada and Washington, and 4 local populations in both Washington and Oregon (USFWS 2015a pp. A-148 to A-151).

Bull trout core areas within Washington support anadromous, fluvial, adfluvial, and resident life history forms. The Puget Sound and Olympic Peninsula geographic regions contain the anadromous life history form. Three core areas within these regions, the Upper Skagit River, Chester Morse, and the Lewis River, are isolated above one or more dams and only contain fluvial, adfluvial, and resident life history forms. PacifiCorps' Yale Hydroelectric Project's Settlement Agreement requires bull trout passage around the three dams in the Lewis River (PacifiCorp 2020 p. 13). When fish passage is provided, bull trout are not expected to become anadromous, but would be more likely to migrate down to the lower Columbia River as a fluvial life history form.

27.3.1.1 Bull Trout Abundance

Since listing in 1999, bull trout abundance has been identified as relatively stable range-wide (USFWS 2015b p. 8). The NatureServe status assessment tool (Faber-Langendoen et al. 2009, as cited in USFWS 2015b p. 8), indicated that the Coastal RU was "vulnerable to extirpation" with a NatureServe Rank Score of 3.31. The NatureServe Rank Scores are based on nine factors: linear distance of occupancy; number of occurrences, or local populations; adult population size; environmental specificity; intrinsic vulnerability; short-term trend; long-term trend; threat scope; and threat severity. NatureServe scores range from 0 to 5.5, with low scores being the least robust, most threatened RU, and high scores being the most robust, least threatened RU. When a factor is unavailable for a core area, NatureServe is capable of running the model with an "unknown" value for that factor. No specific bull trout abundance or density estimates have been established for any Coastal RU core areas within Washington. The status of core areas in the Coastal RU, including those in Oregon, is variable (USFWS 2015a p. A-6).

The Olympic Peninsula geographic region has two core areas, the Dungeness River and Skokomish River, which were identified as having small population sizes (USFWS 2015a p. A-27). The Quinault River core area was identified as the one stronghold in this geographic region (USFWS 2015a p. A-3). Similar to the Puget Sound geographic region, abundance information is lacking for many of the core areas. Scattered surveys including redd counts, bull trout observations, snorkel surveys, etc. were conducted in many of the core areas within the Olympic Peninsula geographic region. However, long-term surveys or surveys after 2010 did not occur, so it is not possible to assess bull trout abundance trends through 2019.

Given the lack of data for the Olympic Peninsula geographic region, population trends and abundance are unclear for most of the core areas, including the Queets, Quinault, and Hoh. Data available for the Skokomish River and Dungeness core areas indicate relatively stable bull trout populations. Screw trap data in the Dungeness River core area between 2007 and 2019 show that the highest number of juvenile bull trout caught was 147 in 2014, but the number has decreased since, with only 2 juvenile bull trout caught in 2019 (Appendix M Table 1 and Figure 1). Although, the 5-year mean shows a relatively stable number of bull trout caught in the screw trap, large numbers caught in 2008 and 2014 indicate a decreasing trend. The Skokomish River core area appears to be more stable than the Dungeness. Further, although survey efforts were not comparable, more bull trout were observed during spawning surveys and redd counts in the NF Skokomish River than in the SF Skokomish River (Appendix M Table 2 and Figure 2). Bull trout abundance is expected to increase in the Elwha River given the removal of two dams that blocked passage.

27.3.1.2 Climate Change

Within Western Washington, predicted environmental changes as a result of climate change include increased air temperature, reduced snow accumulation, increased frequency and intensity of rain events, and declining summer precipitation (Mauger et al. 2015). These changes result in increases in river water temperatures, winter flood risk, higher flood flows, and decreased river baseflows. Within Washington State, the air temperature has increased approximately 1.5 °F (0.8 °C) between 1900 and 2014 (NOAA 2020, USFWS 2020).

All life stages of bull trout rely on cold water. The onset of bull trout spawning is determined by stream temperatures falling below 48 °F (9 °C). Within the Puyallup, Lower Skagit River and Chester Morse core areas, spawning surveys have shown that bull trout spawning begins approximately two weeks after such temperature drops occur (Barkdull, B., pers. comm. 2020; Marks, E., pers. comm. 2020; Seattle City Light, unpublished data, 2020). While specific reasons for the later onset of spawning has not been determined, increased stream temperatures as a result of climate change may be a cause. In addition, bull trout spawning streams are being altered by changes in flows. A spawning stream will be dry one day and after a rain, the stream is drastically altered due to high flows (Barkdull, B., pers. comm. 2020). With changes in stream water temperatures and flows, bull trout may be utilizing new waters for spawning that are not surveyed. These streams may have the cold water required for bull trout spawning.

The long-term consequences of delays in bull trout spawning are unknown. The period of egg incubation to emergence of fry may take up to 210 days (7 months). If winter and spring water temperatures are also warmer due to climate change, it is unknown whether bull trout incubation will be affected and, if so, what impacts this may have on survival of eggs and fry.

27.3.1.3 Threats

In the Olympic Peninsula geographic region, angling or harvest of bull trout was identified as the primary threat in four bull trout core areas: Hoh, Queets, Quinault, and Skokomish River core areas (Appendix M) Table *3*, USFWS 2015, pp. A-17 to A-20). Reduced prey abundance is also a threat. With the removal of two dams on the Elwha River, bull trout and their prey base (primarily juvenile salmonids) have been improving as access to more than 30 miles of pristine spawning and rearing habitat was restored. Transportation networks, and both improved and unimproved forest roads, have caused significant impacts in this region. Many roads within this region are adjacent to streams and have numerous stream crossings that have direct impacts to the stream banks, habitat, and channels as the roads periodically fail. Road maintenance results in a continuous supply of sediments that reduces spawning habitat.

Within shared FMO, residential development and urbanization is a primary threat along the Strait of Juan de Fuca. Along the Pacific Coast and tributaries, legacy forest management is a primary threat (Appendix 4 Table 4, USFWS 2015, pp. A-21).

Connectivity between core areas in this geographic region is naturally low due to the geographic distance between them: one core area is located in Hood Canal, two are in the Strait of Juan de Fuca, and three are along the Washington Coast (USFWS 2015, p. A-17). However, bull trout can migrate between nearby core areas, or can migrate to non-core areas or FMO habitat (Humptulips, Chehalis, Moclips, Raft, etc.). Removal of the Elwha River dams provides unimpeded passage for bull trout migration throughout the core area from spawning areas in the headwaters to the marine water in the Strait of Juan de Fuca.

27.4 Bull Trout Foraging, Migration and Overwintering Habitats Outside of Core Areas

Marine waters, including coastal rivers, estuaries, and nearshore waters, provide bull trout access to a productive forage base and to overwintering areas protected from extreme flow events. Many coastal tributaries seasonally occupied by bull trout are not believed to support spawning. These waters have been identified by the recovery planning teams as important FMO habitat for bull trout from core areas in the Olympic Peninsula (USFWS, 2004).

Coastal rivers and most independent tributaries outside of bull trout core areas are unlikely to support spawning and rearing populations due to their low elevation and lack of suitable water temperatures for these life stages. However, to locate seasonally abundant prey species in these creeks and rivers, bull trout use marine waters as a migratory corridor to move from their core area into at least the downstream portion of another river or creek basin (Brenkman and Corbett 2005; Ogg et al. 2008). Because bull trout forage on salmon fry and eggs, it is believed by the recovery planning team that bull trout will use portions of these rivers that overlap salmon rearing. Bull trout may also use tributary mouths as freshwater "stepping stones" while migrating through marine waters and as refugia from high flows in their natal rivers during winter (USFWS, 2004).

27.4.1 Grays Harbor and Chehalis River Tributaries

Bull trout have been historically, or are currently, documented in tributaries west of, and including, the Satsop River in the Chehalis River system. Bull trout have been caught by steelhead anglers in the Wynoochee, West Fork Satsop, and Canyon rivers. Historical observations of bull trout were reported in the Humptulips River during WDFW creel checks in 1958 and 1973. Based on the professional judgment and experience of members of the bull trout recovery planning team, areas used by anadromous salmon and steelhead in Grays Harbor and the Chehalis River upstream to and including portions of the Satsop, Wynoochee, Wishkah, Hoquiam, and Humptulips rivers have been identified as key recovery habitat that provides FMO habitat for bull trout (USFWS, 2004).

With the exception of the Satsop River watershed, no bull trout have ever been observed on National ONF lands within these watersheds. ONF lands generally include the upper limits of anadromous fish habitat and headwater areas rather than the larger lower reaches and estuaries where migratory bull trout are most commonly found. Seining surveys conducted in the Satsop, Wynoochee, and Humptulips rivers between 1973 and 1980 did not capture any bull trout (Brix 1981). Electrofishing, day snorkeling, and night snorkeling surveys conducted by the ONF in 1997, 1999, 2000, and 2001 in the Satsop and Wynoochee river basins failed to detect bull trout (USFS 2009). In addition, no bull trout have ever been observed at the fish trapping station below Wynoochee Dam nor have they ever been captured in the sport fishery within Wynoochee Lake (USFS 2009). The Satsop River is historic bull trout habitat, but the presence of bull trout has not been documented since the 1960's, and they may have been extirpated from the basin. In the Humptulips River basin, bull trout have not been documented above the confluence of the East Fork and West Forks. ONF lands begin several miles above this point (USFS 2007). However, no formal surveys targeting bull trout have been conducted in the Wishkah, Humptulips, or Hoquiam rivers.

Based on the available information, bull trout may be seasonally present on ONF lands within the Chehalis River basin tributaries, in association with spawning or smolting salmon or steelhead. The number of individuals present in these watersheds is likely to be low, and occurrences of bull trout in the upper reaches of these watersheds is likely infrequent.

27.4.2 Hood Canal and Strait of Juan de Fuca Tributaries

Tributaries that flow into the Strait of Juan de Fuca that are known to provide bull trout foraging, migration, or overwintering habitat include Bell, Siebert, Morse, and Ennis creeks. However, none of these streams occur within the ONF. Historical accounts and anecdotal reports have documented occasional adult bull trout in the estuaries and lower portions of Hood Canal drainages including the Duckabush, Dosewallips, Hamma Hamma, and Quilcene rivers, but these drainages are not currently believed to support spawning populations. Bull trout observations in the Dosewallips River were last documented in 1991 (USFWS, 2004). Although there are two historical reports of adult bull trout in the Big Quilcene River, no bull trout have been trapped at the Quilcene National Fish Hatchery in recent years, nor have any bull trout been observed in recent snorkel surveys by WDFW and the ONF (USFS 2007).

Based on the available information, migratory bull trout originating from the Skokomish River basin may be seasonally present on ONF lands within the Dosewallips River in association with spawning salmon or steelhead. The number of individuals present in the watershed is likely to be low, and occurrence of bull trout in the Dosewallips River watershed is likely to be infrequent.

27.5 Environmental Conditions in the Action Area

Since the bull trout was listed, federal, state, and private actions occurring in the Olympic Peninsula geographic region have resulted in short- and/or long-term adverse and beneficial effects to bull trout. These actions include statewide Federal restoration programs that include riparian restoration, replacement of fish passage barriers, and fish habitat improvement projects; federally funded transportation projects involving repair and construction of roads and bridges; dredging in Grays Harbor, and section 10(a)(1)(B) permits for HCPs addressing forest management practices. The largest restoration project that has occurred on the Olympic Peninsula since the bull trout was listed was the removal of Lower Elwha and Glines Canyon dams on the Elwha River. Environmental conditions below the dams have been temporarily degraded by a huge flush of stored sediment, but the population status of the Elwha River bull trout has improved relative to previous and fish are using newly created estuarine habitats in response to the restoration (Quinn, et al., 2017; Lincoln, et al., 2018).

Significant forest management activities occurring on the Olympic Peninsula include timber harvesting primarily on State, private, and Tribal lands. Forest management activities on the Quinault Indian Reservation incorporate riparian buffers and conservation measures designed to reduce impacts to bull trout as prescribed by the Quinault 10-year Forest Management Plan, but adverse effects to bull trout continue to occur due to the loss of large trees that contribute to channel complexity and available habitat (Wohl et al., 2017). The USFWS, NMFS, and Environmental Protection Agency assisted the Simpson Timber Company (now Green Diamond Resources) in completing a HCP in 2000. The principle area of the HCP overlaps bull trout distribution in the South Fork Skokomish River and the accessible reaches of its major tributaries. The HCP includes management prescriptions designed to address wetlands, unstable slopes, road construction, road maintenance and decommissioning, certain harvest limitations to moderate snowmelt runoff, and riparian buffers that vary from 5 to 65 meters. The culvert replacements identified in the HCP’s conservation program are designed to provide long-term benefits to the watershed and bull trout by restoring habitat connectivity and watershed function.

State forest practice regulations for private land timber harvests were significantly revised in 2000, following the Forest and Fish Agreement, which culminated in the Washington State Forest Practices HCP for aquatic species (WDNR 2005). Revised regulations increased riparian protection, unstable slope protection, and recruitment of large wood. Road construction and maintenance standards have improved significantly over the old regulations. Because there is uncertainty in the ecological response associated with some of the prescriptions, the Forest and Fish Agreement relies on an adaptive management program for assurance that the new rules will meet the conservation needs of bull trout. The updated regulations are designed to significantly reduce the severity of future timber harvest impacts to bull trout-occupied streams on private lands. However, the negative effects to ecological function from historic (20^{th} century) forest practices will likely continue to be a threat for decades with historic impacts for which recovery is slowed by ongoing state and private timber harvest will continue to have adverse (albeit reduced) effects on bull trout and bull trout habitat (Wohl et al., 2017).

27.6 Climate Change

Bull trout will be affected, both directly and indirectly, by changes in climate and the ecological response to those changes within the action area. Changes in temperature and precipitation patterns are altering hydrological regimes within ONF. Changes include reductions in snowpack, earlier spring snowmelt, shifts away from snow-dominated hydrological patterns and toward rain-dominated patterns, increased fall and winter flooding, reduced streamflow during the summer, warmer stream temperatures, and glacial melting. Changes in forest disturbance regimes, described in the spotted owl climate change section of this Opinion, will also affect bull trout habitat. Anadromous bull trout within the action area will also be affected by changes in marine habitat conditions, outside of the action area. Many of these changes will affect bull trout directly, and some changes also have the potential to exacerbate other stressors that affect bull trout.

27.6.1 Changes in the Physical Environment

Ongoing physical changes to the climate in ONF, discussed in spotted owl climate change section of this Opinion, include warming air temperatures in every season, reduced precipitation during spring and summer, and increased precipitation during fall and winter. These changes, in turn, affect winter and spring snowpack. More precipitation will fall as rain, rather than snow, and when snow does fall, it is less likely to persist. Parts of the ONF have historically maintained snowpack until April 1, but by the mid-21^{st} century, only high-elevation areas of the Olympic Peninsula, mainly in Olympic National Park, will maintain snowpack into the spring, and even these areas will experience dramatic reductions in the amount of spring snowpack (Elsner et al. 2010, p. 243). Most of the watersheds of the Olympic Peninsula already have hydrological regimes dominated by rainfall, particularly at low elevations, but high-elevation snowpack has historically also influenced streamflow patterns, and in particular the Elwha and Dungeness watersheds are currently classified as "transitional" between rain- and snow-dominated (Elsner et al. 2010, p. 230; Mantua et al. 2010, p. 203). With increasing temperatures over the coming decades, all watersheds in the Olympic Peninsula will have rain-dominated hydrological regimes (Mantua et al. 2010, p. 203).

Changes in rainfall, snowpack, and snowmelt are leading to changes in the timing and magnitude of peak streamflows (Elsner et al. 2010, p. 249). In rain-dominated hydrological regimes, peak streamflow typically occurs during the winter months, whereas in snow-dominated regimes, streamflow peaks as the snowpack melts during the late spring or early summer. Transitional regimes may have two peaks, one during the winter and the other in the spring, or a broad plateau of high streamflow, encompassing both the winter rains and spring snowmelt. Loss of spring snowpack and a shift toward more completely rain-dominated hydrological systems will shift peak streamflows earlier in the winter. This shift is most likely to be noticeable in the northeastern areas of the ONF, where the current hydrological regime is transitional; elsewhere, where the hydrological regime is already rain-dominated, the timing of peak streamflow is likely to remain more stable. Historically, the Elwha and Dungeness Rivers have had two streamflow peaks per year in December and June, with a higher, sharper June peak for the Dungeness River and two relatively broad, even peaks for the Elwha River (Elwha-Dungeness Planning Unit 2005, p. 2.8-7; Magirl et al. 2015, p. 674). With a shift toward rain dominance, the December peaks are expected to increase as the June peaks flatten, shift earlier, and finally disappear.

Winter flooding risk has increased over much of the Olympic Peninsula, and that trend is expected to increase. Over the course of the 20th century, 20-year and 100-year floods increased in magnitude by up to about ten percent across most of the Olympic Peninsula (Hamlet and Lettenmaier 2007, pp. 9-10). This trend is expected to continue, with 20-year flood magnitudes projected to increase up to 50 percent in the Dungeness River watershed by mid-century, and up to 30 percent in the Elwha and Quinault watersheds, with greater and more widespread increases as the century progresses (Mantua et al. 2010, p. 205). In addition, in transitional watersheds like the Elwha and Dungeness, winter flood magnitudes associated with 20-year flood events in the 20th century are projected to return every 5 to 10 years by the mid-21st century (Mantua et al. 2010, p. 204).

As winter rainfall increases, and especially where it replaces snow, erosion is expected to increase. Landslides and bank erosion lead to channel instability and increased sediment loads in streams (Bakke 2009, p. 3; Hamlet et al. 2013, p. 407). These effects are expected to be moderated by some geological conditions and exacerbated by others. For example, streams flowing through bedrock are less sensitive to hydraulic energy, and streams at high enough elevations to maintain snow-dominated winter precipitation patterns will be less subject to these changes (Bakke 2009, pp. 3-4). Conversely, streams fed by retreating glaciers and those flowing through landscapes of unstable soils or burned areas will be more sensitive to these changes (Bakke 2009, p. 4).

The timing, volume, and duration of low flows are also changing. Annual summer low flows on the Olympic Peninsula are expected be around 5 to 45 percent lower by the mid-21st century, than they were during the 20th century, and the duration of the summer low-flow period is expected to lengthen (Mantua et al. 2010, pp. 204-206). Extreme summer low flows, defined as the 7-day average low flow with a 10-year return interval, are also expected to decrease in volume by 5 to 40 percent (Mantua et al. 2010, p. 204).

As air temperatures rise, water temperatures are generally rising as well, but at a slower rate (Isaak et al. 2010, p. 1365; Isaak and Rieman 2013, p. 746; Morrill et al. 2005, p. 145). During the 20th century, temperature contours within streams shifted upslope, so that water of a given temperature can now be found approximately 1.5 to 43 km upslope of where water of the same temperature was located 100 years ago (Isaak and Rieman 2013, p. 746). If the air temperature warms by 2 °C by the 2050s, upslope shifts of another 5 to 143 km can be expected (Isaak and Rieman 2013, p. 746). Stream temperatures within ONF are expected to remain relatively cool through mid-century, but in a business-as-usual future scenario, September temperatures in some bull trout streams within the ONF are projected to exceed 12 °C by the 2040s (Isaak et al. 2016a). The streams and rivers within the ONF that are projected to cross this threshold by mid-century include portions of the Skokomish River, Wynoochee River, Quinault River, Matheny Creek, and Sams River. Nearly all streams within the ONF are projected to remain below 15 °C in September, on average, even through the 2080s (Isaak et al. 2016a).

Climate change-induced alterations in water flow and temperature are likely to be moderated in some places by inputs from groundwater, persistent high-altitude snowpack, or glacial melt (Luce et al. 2012, p. 30). These factors are not always included in the models commonly used to project streamflow characteristics (Hamlet et al. 2013, p. 407). Stream reaches influenced heavily by these factors are expected to provide cold-water refugia even as climate change progresses (Bakke 2009, p. 5; Isaak et al. 2010, p. 1365). However, glaciers in the Olympic Mountains are rapidly shrinking, and are expected to be nearly gone by the end of the 21st century (Fountain et al. 2019, p. 1; Riedel et al. 2015, pp. 10-15). Glacial leads to reductions in summer streamflow, as has been observed in the Elhwa River, and increases in summer water temperatures (Pelto 2018, p. 1; Riedel et al. 2015, p. 15). As air temperatures warm, cold-water refugia may be isolated from one another by stretches of increasingly warm water. Additionally, other factors may exacerbate warming in some areas. For example, within areas recently burned by wildfire, water temperature increases may be several times greater than in areas outside of fire perimeters (Isaak et al. 2010, pp. 1360, 1364).

Just outside of the action area, marine waters are also affected by climate change. 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). 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). 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).

27.6.2 Changes in Forested, Aquatic, and Marine Ecosystems

Forest disturbance regimes are changing, as discussed in the spotted owl climate change section of this Opinion. Where streams flow through disturbed forests, changes in vegetation structure and soils lead to changes in stream temperature. Various factors lead to warming; for example, the death of trees shading the stream allows more sunshine to warm the water. Other factors lead to cooling; for example, when fewer trees take up water from the soil, more water reaches the stream. After a fire, solar radiation generally has the greatest effect on stream temperatures (Isaak et al. 2010, p. 1360; Leach and Moore 2010, p. 1375; Luce et al. 2012, p. 29), so the competing factors balance on the side of warming. This warming can be substantial, between 0.5 and 4 °C for average temperatures and 2.5 – 10 °C for maximum temperatures, with the largest increases in streams that had post-fire debris flows (Dunham et al. 2007, p. 341; Luce et al. 2012, p. 30). These changes last at least a decade following fire, likely up to several decades as tall trees return, and may become relatively permanent if the burned area converts from forest to shrub- or grassland (Dunham et al. 2007, p. 342; Isaak et al. 2010, pp. 1351; Luce et al. 2012, p. 30). Other disturbances that kill trees in riparian zones are also likely to magnify stream warming.

Forest disturbances also lead to changes in the timing and magnitude of stream flows. Following large fires, local peak flows generally increase by less than 10-fold, but sometimes up to several hundred-fold, with flooding associated with autumn storms or rain-on-snow events (Luce et al. 2012, pp. 21, 23). Snow melts earlier and faster in the footprint of severe fires and other disturbances that kill many trees, such as insect infestations, because the snow is less shaded by vegetation (Luce et al. 2012, p. 23). In the years following fires, the rate of snow and glacier melt also increase in areas near but outside of the fire perimeter due to the deposition of small black carbon particles, which absorb light and heat instead of reflecting it (Delaney et al. 2015, pp. 9169-9170; Kaspari et al. 2015, pp. 2800-2804). This faster melting can increase peak stream flows. Summer base flows may also increase after disturbances, if there is less foliage to intercept rainfall and/or less transpiration moving water from the ground to the atmosphere (Luce et al. 2012, pp. 24-25; Vose et al. 2016b, p. 339).

Furthermore, forest disturbances alter geomorphology. Rainfall running off severely burned soil can lead to dramatic gullies and debris flows (Luce et al. 2012, p. 21). Debris flows are sometimes triggered by the first heavy rainfall following a fire, but the risk of debris flows remains elevated up to a decade following fire (Luce et al. 2012, p. 34). Debris flows can fundamentally alter the structure of the affected portions of the stream, killing organisms and simplifying their habitat along the stream segments where the debris flow passes, but also adding substrate and large wood needed for complex stream habitats in the downstream areas where the debris flow deposits its contents (Luce et al. 2012, pp. 34-36). Streams affected by debris flows are expected to recover their channel and sediment characteristics within a few years, but habitat conditions optimal for various stream organisms can take several decades to recover (Luce et al. 2012, p. 36).

Not all effects of forest disturbances are negative. For example, tree mortality in riparian zones provides a source of large wood that provides complex aquatic habitat within streams (Luce et al. 2012, p. 34). Landslides and debris flows provide substrates such as gravel and cobble, which are also necessary for complex aquatic habitats (Luce et al. 2012, p. 34). Wildfire may increase the productivity of streams and allow for the maintenance of a diverse community of invertebrates (Isaak et al. 2010, pp. 1361-1363; Luce et al. 2012, p. 76). Wildfires and other tree mortality events have naturally occurred throughout history within the action area, and stream ecosystems of the action area evolved with and have been shaped by these disturbances. However, increases in the frequency or scale of disturbances are likely to alter the effects of the disturbances and the trajectory of streams' recovery from the disturbances.

Changes in temperature and hydrology, as well as the changes in disturbances described above, may alter food webs within streams and lakes within some ONF streams. Increases in fall and winter flooding, caused by a shift in winter precipitation from more snow to more rain, will likely wash organic matter out of stream systems, reducing food availability for detritivorous stream invertebrates (Gibson et al. 2005, p. 855). In addition, these flows are likely to wash away the invertebrates that are adapted to emerge in the spring, prior to spring peak flows (Gibson et al. 2005, p. 855). These changes are most likely to affect watersheds that are changing from transitional to rain-dominated, since watersheds that are already rain-dominated presumably host aquatic food webs that are already adapted to winter peak flows.

In the marine environment, changes in temperature, carbon dioxide, and nutrient levels are likely to affect primary productivity by phytoplankton, macroalgae, kelp, eelgrass, and other marine photosynthesizers (IPCC 2019, p. 5-72; Mauger et al. 2015, p. 11-5). Overall primary productivity is most likely to increase (Gao and Campbell 2014, pp. 451, 454; IPCC 2019, pp. 5-31, 5-38; Nagelkerken and Connell 2015, p. 13273; Roberts et al. 2014, pp. 11, 22, 108; Thom 1996, pp. 386-387), but phytoplankton species that form calcium carbonate shells are expected to decline in abundance with acidification (Feely et al. 2004, pp. 365-366; IPCC 2019, p. 5-62; Kendall 2015, pp. 26-46). Eelgrass beds and kelp forests, two marine ecotypes that are important food webs in the waters around the Olympic Peninsula, may benefit from some changes in climate and be harmed by other changes. Bull kelp (*Nereocystis luetkeana*) responds to higher carbon dioxide concentrations with greater productivity, but kelp forests are sensitive to high temperatures (IPCC 2019, p. 5-72; Thom 1996, pp. 385-386). Along Washington's outer coast and the Strait of Juan de Fuca, bull kelp and giant kelp (*Macrocystis pyrifera* [Agardh]) canopy area did not change substantially over the 20th century, though a few kelp beds have been lost (Pfister et al. 2018, pp. 1527-1528). In southern Puget Sound, bull kelp declines were observed between 2013 and 2017-2018, likely resulting from increasing temperature along with other stressors (Berry et al. 2019, p. 43). Similarly, between 1999 and 2013, eelgrass (*Zostera marina*) growth rates in Sequim Bay and Willapa Bay increased, but at a site in central Puget Sound, shoot density over a similar time period was too variable to detect trends, and negative effects may dominate in other areas (Thom et al. 2014, pp. 5-9). Important primary producers in the marine waters surrounding the Olympic Peninsula appear likely to experience geographically variable effects of climate change over the coming decades.

In contrast, increases in harmful algal blooms (also known as red tides or toxic algae) have been documented over the past several decades, and these changes are at least partly due to climate change (IPCC 2019, pp. 5-85 – 5-86; Trainer et al. 2003, pp. 216, 222). Future conditions are projected to favor higher growth rates and longer bloom seasons for these species. In the case of one species, *Alexandrium catanella,* increases in the length of bloom season, up to 30 additional days per year at the eastern end of the Strait of Juan de Fuca, are projected primarily due to increases in sea surface temperature (Moore et al. 2015, pp. 7-9). In another genus of toxic algae, *Pseudo-nitzschia*, toxin concentrations increase with increasing acidification of the water, especially in conditions in which silicic acid (used to construct the algal cell walls) or phosphate is limiting (Brunson et al. 2018, p. 1; Tatters et al. 2012, pp. 2-3). These and many other harmful alga species also exhibit higher growth rates with higher carbon dioxide concentrations (Brandenburg et al. 2019, p. 4; Tatters et al. 2012, pp. 3-4). During and following the marine heatwave in 2015, an especially large and long-lasting outbreak of *Pseudo-nitzschia* species stretched from southern California to the Aleutian Islands, persisted from May to October, rather than the typical span of a few weeks, and produced extremely high concentrations of toxic domoic acid (Du et al. 2016, pp. 2-3; National Ocean Service 2016; NOAA Climate 2015, pp. 1-2; Ryan et al. 2017, p. 5575). With future climate change, toxic algae blooms are likely to be more frequent than in the past, and the larger, more toxic event of 2015 may become more typical (McCabe et al. 2016, p. 10374).

Forage fish may be affected by the biotic changes mentioned above, and also are likely to be affected directly by the physical alterations associated with climate change. For example, many fish, including Pacific herring (*Clupea pallasii*), are negatively affected by acidification. Depending on species, life stage, and other factors such as warming and hypoxia, these effects include embryo mortality, delayed hatching, reduced growth rates, reduced metabolic rates, altered sensory perception, and changes in behavior, among other effects (Baumann 2019, entire; Hamilton et al. 2014, entire; Nagelkerken and Munday 2016, entire; Ou et al. 2015, pp. 951, 954; Villalobos 2018, p. 18). A food web model of Puget Sound shows that moderate or strong acidification effects to calcifying species are expected to result in reductions in fisheries yield for several fish species, including Pacific herring, and increased yield for others, with an overall reduction in forage fish biomass (Busch et al. 2013, pp. 827-829), and another model of Northeast Pacific food webs projects similar declines in small pelagic fish abundance with acidification and reduced oxygen levels (Ainsworth et al. 2011, pp. 1219, 1224). Delayed upwelling in 2005, which may become more typical in the future, led to reduced growth rates, increased mortality, and recruitment failure of juvenile northern anchovies (*Engraulis mordax*) off of the Washington coast (Takahashi et al. 2012, pp. 397-403), but anchovy abundance was unusually high in Washington's inland waters in 2005, as it was in 2015 and 2016 following the marine heatwave (Duguid et al. 2019, p. 38). Warming, acidification, and hypoxia can also create conditions that allow jellyfish to outcompete forage fish (Brodeur et al. 2014, pp. 177-179; Lesniowski et al. 2015, p. 1380; Parsons and Lalli 2002, pp. 117-118; Purcell 2005, p. 472; Purcell et al. 2007, pp. 154, 160, 163, 167-168; Richardson et al. 2009, pp. 314-216). Although some species of forage fish in some of Washington's marine areas may benefit from climate change, marine forage fish abundance is likely to decrease overall in the coming decades.

27.6.3 Climate Change Effects to Bull Trout in Olympic National Forest

Bull trout in ONF will be affected by climate change both directly and indirectly. Warming freshwater and marine water temperatures, hypoxia, and acidification can all affect bull trout directly, as can changes in flooding and sediment loading. Changes in flooding, as well as altered patterns of forest disturbance, can alter the structure and function of bull trout habitat. All of these changes may also alter biotic interactions between bull trout and other species, such as prey or competitors.

Warming stream temperatures are likely to affect bull trout distribution and especially reproduction, but are less likely to affect habitat connectivity within ONF. As noted above, parts of some bull trout streams within ONF that are currently cooler than 12 °C in September are expected to warm beyond this threshold by the mid-21st century. This warming may be associated with decreased likelihood of bull trout occupancy in these areas, though at fine scales, current bull trout occupancy is often associated with localized features, such as groundwater inputs, that create cold water refugia; these areas may be less subject to the warming that is projected (Baxter and Hauer 2000, p. 1476; Isaak et al. 2016b, p. 4375). Of the spawning and rearing habitat reaches within ONF, few now have September water temperatures cooler than 9 °C; those that do are projected to exceed this threshold by the mid-21st century (Isaak et al. 2016a). These reaches may become less suitable for spawning and rearing, and suitable spawning and rearing habitat may become more fragmented or, where possible, recede upslope into Olympic National Park. Alternatively, or in addition, bull trout may shift the timing of spawning later in the fall, when cooler water temperatures return. The loss of rearing habitat due to warming water has been identified as a major climate-related effect to bull trout in the action area (Halfosky et al. 2011, p. 46). In contrast, September water temperatures above 15 °C are not projected to be typical for any bull trout streams within the ONF, even by the late 21st century. This indicates that thermal barriers to bull trout migration are not likely to be widespread in the action area.

Warming water can interact with other aspects of water quality to affect bull trout. With increasing water temperatures, salmonids show 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. In addition, where contaminants, such as 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 ONF waters.

Similarly, deoxygenation and acidification in the marine waters near the action area are likely to affect anadromous bull trout that spawn in the action area. Hypoxia is not expected to be a major stressor in the freshwater habitats of ONF, 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). Similarly, the effects of ocean acidification on bull trout are unknown, but may be similar to those observed for other salmonids. For example, pink salmon (*Oncorhynchus gorbuscha*) 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 (*Oncorhynchus kisutch*) 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 to the ONF from marine waters may suffer from impairments related to hypoxic exposures and ocean acidification, potentially leading to reductions in fitness.

Changes in flooding and peak flows are likely to decrease the success of 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. 989, 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 the ONF, risks are likely to be highest where the hydrological pattern shifts from transitional to rain-dominated, as in the Elwha and Dungeness River watersheds. However, given bull trout habitat selection, even in the remaining, already 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).

Increases in fire and other forest disturbances are expected to affect bull trout habitat in both beneficial and detrimental ways. 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 events that add these elements to the streams will also alter the channel characteristics, temporarily simplifying the channel and removing elements such as pools and off-channel habitats. Forest disturbances that kill riparian vegetation, and especially those that lead to channel-altering events, are expected to increase water temperature beyond the projected temperature increases discussed above.

Climate change is likely to affect the forage availability for bull trout. As described above, 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 and fry, negative effects of climate change on salmon will indirectly affect bull trout by reducing the availability of prey. Also, as described above, forage fish availability in the marine environment is likely to decline, reducing the availability of marine prey for anadromous bull trout.

Warming water is also expected to affect interactions between brook trout and bull trout. 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.

In summary, bull trout are sensitive to climate change in a number of ways. On the Olympic Peninsula, climate change effects may be relatively mild compared with other portions of the bull trout range. However, bull trout here are still likely to 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 to hypoxic and acidified conditions in their marine habitats, and all life history forms are likely to experience reductions or shifts in forage availability. Climate change effects are likely to be greatest in the Elwha and Dungeness watersheds, which are experiencing a shift from transitional to rain-dominated hydrological patterns.

27.7 Threats to Bull Trout on the Olympic Peninsula

Within the Olympic Peninsula geographic region of the Coastal RU, historic 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 within the peninsula including the ONF (USFWS, 2015).

Threats from current land management activities are also present in all bull trout core areas within the Olympic Peninsula geographic region. Land and water management activities that depress bull trout populations and degrade habitat in this management unit include some aspects of operation and maintenance of dams and other diversion structures, forest management practices, agriculture practices, road construction and maintenance, and residential development and urbanization (USFWS, 2015). Development and urbanization impact 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 are considered a significant threat to bull trout populations on the Olympic Peninsula (USFWS, 2004).

Dams and diversion structures impede or limit bull trout migration, entrain individuals, and impair downstream habitat in the Dungeness, and Skokomish river core areas. Historic (20th century) forestry activities still impact bull trout through decreased recruitment of large woody debris, increased water temperatures from reduced shading, lack of pools and habitat complexity, and increased sedimentation from timber harvesting on unstable slopes and road construction. 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 woody debris, and reduced habitat complexity by diking, stream channelization, and bank hardening (USFWS, 2004).

27.7.1 Forest Roads on the ONF

Forest roads on the ONF have been a chronic source of sediment for decades. Today, the ONF manages a 2,000 mile-long system of roads, and 593 miles of those roads are within core areas for bull trout. The majority of the road system was originally built for timber extraction, but many of those roads remain on the landscape as lightly to frequently used recreational access roads, closed roads, and irregularly used haul roads. Much of the road system built before the 1990s was poorly located and hastily designed with little attention given to the effects on riparian function, sedimentation, and fish habitat. In addition to road decommissioning projects, the ONF has performed maintenance on the road system year-round every year to keep the roads drivable, repair damage that could lead to accelerated erosion and sedimentation, and upgrade roads and road crossings to Forest Service standards that support aquatic habitats and passage. Unfortunately, the ONF has not had the funding needed to bring all of the forest roads up to standard or to return to all of the previously maintained roads when they once again need work.

The relationship between road networks, sedimentation, and salmonids (e.g. bull trout) has been recognized by scientists and land managers for a long time. Road networks accelerate erosion rates in watersheds (Haupt 1959, Swanson and Dyrness 1975, Swanston and Swanson 1976, Beschta 1978, Reid and Dunne 1984) by eroding road surfaces, ditches, cut banks, and stream crossings that otherwise would have been bound by vegetation. Chronic sedimentation and road densities were recognized as a threat to watersheds and salmonids in the Aquatic Conservation Strategy in the Northwest Forest Plan (USDA & USDI 1994). When bull trout were listed under the ESA as a threatened species in 1999, fine sedimentation from forest roads and logging practices was described as a major threat to the continued existence of the species (64 FR 58910). Accordingly, the recovery plan for bull trout identified improving (or removing) problem roads and improving routine road maintenance practices as key recovery actions for protecting, restoring, and maintaining habitat conditions for bull trout (USFWS, 2015).

For this analysis, we used GIS, data layers created by the ONF, and the USFWS's bull trout critical habitat layer (USFWS, 2010b) to document the baseline condition of forest roads in the action area. The 593-mile road network in bull trout core areas on the ONF includes 1,348 stream crossings and 168.9 miles of roads located in riparian areas. Of those roads, 5.9 miles are within 200 feet of bull trout core area habitat and cross that habitat in 17 locations. The density, type, and quantity of forest roads vary widely between core area watersheds (Table 31). Road density also varies widely between core area watersheds and subwatersheds (Table 32).

Table 31. The existing network of roads on ONF administered lands in core areas for bull trout.

Core Watershed	Total Road Miles on ONF		Miles of road within 200 ft of BT habitat	Miles of road within 200 ft of streams	Total BT habitat Crossings	Total Stream Crossings
Skokomish	Closed	40.6	3	85.2	6	678
	Native Surface	87.9				
	Gravel	132.8				
	Paved	6.8				
Dungeness	Closed	0.8	2	30.3	5	256
	Native Surface	4.4				
	Gravel	104.5				
	Paved	0				
Elwha	Closed	13.6	0	3.0	0	22
	Native Surface	0				
	Gravel	3.2				
	Paved	0.1				
Hoh	Closed	0	0	0	0	0
	Native Surface	0				
	Gravel	0.3				
	Paved	0				
Queets	Closed	55.3	1	35.2	6	319
	Native Surface	36.6				
	Gravel	38.6				
	Paved	7.9				
Quinault	Closed	20.6	0	15.2	0	97
	Native Surface	16.7				
	Gravel	21.3				
	Paved	1.2				
	TOTALS	**593**	**5.9**	**168.9**	**17**	**1348**

Table 32. Existing road densities on ONF lands by 6th field sub-watersheds in core areas for bull trout.

Core Watershed	Stream Miles on ONF	Bull Trout Critical Habitat Miles on ONF	Sub-Watershed (6th Field) Road Density on ONF[1] (miles per square mile)	
Dungeness River	345.7	19.1	CANYON CREEK/PATS CREEK	2.99
			LOWER GRAY WOLF RIVER	0.51
			MIDDLE DUNGENESS RIVER	2.27
			UPPER DUNGENESS RIVER	0.27
Elwha River	33.9	1.4	LITTLE RIVER/HUGHES CREEK	1.34
			LOWER ELWHA RIVER	1.45
Hoh River	2.9	1.0	MIDDLE HOH RIVER[2]	3.02
Queets River	387.8	21.8	MATHENY CREEK	1.80
			MIDDLE QUEETS RIVER	2.25
			SALMON RIVER	1.43
			SAMS RIVER	1.65
			TSHLETSHY CREEK	0
Quinault River	261.1	5.2	COOK CREEK	2.06
			MIDDLE QUINAULT RIVER	1.41
			BIG CREEK/UPPER QUINAULT RIVER	0.48
			QUINAULT LAKE	0.86
Skokomish River	616.1	30	LOWER N. FORK SKOKOMISH	2.92
			LOWER S. FORK SKOKOMISH	2.74
			MIDDLE N. FORK SKOKOMISH	0.97
			UPPER N. FORK SKOKOMISH	1.08
			UPPER S. FORK SKOKOMISH	2.55
TOTALS	**1647**	**78.5**		

[1] For this analysis of baseline road density, we used roads within the administrative boundary of the ONF.

[2] The ONF manages a very small area in the Hoh watershed (413 acres). The high density indicated here is an artifact of that small area calculation, and likely not indicative of biological effects on bull trout.

Bull trout populations on the Olympic Peninsula have been affected by sedimentation from the construction, use, and maintenance of forest roads, particularly in the Dungeness, Skokomish, Quinault, and Queets river core area watersheds where much of the area was historically and continues to be managed for timber production. Every year, sedimentation and hydrological effects of roads in these watersheds can depress the growth and survival of multiple life stages of bull trout. The impacts of past forest management practices have, and will likely continue, to decline as improved forest management practices are implemented and restoration work is completed (Sugden, 2018). A full explanation of the effects of fine sediment and roads on the biology of bull trout is included in the Effects of the Action section of this Opinion.

Not all forest roads are hydrologically connected to streams that intersect or parallel them, and the magnitude of sedimentation can vary widely. Without site-specific data on the connectivity between individual roads and streams, scientists and land managers rely on using road density as a surrogate for assessing sedimentation, hydrologic interruption, and other watershed-wide effects of roads. The matrix of pathways and indicators (USFWS, 2015) includes road density as an important indicator of bull trout habitat quality. Analyzing road density at a watershed scale is advantageous because it allows for comparison of the status of bull trout populations in multiple watersheds at varying road densities. The disadvantage is that the various effects of roads (e.g., poaching access, sediment, land management) are difficult to isolate from one another. Road density-based analyses assume equal road-stream hydrological connectivity between watersheds (which may not be true depending on landowner attention to road location, design, and maintenance).

The 2015 Bull Trout Recovery Plan reported transportation routes and/or legacy forestry practices in the Hoh, Queets, Quinault, and Skokomish core areas on the Olympic Peninsula (USFWS, 2015, pages 9-13), and some of those densities are still high, though we infer that most have probably decreased in the last two decades (see Section 27.7.1.2 *Commitment to Reducing Road Densities on ONF*). (Table 32). Dunham and Rieman (1999) found the density of roads at the landscape level to be negatively correlated with bull trout occurrence (USFWS, 2015, page 5). Similarly, Quigley and Arbelbide (1997) reported that bull trout were less likely to spawn and rear in basins with high road densities of roads. Quigley et al. (1996) reported a threshold road density of 0.7 to 1.7 miles per square mile; "threshold" meaning that this is the range of road densities that generally separated strong bull trout populations from depressed bull trout populations. The matrix of pathways and indicators (USFWS, 2015) suggests that watersheds with valley bottom roads and more than 1 mile of road per square mile are "functioning at risk" and watersheds with many valley bottom roads and more than 2.4 miles per square mile of roads are "functioning at unacceptable risk". These correlations supported previous 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).

27.7.1.1 Road System Threats by Core Area Watersheds

<u>Skokomish River Watershed</u>: In 1995, road density in 16 of the 21 6th field HUC Skokomish River sub-basins exceeded 2.5 miles of road per square mile, and was up to 6.0 miles of road per square mile in some places (USDA 1995a). The ONF administers 40.8 percent of the all bull trout streams and shorelines in the Skokomish River watershed (Table 30). The ONF has and continues to decommission roads and remove unnecessary or replace impaired stream crossings

in the Skokomish River watershed, but road densities to access private and forested timber and recreation areas remain high on the landscape (Table 32). The Skokomish River populations of bull trout will continue to be threatened by the effects associated with high road densities until a greater amount of restoration is completed. Approximately 100 adult bull trout remain in the Skokomish River watershed, in part because of the continued legacy of forest roads on ONF administered lands. Ongoing restoration work has focused on adding channel complexity through large-wood jams, riparian plantings, road decommissions or closures, and recreational site restoration.

Queets River Watershed: Road densities remain high in the Queets River core area, particularly in the Middle Queets River watershed (Table 32) (on both ONF administered lands and on private timber lands). Private land in the Clearwater River watershed has been the focus of road sediment research because the Lower Clearwater River has a road density of 3.7 miles per square mile, and the Upper Clearwater River has a road density of 3.2 miles per square mile (WSCC 2001). Because of the topography of the Queets River drainage area, floodplain road densities downstream of ONF lands have been estimated in the past to be high, approximately 2.5 miles per square mile (USFWS, 2004). Road construction and decommissioning have continued since then, but road densities remain similar today. The only identified local population of bull trout in the Queets River core area uses a large portion of the ONF administered lands in the Queets River watershed (Table 30), suggesting that road restoration could be a substantial part of conserving bull trout in this core area. Current and future work in the Queets watershed includes road decommissioning, removal or repair of impaired stream crossings, riparian restoration, and restoration of channel complexity using large wood jams.

Quinault River Watershed: The Quinault River core area has been significantly degraded by forest roads on state, private, tribal, and ONF lands, although the ONF currently has low road densities in the Quinault Lake and Big Creek/Upper Quinault River sub-watersheds (Table 32). Intensive logging and road building began in the early 1900's and extended into most of the basin with the exception of a few areas that are now protected reserves such as the Colonel Bob Wilderness (USFWS, 2004, page 77-78). Extensive streambank hardening along roads and developments has further degraded aquatic habitat conditions (USFWS, 2004, page 92). While further road development and decommissioning have occurred since the early 2000's, conditions in the watershed remain similar today. Future planned work considers road decommissioning or closure efforts, recreational access restoration to reduce impacts to riparian areas, and realignment of roads both on and off ONF lands.

Hoh River Watershed: The majority of the Hoh River core area is within the Olympic National Park, where there has not been an intense history of logging and construction of logging roads. Downstream of the Olympic National Park, however, the watershed has been heavily logged by private landowners and the WDNR (USFWS, 2004, page 80). Stream-adjacent roads have caused excessive sedimentation and disconnected side channels much like a dike or levee (WSCC, 2000b). The ONF administers a small portion the Hoh watershed (413 acres). Accordingly, roads on ONF lands in this core area have not likely played a role in the degradation of the Hoh watershed.

Dungeness River Watershed: In 1949, there were only 8.3 miles of logging roads constructed on ONF lands in the Dungeness River watershed but by 1983, there were more than 83 miles of logging roads. Of the 24 sub-basins in the Dungeness core area, 16 exceeded the 2.5 miles of road per square mile threshold, and even more sub-basins exceeded the 1 mile of road per square mile threshold (USFWS, 1999) and the 0.7 to 1.7 mile of road per square mile threshold (USFWS, 2004) around the turn of century. The ONF made significant progress reducing road threats and densities in the early 2000s as part of the Dungeness River Management Team, following a very high rate of road failure during the winter of 1998 to 1999 (USFWS, 2004, page 96), but road densities remain above the thresholds suggested by Quigley and others (1996) (Table 32) for supporting functional bull trout habitat. Extensive mass wasting along service roads 2860, 2870, and 2880 (WSCC, 2000a) was specifically mentioned in the draft bull trout recovery plan as a significant source of sedimentation that needs to continue to be addressed (USFWS, 2004, p. 95). The forest road network in the Dungeness River watershed will continue to have adverse effects on bull trout that could be prevented by additional road decommissioning projects.

Elwha River Watershed: The majority of the Elwha River core area is within the Olympic National Park, and there are only a few identified transportation-related issues (USFWS, 2004). Road densities were fairly low in the upper watershed where most of the bull trout habitat is located. However, the ONF administers a small portion of two sub-watersheds (11,180 acres combined), and road densities were moderate in both of those sub-watersheds (Table 32). While further road development and decommissioning have occurred since the early 2000's, conditions in the watershed remain similar today. The Little River/Hughes Creek sub-watershed contains spawning and rearing habitat for bull trout, and may be degraded by the effects of forest roads; including 2 miles of stream-adjacent ONF roads that have 17 stream crossings. Those roads are currently closed.

27.7.1.2 Commitment to Reducing Road Densities on ONF

For the last two decades, the ONF has worked to reduce the environmental footprint of the road system. Much of this work has benefited the conservation of bull trout. The ONF has decommissioned 145 miles of roads (Forest-wide) since 2007. In the 1990s and early 2000s, road decommissioning work focused on sub-watersheds with high road densities within the Skokomish and Dungeness River core areas. That work was informed by watershed analyses, as required by the NWFP (USDA & USDI 1994, page E-20). The ONF has decommissioned more than 100 miles of road in the Skokomish River core area alone since 1990. Because of the magnitude of completed restoration work and the strength of the science showing the benefits of road removal, we assume that the magnitude and duration of road-caused sedimentation events in bull trout habitat on the ONF have decreased since the early 1990s. However, there is not enough information for bull trout trends on the Olympic Peninsula to suggest how bull trout carrying capacity has changed in response to restoration progress. Much more road decommissioning is necessary to fulfill the ONF's obligations under the Northwest Forest Plan, but that work is still under-funded.

Road decommissioning usually involves "obliterating" roads before they are considered "decommissioned." Under Forest Service terminology, the term "decommission" specifically means removing the road from the ONF's database of roads for which they are responsible.

“Obliterating” usually means ripping the road surface, removing fill from stream channels, and returning the road to a natural hydrological state. Obliteration is the most effective way to eliminate the effects of roads on bull trout in the long-term, but closing roads to traffic, maintaining the road surface (preferably with gravel), and upgrading the drainage design can also significantly reduce sedimentation and hydrologic interruption. The ONF has an annual road decommissioning target of 5 miles, including obliterating roads to restore hydraulic connectivity, native plantings to stabilize slopes, and temporary sediment traps to limit increases in sedimentation during plant establishment. These measures help offset the effects of existing roads on the ONF.

The ONF has made progress towards minimizing the adverse effects of the ONF road system on bull trout in core watersheds, and they remain bound by previous consultations, regulations, and policy to continue reducing the footprint of their road system. In particular, the ONF must comply with the Aquatic Conservation Strategy (ACS) under the NWFP (USDA & USDI 1994). Bull trout were listed as a threatened species in 1999 and, in 2000, the USFWS wrote an Opinion for the effects of continuing to implement the ACS on bull trout and bull trout critical habitat (USFWS, 2000). The four main components of the ACS are Riparian Reserves, Key Watersheds, Watershed Analysis, and Watershed Restoration. Those four components have nine objectives, as summarized in the Record of Decision for the NWFP (USDA 1994c, page B-11). Specifically, the Forest Service and the U.S. Bureau of Land Management committed their administered lands to “maintain and restore the sediment regime under which aquatic ecosystems evolved; … Elements of the sediment regime include the timing, volume, rate, and character of sediment input, storage, and transport.” The ACS also had special protections for Key Watersheds. All of the bull trout core watersheds on the ONF are considered Key Watersheds. The special protections include “No new roads will be built in roadless areas in Key Watersheds,” and “Reduce existing system and non-system road mileage outside roadless areas. If funding is insufficient to implement reductions, there will be no net increase in the amount of roads in Key Watersheds” (USDA 1994, page B-19).

In 2005, the Forest Service promulgated a Travel Management Rule that requires the Forest Service to identify sustainable forest road systems for each National Forest by the year 2015 (70 FR 68264). Implementation of the Travel Management Rule requires a several-step travel analysis process that begins with identifying the current road system and levels of use and management, soliciting public and stakeholder input, and weighing the values and risks of each road segment. Specifically, the analysis will identify future road use needs for Forest Service actions (such as forest health management), analyze what the National Forests can afford to keep and maintain, and then generate a report that informs future proposed road management actions by sub-watershed (or larger scale). This work is on-going and may be the subject of future ESA Section 7 consultation at the planning level or at the project level. Additionally, due the Dungeness Road Management Project, we expect road densities in the Dungeness core area watershed to decrease starting in 2020, as a result of road decommissioning, road to trail conversion, and road closures.

We expect that during the 10-year life of this proposed action, the ONF will continue to implement the ACS and prioritize road decommissioning in Key Watersheds. All of the bull trout core area watersheds on the ONF are also considered Key Watersheds. Road decommissioning prioritization within watersheds will be informed through the watershed analyses that are part of the ACS (USDA 1994c page B-11, USDA 1995a, USDA 1995b). We anticipate that the ONF will continue to focus watershed restoration efforts on the Dungeness and Skokomish core areas. The USFWS previously determined that full compliance with the ACS would not jeopardize the continued existence of bull trout or adversely modify bull trout critical habitat (USFWS, 2000). Future road decommissioning work is covered under the ARBO II (USFWS, 2013), and is essential to fulfilling the Forest Service's requirements under the NWFP and the ACS (USDA & USDI 1994).

27.8 Conservation Role of the Olympic National Forest for Bull Trout

Bull trout core areas and FMO areas all play a critical role in the recovery of bull trout in the Olympic Peninsula region of the Coastal RU (USFWS, 2015). Rivers, lakes, and tributary stream habitat within the ONF boundary provide essential spawning, rearing, foraging, migration, and overwintering habitat for bull trout. In the coastal core areas (including the Hoh, Queets, and Quinault River watersheds), habitat within the ONF is largely limited to foraging and migration habitat in the lower portions of these basins, with potential spawning and rearing habitat in tributaries to the Queets River and short reaches of tributaries above Lake Quinault. Core areas along the Hood Canal/Strait of Juan de Fuca have substantial stream habitat within the ONF. The Skokomish River and the Dungeness River basins have the most stream habitat within the ONF boundary, with over 40 percent of the available habitat occurring within the ONF, including known bull trout spawning and rearing streams.

28 EFFECTS OF THE ACTION: Bull Trout

28.1 Introduction

With the sole exception of some in-water riprap placement and culvert cleaning, implementation of the proposed action would not include work within the wetted width of bull trout habitat. Actions within the wetted width of bull trout habitat usually require work-site isolation and fish capture procedures, and the effects of those procedures are outside the scope of this Opinion. The ARBO II (USFWS 2013) addresses many actions within the wetted width of bull trout habitat, and provides ESA coverage for many of the programs administered by the ONF. The ONF should pursue individual ESA consultations for actions that do not conform to the proposed action herein or to actions covered under the ARBO II.

The USFWS finds implementation of the proposed action in non-core area watersheds for bull trout (such as the Wishkah, Humptulips, Wynoochee, Satsop, Duckabush, Dosewallips, Hamma Hamma, and Quilcene river watersheds) is likely to result in discountable effects to bull trout because bull trout presence in those watersheds within proximity of any measureable adverse in-stream effects is extremely unlikely. As discussed above in the Environmental Baseline section, bull trout presence in those watersheds are very rare, seasonal, and associated with the main-stem rivers and their estuaries far downstream of ONF managed lands. The Effects of the Action analysis on bull trout presented below deals exclusively with considering the effects of proposed activities in core watersheds for bull trout. As discussed in the Environmental Baseline section, core area watersheds for bull trout on the ONF include the Skokomish, Dungeness, Elwha, Hoh, Queets, and Quinault rivers. With the exception of stewardship timber sales, all commercial timber harvest on the ONF occurring throughout the duration of the action will occur outside core area watersheds for bull trout.

In core area watersheds for bull trout, as discussed below, the USFWS finds that implementation of the proposed action, inclusive of the CMs, is likely, in some cases, to result in no effect or insignificant effects to bull trout and bull trout habitat. Other project types are likely to cause adverse effects to bull trout and bull trout habitat even when complying even with the proposed CMs.

The sequence of this analysis will be to discuss the category of insignificant and discountable effects followed by a discussion of adverse effects likely to be caused by the proposed 10-year program of work.

28.2 Analytical Framework for Effects

The NMFS, USFWS, Forest Service, and U.S. Bureau of Land Management developed a framework to facilitate and standardize determinations of effects for ESA conferencing and consultation for proposed and listed salmon, trout, and char through the use of a Matrix of Diagnostics/Pathways and Indicators ("matrix"). The matrix uses 19 habitat indicators and five population indicators to evaluate the current condition of and potential changes to habitat and population characteristics (Table 33).

Table 33 presents the USFWS's deconstruction of the proposed activities in bull trout core watersheds and the corresponding anticipated effects using the matrix indicators. An "I" means that the particular proposed action is likely to have insignificant effects on the corresponding habitat or population indicator and on bull trout. A blank box means that no effect on that habitat or population indicator is expected to be caused by the particular proposed action. The proposed activities that may have adverse effects are in bold font, and have an "A" that corresponds to the habitat indicator that is likely to be adversely affected. Proposed activities that are likely to adversely affect one or more of the matrix indicators will be further addressed later in this Opinion. Culvert cleaning and riprap placement are not included in Table 33 because those proposed actions have direct effects to bull trout and are addressed in the Adverse Effects section.

When reading the table below, recognize that some sets of indicators are affected by the same type of stressor. For instance, if there is an insignificant effect likely to occur to "pool frequency and quality" then we would also expect insignificant effects to occur to "large pools." "Sediment/turbidity" is usually in a set of matrix indicators with "substrate embeddedness," "pool frequency and quality," "large pools," and "width/depth ratio." However, some of the proposed activities are likely to have sediment effects so miniscule that only "sediment/turbidity" is likely to be measurably affected.

Table 33. A deconstruction of the activities covered under the proposed action in bull trout core watersheds that are likely to cause insignificant (I), adverse (A), or no effects (blank) to the matrix indicators.

			Habitat indicators																			Pop'n indicators				
Program	**Subprogram**	**Activity**	**Temperature**	**Sediment/ turbidity**	**Chem. cond./ nutrients**	**Physical barriers**	**Substrate**	**Large woody debris**	**Pool freq & quality**	**Large Pools**	**Off-channel habitat**	**Refugia**	**Width/depth ratio**	**Streambank condition**	**Floodplain connectivity**	**Peak/base flows**	**Drainage network**	**Road density &**	**Disturbance history**	**Riparian conserve. area**	**Disturbance regime**	**Integ of sp, hab cond**	**Subpopulation size**	**Growth and survival**	**Life hist, diver,**	**Persist , genetic**
Recreation Management	Developed Site Operation and Maintenance	Maintenance of developed facilities		I										I												
	Dispersed Site Maintenance	Maintenance of dispersed facilities		I										I												
	Trail Maintenance	Trail maintenance		I										I						I						
	Trail Relocation, Construction, and Restoration	Trail relocation, construction, and restoration		I			I		I	I	I		I	I			I			I						
	Trail Bridge/ Foot Log Construction, Reconstruction, and Removal	Trail bridge/ foot log construction, reconstruction, and removal	I	I	I		I	I	I	I	I		I	I						I						
	Trail Bridge Maintenance	Trail bridge maintenance		I	I																					
	Recreation Site and Trailhead Expansion	Recreation site and trailhead expansion		I	I		I		I	I	I		I	I						I						
	Forest Health (sanitation) Harvest	Forest Health (sanitation) Harvest	I	I	I		I	I	I	I	I		I	I			I			I						

Table 33. A deconstruction of the activities covered under the proposed action in bull trout core watersheds that are likely to cause insignificant (I), adverse (A), or no effects (blank) to the matrix indicators.

			Habitat indicators																			Pop'n indicators				
Program	**Subprogram**	**Activity**	**Temperature**	**Sediment/ turbidity**	**Chem. cond./ nutrients**	**Physical barriers**	**Substrate**	**Large woody debris**	**Pool freq & quality**	**Large Pools**	**Off-channel habitat**	**Refugia**	**Width/depth ratio**	**Streambank condition**	**Floodplain connectivity**	**Peak/base flows**	**Drainage network**	**Road density &**	**Disturbance history**	**Riparian conserve. area**	**Disturbance regime**	**Integ of sp, hab cond**	**Subpopulation size**	**Growth and survival**	**Life hist, diver,**	**Persist , genetic**
Recreation Management (Continued)	Historic Cabin and Roadside Viewpoint Viewshed Management	Historic Cabin and Roadside Viewpoint Viewshed Management	I	I	I		I	I	I	I	I		I	I			I			I						
Administrative Facilities		Maintenance of developed facilities		I	I																					
Hazard/Danger Tree Removal		Removal of large trees	I	I				I												I						
Silviculture		**Log haul**		**A**	**I**		**A**		**A**	**A**	**A**		**A**													
		Temporary road construction and reconstruction		**A**	**I**		**A**		**A**	**A**	**A**		**A**	**I**		**A**	**A**	**A**		**I**						
		Culvert installation and repair		I	I		I		I	I	I		I	I						I						
	Commercial Thinning	**Commercial Thinning**	I	I	I			I								I	I			I						
		Treatment in alder-dominated stands	I	I	I			I								I	I			I						
		Forest Health (sanitation) Harvest	I	I	I			I								I	I			I						

Table 33. A deconstruction of the activities covered under the proposed action in bull trout core watersheds that are likely to cause insignificant (I), adverse (A), or no effects (blank) to the matrix indicators.

			Habitat indicators																			**Pop'n indicators**				
Program	**Subprogram**	**Activity**	**Temperature**	**Sediment/ turbidity**	**Chem. cond./ nutrients**	**Physical barriers**	**Substrate**	**Large woody debris**	**Pool freq & quality**	**Large Pools**	**Off-channel habitat**	**Refugia**	**Width/depth ratio**	**Streambank condition**	**Floodplain connectivity**	**Peak/base flows**	**Drainage network**	**Road density &**	**Disturbance history**	**Riparian conserve. area**	**Disturbance regime**	**Integ of sp, hab cond**	**Subpopulation size**	**Growth and survival**	**Life hist, diver,**	**Persist , genetic**
Silviculture (Continued)	Pre-commercial Thinning	Pre-commercial Thinning	I	I	I			I												I						
		Riparian treatments	I					I						I						I						
	Salvage sales	Harvest	I	I	I			I												I						
	Planting	Planting																								
	Cone collection	Cone collection																								
	Seed orchard operation and maintenance	Seed orchard operation and maintenance																								
Transportation System	**Road Reconstruction**	**Road reconstruction**		**A**	**I**		**A**		**A**	**A**	**A**		**A**	**I**		**A**	**A**	**A**		**I**						
		Culvert installation and repair		I	I		I		I	I	I		I	I						I						
	New Road Construction	**New road construction**		**A**	**I**		**A**		**A**	**A**	**A**		**A**	**I**		**A**	**A**	**A**		**I**						
	Bridge Construction and Reconstruction	Bridge installation and repair		I	I		I		I	I	I		I	I						I						
	Transportation System Repair	**Road repairs**		**A**	I		**A**		**A**	**A**	**A**		**A**	**I**		**I**	**A**	**A**		**I**						
	Rock Sources	Blasting and collection of rock		I	I																					

Table 33. A deconstruction of the activities covered under the proposed action in bull trout core watersheds that are likely to cause insignificant (I), adverse (A), or no effects (blank) to the matrix indicators.

Program	Subprogram	Activity	Habitat indicators																			Pop'n indicators				
			Temperature	Sediment/ turbidity	Chem. cond./ nutrients	Physical barriers	Substrate	Large woody debris	Pool freq & quality	Large Pools	Off-channel habitat	Refugia	Width/depth ratio	Streambank condition	Floodplain connectivity	Peak/base flows	Drainage network	Road density &	Disturbance history	Riparian conserve. area	Disturbance regime	Integ of sp, hab cond	Subpopulation size	Growth and survival	Life hist, diver,	Persist , genetic
Road Maintenance	Culvert Replacement And Installation	Culvert installation and repair		I	I		I		I	I	I		I	I						I						
	Grading	**Grading**		**A**			**A**		**A**	**A**	**A**		**A**	**I**		**I**	**I**									
	Drainage Maintenance	**Drainage maintenance**		**A**			**A**		**A**	**A**	**A**		**A**	**I**		**A**	**A**									
	Brushing	Brushing																								
	Downed Tree Removal	Downed tree removal																								
	Pavement Repairs	pavement repairs			I																					
	Surfacing Replacement	surfacing replacement			I																					
	Bridge Maintenance	bridge maintenance		I	I																					
	Gate Installation and Maintenance	gate installation and maintenance																								
	Painting	painting			I																					
	Shoulder Maintenance	shoulder maintenance		I			I		I	I	I		I	I		I										
	Road Daylighting	Road Daylighting		I			I		I	I	I		I	I		I										

Table 33. A deconstruction of the activities covered under the proposed action in bull trout core watersheds that are likely to cause insignificant (I), adverse (A), or no effects (blank) to the matrix indicators.

Program	Subprogram	Activity	Habitat indicators																			Pop'n indicators				
			Temperature	Sediment/ turbidity	Chem. cond./ nutrients	Physical barriers	Substrate	Large woody debris	Pool freq & quality	Large Pools	Off-channel habitat	Refugia	Width/depth ratio	Streambank condition	Floodplain connectivity	Peak/base flows	Drainage network	Road density &	Disturbance history	Riparian conserve. area	Disturbance regime	Integ of sp, hab cond	Subpopulation size	Growth and survival	Life hist, diver,	Persist , genetic
Lands and Special Uses	**Road Use and Access Permits**	**road repairs**		**A**	**I**		**A**		**A**	**A**	**A**		**A**	**I**		**I**	**A**	**A**		**I**						
		culvert installation and repairs		I	I		I		I	I	I		I	I						I						
	Road and Trail Easements	**road and trail repairs**		**A**	**I**		**A**		**A**	**A**	**A**		**A**	**I**		**I**	**A**	**A**		**I**						
		culvert installation and repair		I	I		I		I	I	I		I	I						I						
	Tailhold and Guyline Anchor Permits	cutting of large trees for tailholds and guylines	I					I												I						
	Utilities	clearing of utility corridors	I	I				I												I						
	Communication and Weather Sites	installation and maintenance of comm. and weather sites																								
	Research and Monitoring Permits	surveys in rivers, creeks		I																						
	Water Transmission Permits	transmitting water	I						I	I																

Table 33. A deconstruction of the activities covered under the proposed action in bull trout core watersheds that are likely to cause insignificant (I), adverse (A), or no effects (blank) to the matrix indicators.

			Habitat indicators																			Pop'n indicators				
Program	**Subprogram**	**Activity**	**Temperature**	**Sediment/ turbidity**	**Chem. cond./ nutrients**	**Physical barriers**	**Substrate**	**Large woody debris**	**Pool freq & quality**	**Large Pools**	**Off-channel habitat**	**Refugia**	**Width/depth ratio**	**Streambank condition**	**Floodplain connectivity**	**Peak/base flows**	**Drainage network**	**Road density &**	**Disturbance history**	**Riparian conserve. area**	**Disturbance regime**	**Integ of sp, hab cond**	**Subpopulation size**	**Growth and survival**	**Life hist, diver,**	**Persist , genetic**
Lands and Special Uses (Continued)	Outfitter Guide Permits	outfitter guide permits																								
	Developed Facilities Permits	maintenance of developed facilities		I	I									I												
	Recreation Residence Maintenance	maintenance of developed facilities		I	I									I												
	Communication Site Line-of-Sight Vegetation Removal	Communication Site line-of-sight vegetation removal	I	I	I			I												I						
	Permits for Other Special Uses	permits for other special uses		I										I						I						
Land Line Survey and Boundary Adjustments		land line survey and boundary adjustments																								
Administrative Tours and Remote Site Inspections		administrative tours and remote site inspections																								
Waste Cleanup		waste cleanup		I	I									I						I						

Table 33. A deconstruction of the activities covered under the proposed action in bull trout core watersheds that are likely to cause insignificant (I), adverse (A), or no effects (blank) to the matrix indicators.

Program	Subprogram	Activity	Habitat indicators																			Pop'n indicators				
			Temperature	Sediment/ turbidity	Chem. cond./ nutrients	Physical barriers	Substrate	Large woody debris	Pool freq & quality	Large Pools	Off-channel habitat	Refugia	Width/depth ratio	Streambank condition	Floodplain connectivity	Peak/base flows	Drainage network	Road density &	Disturbance history	Riparian conserve. area	Disturbance regime	Integ of sp, hab cond	Subpopulation size	Growth and survival	Life hist, diver,	Persist , genetic
Fire Hazard Reduction	Hand Piling and Burning	hand piling and burning			I																					
	Machine Piling and Burning	machine piling and burning		I	I																					
	Landing Piling and Burning	landing piling and burning		I	I																					
	Chipping and Burning	chipping and burning			I																					
	Broadcast Burning and Underburning	broadcast burning and underburning		I	I																					
Special Forest Products	Salal Harvest	salal harvest																								
	Bear Grass Harvest	bear grass harvest																								
	Bough Cutting	bough cutting	I																							
	Mushroom Picking	mushroom picking																								
	Other Forest-Product Requests	other forest-product requests																								
	Christmas Tree Cutting	Christmas tree cutting	I		I			I																		
	Disposition of Confiscated Materials	disposition of confiscated materials																								

Table 33. A deconstruction of the activities covered under the proposed action in bull trout core watersheds that are likely to cause insignificant (I), adverse (A), or no effects (blank) to the matrix indicators.

			Habitat indicators																			Pop'n indicators				
Program	**Subprogram**	**Activity**	**Temperature**	**Sediment/ turbidity**	**Chem. cond./ nutrients**	**Physical barriers**	**Substrate**	**Large woody debris**	**Pool freq & quality**	**Large Pools**	**Off-channel habitat**	**Refugia**	**Width/depth ratio**	**Streambank condition**	**Floodplain connectivity**	**Peak/base flows**	**Drainage network**	**Road density &**	**Disturbance history**	**Riparian conserve. area**	**Disturbance regime**	**Integ of sp, hab cond**	**Subpopulation size**	**Growth and survival**	**Life hist, diver,**	**Persist , genetic**
Special Forest Products (Continued)	Cutting of Firewood, Posts, and Rails	cutting of firewood, posts, and rails	I		I			I																		
Tribal Requests		cutting of large trees for tribes	I		I			I																		

28.3 Insignificant and Discountable Effects of the Proposed Action on Bull Trout

Proposed actions that will result in only insignificant effects will be grouped by indicator and discussed below. However, in-water riprap placement in S&R habitat and in FMO habitat with substrate where juvenile bull trout may seek shelter when disturbed, and when implemented according to the project description and conservation measures (including placement only above, below, or next to existing riprap or infrastructure, or outside of the bankfull channel, and with Level 1 team evaluation when necessary), would have both insignificant and discountable effects on bull trout and bull trout habitat. Indirect habitat effects from the placement of riprap are discussed with other indirect habitat effects in the pathways and indicators analysis, below. Potential direct effects on bull trout from the in-water placement of rock include 1) the possibility of direct contact with bull trout and 2) turbidity from rock contact with the bank and substrate.

Injury to bull trout individuals when placing riprap in-water is extremely unlikely to occur, and therefore would be discountable because riprap placement will be limited to exclude S&R habitat and FMO habitat with substrate where juvenile bull trout may seek shelter when disturbed. Additionally, further protection is afforded by following project description and conservation measures (including placement only above, below, or next to existing riprap or infrastructure, or outside of the bankfull channel -with Level 1 team evaluation when necessary). For all in-water riprap placements, the Level 1 team will evaluate the quantity of rock placed, the location of that rock, and probability of bull trout presence in determining if the project is consistent with the effects analyzed in this Opinion.

When limiting the placement of riprap to areas where juvenile bull trout will not be exposed, and following the project description and conservation measures (including placement only above, below, or next to existing riprap or infrastructure, or outside of the bankfull channel), the turbidity created by in-water placement of riprap would not be great enough to measurably affect bull trout or bull trout habitat, and therefore would be insignificant. For all in-water riprap placements, the Level 1 team will evaluate the quantity of rock placed, the location of that rock, and probability of bull trout presence in determining if the project is consistent with the effects analyzed in this Opinion, and therefore, will avoid and minimize turbidity exposure to bull trout

28.3.1 <u>Effects of the Action on Sediment Indicators</u>

Implementation of the following CMs and Project Descriptions (PDs) under the proposed actions marked as "I" in Table 33 under the sediment indicators is likely to cause insignificant effects on the sediment indicators "sediment/turbidity" for the following reasons:

1. Projects potentially affecting the bed or banks of streams, lakes, or other water bodies must meet all conditions specified in the Memorandum of Understanding with Washington Department of Fish and Wildlife regarding ONF hydraulic projects, including appropriate in-water work timing periods (WDFW and USFS 2017).

2. Erosion prevention and control methods shall be used as necessary during and immediately after project implementation to minimize loss or displacement of soils and to prevent delivery of sediment into waterbody. These may include, but are not limited to, operational techniques, straw bales, silt fencing, erosion control blankets, temporary

sediment ponds, and/or immediate mulching of exposed areas. Disturbed ground with the potential to deliver sediment into waterbodies shall be revegetated or protected from surface erosion by seeding, mulching, other methods prior to the fall rainy season. After project completion, disturbed streambanks and lakeshores shall be revegetated with site-appropriate vegetation to maintain soil stability and provide shade and future sources of large wood. Revegetation can be accomplished by planting or natural reproduction, depending on site conditions.

3. Replacement and installation of culverts greater than 36 inches in diameter within 0.5 mile of bull trout-bearing streams shall be reviewed by Level 1 for consistency with this programmatic.

4. Replacement and installation of culverts less than 36 inches in diameter within 0.25 mile of bull trout-bearing streams shall occur during the low-flow in-water work period (WDFW and USFS 2017).

5. If culvert work is planned to occur immediately upstream from an incised channel (a streambed that has become eroded, deepened, and disconnected from its floodplain), the culvert inlet will be placed at the same elevation as the existing natural streambed. If this is not feasible, the project will be reviewed by Level I to determine consistency with this Opinion.

6. If wet-weather conditions during project operations generate and transport sediment to a stream channel or other water body, operations shall cease operations until the weather conditions improve, unless delaying operations would increase the risk of adverse resource impacts.

7. Disturbed ground where log stringers were dragged shall be evaluated and erosion-control measures applied where needed.

8. Commercial harvest activities and associated activities will implement no-cut buffers in proximity to bodies of water, and seasonal restrictions for road construction to minimize sediment delivery to streams (Appendix L - Project Design Criteria for Commercial Thinning and Associated Activities Table).

Rationale: The amount of turbidity and suspended sediment mobilized into bull trout habitats (e.g., S&R habitat) is likely to be significantly reduced or prevented because most work will occur outside bull trout core areas and by CM/PDs that restrict the timing and location of ground- and channel- disturbing work (sediment CM/PDs 1, 3, 4, 5, 6, 8). Working outside bull trout core areas and within S&R habitats, and these CM/PDs protect bull trout from high concentrations of suspended sediment.

The amount of sediment mobilized into bull trout streams from projects occurring <u>in the active channel</u> of adjacent tributaries without bull trout will be reduced by the CM/PDs above that prevent ground and channel disturbance (1, 2) and CM/PDs that capture the sediment after it is mobilized (1, 2). The sediment that does mobilize into the stream during and after project activities would be delivered to bull trout habitat in quantities that are not expected to be meaningfully measured as an adverse effect, and would therefore be insignificant. This finding is based on the fact that CM/PDs 3 and 4 specify that projects would A) occur at least 0.5 mile upstream from bull trout habitat, B) disturb a small quantity of sediment (culverts less than 36 inches in diameter) and occur more than 0.25 mile upstream of bull trout habitat, C) disturb a small quantity of sediment (culverts less than 36 inches in diameter) and occur during the low-flow in-water work window, or D) be reviewed by the Level 1 team for consistency with this Opinion. Culverts 36 inches in diameter or smaller are installed on cross drains or first-order swales. Perennial streams and most ephemeral/intermittent streams require larger culverts because the culvert must accommodate the 100-year flow event plus debris. Streams small enough to be accommodated by a 36 inch diameter culvert are not expected to transport significant amounts of sediment during or after culvert work because of limited stream power, limited channel adjustment, and little or no sediment wedge. Additionally, sediment is reasonably certain to be diluted, deposited, or otherwise be undetectable 0.5 mile downstream of disturbed sites (or 0.25 mile downstream of disturbed sites during low-flow) based on our analysis of pertinent literature (Bilby 1985, Duncan 1987, Foltz 2008, Lachance 2008).

The amount of sediment mobilized into streams from projects occurring outside of the active channel is likely to be reduced by CM/PDs that require buffers for certain types of activity close to bodies of water (8), prevent ground disturbance (2), and several CM/PDs that capture the sediment after it is mobilized but before it reaches the stream (1, 2, 7). Sediment that does reach the stream during and after project activities is likely to be in small quantities that are not expected to measurably affect bull trout, and therefore would be insignificant.

28.3.2 Effects of the Action on Stream Temperature Indicators

Given implementation of the following CMs and PDs under the proposed actions marked as “I” in Table 33 under the sediment indicators, the proposed actions are likely to cause insignificant effects on the stream temperature indicators “temperature” and “riparian conservation areas” for the following reasons:

1. No cutting of standing trees for firewood or posts shall be permitted within 100 feet of streams, lakes, or other waterbodies.

2. Any project involving placement/repair of instream diversion or withdrawal structures, or excavation within the bankfull stream channel within bull trout core watersheds shall be reviewed by the Level 1 Team to ensure consistency with this programmatic consultation.

3. The Black Diamond Water District Permit, and any other permit renewal not listed in Table 5, will be reviewed by the Level 1 Team to determine if it is consistent with the effects anticipated in the Opinion or if a separate consultation is warranted.

4. Commercial harvest and associated activities will implement no-cut buffers in proximity to bodies of water to minimize removal of shade trees (Appendix L).

Rationale: Trees can moderate summer stream temperature maximums and averages by shading the stream from solar radiation. The vast majority of trees that provide shade to a waterbody are within 100 feet of that waterbody (Brazier and Brown 1974, Steinblums et al. 1984, Beschta et al. 1987). Under the proposed action, the ONF may remove trees that shade streams if the trees are hazard trees or are to be used for trail bridges, foot logs, tribal purposes, tailholds, or guylines. Based on past practices, the ONF is rarely expected to use stream-shading trees for trail bridges, foot logs, tribal purposes, tailholds, and guylines, but there may be instances where the only appropriate tree is shading a water body. Firewood and post collection will not result in the removal of trees within 100 feet of streams, lakes, or other waterbodies (CM/PD 1). Additionally, commercial thinning activities, with the exception of treatment within alder-dominated stands, will apply no-cut buffers and activity restrictions in proximity to streams and wetlands (CM/PD 4). The ONF will treat up to 500 acres of alder-dominated stands over the 10-year duration of this programmatic. While removal of these trees near streams may lead to small increases in stream temperature, these increases are minor in the context of natural temperature variability. Additionally, since all commercial thinning, with the exception of relatively small stewardship timber sales, will occur only outside bull trout core areas, any temperature increases would not affect spawning and rearing habitat. Therefore, the effects of commercial thinning on temperature are considered insignificant.

In the case of hazard trees and logs for trail bridges, foot logs, tribal purposes, tailholds, or guylines, only single trees would be removed. We anticipate that the removal of one tree would have insignificant effects on the temperature of the adjacent stream and subsequently would be likely to have insignificant effects on bull trout. Cumulatively over the 10 years of the proposed program, many single trees that shade streams may be removed by the activities in this programmatic. However, we expect that those trees would be removed throughout space (i.e., in different streams and watersheds) such that the additive effects would not be expected to measurably affect bull trout, and therefore would be insignificant.

Stream temperature may also be affected by water withdrawals because smaller streams have less mass and therefore usually have greater temperature variation in response to solar radiation. The withdrawal of water is an interdependent action with the permit authorized by the ONF to transmit water. Eight of the ten water transmission and withdrawal permits that may be renewed in core watersheds for bull trout under the proposed action are for less than 1 cubic feet per second (cfs) (most are for less than 0.1 cfs), are being withdrawn from streams not occupied by bull trout, and the nearest bull trout stream has significantly more flow even during low flow conditions (Table 5). Further, the water being withdrawn is mostly returned to the watershed after use (wastewater, irrigation, etc.). For those reasons, the USFWS concludes that these withdrawals of less than 1 cfs would not have a measureable adverse effect on water temperatures in bull trout habitat. The Black Diamond Water District permit renewal will be reviewed by the Level 1 Team (CM/PD 3) when information is available to determine if it also meets the criteria of this rationale. The effect of water withdrawal from the USFWS's Quinault National Fish Hatchery on bull trout has already been consulted on under Section 7, and accordingly in this Opinion, we are only consulting on the issuance of a waterline permit and not the interdependent withdrawal of water. Therefore, the renewal of water transmission and withdrawal permits under the proposed action is likely to have insignificant effects on bull trout.

28.3.3 Effects of the Action on Contaminant Indicators

Given implementation of the following CMs and PDs under the proposed actions marked as "I" in Table 33 under the sediment indicators, those proposed actions are likely to cause insignificant effects on the contaminant indicator "chemical condition/nutrients" for the following reasons:

1. Proposed projects with the potential to affect the bed or banks of streams, lakes, or other water bodies must meet all of the conditions specified in the MOU with WDFW regarding ONF hydraulic projects, including appropriate in-water work timing periods (WDFW and USFS 2017).

2. All machinery maintenance involving potential contaminants (fuel, oil, hydraulic fluid, etc.) shall occur at a site that is at least 100 feet from stream banks, water bodies, or wetlands.

Rationale: With implementation of the proposed action, there is a potential for contaminants to enter bull trout habitat from machines or treated wood. Machines (e.g., chainsaws, backhoes, trucks) may spill or leak contaminants such as gasoline, grease, and coolant during the proposed activities. For purposes of this analysis, a "spill" is considered to be a large, single event where contaminants discharge from a containers or machine. A "leak" is considered to be a small, continuous source of contaminants escaping from imperfectly sealed containers or machinery. Although the probability of a spill from an individual action covered by the proposed action is discountable, the cumulative probability of a spill during the program of activities is not discountable. However, contaminants CM/PDs 1 and 2 require that machinery be refueled and repaired at least 100 feet from waterbodies and that all machinery be cleaned before being used near or in waterbodies. The USFWS accordingly anticipates that spills in the wetted channel are discountable, and spills 100 feet from waterbodies are possible, but insignificant because contaminated soil could be cleaned up before it drained into bull trout habitat. A spill containment plan is required by the MOU (CM/PD 1) (WDFW and USFS 2017). Leaks also would be mitigated by CM/PDs 1 and 2. The MOU requires that machinery be inspected daily for leaks and repaired before work can begin (WDFW and USFS 2017). We anticipate that leaks may occur in bull trout habitat or tributaries to those habitats, but that the effects of these small amounts of contaminants are not expected to measurably affect bull trout, and therefore would be insignificant).

The proposed action includes in-water and over-water construction with treated wood and concrete components. The ONF most commonly uses treated wood in small, overwater structures such as trail bridges and boardwalks. CM/PD 1 requires the ONF to not use wood treated with creosote or pentachlorophenol and to use treated wood that meets or exceeds the standards established in the most current edition of "Best Management Practices for the Use of Treated Wood in Aquatic and Other Sensitive Environments" (WWPI 2012) and any current amendments or addenda to it. The best management practices referred to above 1) restrict the type of treated wood to be used in high and low risk environments, 2) ensure that the contaminants in the wood are as sealed as possible, and 3) define low impact construction and removal procedures. The USFWS is reasonably certain that the proposed treated wood projects, if adhering to the best management practices above, will release an insignificant amount of contaminants into bull trout habitat because the contaminant concentrations will dilute and not bioconcentrate or biomagnify in the environment or aquatic food chain (Stratus 2006, NOAA 2009). CM/PD 1 also requires the ONF to prevent fresh concrete and concrete by-products from entering waterbodies and to ensure that structures containing concrete are sufficiently cured to prevent leaching prior to contact with a waterbody. For those reasons, concrete contaminants are also likely to have insignificant effects on bull trout.

28.3.4 Effects of the Action on Watershed Hydrology Indicators

Given implementation of the following CMs and PDs under the proposed actions marked as "I" in Table 33 under the sediment indicators, the proposed actions are likely to cause insignificant effects on the watershed hydrology indicators "peak/base flows" and "drainage network increase" for the following reasons:

1. Any project involving placement/repair of instream diversion or withdrawal structures, or excavation within the bankfull stream channel within bull trout core watersheds shall be reviewed by the Level 1 Team to ensure consistency with this programmatic consultation.

2. The Black Diamond Water District Permit, and any other permit renewal not listed in Table 5, will be reviewed by the Level 1 Team to determine if it is consistent with the effects anticipated in the Opinion or if a separate consultation is warranted.

Rationale: The proposed trail work and roadwork may affect watershed hydrology by re-routing water down trails, road, and drainage features. Some of this work is anticipated to have adverse effects to bull trout via watershed hydrology indicators or other indicators (Table 33) and will be addressed later in this Opinion. Trail work, however, is anticipated to have insignificant effects on bull trout via watershed hydrology indicators for the reasons discussed below.

In watersheds where there is a high density of roads, trails, or other means of re-routing water into streams prematurely, the timing and quantity of streamflow in bull trout habitat can be significantly affected. Hydrologic effects at the subwatershed scale are generally linked to high road density (via extension of the stream network) or clearcut timber harvest. Many studies have attempted to quantify this relationship and establish a threshold where the response of streams is measurable (Jones and Grant 1996, Thomas and Megahan 1998, Beschta et al. 2000, Jones et al. 2000, Jones and Grant 2001, Wigmosta and Perkins 2001, Grant et al. 2008). After reviewing this body of literature, the USFWS is reasonably certain that trail work (relocation, construction, and restoration) would not measurably affect streamflow in watersheds of any size because the proposed activities would occur at a very small scale relative to the scale of disturbances analyzed in that literature. Therefore, the anticipated effects to bull trout and their habitats are not expected to measurably affect bull trout, and therefore would be insignificant.

Additionally, timber harvest, such as the stewardship timber sales occurring within bull trout core area watersheds, can affect peak/base flows depending upon their site-specific effects, elevation within a watershed, and the proportion of basin forest that has been altered by roads and prior timber harvest (Grant et al. 2008, p. 6). The effects of thinning treatments on local hydrology are not well documented, but are considered to be substantially less than clearcut timber harvest (Grant et al. 2008, p. 15). We assume that thinning 50 percent of the trees over 100 percent of an area represents a 50 percent harvested Equivalent Clearcut Area (ECA) (Grant et al. 2008, p. 15). For example, thinning 58 percent of a watershed would create a 29 percent ECA. Predicted increases within the rain zone are expected to occur when about 29 percent of the watershed (clearcut) is harvested (Grant et al. 2008, 35-39). In other words, if less than approximately 29 percent within a small drainage area (10 km^2 or 2,471 acres) in the rain zone (like the project area) is clear cut harvested, there are no data supporting a resultant increase in peak flow. Considering the stewardship timber sales are relatively small (less than 1,000 acres in size) and will always implement thinning treatments, rather than clearcutting, we expect that timber harvest covered under this programmatic will never exceed 29 percent ECA within small watersheds (10 km^2 or 2,471 acres) located in bull trout core areas. Therefore, commercial timber harvest is likely to have insignificant effects on bull trout.

Watershed hydrology may also be affected by domestic water withdrawals. The withdrawal of water is an interdependent action of the ONF permit to transmit water. Eight of the ten water transmission and withdrawal permits that may be renewed in core watersheds for bull trout under the proposed action are for less than 1 cubic feet per second (cfs) (most are for less than 0.1 cfs), are being withdrawn from streams not occupied by bull trout, and the nearest bull trout stream has significantly more flow even during low flow conditions (Table 5). Further, the water being withdrawn is mostly returned to the watershed after use (wastewater, irrigation, etc.). For these reasons, these withdrawals of less than 1 cfs are not likely to have a measureable adverse effect on watershed hydrology in bull trout habitat. The Black Diamond Water District permit renewal will be reviewed by the Level 1 Team (CM/PD 2) when information is available to determine if it also meets the criteria of this rationale. The effect of water withdrawal from the USFWS's Quinault National Fish Hatchery on bull trout has already been consulted on under Section 7, and accordingly in this Opinion, we are only consulting on the issuance of a waterline permit and not the interdependent withdrawal of water. Therefore, the renewal of water transmission and withdrawal permits are likely to have insignificant effects on bull trout

28.3.5 Effects of the Action on Large Wood Indicators

Given implementation of the following CMs and PDs under the proposed actions marked as "I" in Table 33 under the sediment indicators, those proposed actions are likely to cause insignificant effects on the large wood indicator "large woody debris" for the following reasons:

1. Existing large wood in stream channels shall be left in place if feasible or replaced in the stream channel at the conclusion of the project, unless doing so would cause degradation of habitat or put a drainage structure at risk.

2. Large woody material removed from a culvert inlet shall be put back into the stream channel downstream of the culvert unless doing so would cause increase the potential for damage to a culvert directly downstream.

3. All natural woody material in streams, lakes, or wetlands shall be left in place.

4. To retain the largest pieces of downed wood possible in stream channels and floodplains and minimize the need to cut large riparian trees during trail clearing activities, trails shall be relocated away from streambanks and out of floodplains where feasible.

5. Any tree proposed for use as a bridge stringer or footlog within 100 feet of bull trout habitat shall be reviewed by an Aquatic Specialist to ensure the tree is not critical to riparian/ stream function.

6. To retain the largest pieces of downed wood possible in stream channels and floodplains, bucking of large trees during trail-clearing activities in riparian areas shall be minimized.

7. No cutting of standing or downed trees for firewood, posts, and rails is permitted within 100 feet of stream channels.

8. To ensure adequate amounts of large wood in streams, any trees greater than 12 inches dbh to be felled within reach of a stream shall be felled toward the stream and left in place if feasible. If an aquatic specialist determines the trees are not needed to meet current instream large wood objectives, they may be removed for use in instream aquatic improvement projects or other administrative uses, left on-site to improve terrestrial large woody habitat, or sold.

9. Pre-commercial thinning, also known as young stand thinning, stocking level control, or density control, generally occurs in plantation stands that are 10 to 25 years of age. The units typically consist of densely stocked conifer stands (800 to 5,000+ trees per acre) with varying numbers of minor species. Generally, trees less than 6 inches dbh are cut. Thinning increases growth rates and produces larger trees with deeper crowns and heavier limbs.

10. Commercial timber harvest and associated activities will implement no-cut buffers in proximity to bodies of water to minimize reduction of large wood input into streams (Appendix L).

Rationale: All large wood CM/PDs for the proposed program of activities have been designed to maintain or enhance the presence of large wood in aquatic habitats. These measures would prevent large wood from being removed from streams (large wood CM/PDs 1, 2, 3) and reduce the loss of riparian trees that may become in-stream large wood (4 to 8, 10). Some riparian trees may be removed during special uses with single trees despite the CM/PDs above. However, the USFWS is reasonably certain that the effects on bull trout habitat from removal of a single tree at multiple sites are not likely to have a measurable or detectable adverse effect on individual bull trout. The trees removed during a pre-commercial thinning are not currently large enough to function as large wood, and the future potential of those trees as large wood would be replaced by neighboring trees that are "released" by the pre-commercial thin (9). The few riparian trees and logs likely to be cut during the proposed activities must be determined by an aquatic specialist to be pieces of wood were not needed to meet in-stream large wood objectives. We concur that in these situations a minor loss of future large wood recruitment would not measurably affect bull trout or their habitat. For these reasons, the USFWS concludes that those proposed projects that are implemented in accordance with the 10 CMs/PDs above are likely to have insignificant effects on large wood indicators and bull trout.

28.3.6 Effects of the Action on In-stream Habitat Indicators

Given implementation of the following CMs (*in addition to Sediment CM/PDs*) and PDs under the proposed actions marked as "I" in Table 33 under the sediment indicators, those proposed actions are likely to cause insignificant effects on the in-stream habitat indicators "pool frequency and quality," "large pools," "off-channel habitat," "width/depth ratio," "streambank condition," and "floodplain connectivity" for the following reasons:

1. Replacement of riprap above water where riprap previously existed to protect the bridge is covered by this programmatic Opinion without Level 1 review. Placement of riprap in new locations above, below, or next to existing riprap or infrastructure (such as bridge abutments), shall be reviewed by the Level 1 team to ensure consistency with this programmatic consultation. Any placement of riprap into the water in bull trout habitat shall also be reviewed by the Level 1 team to ensure consistency with this programmatic consultation. Riprap placement in new locations is not covered by this programmatic Opinion. When a riprap project that would have otherwise been evaluated by the Level 1 team for consistency with this project is performed as an emergency action, the Level 1 team will instead review that project after-the-fact and determine if the effects were consistent with those consulted on this Opinion or if the action requires separate emergency consultation with USFWS.

2. Any project involving placement/repair of instream diversion or withdrawal structures, or excavation within the bankfull stream channel within bull trout core watersheds shall be reviewed by the Level 1 Team to ensure consistency with this programmatic consultation.

3. The Black Diamond Water District Permit, and any other permit renewal not listed in Table 5, will be reviewed by the Level 1 Team to determine if it is consistent with the effects anticipated in the Opinion or if a separate consultation is warranted.

4. Commercial timber harvest and associated activities (including forest health/sanitation harvest, and historic cabin and roadside viewpoint viewshed management) will implement no-cut buffers in proximity to bodies of water to minimize removal of shade trees (Appendix L).

Rationale: In-stream habitat would not be directly affected by the proposed program of activities because all of the proposed work would occur outside of the active channel in bull trout habitat, with the exception of riprap placement during bridge and road repair. In-stream habitat may be indirectly affected by many proposed project types. The habitat indicators "pool frequency and quality," "large pools," "off-channel habitat," and "width/depth ratio" are all indirectly affected by actions that contribute sediment to bull trout-occupied streams (directly or via a tributary). The rationale stated above for the USFWS's finding on the effects of some of the proposed actions to sediment indicators is incorporated here by reference to explain why the proposed sediment CM/PDs are adequate for limiting the effects of specific proposed actions identified in

Table 33 to insignificant effects on bull trout habitat (including these indicators). The habitat indicators “pool frequency and quality,” “large pools,” “off-channel habitat,” and “width/depth ratio” may also be indirectly affected by actions that reduce large wood, but the previously stated rationale for the USFWS’s finding on the effects of some of the proposed actions to large wood provides the rationale for why the proposed large wood is incorporated here by reference to explain why the proposed large wood CMs/PDs are adequate for limiting the effects of specific proposed actions identified in Table 33 to insignificant effects on bull trout habitat, including the above habitat indicators.

The habitat indicators “off-channel habitat”, “width/depth ratio”, “streambank condition” and “floodplain connectivity” may be directly and indirectly affected by the placement of riprap to protect bridges, roads, and other existing infrastructure. However, the USFWS finds that the likely effects of these activities (Table 33), to bull trout habitat would be insignificant because riprap placement will not occur in S&R habitat and in FMO habitat with substrate where juvenile bull trout may seek shelter when disturbed and includes small amounts of rock (less than 300 cy per project) placed either exactly where baseline riprap previously existed or immediately adjacent to where riprap or infrastructure currently exists (in-stream CM/PD 1). The change in quality of in-stream habitat around the replaced riprap compared to baseline habitat quality is not anticipated to measurably affect bull trout or their habitat, and therefore would be insignificant. For all in-water riprap placements and placement of riprap where riprap did not previously exist, the Level 1 team will evaluate the quantity of rock placed and the location of that rock in determining if the project is consistent with the effects analyzed in this Opinion (in-stream CM/PD 1).

In-stream habitat indicators may also be indirectly affected by domestic water withdrawals. The withdrawal of water is an interdependent action of the proposed ONF permits to transmit water. Eight of the ten water transmission and withdrawal permits that may be renewed in core watersheds for bull trout under the proposed action are for less than 1 cubic feet per second (cfs) (most are for less than 0.1 cfs), are being withdrawn from streams not occupied by bull trout, and the nearest bull trout stream has significantly more flow even during low flow conditions (Table 5). Further, the water being withdrawn is mostly returned to the watershed after use (wastewater, irrigation, etc.). For these reasons, the USFWS finds that that these withdrawals of less than 1 cfs would not have a measureable effect on in-stream habitat indicators in bull trout habitat. The Black Diamond Water District permit renewal will be reviewed by the Level 1 Team (CM/PD 3) when information is available to determine if it also meets the criteria of this rationale. The effect of water withdrawal from the USFWS’s Quinault National Fish Hatchery on bull trout has already been consulted on under Section 7, and accordingly in this Opinion, we are only consulting on the issuance of a waterline permit and not the interdependent withdrawal of water. Therefore, the proposed renewal of water transmission and withdrawal permits are likely to have insignificant effects on bull trout.

28.3.7 Effects of the Action on Bull Trout Population Indicators

Population indicators in the matrix include “integration of species and habitat conditions,” “subpopulation size,” “growth and survival,” “life history diversity and isolation,” and “persistent genetic integrity”.

The USFWS finds that those proposed actions marked as "I" in Table 33 under population indicators are not likely to affect these population indicators because these projects were determined above to be likely to have insignificant effects to individual bull trout. If effects to individual bull trout are likely to be insignificant, then the action is also not likely to result in measurable or detectable effects at the population level.

28.3.8 Effects of the Action on Other Matrix Indicators

Other indicators in the matrix not addressed above are "physical barriers," "disturbance history," "disturbance regime," and "refugia."

Based on our review of the BA, "Physical barriers" will not be created by the proposed action because culverts will be engineered to pass bull trout. "Disturbance history" and "disturbance regime" will not be affected by the proposed action because the anticipated insignificant effects to other indicators are not severe enough to cause a "disturbance." "Refugia" will not be affected by the proposed action because "refugia" is combination of other indicators on a much larger scale, and each of those combining indicators will be insignificantly affected by the proposed action.

28.3.9 Summary of Insignificant and Discountable Effects of the Proposed Action on Bull Trout

The USFWS finds that the proposed activities that would occur in non-core watersheds for bull trout (such as the Wishkah, Humptulips, Wynoochee, Satsop, Duckabush, Dosewallips, Hamma Hamma, and Quilcene river watersheds) are likely to result in discountable effects to bull trout with or without the CMs listed in the project descriptions because bull trout presence within proximity of significant in-stream effects is extremely unlikely. As described in the Environmental Baseline section above, bull trout occurrence in those watersheds is very rare, seasonal, and almost always associated with main-stem rivers and estuaries far downstream of ONF managed lands.

The USFWS anticipates that the proposed projects (not otherwise identified as having adverse effects), when implemented in core watersheds (the Skokomish, Dungeness, Elwha, Hoh, Queets, and Quinault rivers), would result in insignificant effects to bull trout given application of the CMs/PDs listed above. Indirect adverse effects are not expected from the proposed projects because we anticipate insignificant effects on all of the indicators that comprise bull trout habitat. Direct adverse effects (e.g., loud underwater sound, capture, etc.) are not expected from the proposed projects because all work will take place outside of bull trout habitat and blasting shall be set back from the wetted width of adjacent bull trout habitat at a distance determined by Appendix D or determined by the Level 1 team to be consistent with this programmatic. Therefore, the USFWS concurs that projects in core watersheds for bull trout that meet the project descriptions and conservation measures (including when required, review and approval by Level 1), are not likely to adversely affect bull trout.

28.4 Adverse Effects of the Proposed Action on Bull Trout

28.4.1 Effects of Using and Maintaining Forest Roads

The ONF's proposed program of actions includes several that the USFWS has historically identified as likely to adversely affect bull trout. We anticipate that adverse effects to bull trout and their habitats would result from new and temporary road construction, road reconstruction, road repairs, log hauling (and other repetitive driving of large trucks), road grading/blading, and drainage maintenance activities that occur within bull trout core areas. These activities will occur for both routine management activities, and commercial thinning and associated activities. However, the USFWS also identified some of those same actions (road reconstruction, road repairs, road grading/blading, and drainage maintenance) as likely to reduce the impact of adverse effects of roads on bull trout. Matrix indicators that may be significantly affected, with resulting significant effects on bull trout, include "sediment/turbidity," "substrate embeddedness," "pool frequency and quality," "large pools," "off-channel habitat," "width/depth ratio," "peak/base flows," "drainage network increase," and "road density and location" (Table 33). "Sediment/turbidity" and "substrate embeddedness" are the indicators that would be the most significantly affected.

Within bull trout core areas (although this occurs in all watersheds), the road network on which these proposed activities would occur is a significant source of fine sediment that is likely to be transported to bull trout habitat when the ditch, road surface, or disturbed cut/fill is hydrologically connected to streams by surface water. In the short term (days to months), road maintenance is likely to result in increased sedimentation when the disturbed surface of the repaired, rebuilt, or temporary feature is hydrologically re-connected to the stream network. In the long term (years), these road-maintenance activities protect the integrity of the road bed and reduce the likelihood of catastrophic failure. Road blading/grading, road repairs, road reconstruction, and drainage maintenance are necessary actions to reduce the magnitude of chronic sedimentation and the risk of mass soil movements that would potentially occur if the roads were not maintained. Failure to properly maintain road drainage can result in large sediment inputs to streams (Furniss et al. 1991). Un-maintained or poorly constructed roads experience accelerated erosion as drainage design breaks down. Road maintenance projects are therefore a high priority to keep roads drivable and reduce chronic sedimentation. Well-used road surfaces that are not graded regularly will develop ruts that transport water down the road and accelerate road surface erosion. Stream crossings pose the greatest risk to fish habitats of any road feature. When culverts are plugged by debris or overtopped by high flows, road damage, channel realignment, and severe sedimentation can occur (Furniss et al. 1991).

However, road maintenance also prolongs the life of the road network as an extension of the drainage network and a source of fine sediment. In the absence of such maintenance, roads would eventually erode away through chronic and/or episodic mechanisms and, over the course of decades, re-vegetate to a natural hydraulic state. The proposed road work, as modified by the CMs, is anticipated to reduce the magnitude of both short-term and chronic adverse effects, but will not eliminate them. Rashin and others (1999, page ix) found that best management practices for sediment control on forest roads during and after roadwork were generally ineffective or only partially effective at *preventing* chronic sediment delivery to streams when the activity occurred near streams. They did, however, find that majority of the best management practices for sediment control on forest roads during and after roadwork were effective at *reducing* chronic sediment delivery to streams when the activity occurred near streams (Rashin et al. 1999).

The ONF is proposing to implement 10 years of road work and maintenance activities. The effects of the actions evaluated in this Opinion include sedimentation from new and temporary roads, short-term sedimentation from culvert cleaning, and actions that modify the road bed (road reconstruction, blading/grading, etc.). In this Opinion, we will roughly quantify the entire chronic sedimentation effects of the road system, and then qualitatively attribute a portion of that sedimentation to the proposed action. The degree to which maintenance and other covered activities prolong the life of the road and associated adverse effects is highly variable and cannot be quantified.

28.4.1.1 Factors Influencing Sedimentation

Estimating how much sediment is eroded from road networks and contributed to streams, and learning how to build better roads, has been the subject of a large body of literature. In lieu of measuring sediment concentrations and discharge at each stream/road interface, there are several key factors that can be used to predict the amount of forest road sedimentation into streams. The underlying geology, orientation, design, traffic pattern, and location of a road relative to waterbodies controls how much sediment is produced and how much of that sediment is delivered to those adjacent waterbodies. Dubé and others (2004) created the WARSEM model (Washington Road Surface Erosion Model) to use those predictive factors (and others) to estimate the quantity of sediment delivery occurring at each road/stream interface in tons per kilometer per year. The Forest Service and Utah State University created a similar model (RSAM, Prasad et al. 2006) to estimate sediment delivery from road surfaces to stream systems in federally managed forests. These modeling efforts and road-specific data are important because not all forest roads are hydrologically connected to streams that intersect or parallel them, and the magnitude of sediment delivery can vary widely.

Based on our review of Dubé and others (2010, page 2) and other literature, we have prepared the following summary of literature on road-surface erosion: Longer continuous road segments (Mills et al. 2003) and steeper gradients (Luce and Black 1999) tend to have more road-surface erosion. The type of road surface and its durability is also important; surfacing with durable gravel or vegetation can reduce erosion rates (Meyers 2007, Coe 2006, Mills et al. 2003, Foltz 1996, Burroughs and King 1989, Kochenderfer and Helvey 1987, Swift 1984, Reid and Dunne 1984). The more traffic that uses the road, and the heavier the vehicles are, the more sediment will be generated (particularly during wet weather) (Mills et al. 2003, Foltz 1996, Reid and Dunne 1984, Sulivan and Duncan 1981). The degree of rutting also increases road-surface erosion rates and fixing that rutting by grading temporarily increases road-surface erosion rates (Meyers 2007, Sugden and Woods 2007, Foltz and Burroughs 1990, Burroughs and King 1989). Adjacent to the road surface, ditch erosion increases when the cutbank intercepts sub-surface flow (MacDonald et al. 2001).

Road building also increases the probability and severity of landslides and other mass movements of sediment on a watershed scale. Roads generally accelerate soil-erosion rates due to surface erosion and mass soil movement such as slumps and earth flows, debris avalanches, debris flows, and debris torrents. Several studies in the western Cascade Mountain range of Oregon showed that mass soil movements associated with roads are 30 to more than 300 times greater in volume than in undisturbed forest (Sidle et al. 1985 in Furniss et al. 1991, page 298). However, when best management practices minimize ditch erosion, culvert plugging, and landslides on the cut slope, the majority of sedimentation is derived from the road surface.

The type and intensity of vehicular traffic on a road are two of the most significant factors that control road surface erosion rates. Regular road use can cause chronic sediment inputs to streams in excess of what would be delivered from a road closed to traffic. Reid and Dunne (1984) found that gravel forest roads, when heavily used by logging trucks, generated up to 800 tons of sediment per mile per year from surface erosion in the Olympic Mountains of Washington (Clearwater River Basin). Sedimentation was found to be related to traffic intensity and was highest on heavy-use gravel roads compared to unused roads or paved roads. The rate of sedimentation on roads heavily used by logging trucks was more than 130 times greater than lightly used roads (6.1 tons/mile/year), paved roads (3.2 tons/mile/year), and abandoned roads (0.82 tons/mile/year) (Ried and Dunn 1984). Heavy use was defined as more than four loaded logging trucks per day, moderate use was defined as one to four loaded logging trucks per day, light use was defined as no logging trucks but some light vehicles, and abandoned roads were closed to all traffic. Sediment yield from cutbanks and ditches alongside paved roads was less than 1 percent of that from gravel roads in their study. Dubé and others (2010) surveyed and then modeled sediment movement from roads into stream on State and private timber lands in Washington. The study included 23 sampled roaded areas on the west side of the Cascade Mountain Range crest. The majority of the sampled roads were gravel (92 percent) and "occasionally" used (85 percent), meaning they were used by less than one logging truck per day. The average estimated sediment delivery of these 23 roads was 4.3 tons per kilometer per year (6.9 tons per mile per year) (standard deviation was high; 4.73 tons per kilometer per year or 7.6 tons per mile per year).

The percentage of the total road-surface-generated erosion (controlled by the factors previously mentioned) that is deposited into streams is determined by the distance between the runoff point and the waterbody (Brake et al. 1997, Megahan and Ketcheson 1996, Swift 1985, Trimble and Sartz 1957), the hill-slope gradient and the number of obstructions between the road and the waterbody (Brake et al. 1997, Megahan and Ketcheson 1996), and the volume of flow and erosion from the road (Ketcheson and Megahan 1996). Without site-specific information, it is reasonable to assume that the roads and outfalls within 200 feet of a stream will contribute some portion of the eroded fine sediment to that stream (Dube et al. 2004).

28.4.1.2 Forest Service Standards for Forest Roads

When the ONF builds, rebuilds, repairs, or hauls on a segment of road, they are required to bring that road segment into compliance with a collective set of conditions that we will refer to as the 'Forest Service Standard' in this Opinion. Those standards can be met through different designs and treatments, depending on the maintenance level of the road and the site-specific conditions that affect feature stability and connectivity with streams. The Forest Service Standards are described in several different Forest Service publications, including but not limited to the list in Appendix J: *Forest Service Road Standards.* Protocols for monitoring the effectiveness of the work completed are also specified in Appendix J. Road segments that are continually treated with the Forest Service Standards contribute a significantly minimized rate of sedimentation to streams when (and if) hydrologically connected. Unfortunately, the Forest Service does not have the funding to maintain all of their road systems to those standards; and that problem is the subject of a larger effort to reduce the Forest Road systems to an affordable size (70 FR 68264).

28.4.1.3 Estimating Sedimentation from the Proposed Action

There are 2,200 miles of road in the ONF transportation system. Of those 2,200 miles, 593 miles are within bull trout core area watersheds. The ONF is proposing to construct 2 miles of new permanent roads, construct 18 miles of new temporary roads, and reconstruct approximately 130 miles of temporary roads associated with commercial thinning over the 10-year term of the proposed action. All commercial thinning, with the exception of stewardship timber sales, will occur outside bull trout core area watersheds. Therefore, only a small portion of this road construction will be occurring within bull trout core areas. Additionally, the ONF will construct 4 miles of new roads, 20 miles of temporary roads, and 100 miles of reconstructed roads during the 10-year term of the proposed action in association with all other action categories, including routine maintenance. Each year, grading would occur on roads that are classified with maintenance levels (MLs) 3 or 4 (18 percent of 2,200 miles), drainage maintenance would occur on roads that are classified with maintenance levels ML's 2 to 4 (71 percent of 2,200 miles), and road repairs would occur wherever and whenever a road segment was damaged. An explanation of the MLs can be found in the description of the proposed action, above. Log hauling would occur during timber sales and as part of special use permits and easements, but the location and quantity of that hauling was not specifically estimated in the BA. Regardless of the quantity and location of the hauling, the CMs and Best Management Practices (BMPs) for hauling in this Opinion will ensure that effects of those actions are within the scope of effects that are analyzed in this Opinion.

New and temporary road construction, road reconstruction, road repairs, log hauling (and other repetitive driving of large trucks), road grading/blading, and drainage maintenance are likely cause short-term increases in sediment transport from road surfaces to stream systems (e.g., road grading) and reconstruct some road features that contribute chronic (albeit reduced) sedimentation (e.g., road reconstruction). The exact quantity of work that would occur on the 593 miles of roads in bull trout core areas is unknown. In the absence of this information, our reasonable worst-case assumption is that all of those 593 miles of road will be maintained, graded, and/or repaired over the 10-year term of the proposed action, and that all 124 miles of new, temporary, and reconstructed road, for all activities other than commercial thinning, will be within bull trout core areas. Additionally, our reasonable worst-case assumption for commercial thinning is that all five of the stewardship sales covered under this programmatic, including associated road construction and reconstruction, will occur within bull trout core areas. We used a GIS database of streams and roads on the ONF to quantify the length of roads in each sub-watershed, the surfacing type and maintenance level on each road, the density of roads in each sub-watershed and the number of road-stream interfaces in each bull trout core watershed

(Tables 31 and 32). Based on that database, we have conservatively estimated that the proposed roadwork and road use on the ONF is likely to introduce sediment into bull trout-occupied habitat during rainy conditions at 1,348 stream crossings and along 168.9 miles of stream-adjacent (e.g., within 200 feet) roads during the 10-year term of the proposed action and for 20 years afterwards (Gomi et al. 2005, p.892) (Table 31). Additionally, we assume that each stewardship sale will require road construction and reconstruction for roads that are within 200 feet of bull trout habitat or that intersect with streams that are less than a half mile upstream of bull trout habitat. We expect that each of the stewardship sales will require road reconstruction on temporary roads that are within 200 feet of bull trout habitat or intersect with streams that are less than a half mile upstream of bull trout habitat. Because we do not know where the stewardship timber sales will be located within the action area, we assume for purposes of analysis that all five of the stewardship sales may occur within any one of the bull trout core areas within the action area. Because the vast majority of road networks used for the stewardship timber sales is likely to be part of the existing road network, we expect that these stewardship timber sales will contribute very few, if any, stream crossings and stream-adjacent road segments in addition to what has been described above.

The ONF does not have road inventory data that include the predictive factors needed to identify which roads are chronic sources of sedimentation using the WARSEM model, RSAM model, or an equivalent model. Our estimate of the quantity of sediment generated by the covered activities will have to be based on the road data that is available in addition to data (measured and modeled) from the applicable road sediment literature. Specifically, our analysis is based on an estimate of hydrologic connectedness and an estimate of sedimentation rate for each ML/surfacing type group. On private and State lands that are held to Washington State Forest Practices Rules (RCW 76.09, WAC 222, WDNR 2005), Dubé and others (2010) found that in some sample units west of the Cascade Mountain range crest, up to 30 percent of the road network was hydrologically connected to streams. In our GIS analysis of forest roads on the ONF, we found that 168.9 of the 593 miles (28 percent) of roads in bull trout core areas are within 200 feet of streams. The road system on the ONF is likely to be just as hydrologically connected, if not more so, than the sample areas in Dubé's monitoring project for three reasons: 1) the majority of the ONF road system was built in the 1950s, 60's, and 70's when road standards did not include measures to reduce sedimentation into streams; 2) roads used to haul timber have strict standards to reduce connectivity, whereas recreational roads often fall into disrepair; and 3) road systems on the ONF have a high density of stream crossings (Tables 31 and 32). For example, the ONF has not proposed to blade native surface roads that have been assigned a ML of 2. For these reasons, we assume that 30 percent of the forest roads on the ONF in core areas for bull trout (all ML's and surfacing types) are hydrologically connected to the stream network. Sedimentation rates for each surface type were summarized above in the discussion of "factors influencing sedimentation."

The information developed for our analysis of the road network on the ONF can be used in conjunction with information in the literature on road surface erosion to roughly estimate the yearly sedimentation rate into bull trout habitat within core areas (Table 34). We expect that the extent and severity of adverse effects would be roughly commensurate with the yearly sedimentation rate, with variability determined by natural flow regime, sediment budgets, and substrate size. Those adverse effects are described in the sections below.

Table 34. Estimated average sediment delivery rates for roads that are hydrologically connected to streams based on the ML and surface type.

Maintenance Level	Surface Type	Estimated Average Sediment Delivery (tons/kilometer/year)	Estimated Average Sediment Delivery (tons/mile/year)	Sources
1	Closed Roads	0.51	0.82	Reid and Dunne 1984
2, 3, 4	Native Surface	29	47	Synthesis[1]
	Gravel[2]	3.8	6.1	Reid and Dunne 1984
4 & 5	Paved	2.0	3.2	Reid and Dunne 1984

[1] Kochenderfer and Helvey (1987), Swift (1984), and Burroughs and King (1989) found that native surfaces produce 5 to 10 times as much sediment as gravel roads (Dubé et al. 2004). Since lightly-used gravel roads produce 3.8 tons/kilometer/year, we assume that lightly-used native surface roads produce 7.5 times as much sediment as lightly-used gravel roads, estimated at 29 tons/kilometer/year (47 tons/mile/year).

[2] On the ONF, ML 4 gravel roads only exist in the Skokomish River watershed. There are 12.2 miles of this road type. Data for gravel roads frequently used by vehicles other than logging trucks are not available. In the absence of that data, we estimated that the sedimentation rate on these roads would be approximately equal to ML 3 gravel roads because the extra vehicle traffic may be mitigated by additional maintenance and better road design to handle that extra traffic.

Table 35. Estimated average sediment delivery rates from roads within bull trout core areas on the ONF.

Core Watershed	Total ONF Road Miles	Yearly Sediment Yield[1] (tons)	Estimated Connectivity	Yearly Sedimentation (tons)
Skokomish	245	4,996	30%	1,499
Dungeness	110	843	30%	253
Elwha	16.8	31	30%	9.3
Hoh	0.3	N/A	N/A	N/A
Queets	139	2,027	30%	608
Quinault	60	936	30%	281

NOTE: These values were calculated by multiplying the miles within each watershed on ONF lands for each road type by their respective estimated yearly sediment yields, adding them together, and then multiplying by the estimated connectivity. The result is an estimated yearly yield of forest road sediment in each watershed.

[1] For each watershed, the equation used for estimating yearly sediment yield is:
(ML1 x 0.82) + (ML2,3,4 dirt x 47) + (ML2,3,4 gravel x 6.1) + (ML4,5 paved x 3.2)

Gomi et al. (2005) reviewed published literature to determine sediment recovery rates to pre-logging conditions in Pacific Northwest watersheds. Suspended sediment concentrations peaked at three years post-harvest, but sediment levels took over 20 years to reach pre-logging conditions (Gomi et al. 2005, p. 892).

28.4.2 Effects on Individual Bull Trout

28.4.2.1 Direct Effects

Culvert cleaning (a type of drainage maintenance activity) is the only proposed action that is likely to have a direct adverse effect on bull trout. All other proposed actions likely to have adverse effects on bull trout would cause those effects indirectly (i.e., later in time) when the disturbed road surface or ditch is hydrologically re-connected to the stream network. Culvert cleaning that would occur in dry channels would have only indirect effects on bull trout for the same reason.

Culvert cleaning involves excavating sediment and debris from inside and upstream of the clogging culvert. A turbidity plume of fine sediment may be created by excavating in the flowing channel. Particles smaller than 2mm in diameter are considered to be fine sediment (Suttle et al. 2004) and this fine material is the size most harmful to fish and water quality (Tagart 1976, Cedarholm et al. 1981, Reiser and White 1988). When this short-term pulse of turbidity occurs in the presence of bull trout, individuals are directly affected. When this short-term pulse of turbidity deposits sediment into the substrate, the effects of that deposition occur later time, and that is an indirect effect that will be analyzed later in this Opinion.

Because bull trout may be present in some stream reaches year-round, there is a likelihood that juveniles and adults may be injured or displaced by culvert-cleaning-generated sediment plumes that occur within or directly adjacent to occupied habitat. Sediment plumes would be most significant in small streams where less water is available to dilute the turbidity plume. Fry and juveniles inhabit small streams, stream margins, and side channels that provide cover and prey (McPhail and Baxter 1996, Sexauer and James 1997). Adult and sub-adult fish can also occur in spawning streams year-round; however, adult fish are more likely to be associated with deep pools and mainstem river channels with sufficient depth and flow to quickly dilute turbidity from such activities to non-harmful levels.

Fine sediment plumes caused by a typical culvert replacement may travel up to 0.5 miles downstream of the culvert at concentrations above background (or 0.25 miles during low-flow) based on our analysis of pertinent literature (Bilby 1985, Duncan 1987, Foltz 2008, Lachance 2008). However, we anticipate that the proposed culvert cleanings would disturb a smaller quantity of sediment and be shorter in duration than a typical culvert replacement, leading to a smaller and less concentrated turbidity plume that dissipates more quickly. Potential exposures of juvenile and adult bull trout to increased turbidity would be frequent (particularly during and after high-precipitation storms when the ONF is cleaning the most culverts) but brief (minutes to hours), and water quality is expected to return to background levels within minutes to several hours. Those frequent but brief direct exposures would only occur when the cleaned culvert is within bull trout habitat or on a tributary less than a 0.5 mile upstream of bull trout habitat.

We are not aware of any measurements of turbidity downstream of culvert cleanings that would be relevant to this analysis. Further, we do not have enough site-specific information to estimate downstream suspended sediment concentrations or turbidity Nephelometric Turbidity Units using our accustomed method (USFWS, 2010). Instead, our best professional judgment, informed by Newcombe and Jensen (1996), indicates that 1) adult bull trout will not be significantly affected by the anticipated small turbidity plumes but 2) juvenile bull trout may experience sublethal effects including avoidance, abandonment of cover, short-term reductions in feeding rates, gill irritation, and increased respiration (equivalent to 55 mg/L to 148 mg/L of suspended sediment). We consider those sublethal effects to be a significant disruption and/or impairment of normal behaviors (USFWS, 2010).

Therefore, adverse effects to juvenile bull trout are reasonably certain to occur any time of the year below culvert-cleaning actions in the six core areas that are within bull trout habitat or less than 0.5 miles upstream from bull trout habitat. The duration of these effects is expected to be short-term (minutes to hours), and the likelihood that these effects would actually lead to mortality is low due to the short duration of the effects and small turbidity plume.

28.4.2.2 Indirect Effects

The proposed program of new and temporary road construction, road reconstruction, road repairs, log hauling (and other repetitive driving of large trucks), road grading/blading, and drainage maintenance is anticipated to cause indirect adverse effects to bull trout by degrading their habitat with fine sedimentation and altering watershed hydrology. The proposed road reconstruction and road maintenance would also reduce the adverse effects to bull trout habitat by preventing accelerated future erosion that would potentially occur without maintenance. These effects are indirect because they would occur when rainy conditions hydrologically connect the road to a stream (often days, months, and years after the proposed action). Individual bull trout of multiple life stages are likely to be adversely affected by the proposed actions during the 10-year program and for up to 20 years afterwards, and the majority of the effects would occur indirectly through the modification of habitat. We expect that the extent and severity of adverse effects would be roughly commensurate with the yearly sedimentation rate estimated above, with variability determined by natural flow regime, sediment budgets, and substrate size. As described above, these adverse effects to bull trout from sedimentation and altered flow regimes are partially attributable to, and an extension of, the degraded baseline condition of the watershed.

Maintenance activities will occur on the existing road network within the ONF. Adverse effects to bull trout from these maintenance activities will occur throughout the year when rain events result in sediment being washed into the river. Determining exactly where and when bull trout will be adversely affected by increased fine sediment loading is not feasible, but the negative correlations between roads, fine sediment, and salmonid habitat are well established. Furniss et al. (1991) summarizes the effects of roads to streams and salmonid habitat (i.e., bull trout) in the following manner: “Forest roads can cause serious degradation of salmonid habitats in streams. Numerous studies have documented the changes that occur in streams as a result of forest roads and related effects. Roads modify natural drainage networks and accelerate erosion processes. These changes can alter physical processes in streams, leading to changes in streamflow regimes, sediment transport and storage, channel bank and bed configurations, substrate composition, and stability of slopes adjacent to streams. These changes can have important biological consequences, and they can affect all stream ecosystem components. Salmonids require stream habitats that provide food, shelter, spawning substrate, suitable water quality, and access for migration upstream and downstream during their life cycles. Roads can cause direct or indirect changes in streams that affect each of these habitat components." Road-caused erosion and fine sediment delivery can affect the long-term development of complex channel morphology and aquatic habitat by increasing the frequency and magnitude, and altering the composition of, debris flows (Jones et al. 2000). In particular, the negative effects of fine-sediment delivery into gravel-bedded rivers on salmonid individuals and populations have been recognized (Bisson and Sedell 1984, Reeves et al. 1993, Waters 1995, Quigley et al. 1996, Dunham and Rieman 1999, Suttle et al. 2004).

The proposed actions are likely to cause yearly road surface, cut-slope, and ditch sedimentation in each watershed (Tables 34 and 35). Fine sedimentation is reasonably certain to adversely affect individual bull trout by reducing water quality and increasing substrate embeddedness. Altered flow regimes are also reasonably certain to adversely affect bull trout by changing the hydrological processes that maintain and create habitat. On the 6^{th} field watershed scale, the proposed action would maintain and slightly increase road densities, which may be correlated with increased fine sedimentation and altered flow regimes in some watersheds.

28.4.2.2.1 Effects to Water Quality

Road maintenance and road-building activities will adversely affect water quality, but will also reduce the severity of adverse effects of roads in bull trout habitat during the 10-year term of the proposed action and for 20 years afterwards. We previously explained why road maintenance activities will likely both adversely affect bull trout and lessen the severity of adverse effects over different time scales. Accordingly, water quality degradations may occur at the interfaces between road and streams during and after rainstorms throughout the year. Over the long term (years), road maintenance actions reduces the potential for chronic sedimentation and the risk of mass soil movements. However, road maintenance and road building activities retain roads on the landscape and thus prolongs the life of the road network as an extension of the drainage network and a source of fine sediment that would adversely water quality in each core area watershed for bull trout. Below, we describe the potential for short-term and long-term adverse effects in more detail.

<u>Short Term Effects</u>: Potential exposures to short-term water-quality degradation caused by the proposed action will depend on several factors such as level of maintenance activities, road usage, and severity of rain events and may last minutes, hours, or days for prolonged rain events. These exposure events would occur frequently over the 10-year term of the proposed action and for 20 years afterwards. The anticipated effects to individuals are similar to what was previously described in the direct effects section.

<u>Long Term Effects</u>: The effects of the proposed action on long-term water quality in core areas for bull trout are more difficult to predict and describe, as these effects are ongoing and have been occurring for decades since the roads were built and maintained. The estimated yearly fine

sedimentation rates into each core area may or may not significantly reduce water quality depending on how that sedimentation is distributed throughout the year, the background fine sediment load in the rivers, and how much of the sediment is suspended vs. deposited at any given moment and location. Elevated turbidity may not necessarily adversely affect salmonids, due to the species' adaptations to naturally variable sediment loads associated with seasons and different watershed controls (ACMRR/IABO Working Party on Ecological Indices of Stress to Fishery Resources 1976, pp 13, 15; Birtwell 1999, p. 7). Due to uncertainty regarding the magnitude of suspended fine sediment and lack of information regarding background concentrations, the effects of the action on long term water quality, and the subsequent effects on individual bull trout are difficult to enumerate. We conservatively estimate that water quality will be degraded in some creeks and rivers at some times of the year during the 10 years covered by this programmatic and for 20 years afterwards, and that the effects may include a reduction in feeding rates, gill irritation, increased respiration, and decreased survival of eggs and alevins in spawning habitat. The distance of sediment travel, and the locations where sediments would settle out and accumulate will vary based on the relationship between stream morphology and in-stream flows that are driven by the frequency and intensity of storm events. Embeddedness will likely be relatively high in stream reaches where flows tend to slow downstream of sediment sources. Depending on the intensity of subsequent storm events, sediments may continue to accumulate in certain areas, or become remobilized and move farther downstream. Therefore, sediments that enter intermittent and perennial streams upstream of spawning habitat, may eventually, if not immediately, reach that habitat. With each storm events, sediments continue to accumulate and move downstream.

28.4.2.2.2 Sediment Deposition into In-stream Substrates

Deposition of fine sediment into stream substrates can adversely affect bull trout by reducing macro-invertebrate densities, changing macro-invertebrate species assemblages, reducing the size and quantity of forage fish, and most importantly by reducing the growth and survival rate of eggs, alevin, smolts, and juveniles in spawning habitat. Most of the research on the effects of fine-sediment deposition on fish addressed other salmonids, but there is good reason to assume that bull trout are just as sensitive if not more sensitive to changes in the substrate condition because "the association with substrate appears more important for bull trout than for other species" (Nakano et al. 1992, Pratt 1984, in Rieman and McIntyre 1993, page 5). Further, bull trout have more spatially restrictive biological requirements at the individual and population levels than other salmonids (USFWS 1998, page 5) and may not be able to move to avoid the adverse effects of fine-sediment deposition.

<u>Effects to Spawning Habitat</u>: Sedimentation from the proposed action is reasonably certain to lower the survival rate of bull trout eggs, alevin, smolts, and juveniles in spawning habitat. This effect will occur in depositional areas where fine sediments are deposited in the substrate. Whenever flow is great enough to move the bed-load, fine sediment is again transported downstream to the next depositional area. If those depositional areas are being used by bull trout for spawning or rearing, we expect that the survival rate of incubating salmonid eggs and alevins would likely be reduced.

Bull trout embryo survival, fry emergence, and overwinter survival are negatively influenced by the increasing percentage of fine sediments in the substrate (Shepard et al. 1984, pp. 146, 152; Pratt 1984, Weaver and Fraley 1991- in Rieman and McIntyre 1993). Egg survival depends upon a continuous supply of well oxygenated water through the streambed gravels (Cederholm and Reid 1987, Anderson et al. 1996, page 13). Deposition of fine sediments can reduce the water flow through the substrate and, therefore, reduce oxygen to eggs and alevins which can decrease egg survival, decrease fry emergence rates (Phillips et al. 1975, Cederholm and Reid 1987; Chapman 1988; Bash et al. 2001), and the delay development of alevins (Everest et al. 1987). These adverse effects to bull trout egg, alevin, and smolt survival in spawning areas would occur in the Dungeness, Skokomish, and Elwha core area watersheds for the 10-year term of the proposed action and for 20 years afterwards. These three core areas are the only ones that contain S&R habitat on the ONF.

Effects to Macroinvertebrates: Fine sedimentation from the proposed action is reasonably certain to reduce macroinvertebrate densities and change species assemblages by changing the habitat qualities of the substrate in depositional areas. Those habitat changes are reasonably certain to reduce foraging opportunities for bull trout. This effect would occur in the aquatic action area during the 10-year term of the proposed action and for 20 years afterwards. Some of the changes in macroinvertebrate densities and assemblages have already occurred and will continue to occur because of the portion of the sedimentation that is attributable to the baseline condition.

Turbidity and suspended solids can adversely affect certain macroinvertebrate species by increasing invertebrate drift, changing the abundance of food sources, causing respiratory problems, and obstructing habitat (Cordone and Kelley 1961, Cederholm and Reid 1987). Sediment deposition into substrate removes macroinvertebrate habitat by filling interstitial space and rendering attachment sites unsuitable. The loss of habitat caused by this increased substrate embeddedness is a particular concern for invertebrates that inhabit the stream bottom (benthic invertebrates). Any modification of the streambed by deposited sediment will most likely have a profound effect upon the benthic invertebrate community (Waters 1995) in which certain invertebrate species and groups will perish or seek a more favorable habitat (Rosenberg and Snow 1975). Studies have shown that the degree to which substrate particles are surrounded by fine material is strongly correlated with macroinvertebrate abundance and composition (Birtwell 1999); and that at an embeddedness of one-third, insect abundance can decline by about 50 percent, especially for riffle-inhabiting taxa (Waters 1995).

Macroinvertebrates are a significant food source for salmonids. Salmonids, including bull trout, favor certain groups of macroinvertebrates, such as mayflies, caddisflies, and stoneflies. These aquatic insect species prefer large substrate particles in riffles and are negatively affected by fine sediment (Everest et al. 1987, Waters 1995, Suttle et al. 2004). With increasing fine sediment, invertebrate composition and density changes from available, preferred species (i.e., mayflies, caddisflies, and stoneflies) to non-preferred, more unavailable species (i.e., aquatic worms and other borrowing species) (Reid and Anderson 1999, page 10; Henley et al. 2000, page 126, 130; Shaw and Richardson 2001, page 2219; Suren and Jowett 2001, page 726; Suttle et al., page 971).

Fine sediment negatively impacts juvenile salmonids by impairing the food webs that support them (Crouse et al. 1981, Murphy and Hall 1981, Reeves et al. 1993). Suttle and others (2004) found that increasing substrate embeddedness with fine sediment had a linear negative relationship with salmonid growth and abundance, and suggested that "there is no threshold below which exacerbation of fine-sediment delivery and storage in gravel bedded rivers will be harmless" (page 969). This was also suggested by Weaver and Fraley (1991) (in Rieman and McIntyre 1993, page 6). Not surprisingly, declines in salmonids growth rates generally lead to lowered survival rates (Werner and Gilliam 1984, Walters and Korman 1999).

Effects to Forage Fish: Bull trout are apex predators that prey on a variety of species, including fish (Rieman and McIntyre 1993, page 3). Fish are common in the diet of individual bull trout that are more than 110 millimeters long. Large bull trout may feed almost exclusively on fish. Forage fish species include salmonids, dace, sculpin, whitefish, etc. Unfortunately, the abundance of forage fish is reasonably certain to decline with increasing substrate embeddedness for the same reasons that bull trout survival would decline. Adverse effects to forage fish, and ultimately bull trout growth and survival, are likely to continue to occur in each core area watersheds on the ONF for the 10-year term of the proposed action and for 20 years afterwards.

28.4.2.2.3 Effects to Flow Regimes

The proposed activities may adversely affect watershed hydrology (matrix indicators "width/depth ratio," "peak/base flows," "drainage network increase," and "road density and location") by re-routing water down reconstructed roads, temporary roads, and upgraded/repaired drainage features on existing roads. Roads can increase the length of the channel network in watersheds, acting as new flow paths for water, intercepting subsurface flow, and increasing the drainage density. The re-routed water can enter the stream channel prematurely instead of infiltrating into the forest floor. The altered stream flow rates and volumes, combined with the increase in sedimentation, can result in altered stream channel geometry (Furniss et al. 1991). For instance, an increase in peak flow may move larger substrate materials that were previously static. That increased ability to move bedload may result in changes to width/depth ratio, pools, substrate composition, etc. These channel geometry and habitat changes have already occurred to some degree, because the degraded baseline condition includes the existing road network.

Predicting when, if, and where flow regimes will be altered, and then result in significant habitat changes, is very difficult. Many studies have attempted to quantify the relationship between road networks and changes to the natural condition hydrograph and establish a threshold density where the response of streams is measurable (Jones and Grant 1996, Thomas and Megahan 1998, Beschta et al. 2000, Jones et al. 2000, Jones and Grant 2001, Wigmosta and Perkins 2001, Grant et al. 2008). "The impact of the road network on channel flows was shown to vary during a storm based on the road design, storm characteristics, topography, local geology, and soil moisture conditions" (Wigmosta and Perkins 2001, page 127). Even when peak flows are increased by high road densities, those flows may not affect channel morphology. Grant and others (2008) suggested that peak flow would change channel morphology when channel gradients are less than 0.02 and streambeds are composed of gravel and finer material (page i). Because the of the large geographic scale of the proposed program of actions, we conservatively assume for this consultation that bull trout may be adversely affected by altered flow regimes at some unknown times and locations during the 10 years of implementation and for 20 years afterwards.

28.4.2.2.4 Road Density

The ONF is proposing to construct 2 miles of new permanent roads, construct 18 miles of new temporary roads, and reconstruct approximately 130 miles of temporary roads associated with commercial thinning over the 10-year term of the proposed action. All commercial thinning, with the exception of stewardship timber sales, will occur outside bull trout core areas. Therefore, only a small portion of this road construction will be occurring within bull trout core areas. Additionally, the ONF is proposing to build 4 miles of new roads and 20 miles of temporary roads, and reconstruct 100 miles of roads, associated with all other action categories. Over the 10-year term of the programmatic, the ONF will also maintain up to 2,200 miles of existing roads (593 miles of which are in core area watersheds for bull trout). Those actions would maintain or slightly increase the density of roads within Olympic Peninsula core area watersheds for bull trout (Table 32). Many watersheds and subwatersheds on the Olympic Peninsula already support road densities above the threshold for declining populations (USFWS, 2004 pages 88-96) (Quigley et al. 1996, Quigley and Arbelbide 1997) and above the thresholds for "functioning at risk" and "functioning at unacceptable risk" (USFWS, 1999, page 22). While further road development and decommissioning have occurred since the early 2000's, conditions in the watershed remain similar today. Road density is a watershed-scale indicator for assessing the severity of the effects listed above (decreased water quality, sedimentation into the substrate, and altered flow regimes). Quigley and Arbelbide (1996, page 67) reported that strong salmonids populations were correlated with road densities less than 0.7 miles per square mile and depressed salmonids populations were correlated with road densities between 0.7 and 1.7 miles per square mile. The matrix of pathways and indicators (USFWS, 1999, page 22) suggested that watersheds with valley bottom roads and more than 1 mile per square mile of roads are "functioning at risk" and watersheds with many valley bottom roads and more than 2.4 miles per square mile are "functioning at unacceptable risk." For this consultation, we estimate that maintaining or slightly increasing road densities in sub-watersheds that have road densities above 1 mile per square mile will prolong the adverse effects associated with those road densities that were described in the environmental baseline and in the effects section above.

28.5 Effects of the Action on Bull Trout Core Areas

28.5.1 Dungeness River Core Area

The Dungeness River core area has two local populations of bull trout, one in the middle Dungeness River (from river mile 9 up to river mile 24 and tributaries, including Silver, Gold, and Canyon creeks) and one in the Gray Wolf River (to its confluence with Cameron, Grand, and Cedar creeks) (USFWS, 2015, p. A-10 – A-25). Both local populations occur on ONF administered lands, and the ONF administers 41.5 percent of the all bull trout streams and shorelines in the Dungeness River watershed (Table 30). We anticipate that the proposed project extends some of the adverse baseline effects to both populations in the Dungeness River core area. At some point in their life history, bull trout of all life stages will be exposed to the chronic sedimentation and altered hydrological regimes generated by the proposed action during the 10-year program and for 20 years afterwards. The rate of sedimentation and altered hydrology varies within a river based on the relationship between stream morphology and in-stream flows that are driven by the frequency and intensity of storm events. For this reason, a small number of bull trout (all life stages) are likely to be killed, injured, or have their behaviors significantly disrupted or impaired by the effects discussed above. Using GIS data, we determined that these effects are reasonably certain to occur in 35.9 miles of bull trout habitat in the Dungeness River core area (both within and outside ONF lands) downstream of ONF road-stream interfaces (roads within 200 ft of streams and stream crossings), including 21.4 miles of spawning habitat (Table 36). Additionally, commercial timber harvest associated with up to five stewardship timber sales may require construction of up to 10 stream crossings and/or stream-adjacent road segments. However, because most the vast majority of road networks used for stewardship timber sales, including the associated stream crossings and/or stream-adjacent road segments, is likely to be part of the existing road network, the stewardship timber sales are unlikely to cause adverse effects within additional stream miles.

Table 36. Total stream miles within bull trout core areas with adverse effects associated with the proposed action.

Core Area	**ONF Stream Miles**	**Stream Miles Downstream of ONF**	**ONF Stream Miles above Road-Stream Interface**	**Stream Miles Outside ONF Affected by Project**	**Total Miles with Adverse Effects**
Dungeness	20.5	18.1	2.7	0	35.9
Skokomish	47.4	29.9	0	4.4	81.7
Elwha	9.3	14.1	0	0.4	23.8
Hoh	1.8	0	0	0	1.8
Queets	28.2	42.8	0	0	71.0
Quinault	19.7	40.6	0	0	60.3
Total					274.5
	Total S&R Stream Miles	S&R Stream Miles Affected by Project			
Dungeness	27.3	21.4			
Skokomish	24.7	23.3			
Elwha	52.4	2.9			
Total	104.4	47.6			

Spawning and rearing habitat in the Gray Wolf River will be only slightly affected by the proposed action (there are only a few crossings in the upper watershed) and some FMO habitat in the Canyon Creek/Pats Creek watershed will be unaffected by the proposed action because road-crossings do not occur in that watershed.

The severity of effects to each exposed individual bull trout in the Dungeness River core area depends on the life stage of that individual and its location within the watershed. Bull trout are migratory and their exposure may vary within a year and across multiple years as sediment continues to enter the rivers and move downstream during and after rain events. Spawning located downstream of road-stream interfaces will be affected multiple times during the year based on frequency and intensity of rain events. Eggs and alevin are the only life stage that would be directly killed as a result of substrate embeddedness, poor water quality, and the other anticipated habitat changes that reduce egg to fry survival. Juveniles, as explained in the effects section above, are not likely to be directly killed but are very sensitive to the anticipated reduction in prey availability. Accordingly, an unknown number of juveniles are expected to die or experience reduced fitness and growth because of the effects of the proposed action on prey resources. Adult and sub-adult bull trout are less sensitive to reductions in prey availability because they have a more varied diet and are mobile enough to forage in larger areas. However, some adult and subadult bull trout in this core area are reasonably certain to have their foraging behaviors disrupted or impaired by the proposed action. At a watershed scale, we cannot predict how frequently adult and subadult bull trout foraging behaviors will be impaired to an extent that is likely to cause the injury or death of affected individuals (i.e., when bull trout are unable to find adequate forage elsewhere). Individual bull trout of all life stages downstream of multiple stream crossings and stream adjacent roads (such as in the Middle Dungeness River) are likely to experience greater effects than individuals downstream of fewer stream crossings and stream adjacent roads. Individual bull trout of all life stages on ONF lands upstream of crossings (such as in the upper portions of the Lower Gray Wolf River watershed or the Upper Dungeness River watershed) are upstream of chronic sedimentation inputs and therefore would not be adversely affected by the proposed action.

We are unable to reasonably predict the number of individuals that experience disrupted or impaired essential behaviors, injury, suffocation, etc., but we expect that the adverse effects to population size and productivity would be roughly commensurate with baseline conditions. The sedimentation rate into the Dungeness River watershed is approximately 253 tons per year, dispensed at 256 crossings and 30.3 miles of stream adjacent roads (Tables 30 and 34). Road densities would remain high in two Dungeness River sub-watersheds (Table 32). We acknowledge that the estimated sedimentation rate in the Dungeness River core area is attributable to the degraded environmental baseline caused by past management activities. That sedimentation will be extended into the future by activities conducted under the proposed action. In addition to road surface sedimentation, road networks in the Dungeness River watershed are associated with accelerated mass soil movements (slumping, slides, etc.) that may occur during the 10-year term of the proposed action and for 20 years afterwards. This is particularly an issue in the Dungeness River watershed because of its steep topography and loose, gravely soil (USDA 1995b).

In summary, bull trout populations in the Dungeness River core area will continue to be depressed by poor water quality, increased substrate embeddedness, and altered flow regimes caused by the maintenance of moderate to high road densities under the proposed action. An unquantifiable number of bull trout eggs and alevins associated with spawning and rearing habitats are reasonably certain to be killed by the direct and indirect effects of the proposed action that cause a reduction in egg to fry survival, as described above. In addition, an unquantifiable number of bull trout juveniles, sub-adults, and adults associated with bull trout-occupied stream miles below ONF stream crossings are reasonably certain to have their foraging behaviors significantly disrupted or impaired by the direct and indirect effects described above. We are unable to predict how those deaths or impaired behaviors will change the total number of adult bull trout in the Dungeness River core area over the 10-year duration of the proposed action and 20 years afterwards because 1) the effects of the action are a continuation of the degraded environmental baseline, and 2) neither population trend data nor accurate population estimates are available for the Dungeness local populations. Further, several proposed actions will reduce the severity of those effects. In essence, the effects to bull trout from the proposed action are expected to be similar in kind to what has occurred previously in the Dungeness River watershed every year since the road system was established. Without trend data, we cannot predict the extent to which the proposed action will influence the Dungeness River core area populations over the 10 years of the proposed action and 20 years afterwards. Further discussion of the effects of the proposed action on bull trout reproduction, numbers, survival, and recovery is presented in the integration and synthesis section of this Opinion.

28.5.2 Elwha River Core Area

There are two local populations of bull trout in the Elwha River core area, one upstream of Carlson Canyon and one downstream of Carlson Canyon. Additionally, the Little River has also been identified as a potential local population now that the Elwha and Glines Canyon dams are removed. There is insufficient information to estimate adult bull trout abundance in the Elwha River core area, and bull trout in this area are considered to be at an increased risk of extirpation (USFWS, 2015, p. A-10 – A-25). A discussion of the limited information regarding bull trout abundance in this core area is included in the Environmental Baseline of this Opinion. The ONF administrative boundary includes 11,180 acres adjacent to approximately 2.5 miles of main-stem Elwha River below Carlson Canyon and approximately 3 miles of the mainstem Little River plus tributaries. However, ONF land ownership is largely upstream of the main-stem Elwha River and the Little River. The ONF administrative boundary includes 8.9 percent of all bull trout-occupied streams and shorelines in the Elwha River watershed (Table 30). We anticipate some adult and subadult migratory individuals downstream of Carlson Canyon and some bull trout of all life stages within the Little River will likely be exposed to the chronic sedimentation and altered hydrological regimes generated by the proposed action at some point in their life history during the 10-year duration of the program and 20 years afterwards. A smaller subset of those individuals exposed would be killed, injured, or have their behaviors significantly disrupted or impaired by the effects discussed above. Using GIS data, we determined that these effects are reasonably certain to occur in 23.8 miles of bull trout habitat in the Elwha River core area watershed downstream of ONF road-stream interfaces, including 2.9 miles of spawning habitat (Table 35). Additionally, commercial timber harvest from up to five stewardship timber sales may require construction of up to 10 stream crossings and/or stream-adjacent road segments. However, because the vast majority of road networks used for stewardship timber sales, including the associated stream crossings and/or stream-adjacent road segments, is likely to be part of the existing road network, the stewardship timber sales are unlikely to cause adverse effects to additional stream miles.

The two dams on the Elwha River were removed in 2011 and 2014. Sediment movement within the Elwha River related to these removals will vary throughout the year as the river stabilizes. Downstream of the previous dams, high sediment loads may overwhelm any effects of the proposed action. This would not occur in the Little River watershed. The majority of bull trout habitat in the Elwha River core area (including spawning habitat) is upstream of ONF ownership and will be unaffected by the proposed action.

The severity of effects of the proposed action to each exposed individual bull trout in the Elwha River core area depends on the life stage of that individual and its location within the watershed. Bull trout are migratory and their exposure may vary within a year and across multiple years as sediment continues to enter rivers and move downstream during and after rain events. Spawning located downstream of road-stream interfaces will be affected multiple times during the year based on frequency and intensity of rain events. Eggs and alevin are the only life stage that would be directly killed as a result of substrate embeddedness, poor water quality, and the other anticipated habitat changes caused by the proposed action that reduce egg to fry survival. Juveniles, as explained in the effects section above, are not likely to be directly killed but are very sensitive to the anticipated reduction in prey availability. Accordingly, an unknown number of juveniles are expected to die or experience reduced fitness and growth because of the effects of the proposed action on prey resources. Adult and sub-adult bull trout are less sensitive to reductions in prey availability because they have a more varied diet and are mobile enough to forage in larger areas. However, some adult and subadult bull trout in this core area are reasonably certain to have their foraging behaviors disrupted or impaired by the proposed action. At a watershed scale, we cannot predict how frequently adult and sub-adult bull trout foraging behaviors will be impaired to an extent that is likely to cause the injury or death of affected individuals (i.e., when bull trout are unable to find adequate forage elsewhere). Individual bull trout of all life stages downstream of multiple stream crossings and stream adjacent roads (such as in the lower Little River) are likely to experience greater effects than individuals downstream of fewer crossings and stream-adjacent roads. Individual bull trout of all life stages on ONF lands (or Olympic National Park lands) upstream of crossings (such as in the upper Little River/Hughes Creek watershed or the local population above Carlson Canyon) are upstream of chronic sediment inputs and therefore would not be adversely affected by the proposed action.

We are unable to reasonably predict the number of individuals that are likely to experience a significant disruption or impairment of behaviors, injury, suffocation, etc., but we expect that the adverse effects to population size and productivity would be roughly commensurate with baseline conditions. The sedimentation rate into the Elwha River watershed is approximately 9.3 tons per year, dispensed at 22 crossings and 3.0 miles of stream adjacent roads (Tables 31 and 35). Road densities would remain moderately high in each sub-watershed (Table 32). We acknowledge that the estimated sedimentation rate in the Elwha River core area is attributable to the degraded environmental baseline caused by past management activities. That sedimentation will be extended into the future by activities conducted under the proposed action.

In summary, bull trout populations in the Elwha River core area are likely to continue to be depressed by poor water quality, increased substrate embeddedness, and altered flow regimes caused by the maintenance of moderate road densities under the proposed action. An unquantifiable number of bull trout eggs and alevins associated with approximately 2.9 miles of spawning and rearing habitats are reasonably certain to be killed by the direct and indirect effects of the action that would cause a reduction in egg to fry survival, as described above, and an unquantifiable number of bull trout juveniles, sub-adults, and adults associated with bull trout occupied stream miles below ONF stream crossings are reasonably certain to have their behaviors significantly disrupted or impaired by the direct and indirect effects described above. We are unable to predict how those deaths or impaired behaviors will change the total number of adult bull trout in the core area over the 10-year duration of the proposed action and 20 years afterwards because 1) the effects of the action are a continuation of the degraded environmental baseline, and 2) neither population trend data nor accurate population estimates are available for the Elwha River local populations of bull trout. Further, several proposed actions will reduce the severity of those effects. In essence, the effects to bull trout from the proposed action are expected to be similar in kind to what has occurred previously in the Elwha River watershed every year since the road system was established. Without trend data, it is difficult to predict the magnitude of the proposed action's influence on the Elwha River core area populations over the 10 years of the proposed action and 20 years afterwards. Further discussion of the effects of the proposed action on bull trout reproduction, numbers, survival, and recovery is presented in the integration and synthesis section of this Opinion.

28.5.3 Hoh River Core Area

There are two local populations of bull trout in the Hoh core area, one in the South Fork Hoh River, and one in the Hoh River upstream of the confluence with the South Fork Hoh River (USFWS, 2015, p. A-10 – A-25). Currently there is insufficient information for a precise estimate of adult bull trout abundance but, based on the expertise of the Olympic Peninsula Bull Trout Recovery Planning Team, the Hoh River core area likely supports at least 500 but fewer than 1,000 adults (Olympic Peninsula Bull Trout Recovery Unit Team 2003, in USFWS, 2004, page 138).

The ONF administers a 413-acre piece of land adjacent to the main-stem Hoh River downstream of the confluence that divides the local populations. That piece of land contains or is adjacent to 1.3 percent of the all bull trout streams and shorelines in the Hoh River watershed (Table 30). The ONF has jurisdiction over 0.3 miles of roads on that piece of land; however, those roads do not cross any streams (Table 31). Due to the small amount of land area and roads within this core area, we anticipate that ONF stewardship timber sales, and road use and maintenance actions in the Hoh River watershed will not affect bull trout or their habitat. Accordingly, the Hoh River core area will not be discussed further in the bull trout chapter of this Opinion.

28.5.4 Queets River Core Area

The Queets River core area contains one identified local population of bull trout. That population is thought to originate in the Queets River and associated tributaries upstream of the confluence with Tshletshy Creek (Olympic Peninsula Recovery Planning Team, *in litt.* in USFWS, 2004, page 55). The administrative boundary of the ONF includes lands in five subwatersheds within this core area that provide foraging, migration and overwintering habitat for bull trout and 16.7 percent of the all bull trout-occupied streams and shorelines in the Queets River watershed (Table 30). We anticipate that the proposed project extends the adverse baseline effects to some bull trout individuals from the Queets River population (estimated to be 500 to 1000 adult bull trout plus sub-adults) that will be exposed to the chronic sedimentation and altered hydrological regimes when they migrate to waterbodies downstream of ONF lands or when their food supply is adversely affected by sediment from ONF lands. A smaller subset of those individuals exposed are likely to have their behaviors significantly disrupted or impaired by the effects discussed above. Using GIS data, we determined that these effects are reasonably certain to occur in 71 miles of bull trout habitat in the Queets River core area watershed downstream of ONF road-stream interfaces (Table 35). Those 71 miles do not include any spawning and rearing habitat for bull trout, therefore, all spawning and rearing habitat in the Queets River core area would be unaffected by the proposed action. Additionally, commercial timber harvest from up to five stewardship timber sales may require construction of up to 10 stream crossings and/or stream-adjacent road segments. However, because most the vast majority of road networks used for stewardship timber sales, including the associated stream crossings and/or stream-adjacent road segments, is likely to be part of the existing road network, the stewardship timber sales are unlikely to cause adverse effects to additional stream miles.

Adult and sub-adult bull trout are less sensitive to reductions in prey availability than juveniles because they have a more varied diet and are mobile enough to forage in larger areas. However, some adult and subadult bull trout in this core area are reasonably certain to have their foraging behaviors disrupted or impaired by the proposed action. At a watershed scale, we cannot predict how frequently adult and sub-adult bull trout foraging behaviors will be impaired to an extent that is likely to cause the injury or death of individuals (i.e., when bull trout are unable to find adequate forage elsewhere). Individual adult and subadult bull trout that forage for fish or invertebrates downstream of multiple ONF stream crossings and stream adjacent roads (such as in the lower Matheny Creek watershed) are likely to experience greater disruptions to their essential foraging behavior than individual bull trout downstream of fewer stream crossings and stream-adjacent roads. Individual bull trout of all life stages in the Olympic National Park upstream of ONF lands are upstream of ONF's chronic sedimentation inputs and therefore would not be adversely affected by the proposed action.

We are unable to reasonably predict the number of individuals that would be adversely affected, but we expect that the adverse effects to population size and productivity would be roughly commensurate with baseline conditions. The sedimentation rate into the Queets River watershed is approximately 608 tons per year, dispensed at 319 crossings and 35.2 miles of stream adjacent roads (Tables 31 and 35). Road densities would remain moderate to high in each sub-watershed (expect for the Tshletshy Creek watershed) (Table 32). We acknowledge that the estimated sedimentation rate in the Queets River core area is attributable to the degraded environmental baseline caused by past management activities. That sedimentation will be extended into the future by activities conducted under the proposed action.

In summary, bull trout populations in the Queets River core area are likely to continue to be depressed by poor water quality, increased substrate embeddedness, and altered flow regimes caused by the maintenance of moderate to high road densities under the proposed action. An unquantifiable number of bull trout sub-adults and adults associated with all bull trout occupied stream miles below ONF stream crossings are reasonably certain to have their behaviors significantly disrupted or impaired by the direct and indirect effects described above. We are unable to predict how those deaths or impaired behaviors will change the total number of adult bull trout in the Queets River core area over the 10-year duration of the proposed action and 20 years afterwards because 1) the effects of the action are a continuation of the degraded environmental baseline, and 2) neither population trend data nor an accurate population estimate are available for the Queets local population. Further, several proposed actions will reduce the severity of those effects. In essence, the effects to bull trout from the proposed action are expected to be similar in kind to what has occurred previously in the Queets River watershed every year since the road system was established. Without trend data, it is difficult to predict the magnitude of the proposed action's influence on the Queets River core area populations over the 10 years of the proposed action and 20 years afterwards. Further discussion of the effects of the proposed action on bull trout reproduction, numbers, survival, and recovery is presented in the integration and synthesis section of this Opinion.

28.5.5 Quinault River Core Area

The Quinault River core area contains two local populations of bull trout, one in the North Fork Quinault River and its associated tributaries and one in the upper mainstem Quinault River, upstream from the confluence with the North Fork Quinault River (USFWS, 2015, p. A-10 – A-25). The two known local populations occur entirely within the Olympic National Park, but migratory individuals frequently use streams on ONF land for foraging, migrating, and overwintering. Streams on ONF land in the Quinault River core area are important spawning areas for fish species that bull trout eat (USFWS, 2010b, page 49-50). The ONF administrative boundary includes 12.7 percent of the all bull trout-occupied streams and shorelines in the Quinault River watershed (Table 30). We anticipate that the proposed project extends the adverse baseline effect to some individuals from both populations in the Quinault River core area (estimated to be 500 to 1000 adult bull trout plus sub-adults). At some point in their life history, bull trout will be exposed to the chronic sedimentation and altered hydrological regimes generated by the proposed action when they migrate to waterbodies downstream of ONF lands or when their food supply is adversely affected by sediment. A subset of those individuals exposed would have their behaviors significantly disrupted or impaired by the effects discussed above. Using GIS data, we determined that these effects are reasonably certain to occur in 60.3 miles of bull trout habitat in the Quinault River core area watershed downstream of ONF road-stream interfaces (Table 35). Those 60.3 miles do not include any spawning and rearing habitat for bull trout, therefore, all bull trout spawning and rearing habitat in the Quinault River core area will be unaffected by the proposed action. Additionally, commercial timber harvest from up to five stewardship timber sales may require construction of up to 10 stream crossings and/or stream-adjacent road segments. However, because most the vast majority of road networks used for stewardship timber sales, including the associated stream crossings and/or stream-adjacent road segments, is likely to be part of the existing road network, the stewardship timber sales are unlikely to cause adverse effects to additional stream miles.

Adult and sub-adult bull trout are less sensitive to reductions in prey availability than juveniles because they have a more varied diet and are mobile to forage in larger areas. However, some adult and subadult bull trout in this core area are reasonably certain to have their foraging behaviors disrupted or impaired by the proposed action. At a watershed scale, we cannot predict how frequently foraging adult and sub-adult bull trout behaviors will be impaired to an extent that is likely to cause the injury or death of individuals (i.e., when bull trout are unable to find adequate forage elsewhere). Individual adults and subadult bull trout that forage for fish or invertebrates downstream of multiple ONF stream crossings and stream adjacent roads (such as in lower Cook Creek) are likely to experience greater disruptions to their essential foraging behavior than individual bull trout downstream of fewer stream crossings and stream-adjacent roads. Individual bull trout of all life stages in the Olympic National Park upstream of ONF lands are upstream of ONF's chronic sedimentation inputs and therefore would not be adversely affected by the proposed action.

We are unable to reasonably predict the number of individual bull trout that are likely to die as result of disrupted or impaired essential behaviors, but we expect that the adverse effects to population size and productivity would be roughly commensurate with baseline conditions. The sedimentation rate into the Quinault River watershed is approximately 281 tons per year, dispensed at 97 crossings and 15.2 miles of stream adjacent roads (Tables 31 and 35). Road densities would remain moderate to high in two sub-watersheds and low in the other two sub-watersheds (Table 32). We acknowledge that the estimated sedimentation rate in the Quinault River core area is attributable to the degraded environmental baseline caused by past management activities. That sedimentation will be extended into the future by activities conducted under the proposed action.

In summary, bull trout populations in the Quinault River core area are likely to continue to be depressed by poor water quality, increased substrate embeddedness, and altered flow regimes caused by the maintenance of moderate to high road densities under the proposed action. An unquantifiable number of bull trout sub-adults and adults associated with all bull trout occupied stream miles below ONF stream crossings are reasonably certain to have their behaviors significantly disrupted or impaired by the direct and indirect effects described above. We are unable to predict how those deaths or impaired behaviors will change the total number of adult bull trout in the Quinault core area populations over the 10-year duration of the proposed action and 20 years afterwards because 1) the effects of the action are a continuation of the degraded environmental baseline, and 2) neither population trend data nor an accurate population estimate are available for the Quinault core area local populations. Further, several proposed actions will reduce the severity of those effects. In essence, the effects to bull trout from the proposed action are expected to be similar in kind to what has occurred previously in the Quinault River watershed every year since the road system was established. Without trend data, it is difficult to predict the magnitude of the proposed action's influence on the Quinault River core area populations over the 10 years of the proposed action and 20 years afterwards. Further discussion of the effects of the proposed action on bull trout reproduction, numbers, survival, and recovery is presented in the integration and synthesis section of this Opinion.

28.5.6 Skokomish River Core Area

The Skokomish River core area has two local populations, one in the North Fork Skokomish River (including Elk and Slate creeks) and one in the South Fork Skokomish River (including Church Creek) (USFWS, 2015, p. A-10 – A-25). Additionally, Browns Creek has also been identified as a potential local population. All three populations occur on ONF administered lands, and the ONF administrative boundary includes 40.8 percent of the all bull trout-occupied streams and shorelines in the Skokomish River watershed (Table 30). The 2015 5-year review stated that the Skokomish River core area had a rapidly declining short-term abundance trend (USFWS, 2008 and 2015- 5-year review). Bull trout redd surveys between 2005 and 2017 in the North Fork Skokomish River show a stable number of redds and between 2012 and 1017 in the South Fork Skokomish River a variable, but low number (less than 30 redds) except in 2013 when 145 redds were observed. We anticipate that the proposed project will extend adverse baseline effects to some individuals from all three populations in this core area. At some point in their life history, all life stages of bull trout will be exposed to the chronic sedimentation and altered hydrological regimes caused by the proposed action during the 10-year proposed action and for 20 years afterwards. Because the rate of sedimentation and altered hydrology varies within a river based on the relationship between stream morphology and in-stream flows that are driven by the frequency and intensity of storm events, a subset of those individuals exposed would be killed, injured, or have their behaviors significantly disrupted or impaired by the effects discussed above. Using GIS data, we determined that these effects are reasonably certain to occur in 81.7 miles of bull trout habitat in the Skokomish River core area watershed downstream of ONF road-stream interfaces, including 23.3 miles of bull trout spawning habitat (Table 36). Several miles of spawning and rearing habitat in the Upper North Fork Skokomish River watershed will be unaffected by the proposed action because road-crossings do not occur upstream of that habitat. Additionally, commercial timber harvest from up to five stewardship timber sales may require construction of up to 10 stream crossings and/or stream-adjacent road segments. However, because most the vast majority of road networks used for stewardship timber sales, including the associated stream crossings and/or stream-adjacent road segments, is likely to be part of the existing road network, the stewardship timber sales are unlikely to cause adverse effects to additional stream miles.

The severity of effects of the proposed action to each exposed individual bull trout in the Skokomish River core area depends on the life stage of that individual and its location within the watershed. Bull trout are migratory and their exposure may vary within a year and across multiple years as sediment continues to enter rivers and move downstream during and after rain events. Spawning located downstream of road-stream interfaces will be affected multiple times during the year based on frequency and intensity of rain events. Bull trout eggs and alevin are the only life stage that would be directly killed as a result of substrate embeddedness, poor water quality, and the other anticipated habitat changes that reduce egg to fry survival. Juveniles, as explained in the effects section above, are not likely to be directly killed but are very sensitive to the anticipated reduction in prey availability. Accordingly, an unknown number of juveniles are expected to die or experience reduced fitness and growth because of the effects of the proposed action on prey resources.

Adult and sub-adult bull trout are less sensitive to reductions in prey availability because they have a more varied diet and are mobile enough to forage in larger areas. However, some adult and subadult bull trout in this core area are reasonably certain to have their foraging behaviors disrupted or impaired by the proposed action. At a watershed scale, we cannot predict how frequently these behavioral changes will result in injury or death (i.e., when bull trout are unable to find adequate forage elsewhere). Individual bull trout of all life stages downstream of multiple stream crossings and stream adjacent roads (such as in the South Fork Skokomish River) are likely to experience greater effects than individuals downstream of fewer stream crossings and stream adjacent roads. Individual bull trout of all life stages upstream of chronic sedimentation inputs (such as in the upper portions of the North Fork Skokomish River on the Olympic National Park) would not be adversely affected by the proposed action.

We are unable to reasonably predict the number of individuals that would experience disrupted or impaired behaviors, injury, starvation, suffocation, etc., but we expect that the adverse effects to population size and productivity would be roughly commensurate with baseline conditions. The sedimentation rate into the Skokomish River watershed is approximately 1,499 tons per year, dispensed at 678 crossings and 85.2 miles of stream adjacent roads (Tables 31 and 35). Road densities would remain moderate to high in each sub-watershed (Table 32). We acknowledge that the estimated sedimentation rate in the Skokomish River core area is attributable to the degraded environmental baseline caused by past management activities. That sedimentation will be extended into the future by activities conducted under the proposed action.

In summary, bull trout populations in the Skokomish River core area are likely to continue to be depressed by poor water quality, increased substrate embeddedness, and altered flow regimes caused by the maintenance of moderate to high road densities under the proposed action. An unquantifiable number of bull trout eggs and alevins associated with spawning and rearing habitats are reasonably certain to be killed by the direct and indirect effects of the action that would cause a reduction in egg to fry survival, as described above, and an unquantifiable number of bull trout juveniles, sub-adults, and adults associated with bull trout occupied stream miles below ONF stream crossings are reasonably certain to have their behaviors significantly disrupted or impaired by the direct and indirect effects described above. We are unable to predict how those deaths or impaired behaviors will change the total number of adult bull trout in the core area over the 10-year duration of the proposed action and for 20 years afterwards because 1) the effects of the action are a continuation of the degraded environmental baseline, and 2) neither population trend data nor accurate population estimates are available for the Skokomish River local populations. Further, several proposed actions will reduce the severity of those effects. In essence, the effects to bull trout from the proposed action are expected to be similar in kind to what has occurred previously in the Skokomish River watershed every year since the road system was established. With redd data indicating a stable population of bull trout in the Skokomish River core area, we expect that continued road maintenance over the next 10 years and 20 years afterwards will maintain the current level of bull trout within the local populations. Further discussion of the effects of the proposed action on bull trout reproduction, numbers, survival, and recovery is presented in the integration and synthesis section of this Opinion.

29 EFFECTS OF THE ACTION: Bull Trout Critical Habitat

As discussed in the Environmental Baseline section above, the action area is part of the Olympic Peninsula CHU for bull trout. On the Olympic Peninsula, 803.4 miles of streams, 8,318.1 acres of lake surface area, and 418.7 miles of marine shorelines were designated as bull trout critical habitat. There are 86.2 miles of bull trout critical habitat on the ONF. Of those miles, 78.5 are within bull trout core areas, and 7.7 are within non-core watersheds (Table 28). The action area also includes all main-stem bull trout critical habitat downstream of ONF boundaries. Using GIS, we calculated that the action area contains 280.4 miles of bull trout critical habitat. The Olympic Peninsula CHU is essential for maintaining the distribution of the anadromous life history form of bull trout within the Coastal RU; this life-history form is rare across the geographic range of this species (USFWS, 2010b). This CHU is not only essential for maintaining this life history form within the recovery unit, but also within the U.S. coterminous range of bull trout. This CHU is one of only two CHUs that support the anadromous life history form.

For this analysis of the effects of the proposed action on bull trout critical habitat, we initially provide a rationale for why we anticipate that the proposed actions without adverse effects to bull trout will also not have adverse effects to bull trout critical habitat. Secondly, we will analyze the actions that are anticipated to have adverse effects on bull trout and describe how those actions would adversely affect bull trout critical habitat. An important caveat to these determinations is in the Hoh core area, where we do not anticipate that adverse effects to bull trout critical habitat are likely to occur as a result of any of the proposed actions.

29.1 Insignificant Effects to Bull Trout Critical Habitat

Primary constituent elements describe the characteristics of critical habitat that are protected under the ESA. The nine PCEs identified for bull trout critical habitat are described above in the "Status of the Species, Bull Trout Critical Habitat" section of this Opinion. Each of the PCEs correspond to a combination of pathways/indicators from the matrix of pathways and indicators. A crosswalk between the 19 indicators in the matrix and the nine PCEs for bull trout critical habitat is presented in Table 37. Proposed actions that are not anticipated to have adverse effects to bull trout are listed in Table 34 without bold font and with only I's (for insignificant) marked in the corresponding boxes.

For our analysis of effects of the proposed action on the PCEs of bull trout critical habitat, we will assume that if a proposed activity reduces the impact of adverse effects, insignificantly affects, or does not affect a habitat indicator or pathway, the corresponding PCE will be affected in the same manner. We described in the "Insignificant and Discountable Effects of the Proposed Action on the Bull Trout" section, above, that some the proposed project activities, with application of the CMs listed above, are likely to have insignificant effects on the habitat pathways/indicators. Because we anticipate no effects, discountable effects, or insignificant effects to matrix indicators for those activities, we also anticipate the same type of effects to their corresponding PCEs (see the crosswalk in Table 37). If the Level 1 Team anticipates that any of these proposed activities are likely to have greater than discountable or insignificant effects to the PCEs of bull trout critical habitat, further analysis and review of that activity would be needed to determine whether the project is covered by this Opinion (Table 1). Based on the information presented above, we conclude that the effects of those proposed activities determined to have insignificant or discountable effects on the pathways and indicators in the bull trout matrix are also not likely to adversely affect the PCEs of bull trout critical habitat. Additionally, we have determined that in the Hoh River core area, all proposed actions (even new and temporary road construction, road reconstructing, road repairs, log hauling (and other repetitive driving of large trucks), road grading/blading, and drainage maintenance) are not likely to adversely affect any of the bull trout critical habitat PCEs because the roads in that core area under ONF jurisdiction are not stream-adjacent and do not cross any streams.

Table 37. Crosswalk of matrix pathways/indicators with specific PCEs of bull trout critical habitat.

Indicator	PCE 1: Springs, seeps, groundwater	PCE 2: Migratory corridors	PCE 3: Abundant food base	PCE 4: Complex stream channel	PCE 5: Temperature	PCE 6: Substrate	PCE 7: Natural hydrograph	PCE 8: Water quality, quantity	PCE 9: Invasive species
Water Quality									
Temperature		x	x		x			x	
Sediment		x	x			x		x	
Chemical contaminants and nutrients		x	x					x	
Habitat Access									
Physical barriers		x							
Habitat Elements									
Substrate embeddedness			x			x			
Large woody debris			x	x					
Pool frequency and quality			x	x					
Large pools			x	x					
Off-channel habitat				x					
Refugia				x	x				
Channel Conditions and Dynamics									
Wetted width/max. depth ratio				x					
Streambank condition				x					
Floodplain connectivity	x		x	x				x	
Flow/Hydrology									
Changes in peak/base flows	x	x					x	x	
Drainage network increase								x	
Watershed Conditions									
Road density and location									
Disturbance history				x				x	
Riparian reserve			x	x					
Disturbance regime				x			x	x	
Biological Indicators									
Subpopulation size									
Growth and survival									x
Life history diversity and isolation									x
Persistence and genetic integrity									x

29.2 Adverse Effects to Bull Trout Critical Habitat

The proposed actions that may have adverse effects to the PCEs of bull trout critical habitat include new and temporary road construction, road reconstructing, road repairs, log hauling (and other repetitive driving of large trucks), road grading/blading, and drainage maintenance. These effects are likely to occur in 280.4 miles of bull trout critical habitat in 5 bull trout core areas and 2 non-core areas.

The road network on which these proposed activities would occur is a significant source of fine sediment that is likely to be transported to bull trout critical habitat when the ditch, road surface, or disturbed cut/fill is hydrologically connected to streams by surface water. In the short term (days to months), road maintenance is likely to result in increased sedimentation when the disturbed surface of the repaired, rebuilt, or temporary feature is hydrologically re-connected to the stream network. In the long term (years), these road-maintenance activities protect the integrity of the road bed, and reduce the likelihood of catastrophic failure. Road blading/grading, road repairs, road reconstruction, and drainage maintenance are necessary actions to reduce the magnitude of chronic sedimentation and the risk of mass soil movements that may occur if the roads were not maintained. Failure to properly maintain road drainage can result in large sediment inputs to streams (Furniss et al. 1991). Un-maintained or poorly constructed roads experience accelerated erosion as drainage design breaks down. Well-used road surfaces that are not graded regularly will develop ruts that transport water down the road and accelerate road surface erosion. Stream crossings pose the greatest risk to fish habitats of any road feature. When culverts are plugged by debris or overtopped by high flows, road damage, channel realignment, and severe sedimentation can occur (Furniss et al. 1991).

However, road maintenance also prolongs the life of the road network as an extension of the drainage network and a source of fine sediment. In the absence of such maintenance, portions of the roads may eventually erode away through chronic and/or episodic mechanisms and, over the course of decades, re-vegetate to a natural hydraulic state. Rashin and others (1999, page ix) found that best management practices for sediment control on forest roads during and after roadwork were generally ineffective or only partially effective at *preventing* chronic sediment delivery to streams when the activity occurred near streams. They did, however, find that majority of the best management practices for sediment control on forest roads during and after roadwork were effective at *reducing* chronic sediment delivery to streams when the activity occurred near streams (Rashin et al 1999).

The ONF is proposing to implement 10 years of road work and maintenance activities. The effects of new and temporary road construction, road reconstruction, road repairs, log hauling (and other repetitive driving of large trucks), road grading/blading, and drainage maintenance on critical habitat are difficult to separate from the on-going baseline effects of existing roads. For this analysis of effects on bull trout critical habitat, we qualitatively attribute the entire chronic sedimentation effects of the road system to the proposed action as a continued extension of baseline conditions. The adverse effects of that roadwork on PCEs are discussed below.

PCE 1: Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia.

The proposed roadwork/road use actions (specifically new, temporary, and reconstructed roads) are likely to adversely affect springs, seeps, groundwater sources, and subsurface water connectivity, for the reasons described below.

Springs, seeps, and groundwater sources may be adversely affected when new roads or temporary roads intercept and redirect sub-surface flow at the cut bank (MacDonald et al. 2001). Roads can increase the length of the channel network in the watersheds, acting as new flow paths for water, intercepting subsurface flow, and increasing the drainage density. The re-routed water enters the stream channel prematurely instead of infiltrating into the forest floor. The altered stream flow rates and volumes, combined with the increase in sedimentation, can result in altered stream channel geometry (Furniss et al. 1991).

Significant negative changes in springs, seeps, groundwater sources, and subsurface water connectivity (PCE 1) within the action area have already occurred and will continue to occur during the 10 year life of the programmatic and for 20 years afterwards because of past road-building and maintenance activities that are not superseded, but will be extended into the future, by activities conducted under the proposed action. Adverse effects to springs, seeps, groundwater sources, and subsurface water connectivity in critical habitat caused by the proposed action (specifically, road building) are likely to reduce the quality of bull trout critical habitat (PCE 1) in affected areas. These effects are likely to be significant enough to reduce the quality of critical habitat in affected areas downstream of crossings and stream-adjacent roads within designated critical habitat (280.4 stream miles total in all five core areas and two non-core areas for bull trout) during the 10-year duration of the proposed action and for 20 years afterwards.

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.

The proposed roadwork/road use actions (new roads, temporary roads, reconstructed roads, road repairs, log hauling, road grading/blading, and drainage maintenance) are not likely to affect migration habitats or cause permanent, partial, intermittent, or seasonal barriers. Sedimentation from roadwork and road use actions would not be concentrated enough to deter a bull trout from migrating as usual. Therefore, the effects of the proposed action to this PCE are considered insignificant.

PCE 3: An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.

The proposed roadwork/road use actions (new roads, temporary roads, reconstructed roads, road repairs, log hauling, road grading/blading, and drainage maintenance) are likely to adversely affect the food base for bull trout in designated critical habitat in the action area, for the reasons described below. Both macroinvertebrates and forage fish would be affected.

Fine sediment transport into bull trout critical habitat as a result of the proposed action is reasonably certain to reduce macroinvertebrate densities and change species assemblages by changing the habitat qualities of the substrate in depositional areas. Turbidity and suspended solids can also affect macroinvertebrates by increasing invertebrate drift, changing the abundance of food sources, causing respiratory problems, and obstructing habitat (Cordone and Kelley 1961, Cederholm and Reid 1987). Sediment deposition into substrate removes macroinvertebrate habitat by filling interstitial space and rendering attachment sites unsuitable. The loss of habitat caused this increased substrate embeddedness is a particular concern for invertebrates that inhabit the stream bottom (benthic invertebrates). Any modification of the streambed by deposited sediment will most likely have a profound effect upon the benthic invertebrate community (Waters 1995) in which certain invertebrate species and groups will perish or seek a more favorable habitat (Rosenberg and Snow 1975). Studies have shown that the degree to which substrate particles are surrounded by fine material was strongly correlated with macroinvertebrate abundance and composition (Birtwell 1999); and that at an embeddedness of one-third, insect abundance can decline by about 50 percent, especially for riffle-inhabiting taxa (Waters 1995).

Macroinvertebrates are a significant food source for salmonids. Salmonids, including bull trout, favor certain groups of macroinvertebrates, such as mayflies, caddis flies, and stoneflies. These aquatic insect species prefer large substrate particles in riffles and are negatively affected by fine sediment (Everest et al. 1987, Waters 1995, Suttle et al. 2004). With increasing deposition of fine sediment, invertebrate composition and density changes from available, preferred species (i.e. mayflies, caddisflies, and stoneflies) to non-preferred, more unavailable species (i.e., aquatic worms and other burrowing species) (Reid and Anderson 1999, page 10; Henley et al. 2000, page 126, 130; Shaw and Richardson 2001, page 2219; Suren and Jowett 2001, page 726; Suttle et al. 2004, page 971). Fine sediment negatively impacts juvenile bull trout by impairing the food webs that support them (Crouse et al. 1981, Murphy and Hall 1981, Reeves et al. 1993).

The proposed action is also likely to adversely affect PCE 3 by continuing the effects that depress the number and size of available forage fish. Bull trout are apex predators that prey on a variety of species, including fish (Rieman and McIntyre 1993, page 3). Fish are common in the diet of individual bull trout that are more than 110 millimeters long. Large bull trout may feed almost exclusively on fish. Forage fish species include salmonids, dace, sculpin, whitefish, etc. Under baseline conditions, the abundance of forage fish is likely to be depressed because of the substrate embeddedness associated with ongoing road maintenance. The proposed action will maintain that substrate embeddedness, as described in the ‘Introduction to the Effects of Using and Maintaining Forest Roads’ section, above.

Significant negative changes in macroinvertebrate and forage fish densities and assemblages have already occurred and will continue to occur during the 10-year term of the proposed action and for 20 years afterwards because the sedimentation that is attributable to baseline conditions will be extended into the future. As previously discussed, the proposed action would adversely affect bull trout critical habitat by way of sedimentation, depending on site-specific situations and the time scale considered. When they occur, adverse effects to the food base in bull trout critical habitat are likely to be significant enough to reduce the quality of critical habitat in affected areas downstream of crossings and stream-adjacent roads (280.4 stream miles total in five core areas and two non-core areas) during the 10-year term of the proposed action, and for 20 years afterwards.

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 proposed roadwork/road use actions (new roads, temporary roads, reconstructed roads, road repairs, log hauling, road grading/blading, and drainage maintenance) are likely to adversely affect the complexity of river and stream habitats and processes that establish and maintain those habitats in designated critical habitat, for the reasons described below. Complex features that are likely to be affected include substrate embeddedness, pools, and channel-forming processes.

Substrate Embeddedness: Substrates in critical habitat are likely to be embedded with fine sedimentation generated by the proposed actions. As previously described, the proposed action would continue to generate the total estimated quantity of sedimentation in each core watershed as presented in Table 35, that will occur downstream of crossings and stream adjacent roads (Table 31). The anticipated effects of the action on substrate embeddedness were discussed in the Effects of the Action on Bull Trout section above.

Pools: Generally, the fine sediment particles (< 2mm) introduced from road surfaces, cut banks, and ditches are too small and too mobile to fill pools. However, mass soil movements associated with road networks and stream crossings may contribute enough semi-mobile sediment to partially or completely fill pools. Mass soil movements are particularly a concern in the Dungeness River watershed because of its steep topography and loose, gravel soil. We are unable to estimate the extent to which pools are likely to be filled as a result of mass soil movements enabled by the proposed road building and maintenance, but any adverse effects to critical habitat are likely to be associated with the number of crossings and stream adjacent roads in core area watersheds (Table 31).

Channel-Forming Processes: The proposed action is likely to interrupt channel forming processes by re-routing water down reconstructed roads, temporary roads, and upgraded/repaired drainage features on existing roads. Roads can increase the length of the channel network in affected watersheds by acting as new flow paths for water, intercepting subsurface flow, and increasing the drainage density. The re-routed water enters the stream channel prematurely instead of infiltrating into the forest floor. The altered stream flow rates and volumes, combined with an increase in sedimentation, can result in altered stream channel geometry (Furniss et al. 1991). For instance, an increase in peak flow may move larger substrate materials that were previously static. That increased ability to move the bedload may result in changes to the width/depth ratio, pools, substrate composition, etc. of the affected stream. These channel geometry and habitat changes have already occurred to varying degrees within the watersheds in the action area because of the degraded baseline that will be extended into the future. The proposed road reconstruction and road maintenance activities are also likely to reduce the severity of adverse effects to PCE 4 in the short-term by preventing road drainage patterns that interrupt channel forming processes.

Many studies have attempted to quantify the relationship between road networks and changes to the natural condition hydrograph and establish a threshold density where the response of streams is measurable (Jones and Grant 1996, Thomas and Megahan 1998, Beschta et al. 2000, Jones et al. 2000, Jones and Grant 2001, Wigmosta and Perkins 2001, Grant et al. 2008). "The impact of the road network on channel flows was shown to vary during a storm based on the road design, storm characteristics, topography, local geology, and soil moisture conditions" (Wigmosta and Perkins 2001, page 127). Grant and others (2008) suggested that peak flow would change channel morphology when channel gradients are less than 0.02 and streambeds are composed of gravel and finer material (page i).

Significant negative changes in habitat complexity (PCE 4) have already occurred and will continue to occur during the 10-year term of the proposed action and the next 20 years afterwards. The sedimentation and flow regime alteration is attributable to baseline conditions that will be extended in the future by activities conducted under the proposed action. As previously discussed, the proposed action would adversely affect bull trout critical habitat by way of sedimentation and hydrological changes, depending on site-specific situations and the time scale considered. When they occur, adverse effects to habitat complexity in critical habitat are likely to be significant enough to reduce the quality of critical habitat in affected areas downstream of crossings and stream-adjacent roads within designated critical habitat (280.4 stream miles total in all five core areas and two non-core areas) during the 10-year term of the proposed action and for 20 years afterwards.

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.

The proposed roadwork/road use actions (new roads, temporary roads, reconstructed roads, road repairs, log hauling, road grading/blading, and drainage maintenance) are not likely to adversely affect water temperature in bull trout critical habitat. We made this determination because we do not anticipate that sedimentation and hydrological alterations (PCE's 4 and 7) from the proposed action would be great enough and pervasive enough to measurably affect stream temperature. The proposed action will have no effect on this PCE.

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.

The proposed roadwork/road use actions (new roads, temporary roads, reconstructed roads, road repairs, log hauling, road grading/blading, and drainage maintenance) are likely to adversely affect spawning and rearing areas within designated bull trout critical habitat. This effect is likely to occur downstream of ONF road crossings and stream adjacent roads in the Dungeness River, Skokomish River, and Elwha (Little River) watersheds (Table 31). The proposed road reconstruction and road maintenance activities are also likely to reduce the adverse effects to PCE 6 in the short-term by preventing and reducing accelerated sedimentation that would have otherwise occurred.

Sediment transport from the proposed activities into streams is reasonably certain to perpetuate degraded habitat conditions to an extent that is likely to lower the survival rate of bull trout eggs, alevin, smolts, and juveniles in critical habitat areas containing spawning habitat downstream of road-stream interfaces. This effect is likely to occur in depositional areas below crossings where fine sediments are deposited in the substrate. Whenever flow is great enough to move the bed-load, fine sediment is again transported downstream to the next depositional area. If those depositional areas are being used by bull trout for spawning or rearing, we expect that the survival of incubating eggs and alevins would likely be reduced. The relationship between sedimentation, substrate embeddedness, and bull trout survival in the early life stages was previously discussed in the Effects to Bull Trout section, above.

Significant negative changes spawning and rearing areas (PCE 6) have already occurred and will continue to occur during the 10-year term of the proposed action and for 20 years afterwards. The sedimentation and flow regime alteration is attributable to baseline conditions caused by past management activities that are extended into the future by activities conducted under the proposed action.

As previously discussed, the proposed action would adversely affect bull trout critical habitat, by way of sedimentation and hydrological changes, depending on site-specific situations and the time scale considered. When they occur, adverse effects of the proposed action on spawning areas in critical habitat are likely to be significant enough to reduce the quality of critical habitat in the Dungeness River, Skokomish River, and Elwha (Little River). This effect is likely to occur at some locations within designated bull trout critical habitat for spawning and rearing downstream of ONF road crossings and stream adjacent roads (47.6 stream miles in three core areas) during the 10-year term of the proposed action and for 20 years afterwards; and the effects are likely to be significant enough to reduce the quality of critical habitat in the Dungeness River, Skokomish River, and Elwha (Little River).

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.

The proposed roadwork/road use actions (new roads, temporary roads, reconstructed roads, road repairs, log hauling, road grading/blading, and drainage maintenance) are likely to adversely affect the natural hydrograph, by perpetuating the drainage network and drainage density in five core area watersheds for bull trout.

The proposed activities are likely to affect the hydrograph within bull trout core area watersheds on the ONF by re-routing water down reconstructed roads, temporary roads, and upgraded/repaired drainage features on existing roads. Roads can increase the length of the channel network in the watersheds, acting as new flow paths for water, intercepting subsurface flow, and increasing the drainage density. The re-routed water enters the stream channel prematurely instead of infiltrating into the forest floor. The altered stream flow rates and volumes, combined with the increase in sediment that is transported from road surfaces into streams, can result in altered stream channel geometry (Furniss et al. 1991). For instance, and increase in peak flow may move larger substrate materials that were previously static. That increased ability to move the bedload may result in changes to width/depth ratio, pools, substrate composition, etc. These channel geometry and habitat changes have already occurred to some degree, because the degraded baseline condition includes the existing road network.

Many studies have attempted to quantify the relationship between road networks and changes to the natural condition hydrograph and establish a threshold density where the response of streams is measurable (Jones and Grant 1996, Thomas and Megahan 1998, Beschta et al. 2000, Jones et al. 2000, Jones and Grant 2001, Wigmosta and Perkins 2001, Grant et al. 2008). "The impact of the road network on channel flows was shown to vary during a storm based on the road design, storm characteristics, topography, local geology, and soil moisture conditions" (Wigmosta and Perkins 2001, page 127). Grant and others (2008) suggested that peak flow would change channel morphology when channel gradients are less than 0.02 and streambeds are composed of gravel and finer material (page i).

Significant negative changes to the natural hydrograph (PCE 7) have already occurred and are likely to continue to occur during the 10-year term of the proposed action and for 20 years afterwards. The flow regime alteration is attributable to baseline conditions caused by past management activities that will be extended into the future by activities conducted under the proposed action. Because the proposed action extends the effects of the baseline condition, we do anticipate that the natural hydrograph in critical habitat would be adversely affected within designated critical habitat. Adverse hydrograph changes are likely to result in reducing the quality of critical habitat. This effect would occur in some streams within designated critical habitat downstream of ONF road crossings and stream adjacent roads (280.4 stream miles total in five core areas and two non-core areas) during the 10-year term of the proposed action and for 20 years afterwards.

PCE 8: Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.

The proposed roadwork/road use actions (new roads, temporary roads, reconstructed roads, road repairs, log hauling, road grading/blading, and drainage maintenance) are likely to adversely affect water quality such that normal bull trout reproduction, growth, and survival are likely to be inhibited. The proposed road reconstruction and road maintenance activities are also likely to reduce the adverse effects to PCE 6 in the short-term by reducing accelerated sedimentation that would have otherwise significantly reduced water quality. Adverse effects to water quality from the proposed action can occur in both the short term and long term. Short-term water quality degradations may occur at the interfaces between road and streams during and after rain events throughout the 10-year term of the proposed action and the next 20 years afterwards. In the long term, water quality is likely to be degraded by the chronic load of fine sediment moving through the system that will be generated by the road system that was perpetuated by the proposed action.

Potential exposures of bull trout critical habitat to short-term water quality degradations will vary depending on the duration of rain events. These exposure events are likely to occur frequently for the 10-year duration of the proposed action and 20 years afterwards, following rain events.

This effect may occur downstream of any of the stream crossings or stream adjacent roads that are adjacent to critical habitat or close enough upstream (up to 0.5 mile) that significant turbidity reaches critical habitat.

The estimated yearly fine sedimentation rates from road surfaces into critical habitat may or may not significantly reduce water quality depending on how that sedimentation is distributed throughout the year, the background fine sediment load in the affected rivers, and how much of the sediment is suspended vs. deposited at any given moment and location. Elevated turbidity may not necessarily adversely affect salmonids, because are adapted to naturally variable sediment loads associated with seasons and different watershed controls (ACMRR/IABO Working Party on Ecological Indices of Stress to Fishery Resources 1976, pp 13, 15; Birtwell 1999, p. 7).

Significant negative changes to water quality (PCE 8) have already occurred and are likely to continue to occur during the 10-year term of the proposed action and for 20 years afterwards. The estimated sedimentation is attributable to baseline conditions that will be extended into the future by activities conducted under the proposed action. Because the proposed action extends the effects of the baseline condition, we do anticipate that water quality in critical habitat would be adversely affected at some times of the year. Adverse water quality effects are likely to result in reducing the quality of critical habitat. This effect would occur in some streams within designated critical habitat downstream of ONF road crossings and stream adjacent roads (280.4 stream miles total in five core areas and two non-core areas) during the 10-year term of the proposed action and for 20 years afterwards.

PCE 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 proposed roadwork/road use actions (new roads, temporary roads, reconstructed roads, road repairs, log hauling, road grading/blading, and drainage maintenance) would not affect the occurrence of non-native predatory, interbreeding, or competing species.

29.2.1 Summary of the Effects to Bull Trout Critical Habitat

The proposed action is likely to adversely affect some of the 280.4 stream miles of critical habitat within the action area (in both short and long time scales) by reducing the function of primary constituent elements of bull trout critical habitat in the action area (PCE's 1, 3, 4, 6, 7, and 8). The proposed action is also likely to reduce the adverse effects within 280.4 stream miles of critical habitat within the action area at an intermediate time scale (months to years) by reducing the rate of road surface and ditch erosion that would otherwise occur. Those effects are likely to occur after rain events within watersheds containing bull trout critical habitat on the ONF during the 10-year duration of the proposed action and for 20 years afterwards. The anticipated adverse effects to critical habitat would occur as a continuation of the degraded environmental baseline (as was explained previously in the effects to species section of this Programmatic Biological Opinion).

30 CUMULATIVE EFFECTS: Bull Trout And Bull Trout Critical Habitat

Cumulative effects include the effects of future state or private activities, not involving federal activities, 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.

30.1 Adjacent Land Managers

Within and adjacent to the administrative boundary of the ONF there are interspersed tracts of non-Federal land. Land uses that are reasonably certain to occur on these lands include timber harvest, agriculture and development. The USFWS anticipates that such non-Federal actions on those lands may affect bull trout and its critical habitat.

Much of the adjacent non-Federal 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 WDNR HCP (WDNR 2005), the Green Diamond (*nee* Simpson) Company Habitat Conservation Plan (Simpson Timber Company 2000), and the Washington Forest Practices Rules (RCW 76.09, WAC 222).

Non-Federal actions on non-timber lands are likely to include residential development, road management, and small-scale agriculture projects. Because of the limited quantity and patchy distribution of non-Federal lands adjacent to ONF lands, we expect that the effects to bull trout and bull trout critical habitat associated with these actions are likely to be dispersed and mostly downstream of ONF lands. The majority of cumulative effects are likely to occur within bull trout forage, migratory, and overwintering habitats where the greatest concentration of non-Federal lands occur. Within the range of bull trout on the Olympic Peninsula, most of the known bull trout spawning and rearing habitat occurs on Federal lands within the boundaries of the Olympic National Park or the ONF.

30.2 Recreation

The Olympic Peninsula is a popular destination for recreation (e.g., fishing, hiking, and camping). Recreational activities on non-Federal lands within the action area have occurred in the past and are reasonably certain to occur within the future 10-year term of the proposed action. With the exception of fishing, these activities are not likely to have measurable adverse effects on bull trout. Catch-and-release fishing and poaching/illegal harvest of bull trout on non-Federal lands in the action area may cause bull trout injury or mortality in the six bull trout core areas that include non-Federal lands where these activities are reasonably certain to occur. The section 4(d) rule published with the listing of bull trout allows incidental catch of bull trout when legally fishing for other species. Currently it is illegal to catch and keep bull trout anywhere on the Olympic Peninsula. The anticipated future quantity of bull trout injury or mortality associated with incidental sport catch is unknown, but studies have shown that catch-and-release fishing can cause mortality ranging from 3.9 percent for fly-caught fish up to 58 percent for bait-caught fish (Pauley and Thomas 1993; Schisler and Bergersen 1996; Warner and Johnson 1978). The Washington Fish and Wildlife Commission has implemented selective gear rules (i.e., artificial lures with single, barbless hooks) on many of the Olympic Peninsula rivers. These rules may reduce the incidental mortality rate of bull trout from angling. Recreation is not likely to adversely affect bull trout critical habitat.

31 INTEGRATION AND SYNTHESIS OF EFFECTS: Bull Trout And 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 proposed action. In this section, we add the effects of the action and cumulative effects to the environmental baseline and, in light of the status of the species and critical habitat, formulate the USFWS's opinion as to whether the action is likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat.

31.1 Summary of the Current Status of Bull Trout Rangewide

Throughout its range, bull trout are threatened by the combined effects of habitat degradation, fragmentation, and alteration. Six segments of the coterminous United States population of bull trout are essential to the survival and recovery of this species and are identified as recovery units. The survival and recovery of bull trout is dependent upon the maintenance and/or establishment of persistent core area populations throughout its range and unimpeded movement corridors between these core areas to an extent that sufficient genetic diversity and life history forms are present to ensure the resiliency of the overall species' population. The proposed program of activities would be located in the Coastal RU. The Olympic Peninsula geographic region, which is located within Coastal RU, currently contains 6 core areas, 11 local populations, and 2 potential local populations (USFWS, 2015). The limited amount of survey data and key biological information for the Olympic Peninsula geographic region make it difficult to determine status and trends, and contribute to uncertainty about the consequences of the proposed action. We evaluated the impacts of the action in light of the conservation needs of bull trout as determined in the final Recovery Plan.

31.2 Summary of the Environmental Baseline, Effects of the Proposed Action, and Cumulative Effects

The environmental baseline in the action area is affected by a large network of forest roads that generate chronic sedimentation, mass wasting, and hydrological changes. Many of those roads were designed and built prior to the listing of bull trout as a threatened species. That road system has been maintained by the ONF, resulting in continued chronic sedimentation from roads. As a result of the stressors associated with extensive road-caused sedimentation rates within aquatic habitats, as well as other stressors, all of the bull trout core area populations in the action area are considered to be at an increased risk of genetic drift due to small population sizes. Three of the core areas (Skokomish River, Dungeness River, and Elwha River) are considered to be at an increased risk of extirpation due to a lack of resiliency to stochastic events and an increased risk of genetic drift. The environmental baseline also includes previously consulted-on conservation strategies to reduce chronic sedimentation for the benefit of bull trout and other aquatic life (USDA and USDI 1994, USFWS, 2000).

We estimate that baseline chronic sedimentation and hydrological changes are likely to be both perpetuated and somewhat reduced by the proposed action in each bull trout core area watershed for the 10-year duration of the proposed programmatic action and for 20 years afterwards. The proposed action is responsible for a portion of the estimated quantity of sedimentation (Table 35) that will be introduced at crossings and stream-adjacent roads (Table 31) at varying magnitudes across the landscape (Table 32). Additionally some sedimentation will result from roads and road crossings associated with up to five small stewardship timber sales over the duration of the programmatic. The sedimentation is a result of the degraded baseline and will be extended into the future because of the proposed action. In the Dungeness, Skokomish, and Elwha core areas, all bull trout life-stages are likely to be affected, but in the Queets and Quinault core areas, only sub-adults and adults are likely to be affected. The severity of effects to individuals and populations in each core area, as previously described, ranges from insignificant to death. We anticipate more severe adverse effects in core areas where younger life stages would be exposed. The effects of climate change and the cumulative effects of activities on non-Federal actions within the action area may increase the severity of anticipated effects to individual bull trout caused by the proposed action through additive and synergistic stressors.

31.3 Effects to Bull Trout Distribution, Reproduction, and Numbers within the Action Area

31.3.1 Distribution

We do not anticipate that the proposed action will affect the distribution of bull trout in any of the affected core areas because fish passage would not be constricted and habitat effects are not expected to isolate groups of bull trout that are currently connected. Hydrological changes and sedimentation from roadwork and road use actions are not likely to be large enough or concentrated enough to deter a bull trout from migrating as usual. We also do not expect that effects to individuals will reduce the distribution of populations in their core areas (see Reproduction and Numbers discussion, below).

31.3.2 Reproduction

Similar to baseline conditions, bull trout reproduction will be adversely affected by the proposed actions, particularly in the Dungeness, Skokomish, and Elwha watersheds where sedimentation and hydrological changes are likely to reduce egg to fry survival and adversely affect rearing juveniles. The degraded baseline and recent estimates of bull trout abundance (USFWS, 2015) suggest that reproductive rates may be currently depressed, and may have been so since the construction of the road network. The proposed actions (e.g., road reconstruction and maintenance) will perpetuate the existence of the roads, which maintains the long-term chronic effects of roads that are likely to be depressing reproductive rates. Consequently, depressed reproductive rates due to the degraded baseline conditions, are expected to be maintained. A discussion of how this is expected to affect numbers, survival, and recovery is included below.

31.3.3 Numbers

Bull trout numbers would be adversely affected by the proposed actions, particularly in the Dungeness, Skokomish, and Elwha watersheds where sedimentation and altered hydrological regimes adversely affect bull trout at multiple life stages and in sub-watersheds where road densities are high (Table 32). Although we anticipate a continuation of reduced reproductive rates and increased mortality rates of eggs, alevin, and juveniles related to baseline road maintenance activities, those impacts are not expected to lower the estimated annual adult bull trout population in each core area (the metric we refer to as "numbers") for the following reasons:

1. Road-related mortality has had a stronger negative effect on annual adult bull trout population sizes in the last several decades because there were more roads and less attention to BMPs for road work and road design. In the next 10 years, because of conservation measures dictated by the Forest Service's road standards (Appendix J) and the road decommissioning and restoration progress on the ONF, we expect that road-related mortality will have a less negative effect on population sizes than historically. These improvements, in combination with all of the other stressors on bull trout populations, may result in higher or lower annual adult population sizes over the next 10 years, depending on natural variability and climate conditions.

2. Each core area contains spawning/rearing and FMO habitat that will be unaffected by the proposed programmatic action. In the Queets and Quinault core areas, all spawning/rearing habitat will be unaffected by the proposed action. In the Elwha core area, the majority of habitat (including spawning habitat) is upstream of ONF ownership and will be unaffected by the proposed action. In the Dungeness core area, spawning and rearing habitat in the Gray Wolf River will be only slightly affected by the proposed action (there are only a few crossings in the upper watershed) and some FMO habitat in the Canyon Creek/Pats Creek watershed will be unaffected by the proposed action. In the Skokomish core area, some of the spawning and rearing habitat in the Upper North Fork Skokomish River watershed will be unaffected by the proposed action. Reproduction and survival in these unaffected areas are anticipated to buffer the adverse effects of the proposed action on annual adult bull trout population sizes.

3. All anticipated direct mortality would occur to age 0 bull trout (reduced egg to fry survival rate), the majority of impaired essential behaviors would occur to juvenile bull trout, and most of the adult and sub-adult bull trout impacted would have their behaviors significantly disrupted but not impaired. In a population viability context, the survival rate of age 0 bull trout is highly variable and not a primary driver of population size and viability. Adult survival is the most important driver of population viability, and adult survival rates are not likely to be reduced by the proposed action.

For these reasons, we do not anticipate that the proposed action will result in reduced annual adult bull trout populations in any bull trout core area over the next 10 years. A discussion of how the proposed action would affect the survival and recovery of bull trout during the 10-year duration of the proposed action is included below.

31.4 Effects to Bull Trout Survival and Recovery at the Recovery Unit and Range-wide Scales

The current size and productivity of nine bull trout populations and two potential local populations in the five core areas on the ONF (excluding the Hoh River), as well as their recovery potential, are heavily influenced by the quantity and intensity of on-going anthropogenic stressors and sources of mortality. As described in the Environmental Baseline, the ONF road network has likely been a major source of that stress and mortality. The program of proposed actions on those forest roads would both reduce and perpetuate that stress and mortality, as described previously in this Opinion. Accordingly, the result of the proposed action on bull trout survival and recovery is likely to perpetuate the existing conditions for survival and recovery for another 30 years. The final Bull Trout Recovery Plan (USFWS, 2015) characterized those chances and described the Dungeness, Queets, Quinault and Elwha core areas as "at increased risk of genetic drift" and the Skokomish core area as "at risk for in-breeding depression." However, we expect that the survival and recovery rates in these five core areas may improve given on-going restoration efforts on the ONF and long-term improvement of forest road conditions that the Forest Service committed to in the Aquatic Conservation Strategy (USDA and USDI 1994, USFWS, 2000).

31.4.1 Effects to the Olympic Peninsula Geographic Region, Coastal Recovery Unit, and Rangewide

The six core areas in the action area contain all of the extant bull trout populations in the Olympic Peninsula geographic region, the majority of which exhibit an anadromous life history. The Olympic Peninsula and Puget Sound geographic regions within the Coastal RU contain the only anadromous life history forms in the range of bull trout (USFWS, 2015). Essentially, the effects of the action are inseparable from the baseline effects to the Olympic Peninsula geographic region, and the long-term persistence of the Coastal RU is dependent on the survival of each core area on the Olympic Peninsula. Because we concluded that the proposed action would not appreciably reduce the likelihood of long-term bull trout survival and recovery in the action area, we can also conclude that the proposed action would not appreciably reduce the chance of long-term bull trout survival and recovery of the Olympic Peninsula geographic region, Coastal RU, and rangewide.

31.5 Summary of the Status and Conservation Role of Critical Habitat in the Action Area

The action area includes 280.4 miles of designated critical habitat (272.7 core area miles and 7.7 non-core area miles), which is 35 percent of the total critical habitat miles in the Olympic Peninsula Critical Habitat Unit (803.4 miles). Critical habitat in the action area is essential for maintaining the current distribution, abundance, and productivity of bull trout in Olympic Peninsula CHU. The Olympic Peninsula CHU is essential for maintaining bull trout distribution within this unique geographic region of the recovery unit and is essential for maintaining the distribution of the anadromous life history form within the recovery unit which is rare across the geographic range of this species. It is not only essential for maintaining this life history form within this RU, but within its coterminous range. It is one of only two CHUs that contain the anadromous life history form. Since designation in 2010, critical habitat in the action area and in the Olympic Peninsula CHU has continued to serve its role for the recovery of the species. Risk factors that analyze the continued threats to each CHU can be found in the bull trout final critical habitat justification (USFWS, 2010b).

31.6 Summary of Effects of the Proposed Action on Critical Habitat in the Action Area

The proposed action would adversely affect some areas of habitat within 280.4 stream miles of critical habitat by impairing the function of primary constituent elements in the action area (PCE's 1, 2, 3, 4, 6, 7, and 8). Those effects would occur (some constantly and some sporadically) during the 10-year duration of the proposed action and for 20 years afterwards. The anticipated adverse effects to critical habitat would occur as a continuation of the degraded environmental baseline. The cumulative effects on designated bull trout critical habitat in the action area are likely associated with climate change, recreation, and non-Federal land management. The effects of climate change and activities on non-Federal lands within the action area may increase the severity of anticipated adverse effects to PCE's caused by the proposed action through additive and synergistic stressors.

Despite the large geographic extent of the anticipated adverse effects to critical habitat, we expect that critical habitat in the action area will continue to provide its essential functions for the survival and recovery of bull, at its currently diminished level, just as it has every year since the construction of the forest road system on the ONF and adjacent lands. We also anticipate that each CHU would still contribute to maintaining the current distribution, abundance, and productivity of bull trout in Olympic Peninsula CHU. We reach these conclusions for the following reasons:

1. The ONF road system had a stronger negative effect on bull trout critical habitat in the last several decades (compared to the present) because there were more roads and fewer BMPs for road work and road design. In the next 10 years, because of improved conservation measures and best management practices for road work on the ONF, as well as road decommissioning and restoration progress on the ONF, we expect that the ONF road system (and the maintenance of that road system) will have a less negative effect on bull trout critical habitat than it did in the decades prior to the listing of the species and the implementation of the ACS. Adverse effects from the proposed action are largely commensurate with the continuation of existing degraded conditions. Streams are constantly re-setting habitat conditions as watershed conditions, sediment loads, and flow regimes are changing. This point is discussed further in reason number three, below.

2. Each core area contains critical habitat that will be unaffected by the proposed programmatic action. In the Queets and Quinault core areas, all critical habitat for spawning/rearing will be unaffected by the proposed action. In the Elwha core area, the majority of critical habitat (including the vast majority of critical habitat for spawning and rearing) is upstream of ONF ownership and will be unaffected by the proposed action. In the Dungeness core area, critical habitat for spawning and rearing habitat in the Gray Wolf River will be only slightly affected by the proposed action (there are only a few crossings in the upper watershed) and some critical habitat in the Canyon Creek/Pats Creek watershed will be unaffected by the proposed action. In the Skokomish core area, some of the critical habitat for spawning and rearing habitat in the Upper North

Fork Skokomish River watershed will be unaffected by the proposed action. Essential functions of critical habitat for the survival and recovery of bull trout in these unaffected areas are anticipated to buffer the adverse effects of the proposed action on critical habitat in affected areas.

3. Most of the adverse effects of the proposed action on critical habitat are continuously changing depending on frequency and duration of rain events. Streams are constantly re-setting habitat conditions as watershed conditions, sediment loads, and flow regimes are changing. For instance, fine sediment is transported out of depositional areas during high flows, and subsequently fine sediment deposition the following year is not in addition to the sediment that deposited in the previous year. The nature of watershed-scale habitat degradation is patchy, with some reaches affected in some years but not in others. Not all critical habitats will be adversely affected at one time by the proposed action, suggesting that some critical habitats will provide essential functions for the survival and recovery of bull trout while the quality of other critical habitats are temporarily degraded. Even under natural watershed conditions, bull trout would adjust habitat use around changing conditions at the site, reach, stream, and watershed scale.

31.7 Effects to Olympic Peninsula CHU, Recovery Unit, and Critical Habitat Rangewide

The function the Olympic Peninsula Critical Habitat Unit for the survival and recovery of bull trout is expected to be maintained because the essential functions of critical habitat in the affected critical habitat subunits (CHSU) and un-affected CHSUs would be maintained. Accordingly, bull trout distribution within this unique geographic region of the Coastal RU would be maintained and the unique anadromous life history form of bull trout in each CHSU, CHU, and recovery unit would be preserved. The function of critical habitat rangewide for the survival and recovery of bull trout would also be maintained because the function of critical habitat in the Olympic Peninsula Critical Habitat Unit would be maintained.

32 CONCLUSION: Bull Trout And Bull Trout Critical Habitat

After reviewing the current status of bull trout and its critical habitat, the environmental baseline for the action area for the bull trout and its critical habitat, the effects of the proposed action and the cumulative effects, it is the USFWS's Biological Opinion that the activities covered in this 10-year program of actions, as proposed, are not likely to jeopardize the continued existence of the bull trout and are not likely to destroy or adversely modify designated bull trout critical habitat.

33 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 measures described below are non-discretionary, and must be undertaken by the Forest Service for the exemption in section 7(o)(2) to apply. The Forest Service has a continuing duty to regulate the activity covered by this Incidental Take Statement. If the Forest Service fails to assume and implement the terms and conditions, the protective coverage of section 7(o)(2) may lapse. To monitor the impact of incidental take, the Forest Service must report the progress of the action and its impact on the listed species to the USFWS as specified in this Incidental Take Statement [50 CFR 402.14(i)(3)].

34 AMOUNT OR EXTENT OF TAKE

The USFWS anticipates that spotted owls, marbled murrelets, and bull trout could be taken as a result of the proposed action.

34.1 Spotted Owl

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 many historic territories. However, pursuant to 50 CFR 402.14(i)(1)(i), a surrogate can be used to express the anticipated level of take in an incidental take statement (ITS), 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 USFWS's regulations state that significant habitat modification or degradation caused by an action that results in death or injury to a listed species by significantly impairing its essential behavior patterns constitutes take in the form of harm. Those regulations further state that an intentional or negligent act or omission that creates the likelihood of injury to a listed species by annoying it to such an extent as to significantly disrupt its normal behavioral patterns constitutes take in the form of harass. Such annoyance can be caused by actions that modify or degrade habitat conditions (e.g., excessive noise or smoke). In cases where this causal link between effects of a federal action to habitat and take of listed species is established, and the biological opinion or incidental take statement explains why it is not practical to express and monitor the level of take in terms of individuals of the listed species, the USFWS's regulations authorize the use of habitat as a surrogate for expressing and monitoring the anticipated level of take, provided a clear standard is established for determining when the level of anticipated take has been exceeded.

The following discussion presents the USFWS' analysis and findings with respect to the three regulatory criteria for use of a 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 project implementation. Such an undertaking is outside the scope of the proposed action, 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 the spotted owls. In the accompanying Opinion, we provided a detailed analysis of how the anticipated habitat effects are reasonably certain to significantly disrupt normal spotted owl behavior, 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. In the accompanying analysis, we specifically identified 33,665 acres of disturbance to suitable nesting, roosting, and foraging habitat as the cause of take. If the proposed action is modified such that additional acres of suitable spotted owl habitat are exposed to disturbance, the level of take anticipated in this ITS will be exceeded, triggering reinitiation of formal consultation under section 7 of the ESA.

Occupancy of historic spotted owl territories in the action area has declined, and the presence of barred owls has likely displaced spotted owls from many historic territories. For these reasons, the USFWS has used the quantity of suitable spotted owl foraging habitat that is reasonably certain to be occupied as a surrogate measure of take. These habitat acres are the best available surrogate measure of the extent of harass to spotted owls.

We anticipate incidental take of spotted owls associated with 33,665 acres of suitable spotted owl habitat that are likely to be exposed to noise and visual disturbances associated with programmatic activities during the early spotted owl nesting season (March 1 to July 15) over 10 years (average of 3,367 acres annually). The take is in the form of *harass*, because disturbance is likely to significantly disrupt the spotted owls' normal nesting behaviors. We estimate that up to three spotted owl activity centers (three nesting pairs and their young) are likely to be exposed to disruptive activities over 10 years. The effect of this disturbance is expected to include a flush response that creates a likelihood of injury by increasing the risk of nestling predation or the premature departure of a nestling from a nest.

34.2 Marbled Murrelet

The USFWS anticipates marbled murrelets associated with 118 nests will be taken as a result of this proposed action. The incidental take is expected to be in the form of harm to eggs, nestlings, or breeding adults associated with 106 nests, and in the form of harass to eggs, nestlings, or breeding adults associated with 12 nests. This take will occur over a period of ten years.

The USFWS anticipates incidental take of marbled murrelets will be difficult to detect given the bird's cryptic coloring and behavior, and the location of nest sites high in trees with abundant cover, which makes them extremely difficult to find. However, pursuant to 50 CFR 402.14(i)(1)(i), a 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 USFWS's regulations state that significant habitat modification or degradation caused by an action that results in death or injury to a listed species by significantly impairing its essential behavior patterns constitutes take in the form of harm. Those regulations further state that an intentional or negligent act or omission that creates the likelihood of injury to a listed species by annoying it to such an extent as to significantly disrupt its normal behavioral patterns constitutes take in the form of harass. Such annoyance can be caused by actions that modify or degrade habitat conditions (e.g., excessive noise or smoke). In cases where this causal link between effects of a federal action to habitat and take of listed species is established, and the biological opinion or incidental take statement explains why it is not practical to express and monitor the level of take in terms of individuals of the listed species, the USFWS's regulations authorize the use of habitat as a surrogate for expressing and monitoring the anticipated level of take, provided a clear standard is established for determining when the level of anticipated take has been exceeded.

The following narrative presents the USFWS's analysis and findings with respect to the three regulatory criteria for use of a surrogate in this Incidental Take Statement to express the anticipated level of take likely to be caused by the proposed action.

The take of marbled murrelets associated with 118 nests can be anticipated by a surrogate combining the type of activity carried out by the Forest Service and the amount of suitable habitat in close proximity to that activity. For activities introducing noise and visual disturbance to suitable habitat during the murrelet nesting season (April 1 through September 23), the duration of the activity is the third factor in the surrogate used to anticipate take.

1. Measuring take impacts to individual murrelets is not practical, because marbled murrelet nests are extremely difficult to locate without intensive survey effort involving both on-the-ground surveys and tree-climbing. Tree-climbing is difficult, requiring special training, and has the potential to disturb nesting murrelets in and of itself. Even if such intensive efforts were carried out, nests could still be missed.

2. In the accompanying Opinion, we establish that injuries to murrelets, or disruptions of murrelet breeding, feeding, and sheltering behaviors, are expected when murrelets are nesting within specified distances from the proposed activities. The sections regarding the environmental baseline and the effects of the action provide information regarding the average density of murrelet nests within the action area, which has been measured at approximately 370 acres of suitable habitat per nest. For activities introducing noise and visual disturbance to suitable habitat, the effects section additionally establishes the linkage between the duration and timing of the exposure and the severity of the effect, with significant behavioral disruptions expected only when the same area of nesting habitat is disturbed for two days or more during the nesting season.

3. The anticipated level of take may be exceeded if any activity listed in Table 38 exceeds the corresponding amount of habitat listed in the same table at any time before the end of the 10-year duration of the action. However, in some cases, a less-severe effect may exceed the level of take listed in Table 38 without the total anticipated take being exceeded, if the level of take associated with a more-severe effect is decreased by the same amount. For example, if trail bridge, road bridge, and road construction and reconstruction affected 2,360 acres of suitable instead of 2,300, but early-morning log loading affected only 60 acres instead of 120, with no other changes to the level of take listed in Table 38, the total amount of take would not be exceed. Any substitutions of this nature shall be approved by the Level 1 team to ensure that the substitution is appropriate and may be made without causing effects to the species that have not been anticipated.

Table 38. Anticipated take of murrelets

Activity (incl. duration/timing, if applicable)	Distance within which stressor affects habitat	Suitable habitat to be affected over 10 years	Form of take	Murrelets associated with affected habitat
Large helicopter hovering within 500 feet AGL (nesting season)	0 to 100 yards	200 acres	Harm	1 egg or nestling
Blasting (nesting season)	0 to 100 yards	1,240 acres	Harm	4 nests (each affected nest may involve effects to 1 nestling, or 1 adult, or both)
Campgrounds, including dispersed sites	0 to 55 yards	17,410 acres	Harm	50 eggs or nestlings
Commercial thinning where log loading occurs within 2 hours of dawn (nesting season)	0 to 110 yards	120 acres	Harm	1 nestling

Table 38. Anticipated take of murrelets

Activity (incl. duration/timing, if applicable)	Distance within which stressor affects habitat	Suitable habitat to be affected over 10 years	Form of take	Murrelets associated with affected habitat
Commercial thinning where all activities occur between 2 hours after dawn and 2 hours before dusk	0 to 55 yards	18,830 acres	Harm	50 eggs or nestlings
Commercial thinning where all activities occur between 2 hours after dawn and 2 hours before dusk (nesting season)	55 to 110 yards	1,762 acres	Harass	5 eggs, nestlings, or breeding pairs
Trail bridge, road bridge, and road construction and reconstruction, (duration of 2 days or more, nesting season)	0 to 110 yards in most cases, but up to 265 yards, depending on equipment used (see Table 16)	2,300 acres	Harass	7 eggs or nestlings

34.3 Bull Trout

The USFWS anticipates incidental take of individual bull trout will be difficult to detect because of the low likelihood of finding dead or injured adults, sub-adults, or juveniles; delayed mortality; and sublethal nature of effects. However, pursuant to 50 CFR 402.14(i)(1)(i), a surrogate can be used to express the anticipated level of take in an incidental take statement (ITS), 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 USFWS's regulations state that significant habitat modification or degradation caused by an action that results in death or injury to a listed species by significantly impairing its essential behavior patterns constitutes take in the form of harm. Those regulations further state that an intentional or negligent act or omission that creates the likelihood of injury to a listed species by annoying it to such an extent as to significantly disrupt its normal behavioral patterns constitutes take in the form of harass. Such annoyance can be caused by actions that modify or degrade habitat conditions (e.g., excessive noise or smoke). In cases where this causal link between effects of a federal action to habitat and take of listed species is established, and the biological opinion or incidental take statement explains why it is not practical to express and monitor the level of take in terms of individuals of the listed species, the USFWS's regulations authorize the use of habitat as a surrogate for expressing and monitoring the anticipated level of take, provided a clear standard is established for determining when the level of anticipated take has been exceeded.

The following discussion presents the USFWS' analysis and findings with respect to the three regulatory criteria for use of a 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 bull trout across the action area is not practical. To measure take of individual bull trout would require capturing, tagging, and radio-tracking of individual bull trout in the action area prior to, during, and after project implementation. Such an undertaking is outside the scope of the proposed action, is not practicable to implement, and would pose additional risk of harm through capture and handling of individuals.

2. A link is established between the effects of the action on water quality, habitat quality, and bull trout, and take of bull trout. In the accompanying Opinion, we have provided a detailed analysis of how the anticipated habitat effects are reasonably certain to significantly disrupt normal bull trout behavior patterns, including breeding, feeding, or sheltering, and how the anticipated habitat effects are reasonably certain to significantly degrade habitat to the point that actual injury or death would occur.

3. A clear standard is set for determining when the level of anticipated take based on the surrogate has been exceeded. In the accompanying analysis, we specifically identified culvert cleaning, new and temporary road construction, road reconstruction, road repairs, log hauling (and other repetitive driving of large trucks), road grading/blading, and drainage maintenance activities associated with the proposed action as the cause of take. If the proposed action is modified such that additional stream miles will be exposed to project effects by additional crossings and stream-adjacent roads, the level of take anticipated in this ITS will be exceeded, triggering reinitiation of formal consultation under section 7 of the ESA.

The USFWS anticipates that bull will be incidentally taken as a result of culvert cleaning, new and temporary road construction, road reconstruction, road repairs, log hauling (and other repetitive driving of large trucks), road grading/blading, and drainage maintenance activities associated with the proposed action. The forms and amount of incidental take (quantified in stream miles), and the life bull trout life stages expected to be taken within each core area watershed are described in the following sections. As described in the effects analysis, take is reasonably certain to occur over the 10-year term of the proposed action and for 20 years afterwards. We do not anticipate that all bull trout associated with the habitat in these stream miles will be subject to take, but rather an unknown, and likely small, proportion of the affected individuals based on individual bull trout tolerances and environmental circumstances.

34.3.1 Dungeness Core Area

In the Dungeness core area, incidental take of bull trout is reasonably certain to occur from hydrological changes and a portion of the estimated 253 tons of sediment per year delivered at 256 crossings and along 30.3 miles of stream-adjacent roads in four sub-watersheds (Tables 21, 22 and 25). Adult, sub-adult, and juvenile bull trout associated with 35.9 miles of habitat downstream of any of those 256 crossings or 30.3 miles of stream-adjacent roads in the Dungeness core area are reasonably certain to be harassed or harmed by the effects of the proposed action (directly as a result of culvert cleaning and indirectly from adverse effects to habitat). In addition, some bull trout eggs and alevins associated with 21.4 miles of spawning habitat downstream of any of those 256 crossings or 30.3 miles of stream-adjacent roads in the Dungeness core area are reasonably certain to be killed by the smothering effects of sedimentation caused by the proposed action.

34.3.2 Elwha Core Area

In the Elwha core area, incidental take of bull trout is reasonably certain to occur from hydrological changes and a portion of the estimated 9.3 tons of sediment per year, delivered at 22 crossings and along 3.0 miles of stream-adjacent roads, in two sub-watersheds (Tables 21, 22 and 25). Adult, sub-adult, and juvenile bull trout associated with 23.8 miles of habitat downstream of any of those 22 crossings or 3.0 miles of stream-adjacent roads in the Elwha core area are reasonably certain to be harassed or harmed by the effects of the proposed action (directly as a result of culvert cleaning and indirectly from adverse effects to habitat). In addition, some bull trout eggs and alevins associated with 2.9 miles of spawning habitat downstream of any of those 22 crossings or 3.0 miles of stream-adjacent roads in the Elwha core area are reasonably certain to be killed by the effects of the proposed action (reduced egg to fry survival from smothering).

34.3.3 Queets Core Area

In the Queets core area, incidental take of bull trout is reasonably certain to occur from hydrological changes and a portion of the estimated 608 tons of sediment per year, delivered at 319 crossings and along 35.2 miles of stream-adjacent roads, in four sub-watersheds (Tables 21, 22 and 25). Adults and sub-adult bull trout associated with 71 miles of habitat downstream of any of those 319 crossings or 35.2 miles of stream-adjacent roads in the Queets core area are reasonably certain to be harassed or harmed by the effects of the proposed action (directly as a result of culvert cleaning and indirectly from adverse effects to habitat).

34.3.4 Quinault Core Area

In the Quinault core area, incidental take of bull trout is reasonably certain to occur from hydrological changes and from a portion of the estimated 281 tons of sediment per year, delivered at 97 crossings and along 15.2 miles of stream-adjacent roads, in four sub-watersheds (Tables 21, 22 and 25). Adults and sub-adult bull trout associated with 60.3 miles of habitat downstream of any of those 97 crossings or 15.2 miles of stream-adjacent roads in the Quinault core area are reasonably certain to be harassed or harmed by the effects of the proposed action (directly as a result of culvert cleaning and indirectly from adverse effects to habitat).

34.3.5 Skokomish Core Area

In the Skokomish core area, incidental take of bull trout is reasonably certain to occur from hydrological changes and a portion of the estimated 1,499 tons of sediment per year, delivered at 678 crossings and along 85.2 miles of stream-adjacent roads, in five sub-watersheds (Tables 21, 22 and 25). Adult, sub-adult, and juvenile bull trout associated with 81.7 miles of habitat downstream of any of those 678 crossings or 85.2 miles of stream-adjacent roads in the Skokomish core area are reasonably certain to be harassed or harmed by the effects of the proposed action (directly as a result of culvert cleaning and indirectly from adverse effects to habitat). In addition, some bull trout eggs and alevins associated with 23.3 miles of spawning habitat downstream of any of those 678 crossings or 85.2 miles of stream-adjacent roads in the Skokomish core area are reasonably certain to be killed by the effects of the proposed action (reduced egg to fry survival from smothering).

34.4 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 the species or destruction or adverse modification of critical habitat.

34.5 REASONABLE AND PRUDENT MEASURES

The USFWS finds the following reasonable and prudent measures are necessary and appropriate to minimize the impacts (i.e., the amount or extent) of incidental take of marbled murrelets:

RPM 1: Monitor implementation of the action and report on the annual and cumulative activities, and the amount of suitable habitat affected, to ensure that the level of take exempted by this Incidental Take Statement is not exceeded.

RPM 2: To reduce the likelihood of nest predation, work to reduce supplemental feeding of murrelet nest predators by educating the public regarding best practices for food storage and cleanup at campsites and other facilities, and encourage the use of these practices at all ONF facilities and dispersed campsites.

34.6 TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the ESA, the agency must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

To implement RPM 1:

1. The ONF shall submit a monitoring report to the USFWS (Washington Fish and Wildlife Office, Consultation and Conservation Planning Division, Attn: Manager, Forest Resources Branch) by February 15 of each year, 2021 through 2031, to report on the previous calendar year's activities.

   a. This report shall provide the location, date, and duration of each of the following activities, if they occur during the murrelet nesting season (April 1 to Sept. 23) or the spotted owl early nesting season (March 1 to July 15). Information on activities i through iv specifically applies to those that occur within the significant disruption distances indicated in column 4 of Tables 8 and 15 of the accompanying Opinion:

      i. Large helicopter use for activities involving hovering at or below 500 ft AGL, also including information on the helicopter type;

      ii. Blasting, also including information on the explosive type, size of charge, and measures used to minimize noise;

      iii. Commercial thinning and log loading, distinguishing landings where loading occurs within two hours of dawn;

      iv. Trail bridge, road bridge, and road construction and reconstruction activities, including the type of equipment used; and

      v. Other activities involving the use of chainsaws, heavy equipment, pile driving, rock crushing and screening, helicopters, small fixed-wing aircraft, or tree climbing, if the same area of suitable murrelet habitat is exposed to potentially disturbing noise and visible human activity on two days within a single 30-day period in a given year.

   b. In addition, this report shall provide information regarding the locations of all permanent campgrounds and known, established dispersed campsites within 55 yards of suitable murrelet habitat. We acknowledge that it may not be possible for the Forest Service to maintain a complete list of all dispersed campsites, given that some dispersed sites are small, temporary, in backcountry, or otherwise difficult to detect. Therefore, the Forest Service shall provide an estimate of the number of undetected dispersed sites within 55 yards of suitable murrelet habitat, along with a description of the methods used to generate the estimate. This estimate shall be based on the best available information. Surveys for dispersed sites in a representative spatial sample of the Forest Service may aid in the development of the estimate, but are not required. If surveys are not used, the Forest Service should consider how the sample of known sites is likely to differ from sites that are not known (e.g., smaller sites, farther from roads), and the estimation method should reflect those considerations.

   c. For activities listed in 1a above, the report shall list the estimated amount (area) of suitable spotted owl habitat affected by each activity.

d. For activities listed in 1a and 1b above, the report shall list the estimated amount (area) of suitable murrelet habitat affected by each activity.

e. The report shall also provide the following information on the road network:

   i. The current total number of stream crossings and length of stream-adjacent roads (200 feet) under ONF jurisdiction by bull trout core area. For the analysis in this Opinion, the USFWS used the ONF's GIS road layer from 2007 and a USGS GIS stream layer from 2007, but the ONF should use the most up-to-date GIS road and stream data layers available for this monitoring and reporting.

   ii. The length of temporary or permanent roads built and/or reconstructed by bull trout core area on the ONF during the previous year of program implementation.

   iii. The total length of roads decommissioned by bull trout core area on the ONF since the first year of programmatic implementation (the signing date of this Opinion).

To implement RPM 2:

2. In collaboration with the Level 1 team, by February 15, 2022, the ONF shall evaluate, and add to depending on need, its current public information and outreach campaign regarding best practices for food storage, litter, and cleanup for visitors on the Forest Service. This shall be done as a collaborative and iterative process, with input from field office and regional FS and USFWS programs.

   a. This campaign shall encourage practices likely to reduce the accidental or deliberate supplemental feeding of murrelet nest predators, including corvids and small mammals.

   b. This campaign shall be aimed to reach and effectively influence members of the public likely to use established campgrounds, and those who are likely to use dispersed campsites.

   c. This campaign may also be aimed to reach and influence other ONF user groups, such as hikers and special uses permit holders.

   d. Depending on the composition of the user groups to be reached, ONF shall consider the need for materials in languages other than English, and provide them if appropriate.

   e. The annual monitoring report due on February 15, 2022, as described above, shall also include a description of the evaluation and progress on the Forest Service's public information and outreach campaign described above.

The USFWS has determined that no more than the previously quantified extent of incidental take of spotted owls, marbled murrelets, and bull trout will occur as a result of the proposed action. The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, the level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. The federal agency must immediately provide an explanation of the causes of the taking and review with the USFWS need for possible modification of the reasonable and prudent measures.

The USFWS is to be notified within three working days upon locating a dead, injured or sick endangered or threatened species specimen. Initial notification must be made to the nearest U.S. Fish and Wildlife Service Law Enforcement Office. Notification must include the date, time, precise location of the injured animal or carcass, and any other pertinent information. Care should be taken in handling sick or injured specimens to preserve biological materials in the best possible state for later analysis of cause of death, if that occurs. In conjunction with the care of sick or injured endangered or threatened species or preservation of biological materials from a dead animal, the finder has the responsibility to ensure that evidence associated with the specimen is not unnecessarily disturbed. Contact the U.S. Fish and Wildlife Service Law Enforcement Office at (425) 883-8122, or the USFWS Washington Fish and Wildlife Office at (360) 753-9440.

35 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.

In order for the USFWS to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, we request notification of the implementation of any conservation recommendations.

1. Implement a comprehensive program to reduce the effects of food waste and litter on nest predator populations. In addition to the public education and outreach program required as a term and condition, interventions may include wildlife-proof trash receptacles and food storage bins at established campgrounds and other facilities, ensuring that water spigots flow into grates (so that food scraps are washed down out of reach of animals when campers wash dishes at spigots), and dishwashing stations at campgrounds.

2. Create and use a geospatial database that geospatially relates monitoring information that is able to track and display Forest Service activities in murrelet suitable habitat.

3. Reduce the adverse effects of roads on bull trout and their habitat by closing roads, decommissioning roads, applying gravel to well-used dirt roads, and/or relocating roads away from riparian areas in bull trout watersheds. These actions will also assist the ONF in ensuring compliance with the ACS (USDA & USDI 1994).

4. Survey the ONF road network in bull trout core areas to identify road segments and stream crossings where the connectivity between road surface and waterbody is greatest. These data could be used to prioritize road maintenance and restoration and model the total sedimentation impact of the ONF road network. Similar efforts are under way on private and State lands through the development of Road Maintenance and Abandonment Plans.

5. Achieve road densities of less than 1 mile per square mile in bull trout watersheds. These actions will also assist the ONF in ensuring compliance with the ACS (USDA & USDI 1994).

6. In coordination with the USFWS, develop and implement a bull trout survey program to inform an assessment of bull trout population trends and habitat use on the ONF.

7. Conduct ornithological radar surveys to determine the level of murrelet activity within the Olympic National Forest and adjacent areas. In areas where radar detects murrelet presence, follow up with inland protocol surveys, according to the most current standard protocol (currently Evans Mack 2003). In areas where suitable murrelet habitat structure has developed only recently, these surveys are likely to be especially helpful in providing information about how quickly murrelets begin to use newly-developed habitat. Old forest areas are presumed to be occupied, and surveys may help in distinguishing areas that are used more frequently or by larger numbers of murrelets.

8. Provide funding toward Northwest Forest Plan Effectiveness Monitoring at-sea murrelet surveys, with the goal of resuming annual monitoring throughout the monitoring area.

9. Conduct surveys for spotted owls in the action area, using the most current USFWS-endorsed spotted owl survey protocol, especially when planning vegetation management actions, to monitor the status and location of spotted owl activity centers. The surveys may indicate that activity centers have shifted or moved and that conservation measures protecting 300-m radius nest patch areas and 1.4-mile radius core areas should be changed accordingly. The most current USFWS-endorsed spotted owl survey protocol can be found at https://www.fws.gov/oregonfwo/Species/Data/NorthernSpottedOwl/SurveyProtocol.asp

10. For future vegetation management projects, consider deploying acoustic recording units in the project planning area to determine if spotted owls are present. Information collected from acoustic recording units can be used to target specific areas for traditional call-back protocol surveys for spotted owls.

36 REINITIATION NOTICE

This concludes formal consultation on the action outlined in the request for formal consultation. As provided in 50 CFR 402.16, reinitiation of formal consultation is required and shall be requested by the Federal agency or by the USFWS, where discretionary Federal involvement or control over the action has been retained or is authorized by law and: (a) if the amount or extent of taking specified in the incidental take statement is exceeded; (b) if new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (c) if the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion; and (d) if a new species is listed or critical habitat designated that may be affected by the identified action.

37 LITERATURE CITED

Agne, M., P. Beedlow, D. Shaw, D. Woodruff, E. Lee, S. Cline, and R. Comeleo. 2018. Interactions of predominant insects and diseases with climate change in Douglas-fir forests of western Oregon and Washington, U.S.A. Forest Ecology and Management 409:317.

(BA) USFS. 2019. Biological Assessment for Vegetation Management and Associated Activities on the Olympic National Forest 2020-2030. U.S. Forest Service, Olympic National Forest, Olympia, WA. September 14, 2019. 28 pp.

Chan, S.S., D.J. Larson, K.G. Maas-Hebner, W.H. Emmingham, S.R. Johnston, and D.A. Mikowski. 2006. Overstory and understory development in thinned and underplanted Oregon Coast Range Douglas-fir stands. Canadian Journal of Forest Research 36(10):2696-2711.

Curtis, R.O. 1982. A simple index of stand density for Douglas-fir. Forest Science 28(1):92-94.

Drew, T.J. and J.W. Flewelling. 1979. Stand density management: an alternative approach and its application to Douglas-fir plantations. Forest Science, 25(3):518-532.

Garman, S.L., J.H. Cissel, J.H. Mayo. 2003. Accelerating development of late-successional conditions in young managed Douglas-fir stands: a simulation study. Gen. Tech. Rep. PNW-GTR-557. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 57 p. doi:10.2737/pnwgtr-557.

Harvey, Jr., R.D., and P.F. Hessburg Sr. 1992. Long range planning for developed sites in the Pacific Northwest: the context of hazard tree management. FPM-TP039-92. U.S. Department of Agriculture, Forest Service, Pacfic Northwest Region. 125 pp.

Knowles, D. 1996a. Memo to Regional Interagency Executive Committee (REIC), Re: Criteria to exempt specific silvicultural activities in Late-Successional Reserves and Managed LateSuccessional Areas from Regional Ecosystem Office review. Regional Ecosystem Office, Portland, OR. 7p.

Knowles, D. 1996b. Memo to Regional Interagency Executive Committee (REIC), Re: Amendment to “Criteria to exempt specific silvicultural activities in Late-Successional Reserves and Managed Late-Successional Areas from Regional Ecosystem Office review” of July 9, 1996. Regional Ecosystem Office, Portland, OR. 1p.

Long, J.N. 1985. A practical approach to density management. The Forestry Chronicle 61:23-27.

Mellen-McLean, K.; B.G. Marcot, J.L. Ohmann, K. Waddell, S.A. Livingston, E.A. Willhite, B.B. Hostetler, C. Ogden, T. Dreisbach. 2012. DecAID: the decayed wood advisor for managing snags, partially dead trees, and down wood for biodiversity in the forests of Washington and Oregon. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.

Newton, M and E.C. Cole. 1987. A sustained-yield scheme for old-growth Douglas-fir. Western Journal of Applied Forestry. 2(1):22-25.

Tappeiner, J.C., D.A. Maguire, and T.B. Harrington. 2007. Silviculture and Ecology of Western U.S. Forests. Corvallis State University Press, Corvallis, OR.

Toupin, R., G. Filip, and T. Erkert. 2008. Field guide for danger tree identification and response. Pacific Northwest Region, USFS, Oregon, 2008. 68 pp.

WDFW (Washington Department of Fish and Wildlife) and USFS (U.S. Forest Service) 2017. Memorandum of Understanding (MOU) between the Washington State Department of Fish and Wildlife and USDA Forest Service, Pacific Northwest Region Regarding Hydraulic Projects. July 10, 2017.

Wilson, S., and K. Martin. 2010. Variable reproductive effort for two ptarmigan species in response to spring weather in a northern alpine ecosystem. Journal of Avian Biology 41:319.

Spotted Owl and Marbled Murrelets

Allen, C., A. Macalady, H. Chenchouni, D. Bachelet, N. McDowell, M. Vennetier, T. Kitzberger, A. Rigling, D. Breshears, E. Hogg, P. Gonzalez, R. Fensham, Z. Zhang, J. Castro, N. Demidova, J. Lim, G. Allard, S. Running, A. Semerci, and N. Cobb. 2010. A global overview of drought and heat-induced tree mortality reveals emerging climate change risks for forests. Forest Ecology and Management 259:660.

Allen, C., D. Breshears, and N. McDowell. 2015. On underestimation of global vulnerability to tree mortality and forest die-off from hotter drought in the Anthropocene. Ecosphere 6(8):1-http://dx.doi.org/10.1890/.

Anderegg, W., J. Kane, and L. Anderegg. 2013. Consequences of widespread tree mortality triggered by drought and temperature stress. Nature Climate Change 3:DOI: 10.1038/NCLIMATE1635.

Anthony, R.G., E.D. Forsman, A.B. Franklin and others. 2006. Status and trends in demography of northern spotted owls, 1985-2003. Wildlife Monographs 163:2-68.

Awbrey, F.T., and A.E. Bowles. 1990. The effects of aircraft noise and sonic booms on raptors: a preliminary model and a synthesis on the literature on disturbance. U.S. Air Force, Patterson Air Force Base, Ohio.

Becker, B.H., and S.R. Beissinger. 2006. Centennial decline in the trophic level of an endangered seabird after fisheries decline. Conservation Biology Vol. 20, No. 2, pp. 470-479.

Beissinger, S.R., and M.Z. Peery. 2007. Reconstructing the historic demography of an endangered seabird. Ecology 88(2):296-305.

Bell, D., W. Cohen, M. Reilly, and Z. Yang. 2018. Visual interpretation and time series modeling of Landsat imagery highlight drought's role in forest canopy declines. Ecosphere 9(6).

Bingham, B.B., and B.R. Noon. 1997. Mitigation of habitat "take": Application to habitat conservation planning. Conservation Biology 11 (1):127-138.

Bloxton, T.D. and M.G. Raphael. 2006. At-sea movements of radio-tagged marbled murrelets in Washington. Northwestern Naturalist, 87(2): 162-162.

Bloxton, T.D. and M.G. Raphael. 2009. Breeding ecology of the marbled murrelet in Washington State. Five year project summary (2004-2009). Unpublished agency report. USDA Forest Service, Pacific Northwest Research Station, Olympia, Washington. 44 pp.

Buchanan, J.B., L.L. Irwin, and E.L. McCutchen. 1993. Characteristics of spotted owl nest trees in the Wenatchee National Forest. Journal of Raptor Research 27:1–7.

Buchanan, J.B., and L.L. Irwin. 1998. Variation in spotted owl nest site characteristics within the Eastern Cascade Mountains Province in Washington. Northwestern Naturalist 79:33–40.

Buotte, P., S. Levis, B. Law, T. Hudiburg, D. Rupp, and J. Kent. 2018. Near-future forest vulnerability to drought and fire varies across the Western United States. Global Change Biology.

Burger A.E. 2002. Conservation assessment of marbled murrelets in British Columbia; a review of the biology, populations, habitat associations, and conservation. Technical Report Series Number 387. Pacific and Yukon Region. 2002. Canadian Wildlife Service, Environmental Conservation Branch. 169 pp.

Burger, A.E., B. Columbia, and T.A. Chatwin, 2002. Multi-scale studies of populations, distribution and habitat associations of Marbled Murrelets in Clayoquot Sound, British Columbia. Ministry of Water, Land and Air Protection.

Burger, A.E., I.A. Manley, M.P. Silvergieter, D.B. Lank, and others. 2009. Re-use of nest sites by marbled murrelets (*Brachyramphus marmoratus*) in British Columbia. Northwestern Naturalist 90:217-226.

Carey, A.B. 1995. Sciurids in Pacific Northwest managed and old-growth forests. Ecological Applications 5(3):648-661.

Carey, A.B., and T.M. Wilson. 2001. Ecological foundations of biodiversity. Pacific Northwest Research Station, 1999-2000 Biannual Report, Olympia, WA, June 2001. 26 pp.

Catto, J.L., L.C. Shaffrey, and K.I. Hodges. 2011. Northern hemisphere extratropical cyclones in a warming climate in the HiGEM high-resolution climate model. Journal of Climate 24:5336-5351.

Chan, S.S., D.J. Larson, K.G. Maas-Hebner, W.H. Emmingham, S.R. Johnston, and D.A. Mikowski. 2006. Overstory and understory development in thinned and underplanted Oregon Coast Range Douglas-fir stands. Canadian Journal of Forest Research 36(10):2696-2711.

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.

Chang, E.K. 2018. CMIP5 projected change in Northern Hemisphere winter cyclones with associated extreme winds. Journal of Climate 31:6527-6542.

Clark, J., V. Cork, K. Davis, A. Dozic, M. Fischer, C. Hersey, G. Kohler, S. Mathieu, D. Omdal, A. Ramsey, Z. Heath, J. Hof, K. Ripley, B. Smith, S. Brooks, and T. Pahs. 2018. Forest health highlights in Washington – 2018. Forest Health Protection, Pacific Northwest Region, U.S. Forest Service and Forest Health and Resiliency Division, Washington Department of Natural Resources. Portland, Oregon and Olympia. 44 pp.

Comfort, E.J., S.D. Roberts, and C.A. Harrington. 2010. Midcanopy growth following thinning in young-growth conifer forests on the Olympic Peninsula western Washington. Forest Ecology and Management 259:1606–1614.

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.

Crockett, J.L. and A.L. Westerling. 2018. Greater temperature and precipitation extremes intensify Western U.S. droughts, wildfire severity, and Sierra Nevada tree mortality. Journal of Climate 31:341-354.

Davis, R., and J. Lint. 2005. Habitat status and trends. Chapter 3 *in* Northwest Forest Plan—the first 10 years (1994–2003): status and trends of northern spotted owl populations and habitat. Lint, Joseph, tech. coord. 2005.Gen. Tech. Rep. PNW-GTR-648. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 176 p.

Davis, R.J., K.M. Dugger, S. Mohoric, L. Evers, W.C. Aney. 2011. Northwest Forest Plan—the first 15 years (1994–2008): status and trends of northern spotted owl populations and habitats. Gen. Tech. Rep. PNWGTR- 850. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 147 p.

Davis, R.J., J.L. Ohmann, R.E. Kennedy, W.B. Cohen, M.J. Gregory, Z. Yang, H.M. Roberts, A.N. Gray, and T.A. Spies. 2015. Northwest Forest Plan–the first 20 years (1994-2013): status and trends of late-successional and old-growth forests. Gen. Tech. Rep. PNW-GTR-911. Pacific Northwest Research Station, Forest Service, U.S. Department of Agriculture. Portland, Oregon, 112 p.

Davis, R., Z. Yang, A. Yost, C. Belongie, and W. Cohen. 2017. The normal fire environment-Modeling environmental suitability for large forest wildfires using past, present, and future climate normals. Forest Ecology and Management 390:173.

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 pages.

Delaney, D. K.; Grubb, T.G. 2004. Sound recordings of road maintenance equipment on the Lincoln National Forest, New Mexico. Res. Pap. RMRS-RP-49. Fort Collins, CO: USDA Forest Service, Rocky Mountain Research Station. 56 p.

De Santo, T.L., and S.K. Nelson. 1995. Comparative reproductive ecology of the Auks (Family Alcidae) with emphasis on the marbled murrelet. Pages 33-47 in C.J. Ralph, G.L. Hunt, M.G. Raphael, and J.F. Piatt (eds.). Ecology and conservation of the marbled murrelet. General Technical Report. PSW-GTW-152. Pacific Southwest Experimental Station, U.S. Forest Service, Albany, California. 420 pp.

Divoky, G.J. and M. Horton. 1995. Breeding and natal dispersal, nest habitat loss and implications for marbled murrelet populations. Pages 83-87 *in* C.J. Ralph, G.L. Hunt, M.G. Raphael, and J.F. Piatt (eds.). Ecology and conservation of the marbled murrelet. General Technical Report. PSW-GTW-152. Pacific Southwest Experimental Station, U.S. Forest Service, Albany, California. 420 pp.

Dooling, R.J., and Popper, A.N. 2007. Effects of highway noise on birds. Prepared for the California Dept. of Transportation Division of Environmental Analysis. Sacramento, California. Prepared under contract 43A0139 Jones and Stokes Associates. September 2007. 74 pp.

Dugger, K.M., F. Wagner, R.G. Anthony, and G.S. Olson. 2005. The relationship between habitat characteristics and demographic performance of northern spotted owls in southern Oregon. Condor 107:863–878.

Dugger, K.M., R.G. Anthony, and L.S. Andrews. 2011. Transient dynamics of invasive competition: barred owls, spotted owls, habitat and the demons of competition present. Ecological Applications 21(7):2459-2468.

Evans Mack, D., W.P. Ritchie, S.K., Nelson, E. Kuo-Harrison, P. Harrison, and T.E. Hamer. 2003. Methods for surveying marbled murrelets in forests: a revised protocol for land management and research. Pacific Seabird Group Technical Publication Number 2. January 6, 2003. 76 pp.

Falxa, G.A. 2011. Marbled murrelet population monitoring results, 2000-2010. Arcata Fish and Wildlife Office, Arcata, California, March 30, 2011. 6 pp.

Falxa, G.A., D. Baldwin, S.K. Lynch, S.L. Nelson, and S.F. Miller. 2009. Marbled murrelet effectiveness monitoring, Northwest Forest Plan: 2008 summary report, August 2009. 19 pp.

Falxa, G.A., and M.G. Raphael. 2016. Northwest Forest Plan - The First Twenty Years (1994-2013): Status and trend of marbled murrelet populations and nesting habitat. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Gen. Tech. Rep. PNW-GTR-933, Portland, OR. 132 pp.

FHWA (Federal Highway Administration). 2006. Highway construction noise handbook. Chapter 9. Construction equipment noise levels and ranges. U.S. Department of Transportation Federal Highway Administration Office of Natural and Human Environment. Washington, D.C. August 2006. http://www.fhwa.dot.gov/environment/noise/handbook/.

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., and A.R. Giese. 1997. Nests of northern spotted owls on the Olympic Peninsula, Washington. Wilson Bulletin 109:28–41.

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., 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 149:1-35.

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 38:214–230.

Forsman, E.D., T.J. Kaminkski, J.C. Lewis, K.J. Maurice, S.G. Sovern, C. Ferland, and E.M. Glenn. 2005. Home range and habitat use of northern spotted owls on the Olympic Peninsula, Washington. Journal of 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. Cooper Ornithological Society. 106 pp.

Franklin, A.B., D.R. Anderson, R.J. Gutiérrez, and K.P. Burnham. 2000. Climate, habitat quality, and fitness in northern spotted owl populations in northwestern California. Ecological Monographs, 70(4): 539-590.

Gao, Y. J. Lu, L.R. Leung, Q. Yang, S. Hagos, and Y. Qian. 2015. Dynamical and thermodynamical modulations on future changes of landfalling atmospheric rivers over western North America. Geophysical Research Letters. 42:7179-7186.

Ganguly, A., K. Steinhaeuser, D. Erickson, M. Branstetter, E. Parish, N. Singh, J. Drake, and L. Buja. 2009. Higher trends but larger uncertainty and geographic variability in 21st century temperature and heat waves. PNAS. 106: 15555–15559.

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 (2010) 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.

Glick, P., B.A. Stein, and N.A. Edelson (eds.). 2011. Scanning the Conservation Horizon: A Guide to Climate Change Vulnerability Assessment. National Wildlife Federation, Washington, DC. 168 pp.

Goheen, E.M. and E.A. Willhite. 2006. Field guide to the common diseases and insect pests of Oregon and Washington conifers. Portland, Oregon: Pacific Northwest Region, U.S. Forest Service.

Gremel, S. 2007. Spotted owl monitoring in Olympic National Park: 2007 annual report. U.S. Department of the Interior, National Park Service, Olympic National Park, Port Angeles, Washington. 16 pp.

Gremel, S. 2018. Spotted owl monitoring in Olympic National Park: 1992-2018. 2018 annual report. U.S.D.I. National Park Service, Olympic National Park, Port Angeles, WA. 20 pp.

Grenier, J.J. and S.K. Nelson. 1995. Marbled murrelet habitat associations in Oregon. Pp. 191-204 in U.S. Department of Agriculture, Forest Service, General Technical Report PSW-GTR-152, Ecology and Conservation of the Marbled Murrelet. 420 pp.

Grubb, T.G., D.K. Delaney, W.M. Bowerman, and M.R. Wierda. 2010. Golden eagle indifference to heli-skiing and military helicopters in northern Utah. Journal of Wildlife Management 74(6):1275-1285.

Gutierrez, R.J., A.B. Franklin, and W.S. LaHaye. 1995. Spotted owl (Strix occidentalis) in: (A. Poole and F. Gill, eds.). Birds of North America, No. 179.. The Academy of Natural Sciences, Philadelphia, Pennsylvania, and the American Ornithologists Union, Washington D.C. 28 pp.

Gutowsky, S., M.H. Janssen, P. Arcese, T.K. Kyser, D. Ethier, M.B. Wunder, D.F. Bertram, L. McFarlane Tranquilla, C. Lougheed, D. Ryan Norris. 2009. Concurrent declines in nestling diet quality and reproductive success of a threatened seabird over 150 years. Endangered Species Research 9:247-254.

Hall, S.L. 2000. Land management strategies and marbled murrelet occurrence on the Olympic Peninsula, WA. M.S. thesis, University of Washington, Seattle. 76 pp.

Halofsky, J.S., D.C. Donato, J.F. Franklin, J.E. Halofsky, D.L. Peterson, and B.J. Harvey. 2018a. The nature of the beast: examining climate adaptation options in forests with stand-replacing fire regimes. Ecosphere 9:e02140.

Hamer, T.E. 1995. Inland habitat associations of marbled murrelets in western Washington. Pp. 163-175 in U.S. Department of Agriculture, Forest Service, General Technical Report PSW-GTR-152, Ecology and Conservation of the Marbled Murrelet. 420 pp.

Hamer, T.E. and S.K. Nelson. 1995a. Characteristics of marbled murrelet nest trees and nesting stands. Pp. 69-82 in U.S. Department of Agriculture, Forest Service, General Technical Report PSW-GTR-152, Ecology and Conservation of the Marbled Murrelet. 420 pp.

Hamer, T.E., and S.K. Nelson. 1998. Effects of disturbance on nesting marbled murrelets: summary of preliminary results. An unpublished report prepared for U.S. Fish and Wildlife Service, Portland, OR. January 1998. Hamer Environmental, Mount Vernon, Washington and Oregon State University, Corvallis. 24 pp.

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 35:221–227.

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(4):750-768.

Hanson, E., D. Hays, L.L. Hicks, L. Young, and J.B. Buchanan. 1993. Spotted owl habitat in Washington: a report to the Washington Forest Practices Board. Washington Forest Practices Board Spotted Owl Scientific Advisory Group, Olympia, WA, December 20, 1993. 116 pp.

Harvey, Jr., R.D., and P.F. Hessburg Sr. 1992. Long range planning for developed sites in the Pacific Northwest: the context of hazard tree management. FPM-TP039-92. U.S. Department of Agriculture, Forest Service, Pacfic Northwest Region. 125 pp.

Hayes, D.W., H.L. Allen, L.H. Egtvedt, and K.R. Dixon. 1989. Home range size and habitat use of spotted owls in Washington. Preliminary Report. Washington Department of Fish and Wildlife, Olympia, Washington. 30 pp.

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).

Hebert, P.N., and R.T. Golightly. 2006. Movements, nesting, and response to anthropogenic disturbance of marbled murrelets (*Brachyramphus marmoratus*) in Redwood National and State Parks, California. California Department of Fish and Game, 2006-02, Sacramento, California, May, 2006. 321 pp.

Hebert, P.N., and R.T. Golightly. 2007. Observations of predation by corvids at a marbled murrelet nest. Journal of Field Ornithology 78(2):221-224.

Henderson, J.A., D.H. Peter, R.D. Lesher, and D.C. Shaw. 1989. Forested plant associations of the Olympic National Forest. U.S. Department of Agriculture, Forest Service, Pacific Northwest Region, R6-ECOL-TP-001-88, Washington, D.C., June 1989. 502 pp.

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.

Hicks, L.L., H.C. Stabins, and D.R. Herter. 1999. Designing spotted owl habitat in a managed forest. Journal of Forestry 97(7):20-25.

Holthausen, R.S., M.G. Raphael, K.S. McKelvey, E.D. Forsman, E.E. Starkey, and D.E. Seaman. 1995. The contribution of Federal and non-Federal habitat to persistence of the northern spotted owl on the Olympic Peninsula, Washington: report of the Reanalysis Team. General Technical Report PNW-GTR-352. Portland, OR: USDA Forest Service, Pacific Northwest Research Station. 68 pp.

Holthuijzen, A.M., W.G. Eastland, A.R. Ansell, M.N. Kochert, R.D. Williams, and L.S. Young. 1990. Effects of blasting on behavior and productivity of nesting prairie falcons. Wildlife Society Bulletin 18:270-281.

Holtrop, K. 2020. Wildlife Biologist, USFS, Olympic National Forest, Washington. Email to Jamie Hanson and Markus Le, Fish and Wildlife biologists, Washington Fish and Wildlife Office, U.S. Fish and Wildlife Service, Lacey, Washington. Topic: May 20, 2020, email including information on murrelet critical habitat and past monitoring information on critical habitat impacts.

Huber, M., and R. Knutti. 2011. Anthropogenic and natural warming inferred from changes in Earth's energy balance. Nature Geoscience. Published online December 4, 2011; DOI: 10.1038/NGEO1327. 6 pp. plus supplemental material.

Huff, M.H. Status and trends of populations and nesting habitat for the marbled murrelet. Northwest Forest Plan-the first ten years (1994-2003). U.S. Department of Agriculture, Forest Service. Pacific Northwest Research Station, Portland, Oregon. General Technical Report PNW-GTR-650. May 2006. 150 pp.

Hull, C., G.W. Kaiser, C. Lougheed, L. Lougheed, S. Boyd, and F. Cooke. 2001. Intraspecific variation in commuting distance of marbled murrelets (*Brachyramphus marmoratus*): Ecological and energetic consequences of nesting further inland. The Auk 118(4):1036-1046.

IPCC (Intergovernmental Panel on Climate Change). 2007a. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K., and A. Reisinger (eds.)]. IPCC, Geneva, Switzerland. 104 pp.

IPCC. 2007b. Summary for Policymakers. Pp. 1–18. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor, and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, UK, and New York, NY. 996 pp.

IPCC. 2011. Summary for Policymakers. In: Intergovernmental Panel on Climate Change Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, UK, and New York, NY. 29 pp.

IPCC. 2014. 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. Cambridge University Press, Cambridge, UK. 1150 pp.

IPCC. 2014. 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. Intergovernmental Panel on Climate Change, Geneva, Switzerland. 151 pp.

Irwin, L.L., D.F. Rock, and G.P. Miller. 2000. Stand structures used by northern spotted owls in managed forest. Journal of Raptor Research 34:175–186.

Irwin, L.L., D.F. Rock, S.C. Rock, C. Loehle, and P. Van Deusen. 2015. Forest ecosystem restoration: Initial response of spotted owls to partial harvesting. Forest Ecology and Management 354 (2015) 232-242.

Janssen, M.H., P. Arcese, T.K. Kyser, D.F. Bertram, and D.R. Norris. 2011. Stable isotopes reveal strategic allocation of resources during juvenile development in a cryptic and threatened seabird, the marbled murrelet (*Brachyramphus marmoratus*). Canadian Journal of Zoology 89:859-868.

Jones, J.A.; G.E. Grant and B.C. Wemple. 1996. Channel network extension by logging roads in two basins, Western Cascades, Oregon. Water Resource Bulletin 32:1-13.

Kerns, S.J., and D. Allwardt. 1992. Proximity of human activity to northern spotted owl nesting pairs on lands of the Pacific Lumber Company. Unpublished report dated June 1992. Pacific Lumber Company,

Kitaysky, A.S. 2009. Metabolic and developmental responses of alcid chicks to experimental variation in food intake. Physiology and Biochemical Zoology, Vol. 72, No. 4 (July/August 1999), pp. 462-473.

Kuletz, K.J. 2005. Foraging behavior and productivity of a non-colonial seabird, the marbled murrelet (*Brachyramphus marmoratus*), relative to prey and habitat. Ph.D. thesis, University of Victoria, Victoria, B.C. 195 pp.

LCD (Landscape Climate Dashboard). 2020. Climate projections for federally and tribally protected lands of the West: Olympic National Forest. Available at www.climatedashboard.org. Accessed April 28, 2020.

Leskiw, T., and R.J. Gutierrez. 1998. Possible predation of a spotted owls by a barred owl. Western Birds 29:225-226.

Lesmeister, D. 2019. Olympic Peninsula Spotted Owl Demography Study. 2018 annual report. U.S.D.A. Forest Service, Pacific Northwest Research Station, Corvallis, OR. 15 pp.

Littell, J.S., M. McGuire Elsner, L.C. Whitely Binder, and A.K. Snover (eds). 2009. The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate - Executive Summary. In: The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate, Climate Impacts Group, University of Washington, Seattle, Washington.

Littell, J., E. Oneil, D. McKenzie, J. Hicke, J. Lutz, R. Norheim, and M. Elsner. 2010. Forest ecosystems, disturbance, and climatic change in Washington State, USA. Climatic Change 102:129-158.

Livezey, K.B. 2007. Barred Owl habitat and prey: a review and synthesis of the literature. Journal of Raptor Research 41:177–201.

Long, L.L. and C.J. Ralph. 1998. Regulation and observations of human disturbance near nesting marbled murrelets. U.S. Department of Agriculture Forest Service, Pacific Southwest Research Station, Redwood Sciences Laboratory, Arcata, CA. 36 pp.

Lorenz, T.J., M.G. Raphael, T.D. Bloxton, and P.G. Cunningham. 2017. Low breeding propensity and wide-ranging movements by marbled murrelets in Washington. Journal of Wildlife Management 81(2):306-321.

Lorenz, T.J., M.G. Raphael, and T.D. Bloxton. 2019. Nesting behavior of marbled murrelets *Brachyramphus marmoratus* in Washington and British Columbia. Marine Ornithology 47:157-166.

Luce, C., P. Morgan, K. Dwire, D. Isaak, Z. Holden, B. Rieman. 2012. Climate change, forests, fire, water, and fish: building resilient landscapes, streams, and managers. Gen. Tech. Rep. RMRS-GTR-290. Rocky Mountain Research Station, U.S. Forest Service. Fort Collins, Colorado. 207 pp.

Luce, C.H., J.T. Abatzoglou, and Z.A. Holden. 2013. The missing mountain water: slower westerlies decrease orographic enhancement in the Pacific Northwest USA. Science 342:1360-1364.

Malt, J.M., and D.B. Lank. 2009. Marbled Murrelet nest predation risk in managed forest landscapes: dynamic fragmentation effects at multiple scales. Ecological Applications 19(5):1274-1287.

Manning T., J.C. Hagar, and B.C. McComb. 2012. Thinning of young Douglas-fir forests decrease density of northern flying squirrels in the Oregon Cascades. Forest Ecology and Management. 264: 115-124.

Marzluff, J.M., and E. Neatherlin. 2006. Corvid response to human settlements and campgrounds: causes, consequences, and challenges for conservation. Biological Conservation 130(2006) 301-314.

Mass, C. and B. Dotson. 2010. Major extratropical cyclones of the Northwest United States: historical review, climatology, and synoptic environment. Monthly Weather Review 138:2499-2527.

Mauger, G., J. Casola, H. Morgan, R. Strauch, B. Jones, B. Curry, T. Busch Isaksen, L. Whitely Binder, M. Krosby, A. and Snover. 2015. State of knowledge: climate change in Puget Sound. Report prepared for the Puget Sound Partnership and the National Oceanic and Atmospheric Administration. Climate Impacts Group, University of Washington, Seattle. 281 pp.

McIver, W., D. Lynch, J. Baldwin, N. Johnson, M.M. Lance, S.F. Pearson, M.G. Raphael, C. Strong, R. Young, T. Lorenz and K. Nelson. 2020. Marbled murrelet effectiveness monitoring, Northwest Forest Plan: 2019 summary report. 23 pp.

McShane, C., T.E. Hamer, H.R. Carter, R.C. Swartzman, V.L. Friesen, D.G. Ainley, K. Nelson, A.E. Burger, L.B. Spear, T. Mohagen, R. Martin, L.A. Henkel, K. Prindle, C. Strong, and J. Keany. 2004. Evaluation reports for the 5-year status review of the marbled murrelet in Washington, Oregon, and California. EDAW, Inc, Seattle, Washington. 370 pp.

McKenzie, D. and J.S. Littell. 2017. Climate change and the eco-hydrology of fire: will area burned increase in a warming western USA? Ecological Applications 27:26-36.

Meehl, G.A., T.F. Stocker, W.D. Collins, P. Friedlingstein, A.T. Gaye, J.M. Gregory, A. Kitoh, R. Knutti, J.M. Murphy, A. Noda, S.C.B. Raper, I.G. Watterson, A.J. Weaver, and Z.C. Zhao. 2007. Global Climate Projections. Pp. 747–845. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor, and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, UK, and New York, NY. 996 pp.

Meiman, S., R.G. Anthony, E. Glenn, T. Bayless, A. Ellingson, M.C. Hansen, and C. Smith. 2003. Effects of commercial thinning on home range and habitat-use patterns of a male northern spotted owl: A case study. Wildlife Society Bulletin 31(4):1254-1262.

Meyer, C.B., S.L. Miller, and C.J. Ralph. 2002. Multi-scale landscape and seascape patterns associated with marbled murrelet nesting areas on the U.S. west coast. Landscape Ecology 17:95-115.

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, G.S. 1989. Dispersal of juvenile spotted owls in western Oregon. M.S. Thesis. Oregon State University, Corvallis, Oregon.

Miller, S.L., M.G. Raphael, G.A. Falxa, C. Strong, J. Baldwin, T. Bloxton, B.M. Galleher, M. Lance, D. Lynch, and S.F. Pearson. 2012. Recent population decline of the marbled murrelet in the Pacific Northwest. The Condor 114(4):771-781.

MM&A 2008. Blasting and helicopter noise analysis and mitigation plan. Unpublished report prepared for the Pacific Connector Gas Pipeline, L.P., by Michael Minor & Associates, Portland, Oregon. 27 pp.

Mote, P., E. Salathe, V. Duliere, and E. Jump. 2008. Scenarios of future climate for the Pacific Northwest. A report for the Climate Impacts Group, University of Washington, Seattle, Washington. 12 pp.

Neatherlin, E.A. and J.M Marzluff. 2004. Responses of American crow populations to campgrounds in remote native forest landscapes. Journal of Wildlife Management 68(3):708-718.

Nelson, S.K. 1997. The birds of North America, No. 276 - Marbled Murrelet (Brachyramphus marmoratus). In A. Poole and F. Gill (eds.). The birds of North America: life histories for the 21st century. 32 pp.

Nelson, S.K. and T.E. Hamer. 1995a. Nesting biology and behavior of the marbled murrelet. Pages 57-67 in C.J. Ralph, G.L. Hunt, M.G. Raphael, and J.F. Piatt (eds.). Ecology and conservation of the marbled murrelet. General Technical Report. PSW-GTW-152. Pacific Southwest Experimental Station, U.S. Forest Service, Albany, California. 420 pp.

Nelson, S.K., and T.E. Hamer. 1995b. Nest success and the effects of predation on marbled murrelets. Pages 89-97 *in* C.J. Ralph, G.L. Hunt, M.G. Raphael, and J.F. Piatt (eds.). Ecology and conservation of the marbled murrelet. General Technical Report. PSW-GTW-152. Pacific Southwest Experimental Station, U.S. Forest Service, Albany, California. 420 pp.

Nelson, S.K., and A.K. Wilson. 2002. Marbled Murrelet Habitat Characteristics on State Lands in Western Oregon. Unpublished Report submitted to Oregon Department of Forestry, Oregon Department of Fish and Wildlife, U.S. Fish & Wildlife Service, and the National Council for Air and Stream Improvement. Oregon Cooperative Fish and Wildlife Research Unit. Oregon State University, Nash Hall 104. Department of Fisheries and Wildlife, Corvallis, Oregon. 154 pp.

Nelson, S.K., M.H. Huff, S.L. Miller, and M.G. Raphael. 2006. Marbled murrelet biology: habitat relations and populations. *In:* Huff, Mark H.; Raphael, M.G.; Miller, S.L.; Nelson, S.K.; Baldwin, J. tech. coords. Northwest Forest Plan—The first 10 years (1994-2003): status and trends of populations and nesting habitat for the marbled murrelet. Gen. Tech. Rep. PNW-GTR-650. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: 9-30. Chapter 2.

Newman, J.S., E.J. Rickley, T.L. Bland, and K.R. Beattie. 1984. Noise measurement flight test for Boeing Vertol 234/Chinook 47-d. FAA-EE-84-7. Federal Aviation Administration, Washington D.C., September 1984, 180 pp.

North, M.P., J.F. Franklin, A.B. Carey, E.D. Forsman, and T. Hamer. 1999. Forest stand structure of the northern spotted owl's foraging habitat. Forest Science 45(4):520-527.

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.

Oyan, H.S. and T. Anker-Nilssen. 1996. Allocation of growth in food-stressed Atlantic puffin chicks. The Auk 113(4):830-841.

Pater, L.L., T.G. Grubb, and D.K. Delaney. 2009. Recommendations for improved assessment of noise impacts on wildlife. Journal of Wildlife Management 73(5): 788-795.

Payne, A.E. and G. Magnusdottir. 2015. An evaluation of atmospheric rivers over the North Pacific in CMIP5 and their response to warming under RCP 8.5. Journal of Geophysical Research: Atmospheres 120:11173-11190.

Pearson, R.R., and K.B. Livezey. 2003. Distribution, numbers, and site characteristics of Spotted Owls and Barred Owls in the Cascade Mountains of Washington. Journal of Raptor Research 37:265–276.

Pearson, R.R., and K.B. Livezey. 2007. Spotted owls, barred owls, and Late-Successional Reserves. Journal of Raptor Research 41:156–161.

Peery, M.Z., S.R. Beissinger, S.H. Newman, E.B. Burkett, and T.D. Williams. 2004. Applying the declining population paradigm: diagnosing causes of poor reproduction in the marbled murrelet. Conservation Biology 18(4):1088-1098.

Peery, M.Z., and Henry, R.W. 2010. Recovering marbled murrelets via corvid management: A population viability approach. Biological Conservation 143 (2010) 2414-2424.

Peery, M.Z., and G.M. Jones. 2019. Using population viability analyses to assess the potential response of Washington DNR forest management alternatives on marbled murrelets. Appendix C in: Long-Term Conservation Strategy for the Marbled Murrelet Final Environmental Impact Statement. Washington State Department of Natural Resources and U.S. Fish and Wildlife Service, Olympia, September, 2019. Available online at: https://www.dnr.wa.gov/mmltcs

Pierce, K.B., J.L. Ohmann, M.C. Wimberly, M.J. Gregory, and J.S. Fried. 2009. Mapping wildland fuels and forest structure for land management: a comparison of nearest neighbor imputation and other methods. Canadian Journal of Forest Research 39:1901-1916.

Piper, S. 2020a. Wildlife Biologist, USFS, Olympic National Forest, Washington. Email to Jamie Hanson and Markus Le, Fish and Wildlife biologists, Washington Fish and Wildlife Office, U.S. Fish and Wildlife Service, Lacey, Washington. Topic: March 25, 2020, email including information on timing of commercial thinning activities during the early and late nesting seasons for northern spotted owl.

Piper, S. 2020b. Wildlife Biologist, USFS, Olympic National Forest, Washington. Email to Jamie Hanson and Markus Le, Fish and Wildlife biologists, Washington Fish and Wildlife Office, U.S. Fish and Wildlife Service, Lacey, Washington. Topic: April 7, 2020, email including information on habitat loss due to Maple Fire.

Prestemon, J.P. and L. Kruger. 2016. Economics and societal considerations of drought. In: Vose, J.M., Clark, J.S., Luce, C.H., and Patel-Weynand, T., eds. Effects of drought on forests and rangelands in the United States: a comprehensive review and synthesis. Washington Office, Forest Service, U.S. Department of Agriculture Gen. Tech. Rep. WO-93b. Washington, DC. 289 pp.

Prinn, R., S. Paltsev, A. Sokolov, M. Sarofim, J. Reilly, and H. Jacoby. 2011. Scenarios with MIT integrated global systems model: significant global warming regardless of different approaches. Climatic Change 104: 515–537.

Ralph, C.J., G.L. Hunt, Jr., M.G. Raphael, and J.F. Piatt. 1995. Ecology and conservation of the marbled murrelet in North America: an Overview. Pages 3-22 *in* C.J. Ralph, G.L. Hunt, M.G. Raphael, and J.F. Piatt (eds.). Ecology and conservation of the marbled murrelet. General Technical Report. PSW-GTW-152. Pacific Southwest Experimental Station, U.S. Forest Service, Albany, California. 420 pp.

Raphael, M.G., D. Evans Mack, and B. Cooper. 2002. Landscape-scale relationships between abundance of marbled murrelets and distribution of nesting habitat. Condor 104(2) 331-342.

Raphael, M.G., D. Evans Mack, J.M. Marzluff, and J. Luginbuhl. 2002a. Effects of forest fragmentation on populations of the marbled murrelet. Studies in Avian Biology 25:221-235.

Raphael, M.G., G.A. Falxa, K.M. Dugger, B.M. Galleher, D. Lynch, S.L. Miller, S.K. Nelson, and R.D. Young. 2011. Northwest Forest Plan – the first 15 years (1994-2008): status and trend of nesting habitat for the marbled murrelet. Gen. Tech. Rep. PNW-GTR-848. Portland, OR. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 52 pp.

Raphael, M.G., G.A. Falxa, D. Lynch, S.K. Nelson, S.F. Pearson, A.J. Shirk, and R.D. Young. 2016. Chapter 2: Status and Trend of Nesting Habitat for the Marbled Murrelet Under the Northwest Forest Plan. *IN* The first 20 years (1994-2013): status and trend of marbled murrelet populations and nesting habitat. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. Gen. Tech. Rep. PNW-GTR-933. Portland, OR, May 2016. 148 pp.

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 (JAWRA) 42(5):1307-1327.

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.

Rogers, B.M., R.P. Neilson, R. Drapek, J.M. Lenihan, J.R. Wells, D. Bachelet, and B.E. Law. 2011. Impacts of climate change on fire regimes and carbon stocks of the U.S. Pacific Northwest. Journal of Geophysical Research 116:G03037.

Salathé, E.P., L.R. Leung, Y. Qian, and Y. Zhang. 2009. Regional climate model projections for the State of Washington. In: The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate, Climate Impacts Group, University of Washington, Seattle, Washington.

Sheehan, T., D. Bachelet, and K. Ferschweiler. 2019. Fire, CO_2, and climate effects on modeled vegetation and carbon dynamics in western Oregon and Washington. PLoS One 14(1):e0210989.

Singer, S.W., N.L. Naslund, S.A. Singer, & C.J. Ralph. 1991. Discovery and observations of two tree nests of the marbled murrelet. The Condor 93:330-339.

Slijepcevic, A., and Fogarty, L. 1998. Reducing the influence of helicopter rotor wash on fire behavior. Fire Technology Transfer Note Number 16 February 1998. New Zealand Forest Research Institute. 12 pp.

Solomon, S., D. Qin, M. Manning, R.B. Alley, T. Berntsen, N.L. Bindoff, Z. Chen, A. Chidthaisong, J.M. Gregory, G.C. Hegerl, M. Heimann, B. Hewitson, B.J. Hoskins, F. Joos, J. Jouzel, V. Kattsov, U. Lohmann, T. Matsuno, M. Molina, N. Nicholls, J. Overpeck, G. Raga, V. Ramaswamy, J. Ren, M. Rusticucci, R. Somerville, T.F. Stocker, P. Whetton, R.A. Wood, and D. Wratt. 2007. Technical Summary. Pp. 19–91. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor, and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, UK, and New York, NY. 996 pp.

Sovern, S.G., E.D. Forsman, K.M. Dugger, and M. Taylor. 2015. Roosting habitat use and selection by northern spotted owls during natal dispersal. Journal of Wildlife Management 79(2):254-262.

Swarthout, E.C.H., and R.J. Steidl. 2001. Flush responses of Mexican spotted owls to recreationists. Journal of Wildlife Management 65:312-317.

Tempel, D.J., and R.J. Gutierrez. 2003. Fecal corticosterone levels in California spotted owls exposed to low-intensity chainsaw sound. Wildlife Society Bulletin Vol. 31, No. 3 (Autumn, 2003), pp. 698-702.

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. Report of the Interagency Scientific Committee to address the conservation of the northern spotted owl. Unpublished interagency document. 458 pages.

Toupin, R., G. Filip. T. Erkert, M. Barger. 2008. Field guide for danger tree identification and response. USDA Forest Service, Pacific Northwest Region and USDI Bureau of Land Management. R6-NR-FP-PR-01-08. 68 pp.

USDA (U.S. Department of Agriculture) and USDI (U.S. Department of the Interior). 1994. Record of decision for amendments to Forest Service and Bureau of Land Management planning documents within the range of the northern spotted owl; standards and guidelines for management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl (northwest forest plan). Portland, Oregon.

USFS. 1990. Olympic National Forest Land and Resource Management Plan. USDA Forest Service, Pacific Northwest Region, Olympic National Forest. Olympia, WA. 360 pp.

USFS and USDI Bureau of Land Management. 1994a. Final 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. Portland, OR: U.S. Dept. of Agriculture (Forest Service), U.S. Dept. of the Interior (Bureau of Land Management). 2 vols. and appendices.

USFS. 2008. Sound measurements of helicopters during logging operations. R.T. Harrison, R. Farve, and A. Horcher. USDA Forest Service San Dimas Technology & Development Center, San Dimas, CA. Online report at http://www.fs.fed.us/eng/techdev/IM/sound_measure/helo_index.shtml

USFS. 2009. Programmatic Biological Assessment for selected forest management activities Olympic National Forest 2010-2019. U.S. Forest Service, Olympic National Forest, Olympia, WA. June 18, 2009. 158 pp.

USFS. 2017. Implementation monitoring report for completed Nisqually Timber Sale Units. Report prepared by J. Jakubowski, U.S. Forest Service, Cowlitz Valley Ranger District, March 2017.

USFWS (U.S. Fish and Wildlife Service). 1992. Draft final recovery plan for the northern spotted owl. U.S. Fish and Wildlife Service. 2 Volumes. Portland, Oregon. 662 pp.

USFWS. 1994. Biological Opinion for the preferred alternative (9) of the supplemental environmental impact statement of habitat for late successional and old-growth forest within the range of the northern spotted owl. Appendix G. In USDA Forest Service and USDI Bureau of Land Management (eds.). Final environmental impact statement on management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl. Portland, Oregon.

USFWS. 1997. Recovery plan for the threatened marbled murrelet (*Brachyramphus marmoratus*) in Washington, Oregon, and California. Portland, Oregon. 203 pp.

USFWS. 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.

USFWS. 2003. Biological Opinion and letter of concurrence for effects to bald eagles, marbled murrelets, northern spotted owls, bull trout, and designated critical habitat for marbled murrelets and northern spotted owls from Olympic National Forest program of activities for August 5, 2003, to December 31, 2008. Service Reference 1-3-03-F-0833. U.S. Fish and Wildlife Service, Lacey, Washington.

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.

USFWS. 2004. Marbled murrelet 5-year review process: overview, Portland, Oregon. 28 pp.

USFWS. 2006. Biological opinion for the issuance of an incidental take permit (PRT-TE121202-0) to the State of Washington for the implementation of the Washington Forest Practices Habitat Conservation Plan. 1-3-06-FWF-0301. U.S. Fish and Wildlife Service, Western Washington Fish and Wildlife Office, Lacey, WA, May 16, 2006, 1152 pp.

USFWS. 2006a. Transmittal of guidance: Estimating the effects of auditory and visual disturbance to northern spotted owls and marbled murrelets in Northwestern California. Unpublished agency document. U.S. Fish and Wildlife Service, Arcata Fish and Wildlife Office, July 31, 2006. 12 pp, + 2 appendices.

USFWS. 2007. Biological Opinion and letter of concurrence USDA Forest Service, USDI Bureau of Land Management and the Coquille Indian Tribe for programmatic aquatic habitat restoration activities in Oregon and Washington that affect ESA-listed fish, wildlife, and plant species and their critical habitats. Service Reference 13420-2007-F-0055. June 14, 2007. U.S. Fish and Wildlife Service, Portland, Oregon. 258 pp.

USFWS. 2008. Final recovery plan for the northern spotted owl, Strix occidentalis caurina. U.S. Fish and Wildlife Service, Portland, Oregon. xii + 142 pp.

USFWS. 2008. Smoke effects on northern spotted owls. Unpublished agency report. Oregon Fish and Wildlife Office, Portland, Oregon. 5 pp.

USFWS. 2009. Marbled Murrelet (Brachyramphus marmoratus) 5-Year Review. U.S. Fish and Wildlife (U.S. Fish and Wildlife Service). Service, Lacey, Washington, June 12, 2009.

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. Marbled murrelet nesting season and analytical framework for section 7 consultation in Washington. Unpublished agency document. U.S. Fish and Wildlife Service, Washington Fish and Wildlife Office, Lacey, Washington. 8 pp.

USFWS. 2012. Protocol for surveying proposed management activities that may impact northern spotted owls. Revised January 9, 2012. U.S. Fish and Wildlife Service, Oregon Fish and Wildlife Office, Portland, Oregon. 42 pp.

USFWS. 2015. Revised in-air disturbance analysis for marbled murrelets. Unpublished agency document prepared by E. Teachout. U.S. Fish and Wildlife Service, Washington Fish and Wildlife Office, Lacey, Washington. 17 pp.

USFWS. 2019. Marbled Murrelet (*Brachyramphus marmoratus*) 5-Year Review. U.S. Fish and Wildlife Service, Washington Fish and Wildlife Office, Lacey, Washington. May 2019. 115 pp.

USFWS et al. (US Fish and Wildlife Service, USDI Bureau of Land Management and USDA Forest Service). 2008. Methodology for estimating the number of northern spotted owls affected by proposed federal actions. Version 2.0. Oregon Fish and Wildlife Office, Fish and Wildlife Service, Portland, OR. 34 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.

van Mantgem, P.J., N.L. Stephenson, J.C. Byrne, L.D. Daniels, J.F. Franklin, P.Z. Fulé, M.E. Harmon, A.J. Larson, J.M. Smith, A.H. Taylor, T.T. Veblen. 2009. Widespread increase in tree mortality rates in the western United States. Science 323:521-524.

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):549-561.

Vose, J.M, J.S. Clark, C.H. Luce, and T. Patel-Weynand. 2016a. Understanding and anticipating potential drought impacts. In: Vose, J.M., Clark, J.S., Luce, C.H., and Patel-Weynand, T., eds. Effects of drought on forests and rangelands in the United States: a comprehensive review and synthesis. Washington Office, Forest Service, U.S. Department of Agriculture Gen. Tech. Rep. WO-93b. Washington, DC. 289 pp.

Warner, M.D., C.F. Mass, and E.P. Salathé Jr. 2015. Changes in winter atmospheric rivers along the North American west coast in CMIP5 climate models. Journal of Hydrometeorology, 16(1): 118-128.

Wasser, S.K., K.R. Bevis, G. King, and E. Hanson. 1997. Noninvasive physiological measures of disturbance in the northern spotted owl. Conservation Biology 11(4):1019-1022.

Weigl, P.D. 2007. The northern flying squirrel (*Glaucomys sabrinus*): a conservation challenge. Journal of Mammalogy 88:897-907.

Weins, 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 185:1-50.

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. Gen. Tech. Rep. PNW-GTR-880. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station:79–90.

WCB (WorkSafe BC) 2005. Safe work practices for helicopters in the forest industry. Workers Compensation Board of British Columbia. www.worksafebc.com. 34 pp.

WDFW and USFS. 2012. Memorandum of Understanding between Washington Department of Fish and Wildlife and USDA Forest Service, Pacific Northwest Region regarding hydraulic projects conducted by USDA Forest Service, Pacific Northwest Region. NFS 05-MU-11060000-391.

WDNR (Washington Department of Natural Resources) and USFS (U.S. Forest Service). 2018. Forest damage aerial detection survey 1980-2017. GIS data available at http://data-wadnr.opendata.arcgis.com/. Downloaded November 21, 2018.

WDNR. 1997. Final Habitat Conservation Plan. Department of Natural Resources, Olympia, Washington.

WDNR. 2005. Final Forest Practices Habitat Conservation Plan. Washington State Department of Natural Resources, Olympia, Washington. 274 pp. + Appendices.

Weisberg, P.J. and F.J. Swanson. 2003. Regional synchroneity in fire regimes of western Oregon and Washington, USA. Forest Ecology and Management 172:17-28.

Westerling, A.L., H.G. Hidalgo, D.R. Cayan, and T.W. Swetnam. 2006. Warming and earlier spring increase western U.S. forest wildfire activity. Science 313: 940-943.

WSDOT (Washington State Department of Transportation). 2011. Biological assessment preparation for transportation projects – advanced training manual. Washington State Department of Transportation. Olympia, Washington. Available online at: http://www.wsdot.wa.gov/Environment/Biology/BA/BAguidance.htm.

Young, D.J.N., J.T. Stevens, J.M. Earles, J. Moore, A. Ellis, A.L. Jirka, and A.M. Latimer. 2017. Long-term climate and competition explain forest mortality patters under extreme drought. Ecology Letters 20:78-86.

Zharikov, Y., D.B. Lank, F. Huettman, R.W. Bradley, N. Parker, P.P.W. Yen, L.A. Mcfarlane-Tranquilla, and F. Cooke. 2006. Habitat selection and breeding success in a forestnesting alcid, the marbled murrelet, in two landscapes with different degrees of forest fragmentation. Landscape Ecology 21:107-120.

Bull Trout

ACMRR/IABO Working Party on Ecological Indices of Stress to Fishery Resources. 1976. Indices for measuring responses of aquatic ecological systems to various human influences. Fisheries Technical Paper 151, Rome, Italy.

Anderson, P. G., B. R. Taylor, and G. C. Balch. 1996. Quantifying the effects of sediment release on fish and their habitats. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2346.

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.

Bakke, P. 2009. Physical science and climate change: a guide for biologists (and others). Stream Notes April 2009:1-6.

Bakun, A. 1990. Global climate change and intensification of coastal ocean upwelling. Science 247:198.

Barkdull, B. 2020 Memo to File. Re: Bull Trout Use of the Samish River. Washington State Department of Fish and Wildlife. Phone conversation to Jim Muck. March, 2, 2020.

Bash, J., C. Berman, and S. Bolton. 2001. Effects of turbidity and suspended solids on salmonids. Center for Streamside Studies, University of Washington, November 2001.

Bates, B., Z.W. Kundzewicz, S. Wu, and J. Palutikof. 2008. Climate change and water. Intergovernmental Panel on Climate Change, Secretariat, Geneva, June, 2008, 210 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):6720–25.

Baumann, H. 2019. The unusual sensitivity of northern sand lance, a keystone forage fish, to acidification and warming. NECAN Sea Grant Webinar Series, presented September 10, 2019. Video available at https://register.gotowebinar.com/register/2348393410119092491, viewed September 12, 2019.

Baxter, J.S., E.B. Taylor, and R.H. Devlin. 1997. Evidence for natural hybridization between Dolly Varden (*Salvelinus malma*) and bull trout (*Salvelinus confluentus*) in a northcentral British Columbia watershed. Canadian Journal of Fisheries and Aquatic Sciences 54:421-429.

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 57:1470-1481.

Baxter, C.V. 2002. Fish movement and assemblage dynamics in a Pacific Northwest riverscape. Doctoral dissertation. Oregon State University, Corvallis, OR. 174 pp.

Bean, J., A. Wilcox, W. Woessner, and C. Muhlfeld. 2015. Multiscale hydrogeomorphic influences on bull trout (*Salvelinus confluentus*). Canada Journal of Fisheries and Aquatic Science 72:514.

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.

Berry, H., M. Calloway, and J. Ledbetter. 2019. Bull kelp monitoring in South Puget Sound in 2017 and 2018. Nearshore Habitat Program, Aquatic Resources Division, Washington State Department of Natural Resources. Olympia, 72 pp.

Beschta, R. L. 1978. Long-term patterns of sediment production following road construction and logging in the Oregon coast range. Water Resources Research 14:1011–1016.

Beschta, R.L., Pyles, M.R., Skaugset, A.E. and Surfleet, C.G., 2000. Peakflow responses to forest practices in the western Cascades of Oregon, USA. Journal of Hydrology, 233: 102-120.

Bilby, R.E. 1985. Contributions of road surface sediment to a western Washington stream. Forest Science 31(4):827–38.

Birtwell, I.K. 1999. The effects of sediment on fish and their habitat. Fisheries and Oceans Canada, Science Branch, Marine Environment and Habitat Division, Freshwater Environment and Habitat Sciences Section, West Vancouver Laboratory, West Vancouver, B.C., 1999. 34 pp.

Bisson, P. A., and J. R. Sedell. 1984. Salmonid populations in streams in clearcut vs. old-growth forests of western Washington. Pages 121–129 *in* W. R. Meehan, T. R. Merrell, Jr., and T. A. Henley, editors. Fish and wildlife relationships in old-growth forests: proceedings of a symposium. American Institute of Fishery Biologists, Morehead City, North Carolina, USA.

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.

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.

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, 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 P.J. Howell, and D.V. Buchanan, eds. Proceedings of the Gearhart Mountain bull trout workshop, Oregon Chapter of the American Fisheries Society, Corvallis, OR.

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.

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(4):628-630.

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.

Brake, D., M. Molnau, and J.G. King, 1997. Sediment Transport Distances and Culvert Spacings on Logging Roads within the Oregon Coast Mountain Range. Presented at the 1997 Annual International ASAE Meeting Minneapolis, MN. Paper No. IM-975018.

Brandenberg, K.M., M. Velthuis, and D.B. Van de Waal. 2019. Meta-analysis reveals enhanced growth of marine harmful algae from temperate regions with warming and elevated CO2 levels. Global Change Biology doi: 10.1111/gcb.14678.

Brenkman, S.J., and S.C. Corbett. 2003. Seasonal movements of threatened bull trout (*Salvelinus confluentus*) in the Hoh River basin and coastal Washington. Northwest Scientific Association Meeting, Forks, WA, 2003. 3 pp.

Brenkman, S.J. 2003. Edits provided by Sam Brenkman, NPS, to Shelley Spalding, USFWS, for a draft version of "Additions to Recovery Plan" document. January 13, 2003.

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. 2007. Email and attachment from Sam Brenkman, NPS, to Shelley Spalding, USFWS, re: Update North Fork Skokomish. March 21, 2007.

Brenkman, S.J. and J. Meyer. 1999. Distribution and spawning migration of bull trout (*Salvelinus confluentus*) in the Hoh river Basin, Washington. Olympic National Park, Port Angeles, Washington. 45 pp.

Brewin, P.A., and M.K. Brewin. 1997. Distribution maps for bull trout in Alberta. Pages 209-216 In W.C. Mackay, M.K. Brewin, and M. Monita, eds. Friends of the Bull Trout Conference Proceedings, Bull Trout Task Force (Alberta), c/o Trout Unlimited, Calgary.

Brix, R. 1981. Data report of Grays Harbor juvenile salmon seining program, 1973–1980. Washington Department of Fisheries. Progress Report No. 141.

Brodeur, R.D., C. Barceló, K.L. Robinson, E.A. Daly, J.J. Ruzicka. 2014. Spatial overlap between forage fishes and the large medusa Chrysaora fuscescens in the northern California Current region. Marine Ecology Progress Series 510:167-181.

Brown, L.G. 1994. The zoogeography and life history of Washington native char Washington Department of Fish and Wildlife, Fisheries Management Division, Report # 94-04, Olympia, WA, November, 1992. 47 pp.

Brunson, J.K., S.M.K. McKinnie, J.R. Chekan, J.P. McCrow, Z.D. Miles, E.M. Bertrand, V.A. Bielinski, H. Luhavaya, M. Oborník, G.J. Smith, D.A. Hutchins, A.E. Allen, and B.S. Moore. 2018. Biosynthesis of the neurotoxin domoic acid in a bloom-forming diatom. Science 361:1356-1358.

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. Pages 119-126 In W.C. Mackay, M.K. Brewing, and M. Monita, eds. Friends of the Bull Trout Conference Proceedings, , Alberta, Canada.

Burroughs, E.R. Jr., and J.G. King, 1989. Reduction of Soil Erosion on Forest Roads. General Technical Report INT-264. USDA Forest Service, Intermountain Research Station, Ogden, Utah.

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.

Busch, D.S., C.J. Harvey, and P. McElhany. 2013. Potential impacts of ocean acidification on the Puget Sound food web. ICES Journal of Marine Science 70(4):823-833.

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.

Casola, J.H., J.E. Kay, A.K. Snover, R.A. Norheim, L.C. Whitely-Binder, and Climate Impacts Group. 2005. Climate impacts on Washington's hydropower, water supply, forests, fish, and agriculture. Climate Impacts Group (Center for Science in the Earth System, Joint Institute for the Study of the Atmosphere and Ocean) University of Washington, Seattle, WA, October 2005, 44 pp.

Cavender, T.M. 1978. Taxonomy and distribution of the bull trout, Salvelinus confluentus (Suckley), from the American Northwest. California Fish and Game 64(3):139-174.

Cedarholm, C.J., L.M. Reid and E.O. Salo. 1981. Cumulative effects of logging road sediment on salmonid populations of the Clearwater River, Jefferson County, Washington. Pages 38-74 in Proceedings of Conference on Salmon Spawning Gravel: A Renewable Resource in the Pacific Northwest? Report 19. Wash. State University, Water Research Center, Pullman, WA.

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, editors. Streamside Management: Forestry and Fishery Interactions. University of Washington Institute of Forest Resources Contribution 57.

Chapman, D. W. 1988. Critical review of variables used to define effects of fines in redds or large salmonids. Transactions of the American Fisheries Society 117:1–21.

Chan, F., Boehm, A.B., Barth, J.A., Chornesky, E.A., Dickson, A.G., Feely, R.A., Hales, B., Hill, T.M., Hofmann, G., Ianson, D., Klinger, T., Largier, J., Newton, J., Pedersen, T.F., Somero, G.N., Sutula, M., Wakefield, W.W., Waldbusser, G.G., Weisberg, S.B., and Whiteman, E.A. 2016. The West Coast Ocean Acidification and Hypoxia Science Panel: Major Findings, Recommendations, and Actions. California Ocean Science Trust, Oakland, California, USA. April 2016.

Cordone, A. J., and D. W. Kelley. 1961. The influences of inorganic sediment on the aquatic life of streams. Calif. Fish and Game 47 (2):189-228.

Crain, P.V., and S.J. Brenkman. 2010. Elwha River restoration project. Bull trout protection and restoration plan. National Park Service, Olympic National Park, Washington, December 13, 2010. 35 pp.

Crouse, M. R., C. A. Callahan, K. W. Malueg, and S. E. Dominguez. 1981. Effects of fine sediments on growth of juvenile coho salmon in laboratory streams. Transactions of the American Fisheries Society 110:281–286.

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.

Delaney, I., S. Kaspari, and M. Jenkins. 2015. Black carbon concentrations in snow at Tronsen Meadow in Central Washington from 2012 to 2013: temporal and spatial variations and the role of local forest fire activity. Journal of Geophysical Research: Atmospheres 120:9160-9172.

DeHaan, P.W., S.J. Brenkman, B. Adams, and P.V. Crain. 2011. Genetic population structure of Olympic Peninsula bull trout populations and implications of Elwha dam removal. Northwest Science 3(85):463-475.

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.

Du, X., W. Peterson, J. Fisher, M. Hunter, and J. Peterson. 2016. Initiation and development of a toxic and persistent Pseudo-nitzschia bloom off the Oregon coast in spring/summer 2015. PLOS One 11(10): e0163977. doi:10.1371/journal.pone.0163977.

Dubé, 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 08-801. Washington Department of Natural Resources. Olympia, Washington. Coe 2006

Duguid, W.D.P., J.L. Boldt, L. Chalifour, C.M. Greene, M. Galbraith, D. Hay, D. Lowry, S. McKinnell, C.M. Neville, J. Qualley, T. Sandell, M. Thompson, M. Trudel, K. Young, and F. Juanes. 2019. Historical fluctuations and recent observations of northern anchovy Engraulis mordax in the Salish Sea. Deep-Sea Research Part II 159:22-41.

Duncan, S.H., R.E. Bilby, J.W. Ward, and J.T. Heffner. 1987. Transport of road-surface sediment through ephemeral stream channels. Water Resources Bulletin 23(1):113–19.

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.B., and B.E. Rieman. 1999. Metapopulation structure of bull trout: Influences of physical, biotic, and geometrical landscape characteristics. Ecological Applications 9:642-655.

Dunham, J.B., Rosenberger, A.E., Luce, C.H., and B.E. Rieman. 2007. Influences of wildfire and channel reorganization on spatial and temporal variation in stream temperature and the distribution of fish and amphibians. 2007. Ecosystems 10:335-346.

Elsner, M.M., L. Cuo, N. Voisin, J.S. Deems, A.F. Hamlet, J.A. Vano, K.E. Mickelson, S.L. Le, D.P. Lettenmaier, and D.P. Lettenmaier. 2010. Implications of 21st century climate change for the hydrology of Washington State. Climatic Change 102:225-260

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 Salo, E.O., and T.W. Cundy, editors. 1987. Streamside management: forestry and fishery interactions. University of Washington Institute of Forest Resources Contribution 57.

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., 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.

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.

Foltz, R.B. 1996. Traffic and No-Traffic on an Aggregate Surfaced Road: Sediment Production Differences. Paper presented at Food and Agriculture Organization Seminar on Environmentally Sound Forest Road and Wood Transport, Sinaia, Romania, June 17-22, 1996.

Foltz, R. B., and E.R. Burroughs. Jr., 1990. Sediment Production from Forest Roads with Wheel Ruts. In: Watershed Planning and Analysis; Proceedings of a Symposium, July 9-11 1989, Durango CO. ASCE, pp. 266-275.

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.

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.

Fountain, A.G., B. Glenn, C. Gray, and B. Menounos. 2019. Glacier change in the Olympic Mountains, WA over the past and future 100 years. American Geophysical Union, Fall Meeting 2019, abstract C23C-1551. San Francisco, California, December 10, 2019.

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. 1993. Topology of extinction and endangerment of native fishes in the Pacific Northwest and California. Conservation Biology 7(2):342-354.

Frissell, C.A. 1999. An ecosystem approach to habitat conservation for bull trout: groundwater and surface water protection. Flathead Lake Biological Station, University of Montana, Open File Report Number 156-99, Polson, MT, January 07, 1999. 46 pp.

Furniss, M.J., T.D. Roelofs and C.S. Yee. 1991. Road construction and maintenance. Chapter 8 In: Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication 19:297-323.

Gamett, B.L. 2002. Telephone conversation between Bart L. Gamett, Salmon-Challis National Forest, and Shelley Spalding, USFWS, re: relationship between water temperature and bull trout distribution and abundance in the Little Lost River, Idaho. June 20, 2002.

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.

Gerking, S.D. 1994. Feeding ecology of fish. Academic Press, San Diego, California. 51 pp.

Gibson, C.A., J.L. Meyer, N.L. Poff, L.E. Hay, and A. Georgakakos. 2005. Flow regime alterations under changing climate in two river basins: implications for freshwater ecosystems. River Research and Applications 21:849-864.

Giles, M.A., and M. Van der Zweep. 1996. Dissolved oxygen requirements for fish of the Peace, Athabasca and Slave River Basins: a laboratory study of bull trout (Salveninus Confluentus) and mountain whitefish (*Prosopium Williamsoni*), Northern River Basins Study Technical Report No. 120 ed.

Gilpin, M. 1997. Memo to Shelly Spalding, Montana Department of Fish, Wildlife, and Parks. Connectivity on the Clark Fork River: The Bigger Picture. August 27, 1997.

Goetz, F. 1989. Biology of the bull trout, Salvelinus confluentus, a literature review. Willamette National Forest, Eugene, Oregon, February 1989. 53 pp.

Goetz, F., E.D. Jeanes, and E.M. Beamer. 2004. Bull trout in the nearshore. U.S. Army Corps of Engineers, Preliminary draft, Seattle, Washington, June 2004. 396 pp.

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.; Lewis, S.L.; Swanson, F.J.; Cissel, J.H.; McDonnell, J.J. 2008. Effects of forest practices on peak flows and consequent channel response: a state-of-science report for western Oregon and Washington. Gen. Tech. Rep. PNW-GTR-760. Corvallis, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 74 p.

Haas, G.R., and J.D. McPhail. 1991. Systematics and distributions of Dolly Varden (*Salvelinus malma*) and bull trout (*Salvelinus confluentus*) in North America. Canadian Journal of Fisheries and Aquatic Sciences 48.

Halofsky, J.E., D.L. Peterson, K.A. O'Halloran, and C. Hawkins Hoffman. 2011. Adapting to climate change at Olympic National Forest and Olympic National Park. Gen. Tech. Rep. PNW-GTR-844. Pacific Northwest Research Station, U.S. Forest Service, Portland, Oregon, 130 pp.

Hamilton, T.J., A. Holcombe, and M. Tresguerres. 2014. CO_2-induced ocean acidification increases anxiety in Rockfish via alteration of $GABA_A$ receptor functioning. Proceedings of the Royal Society B 281:20132509.

Hamlet, A.F., M.M. Elsner, G.S. Mauger, S.Y. Lee, I. Tohver, and R.A. Norheim. 2013. An overview of the Columbia Basin Climate Change Scenarios Project: approach, methods, and summary of key results. Atmosphere-Ocean 51(4): 392-415.

Hamlet, A.F. and D.P. Lettenmaier. 2007. Effects of 20th century warming and climate variability on flood risk in the western US. Water Resources Research, 43:W06427.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(1):10–26.

Hard, J. 1995. A quantitative genetic perspective on the conservation of intraspecific diversity. American Fisheries Society Symposium 17:304-26.

Haupt, H.F., 1959. Road and Slope Characteristics Affecting Sediment Movement from Logging Roads. Journal of Forestry. Vol. 57, pp. 329-332.

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.

Henley, W. F., M. A. Patterson, R. J. Neves, and A. D. Lemly. 2000. Effects of sedimentation and turbidity on lotic food webs: a concise review from natural resource managers. Reviews in Fisheries Science 8(2): 125-139.

Hoelscher, B., and T.C. Bjornn. 1989. Habitat, density, and potential production of trout and char in Pend Oreille Lake tributaries. Idaho Department of Fish and Game, Project F-710R-10, Subproject III, Job No. 8. Boise, Idaho, January 1989. 60 pp.

Howell, P.J., and D.V. Buchanan. 1992. Proceedings of the Gearhart Mountain bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis, Oregon. 67 pp.

IDFG (Idaho Department of Fish and Game). 1995. List of streams compiled by IDFG where bull trout have been extirpated.

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. 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/>. Downloaded October 4, 2019.

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., and B. Rieman. 2013. Stream isotherm shifts from climate change and implications for distributions of ecthothermic organisms. Global Change Biology 19:742.

Isaak, D., M. Young, C. Luce, S. Hostetler, S. Wenger, E. Peterson, J. Ver Hoef, M. Groce, D. Horan, and D. Nagel. 2016. Slow climate velocities of mountian streams portend their role as refugia for cold-water biodiversity. PNAS 113(16):4374.

Isaak, D.J., S.J. Wenger, E.E. Peterson, J.M. Ver Hoef, S.W. Hostetler, C.H. Luce, J.B. Dunham, J.L. Kershner, B.B. Roper, D.E. Nagel, G.L. Chandler, S.P. Wollrab, S.L. Parkes, and D.L. Horan. 2016a. NorWeST modeled summer stream temperature scenarios for the western U.S. Fort Collins, CO: Forest Service Research Data Archive. GIS data available for download at: https://doi.org/10.2737/RDS-2016-0033; downloaded March 30, 2018.

Isaak, D.J., M.K. Young, C.H. Luce, S.W. Hostetler, S.J. Wenger, E.E. Peterson, J.M. Ver Hoef, M.C. Groce, D.L. Horan, and D.E. Nagel. 2016b. 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.

ISAB (Independent Scientific Advisory Board). 2007. Climate change impacts on Columbia River Basin Fish and Wildlife. ISAB 2007-2. Northwest Power and Conservation Council, Portland, Oregon, May 11, 2007, 146 pp.

Jones, J.A.; Grant, G.E. 1996. Peak flow responses to clear-cutting and roads in small and large basins, western Cascades, Oregon. Water Resources Research. 32: 959-974.

Jones, J.A.; Grant, G.E. 2001. Comment on “Peak flow responses to clear-cutting and roads in small and large basins, western Cascades, Oregon.” Water Resources Research. 37(1): 179-180.

Jones, J.A., Swanson, F.J., Wemple, B.C., Snyder, K.U., 2000. Effects of roads on hydrology, geomorphology, and disturbance patches in stream networks. Conservation Biology 14, 76–85.

Kaspari, S., S.M. Skiles, I. Delaney, D. Dixon, and T.H. Painter. 2015. Accelerated glacier melt on Snow Dome, Mount Olympus, Washington, USA, due to deposition of black carbon and mineral dust from wildfire. Journal of Geophysical Research: Atmospheres 120:2793-2807.

Ketcheson, G.L. and W.F Megahan, 1996. Sediment Production and Downslope Sediment Transport from Forest Roads in Granitic Watersheds. USDA Forest Service, Intermountain Research Station. Research Paper INT-RP-486.

Kochenderfer, J.N., and J.D. Helvey, 1987. Using Gravel to Reduce Soil Losses from Minimum Standard Forest Roads. Journal of Soil and Water Conservation, Vol. 42 pp. 46-50.

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.

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.

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(4):856-65.

Leach, J.A. and R.D. Moore. 2010. Above-stream microclimate and stream surface exchanges in a wildfire-disturbed riparian zone. Hydrological Processes 24:2369-2381.

Leathe, S.A., and P.J. Graham. 1982. Flathead Lake fish food habits study. US EPA, Region VIII, Water Division, Contract R008224-01-4, Denver, Colorado, October, 1982. 209 pp.

Lee, D.C., J.R. Sedell, B.E. Rieman, R.F. Thurow, J.E. Williams and others. 1997. Broadscale assessment of aquatic species and habitats. Pp. 1057-1496, In: T.M. Quigley and S.J. Arbelbide, tech. eds. As assessment of ecosystem components in the interior Columbia Basin and portions of the Klamath and Great Basins. USDA Forest Service, Pacific Northwest Research Station. PNW-GTR-328. Portland, OR.

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, and others. 2015. State of the California Current 2014–15: Impacts of the Warm-Water "Blob." CalCOFI Reports 56:31–68.

Lesniowski, T.J., M. Gambill, S. Holst, M.A. Peck, M. Algueró-Muñiz, M. Haunost, A.M. Malzahn, and M. Boersma. 2015. Effects of food and CO2 on growth dynamics of polyps of two scyphozoan species (*Cyanea capillata* and *Chrysaora hysoscella*). Marine Biology 162(6):1371-1382.

Lincoln AE, Shaffer A, and Quinn TP. Opportunistic use of the estuarine habitat by juvenile bull trout, Salvelinus confluentus, from the Elwha River before, during, and after dam removal. Env Biol Fish 1-1"1-11.

Luce, C.H., and T.A. Black, 1999. Spatial and Temporal Patterns in Erosion from Forest Roads. In: M.S. Wigmosta and S.J. Burges, eds. The Influence of Land Use on the Hydrologic-Geomorphic Responses of Watersheds. AGU Monographs.

Luce, C., P. Morgan, K. Dwire, D. Isaak, Z. Holden, B. Rieman. 2012. Climate change, forests, fire, water, and fish: building resilient landscapes, streams, and managers. Gen. Tech. Rep. RMRS-GTR-290. Rocky Mountain Research Station, U.S. Forest Service. Fort Collins, Colorado. 207 pp.

MacDonald, L.H., R.W. Sampson, and D.M. Anderson. 2001. Runoff and road erosion at the plot and road segment scale, St. John, U.S. Virgin Islands. *Earth Surface Processes and Landforms* 26: 1-22.

Magirl, C.S., J.J. Duda, and J.A. Warrick. 2011. Coastal habitats of the Elwha River, Washington - biological and physical patterns and processes prior to dam removal. U.S. Geological Survey, Scientific Investigations Report 2011-5120, Reston, Virginia, 2011. 264 pp.

Mantua, N., I. Tohver, and A. Hamlet. 2010. Climate change impacts on streamflow extremes and summertime stream temperature and their possible consequences for freshwater salmon habitat in Washington State. Climatic Change 102:187-223.

Marks, E. 2020. Puyallup River Bull Trout Data. Puyallup Tribe. Email to Jim Muck. April 22, 2020.

Mauger, G., J. Casola, H. Morgan, R. Strauch, B. Jones, B. Curry, T. Busch Isaksen, L. Whitely Binder, M. Krosby, A. and Snover. 2015. State of knowledge: climate change in Puget Sound. Report prepared for the Puget Sound Partnership and the National Oceanic and Atmospheric Administration. Climate Impacts Group, University of Washington, Seattle. 281 pp.

MBTSG. 1998. The relationship between land management activities and habitat requirements of bull trout. Montana Fish, Wildlife, and Parks, Helena, MT, May 1998. 77 pp.

McCabe, R.M., B.M. Hickey, R.M. Kudela, K.A. Lefebvre, N.G. Adams, B.D. Bill, F.M.D. Gulland, R.E. Thomson, W.P. Cochlan, and V.L. Trainer. 2016. An unprecedented coastwide toxic algal bloom linked to anomalous ocean conditions. Geophysical Research Letters 43:10366-10376.

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.

McPhail, J.D., and C.B. Murray. 1979. The early life-history and ecology of dolly varden (*Salvelinus Malma*) in the upper Arrow Lakes. Department of Zoology and Institute of Animal Resource Ecology, Fort Steele, British Columbia. 113 pp.

Megahan, W.F., and G.L. Ketcheson, 1996. Predicting Downslope Travel of Granitic Sediments from Forest Roads in Idaho. Water Resources Bulletin, Vol. 32, No. 2, pp. 371-382.

Metzger, Robert. 2012. Fisheries Biologist, U.S. Forest Service, Olympic National Forest, WA. Email sent to Zachary Radmer, Fish and Wildlife Biologist, U.S. Fish and Wildlife Service, Washington Fish and Wildlife Office; on July 5, 2012. Topic: Total miles of roads decommissioned on the Olympic National Forest.

Meyers, E., 2007. Reducing Sediment Production from Forest Roads during Wet-Weather Use. PhD. Dissertation, Oregon State University, August 3, 2007.

Mills, K, L., Dent, and J. Robben, 2003. Wet Season Road Use Monitoring Project. Oregon Department of Forestry, Forest Practices Monitoring Program, Technical Report #17. June 2003.

Mongillo, P.E. 1993. The distribution and status of bull trout/dolly varden in Washington state. Washington Department of Wildlife, 93-22, Olympia, WA, 1993. 45 pp.

Moore, S.K., J.A. Johnstone, N.S. Banas, and E.P. Salathé. 2015. Present-day and future climate pathways affecting Alexandrium blooms in Puget Sound, WA, USA. Harmful Algae 48:1-11.

Morrill, J.C., R.C. Bales, and M.H. Conklin. 2005. Estimating stream temperature from air temperature: implications for future water quality. Journal of Environmental Engineering 131:139-146.

Mote, P.W., and E.P. Salathe Jr. 2010. Future climate in the Pacific Northwest. Climatic Change 102(1):29-50.

Murphy, M. L., and J. D. Hall. 1981. Varied effects of clearcut logging on predators and their habitat in small streams of the Cascade Mountains, Oregon. Canadian Journal of Fisheries and Aquatic Sciences 38:137–145.

Murray, J.W., E. Roberts, E. Howard, M. O'Donnell, C. Bantam, E. Carrington, M. Foy, B. Paul, and A. Fay. 2015. An inland sea high nitrate-low chlorophyll (HNLC) region with naturally high pCO2. Limnology and Oceanography 60(3):957-966.

Myrick, C.A., F.T. Barrow, J. 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. U.S. Fish and Wildlife Service, Lacey, Washington, September 19, 2002. 13 pp.

Nagelkerken, I. and P.L. Munday. 2016. Animal behaviour shapes the ecological effects of ocean acidification and warming: moving from individual to community-level responses. Global Change Biology 22:974-989.

Nakano, S., K.D. Fausch, T. Furukawa-Tanaka, K. Maekawa, and H. Kawanabe. 1992. Resource utilization by bull trout and cutthroat trout in a mountain stream in Montana, U.S.A. Japanese Journal of Ichthyology. 39: 211-217.

National Ocean Service. 2016. West coast harmful algal bloom: NOAA responds to unprecedented bloom that stretches from central California to Alaska Peninsula. https://oceanservice.noaa.gov/news/sep15/westcoast-habs.html. Downloaded December 19, 2017.

Newcombe, CP and JOT Jensen. 1996. Channel suspended sediment and fisheries: a synthesis for quantitative assessment of risk and impact. North American Journal of Fisheries Management 16:693-727.

NMFS (National Marine Fisheries Service). 2016. California Current Integrated Ecosystem Assessment (CCIEA) State of the California Current Report, California Current Integrated Ecosystem Assessment Team. Pp. 20.

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. Accessed October 4, 2019.

NMFS 2009. The use of treated wood products in aquatic environments: Guidelines to NOAA Fisheries Staff for Endangered Species Act and Essential Fish Habitat Consultations in the Alaska, Northwest and Southwest Regions. Prepared by the Southwest Region on October 12, 2009.

NOAA (National Oceanic and Atmospheric Administration) Climate. 2015. Record-setting bloom of toxic algae in north Pacific. https://www.climate.gov/news-features/eventtracker/record-setting-bloom-toxic-algae-north-pacific. Downloaded November 22, 2017.

NOAA National Centers. 2020. State Climate Summaries - Washington [online]. cited 6/13/20.

ODEQ (Oregon Department of Environmental Quality). 1995. 1992-1994 water quality standards review: dissolved oxygen - final issue paper. Oregon Department of Environmental Quality, Portland, OR.

Ogg, L.W. 2004. Email from Larry Ogg, USFS, to Shelley Spalding, USFWS, e: Bull trout sightings in the Dungeness. June 7, 2004.

Ogg, L.W. 2004. Telephone conversation between Larry Ogg, USFS, and Shelley Spalding, USFWS, re: Redd surveys in Dungeness River. December 8, 2004.

Ogg, L., S. Spalding, and M. McHenry. 2008. Dungeness River basin bull trout study 2003–2006. Olympic National Forest. Olympia, Washington. 33 pp.

Olympic Peninsula Bull Trout Recovery Unit Team. 2003. Meeting notes from a January 14, 2003, meeting of the Olympic Peninsula Bull Trout Recovery Unit Team. Held at the USFWS Washington Fish and Wildlife Office in Lacey, WA.

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. Responses of pink salmon to CO2-induced aquatic acidification. Nature Climate Change 5(10):950-955.

PacifiCorp. 2020. Yale Hydroelectric Project - Application For License Amendment.

Parsons, T.R. and C.M. Lalli. 2002. Jellyfish population explosions: revisiting a hypothesis of possible causes. La Mer 40:111-121.

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.

Pauley, G.B. and G.L. Thomas. 1993. Mortality of anadromous coastal cutthroat trout caught with artificial lures and natural bait. North American Journal of Fisheries Management 13(2):337–345.

Pelto, M. 2018. Elwha River: impact of ongoing glacier retreat. Fact sheet, North Cascade Glacier Climate Project, Nichols College, Dudley, Massachusetts. Available at <https://glaciers.nichols.edu/wp-content/uploads/2018/06/elwha-fact-sheet.pdf>, accessed May 4, 2020.

Pfister, C.A., H.D. Berry, and T. Mumford. 2018. The dynamics of kelp forests in the Northeast Pacific Ocean and the relationship with environmental drivers. Journal of Ecology 106:1520-1533.

Phillips, R. W., R. L. Lantz, E. W. Claire, and J. R. Moring. 1975. Some effects of gravel mixtures on emergence of coho salmon and steelhead trout fry. Transactions of the American Fisheries Society 104: 461–466.

Prasad, A., D.G. Tarboton, C.H. Luce, and T.A. Black. 2006. Region Sediment Analysis Model (RSAM)- A GIS Tool to Analyze Forest Road Sediment Production and Stream Impacts. Utah State University, Logan, Utah, and USDA Forest Service, Boise, Idaho.

Pratt, K.L. 1984. Habitat use and species interactions of juvenile cutthroat (*Salmo clarki lewisi*) and bull trout (*Salvelinus confluentus*) in the Upper Flathead River basin. Moscow, ID; University of Idaho. 95 p. Thesis.

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, OR.

Pratt, K.L., and J.E. Huston. 1993. Status of bull trout (Salvelinus confluentus) in Lake Pend Oreille and the lower Clark Fork River. Washington Water Power Company, Spokane, WA, December 1993. 200 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). URL: 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, editors. Available: www.psp.wa.gov/PSmarinewatersoverview.php.

Purcell, J.E. 2005. Climate effects on formation of jellyfish and ctenophore blooms: a review. Journal of the Marine Biological Association of the United Kingdom 85(03):461-476.

Purcell, J.E., S.-I. Uye, and W.-T. Lo. 2007. Anthropogenic causes of jellyfish blooms and their direct consequences for humans: a review. Marine Ecology Progress Series 350:153-174.

Quigley, T.M., R.W. Haynes and R.T. Graham, technical editors. 1996. Integrated scientific assessment for ecosystem management in the interior Columbia Basin and portions of the Klamath and Great Basins. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. Portland, Oregon.

Quigley, T.M. and S.J. Arbelbide, technical editors. 1997. An assessment of ecosystem components in the interior Columbia Basin and portions of the Klamath and Great Basins: Volume III. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. Portland, Oregon.

Quinn TP, Bond MH, Brenkman SJ, et al. 2017. Re-awakening dormant life history variation: stable isotopes indicate anadromy in bull trout following dam removal on the Elwha River, Washington. Env Biol Fish 100: 1659–71.

Rahel, F.J., and J.D. Olden. 2008. Assessing the effects of climate change on aquatic invasive species. Conservation Biology 22(3):521-533.

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.

Reid, L.M., and T. Dunne, 1984. Sediment Production from Forest Road Surfaces. Water Resources Research Vol. 20, No. 11, pp. 1753-1761.

Reid, S. and P. Anderson. 1999. Effects of sediment released during open-cut pipeline water crossings. Canadian Water Resources Journal 24: 23-39.

Rich, C.F. 1996. Influence of abiotic and biotic factors on occurrence of resident bull trout in fragmented habitats, Western Montana. Master's Thesis. Montana State University, Bozeman, MT. May 1996 pp.

Richardson, A.J., A. Bakun, G.C. Hays, and M.J. Gibbons. 2009. The jellyfish joyride: causes, consequences and management responses to a more gelatinous future. Trends in Ecology & Evolution 24(6):312-322.

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, USA. Journal of Glaciology 61:8-16.

Rieman, B.E. and F.W. Allendorf. 2001. Effective population size and genetic conservation criteria for bull trout. North American Journal of Fisheries Management 21:756-64.

Rieman, B.E., and J.D. McIntyre. 1993. Demographic and habitat requirements for conservation of bull trout. Gen. Tech. Rep. INT-302. Ogden, UT: USDA, Forest Service, Intermountain Research Station. 38 p.

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(3):285-296.

Rieman, B.E., and J.D. McIntyre. 1996. Spatial and temporal variability in bull trout redd counts. North American Journal of Fisheries Management 16:132-141.

Rieman, B.E., D. Lee, D. Burns, R.E. Gresswell, M.K. Young, R. Stowell, and P. Howell. 2003. Status of native fishes in western United States and issues for fire and fuels management. Forest Ecology and Management 178(1-2):197-211.

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 7:1111-1125.

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(6):1552–1565.

Reiser, D.W. and R.G. White. 1988. Effects of Two Sediment Size-Classes on Survival of Steelhead and Chinook Salmon Eggs, North American Journal of Fisheries Management, 8:4, 432-437

Reeves, G. H., F. H. Everest, and J. R. Sedell. 1993. Diversity of juvenile anadromous salmonid assemblages in coastal Oregon basins with different levels of timber harvest. Transactions of the American Fisheries Society 122:309–317.

Rosenberg, DM, and NB Snow. 1975b. A design for environmental impact studies with special reference to sedimentation in aquatic systems of the Mackenzie and Porcupine river drainages. Pages 65-78 in Proceedings of the circumpolar conference on northern ecology. National Research Council of Canada, Ottawa.

Ryan, J. P., R.M. Kudela, J.M. Birch, M. Blum, H.A. Bowers, F.P. Chaves, G.J. Doucette, K. Hayashi, R. Marin III, C.M. Mikulski, J.T. Pennington, C.A. Scholin, G.J. Smith, A. Woods, and Y.Zhang. 2017. Causality of an extreme harmful algal bloom in Monterey Bay, California, during the 2014–2016 northeast Pacific warm anomaly. Geophysical Research Letters 44:5571–5579. doi:10.1002/2017GL072637.

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.

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.

Sedell, J.R., and F.H. Everest. 1991. Historic changes in pool habitat for Columbia River Basin salmon under study for TES listing. Pacific Northwest Research Station, Draft U.S. Department of Agriculture Report, Corvallis, Oregon. 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. McKay, M.K. Brewin, and M. Monita, eds. Friends of the Bull Trout Conference Proceedings, Bull Trout Task Force (Alberta), c/o Trout Unlimited, Calgary, Alberta, Canada.

Shaw, E. A. and J. S. Richardson. 2001. Direct and indirect effects of sediment pulse duration on stream invertebrate assemblages and rainbow trout (*Oncorhynchus mykiss*) growth and survival. Canadian Journal of Fisheries and Aquatic Science 58: 2213-2221.

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 67(4):626-640.

Shepard, B. B., S. A. Leathe, T. M. Waver, and M. D. Enk. 1984. Monitoring levels of fine sediment within tributaries to Flathead Lake, and impacts of fine sediment on bull trout recruitment. Pages 146-156 *in* F. Richardson and R. H. Hamre, editors. Wild trout III. Federation of Fly Fishers and Trout Unlimited, Vienna, Virginia.

Sidle, R.C., Pearce, A.J.; O'Loughlin, C.L., 1985: Hillslope stability and land use. Water Resources Monograph 11: 140 pp.

Simpson, J.C., and R.L. Wallace. 1982. Fishes of Idaho. University of Idaho Press, Moscow, ID. 93 pp.

Simpson Timber Company. 2000. Habitat Conservation Plan: Simpson Timber Company Northwest Operations - Shelton, Washington Timberlands. Shelton, Washington. July 2000. 135 pp.

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.

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.

Spruell, P., and A.N. Maxwell. 2002. Genetic analysis of bull trout and Dolly Varden in Washington. Wild Salmon and Trout Genetics Lab, University of Montana, WTSGL 02-101, Missoula, MT, May 01, 2002. 16 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*). Department of Fisheries and Oceans, Canadian Manuscript Report of Fisheries and Aquatic Sciences 2801, Winnipeg, MB, Canada, 2007. 54 pp.

Stratus. 2006. Treated Wood in Aquatic Environments: Technical Review and Use Recommendations. Prepared for National Marine Fisheries Service, Southwest Region, Habitat Conservation Division by Stratus Consulting, Inc., Boulder, CO. December 31, 2006. 162 p. Available at: http://swr.nmfs.noaa.gov/wood/Copperwood_Report-final.pdf

Sugden, B.D., and S.W. Woods, 2007. Sediment Production from Forest Roads in Western Montana. Journal of the American Water Resources Association. Volume 43, No. 1, pp. 193-206.

Sullivan, K.O., and S.H. Duncan, 1981. Sediment Yield from Road Surfaces in Response to Truck Traffic and Rainfall. Weyerhaeuser Technical Report 042-4402.80. Weyerhaeuser Company, Technical Center, Tacoma, WA 98477.

Suren, A. M. and I. G. Jowett. 2001. Effects of deposited sediment on invertebrate drift: an experimental study. New Zealand Journal of Marine and Freshwater Research 35: 725-537.

Suttle, K. B., Power, M. E., Levine, J. M., & McNeely, C. (2004). How fine sediment in riverbeds impairs growth and survival of juvenile salmonids. *Ecological Applications, 14*(4), 969-974.

Swanson FJ, Dyrness CT. 1975. Impact of clear-cutting and road construction on soil erosion by landslides in the western Cascade Range, Oregon. *Geology* 3: 393–396.

Swanston, D.N.; Swanson, F.J. 1976. Timber harvesting, mass erosion, and steepland forest geomorphology in the Pacific Northwest. In: Coates, D.R. Geomorphology and engineering. Stroudsburg, PA: Dowden, Hutchinson, and Ross: 199-221.

Swift, L.W. Jr., 1984. Gravel and Grass Surfacing Reduces Soil Loss from Mountain Roads. Forestry Science, Vol. 30, pp. 657-670.

Swift, L.W. Jr., 1985. Soil Losses from Roadbeds and Cut and Fill Slopes in the Southern Appalachian Mountains. Southern Journal of Applied Forestry, Vol. 8 No. 4, pp. 209-213.

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.

Tagart, J. V. 1976. The survival from egg deposition to emergence of coho salmon in the Clearwater River, Jefferson County, Washington. Master's thesis. University of Washington, Seattle.

Takahashi, M., D.M. Checkley, M.N.C. Litz, R.D. Brodeur, and W.T. Peterson. 2012. Responses in growth rate of larval northern anchovy (*Engraulis mordax*) to anomalous upwelling in the northern California Current. Fisheries Oceanography 21(6):393-404.

Tatters, A.O., F.-X. Fu, and D.A. Hutchins. 2012. High CO2 and silicate limitation synergistically increase the toxicity of Pseudo-nitzschia fraudulenta. PLoS One 7(2):e32116.

Taylor, E.B., Z. Redenbach, A.B. Costello, S.M. Pollard, and C.J. Pacas. 2001. Nested analysis of genetic diversity in northwestern North American char, Dolly Varden (*Salvelinus malma*) and bull trout (*Salvelinus confluentus*). Canadian Journal of Aquatic Sciences 58(2):406-420.

Thom, R.M. 1996. CO2-Enrichment effects on eelgrass (*Zostera marina L.*) and bull kelp (*Nereocystis luetkeana* (Mert.) P & R.). Water, Air, & Soil Pollution 88(3):383-391.

Thom, R., S. Southard, and A. Borde. 2014. Climate-linked mechanisms driving spatial and temporal variation in eelgrass (Zostera marina L.) growth and assemblage structure in Pacific Northwest estuaries, USA. Journal of Coastal Research 68:1-11.

Thomas, G. 1992. Status of bull trout in Montana. Montana Department of Fish, Wildlife and Parks, Helena, MT, August 1992. 83 pp.

Thomas, R. B., and W. F. Megahan. 1998. Peak flow responses to clearcutting and roads in small and large basins, western Cascades, Oregon: A second opinion, *Water Resour. Res.*, *34*(12), 3393–3403, 1998.

Thompson, J. Bull Trout 5 yr Review Cedar River Watershed [online].

Trainer, V.L., B.-T.L. Eberhart, J.C. Wekell, N.G. Adams, L. Hanson, F. Cox, and J. Dowell. 2003. Paralytic shellfish toxins in Puget Sound, Washington state. Journal of Shellfish Research 22(1):213-223.

Trimble, G.R., and R.S. Sartz, 1957. How far from a Stream Should a Logging Road be Located? Journal of Forestry, Vol. 55, pp. 339-341.

USDA (U.S. Department of Agriculture) and USDI (U.S. Department of the Interior). 1994. Record of decision for amendments to Forest Service and Bureau of Land Management planning documents within the range of the northern spotted owl; standards and guidelines for management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl (northwest forest plan). Portland, Oregon.

USDA/USFS. 1995a. South Fork Skokomish Watershed Analysis. Watershed Analysis Team Members included representatives from USFS, Skokomish Tribe, Washington Department of Natural Resources, and USFWS. Completed June 1995. 374pp.

USDA/USFS. 1995b. Dungeness Watershed Analysis. Watershed Analysis Team Members included representatives from USFS, National Park Service: Olympic National Park, Natural Resources Conservation Service, Washington State Department of Fish and Wildlife, Clallam County, Jamestown S'Klallam Tribe, Quilcene Ancient Forest Coalition, M & R Timber Company, and USFWS. Completed September 1995. 154pp.

USFS (U.S. Forest Service). 2002. Summary report of the Olympic National Forest bull trout recovery project 1995–2001. Michael Stutsman and Larry Ogg, authors. Olympia, WA. 54 pp.

USFS. 2009. Programmatic Biological Assessment for selected forest management activities Olympic National Forest 2010-2019. U.S. Forest Service, Olympic National Forest, Olympia, WA. June 18, 2009. 158 pp.

USFWS. 1998. Candidate and listing priority assignment form for bull trout. Western Washington Office, Lacey, Washington. February 12, 1998.

USFWS and NMFS (National Marine Fisheries Service). 1998. Endangered Species Consultation Handbook: Procedures for conducting consultation and conference activities under Section 7 of the Endangered Species Act. U.S. GPO:2004-690-278. March 1998.

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. 47 pp.

USFWS. 2000. Biological opinion for the effects to bull trout (*Salvelinus confluentus*) from continued implementation of the land and resource management plans and resource management plans as amended by the 1994 Northwest Forest Plan record of decision. Pacific Regional Office, Oregon Fish and Wildlife Office, and Western Washington Fish and Wildlife Office, U.S. Fish and Wildlife Service, May 31, 2000. 106 pp.

USFWS. 2002a. Bull trout (*Salvelinus confluentus*) draft recovery plan - Chapter 2: Klamath River. U.S. Fish and Wildlife Service, Portland, Oregon. 82 pp.

USFWS. 2002b. Bull trout (*Salvelinus confluentus*) draft recovery plan - Chapter 25: Saint Mary-Belly River. U.S. Fish and Wildlife Service, Portland, Oregon. 134 pp.

USFWS. 2002c. Chapter 20 of the bull trout (*Salvelinus confluentus*) draft recovery plan: Lower Columbia Recovery Unit, Washington. USFWS, Region 1, Portland, Oregon. 102 pp.

USFWS. 2004. Draft Recovery Plan for the Coastal-Puget Sound Distinct Population Segment of Bull Trout (*Salvelinus confluentus*). Volume I (of II): Puget Sound Management Unit. Portland, Oregon. 389 + xvii pp.

USFWS. 2005. Bull trout core area template - complete core area by core area analysis. U.S. Fish and Wildlife Service, Portland, Oregon. 662 pp.

USFWS. 2007. Programmatic biological opinion aquatic habitat restoration activities in Oregon and Washington. Oregon Fish and Wildlife Office, Portland, Oregon.

USFWS. 2008. Bull trout (*Salvelinus confluentus*) 5 year review: summary and evaluation. U.S. Department of Fish and Wildlife Service, Portland, Oregon, April 25, 2008. 55 pp.

USFWS 2010. Biological effects of sediment on bull trout and their habitat: Guidance for evaluating effects. Prepared by Jim Muck, U.S. Fish and Wildlife Service, Washington Fish and Wildlife Office. Lacey. Completed July13, 2010.

USFWS 2010b. 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. 2015. Bull trout (*Salvelinus confluentus*) 5-year review: Short Form Summary. US Fish and Wildlife Service, 77 FR 13248, Portland, Oregon, November 13, 2015. 8 pp.

USFWS. 2015a. Recovery plan for the coterminous United States population of bull trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, 2015. p. A-10 – A-25

USFWS. 2015b. Coastal recovery unit implementation plan for bull trout (*Salvelinus confluentus*). US Fish and Wildlife Service, September 2015. 160 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.

Villalobos, C. 2018. Interactive effects of ocean acidification and ocean warming on Pacific herring (*Clupea pallasi*) early life stages. Master's Thesis. Western Washington University, Bellingham. 64 pp.

Vose, J.M., C.F. Miniat, C.H. Luce, H. Asbjornsen, P.V. Caldwell, J.L. Campbell, G.E. Grant, D.J. Isaak, S.P. Loheide, and G. Sun. 2016b. Ecohydrological implications of drought for forests in the United States. Forest Ecology and Management 380:335-345.

Walters, C., and J. Korman. 1999. Linking recruitment to trophic factors: revisiting the Beverton-Holt recruitment model from a life history and multispecies perspective. Reviews in Fish Biology and Fisheries 9:187–202.

Warner, K., and P.R. Johnson. 1978. Mortality of landlocked salmon (*Salmo salar*) hooked on flies and worms in a river nursery area. Transactions of the American Fisheries Society 107(6):772-775.

Waters, T. F. 1995. Sediment in streams: sources, biological effects, and control. American Fisheries Society, Bethesda, Maryland, USA.

Watson, G., and T.W. Hillman. 1997. Factors affecting the distribution and abundance of bull trout: an investigation at hierarchical scales. North American Journal of Fisheries Management 17(2):237-252.

WDFW (Washington Department of Fish and Wildlife), FishPro Inc., and Beak Consultants. 1997. Grandy Creek trout hatchery biological assessment. Washington Department of Fish and Wildlife, Olympia, WA, March 1997. 47 pp.

WDFW and USFS. 2012. Memorandum of Understanding between WDFW and USDA Forest Service, Pacific Northwest Region, Regarding Hydraulic Projects Conducted by USDA Forest Service, Pacific Northwest Region. Forest Service Agreement Number: NFS 12-MU-11062754-005.

WDOE. 2002. Evaluating criteria for the protection of freshwater aquatic life in Washington's surface water quality standards - dissolved oxygen: Draft discussion paper and literature summary. Washington Department of Ecology, Publication Number 00-10-071, Olympia, WA, December 2002. 90 pp.

WDOE. 2007. Summary of stream gauge temperature data from long term monitoring stations. Washington Department of Ecology.

WDNR (Washington Department of Natural Resources). 2005. Forest Practices Habitat Conservation Plan – Final. Washington Dept. of Natural Resources, Olympia, WA. http://www.dnr.wa.gov/htdocs/agency/federalassurances/final_fphcp/index.html

Wenger, S., D. Isaak, C. Luce, H. Neville, K. Fausch, J. Dunham, D. Dauwalter, M. Young, M. Elsner, B. Rieman, A. Hamlet, and J. Williams. 2011. Flow regime, temperature, and biotic interactions drive differential declines of trout species under climate change. PNAS 108(34):14175.

Weaver, T., and J. Fraley. 1991. Fisheries habitat and fish populations. Flathead basin forest practices, water quality and fisheries cooperative program. Kalispell, MT: Flathead Basin Commission. 47 p.

Werner, E. E., and J. F. Gilliam. 1984. The ontogenetic niche and species interactions in size-structured populations. Annual Review of Ecology and Systematics 15:393–425.

Wigmosta MS, Perkins WA. 2001. Simulating the effects of forest roads on watershed hydrology. In *Land Use and Watersheds: Human Influence on Hydrology and Geomorphology in Urban and Forest Areas*, Wigmosta MS, Burges SJ (eds). Water and Science Application, Volume 2. American Geophysical Union: Washington, DC; 127–143.

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.

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.

Wohl, E., K. B. Lininger, and J. Baron. 2017. Land before water: the relative temporal sequence of human alteration of freshwater ecosystems in the conterminous United States. Anthropocene 18:27–46.

WSCC (Washington State Conservation Commission). 2000a. Salmon and steelhead habitat limiting factors. Water resources inventory area 18: Dungeness/Elwha watershed.

WSCC. 2001. Salmon and steelhead habitat limiting factors. Watershed resources inventory area 21: Queets/Quinault watershed.

WWF (World Wildlife Fund). 2003. Buying time: A user's manual for building resistance and resilience to climate change in natural systems. World Wildlife Fund, Berlin, Germany, 246 pp.

WWPI (Western Wood Preservers Institute). 2012. Best Management Practices for the use of treated wood in aquatic and other sensitive environments. Revised November 1, 2011. Western Wood Preservers Institute, Vancouver, WA. www.wwpinstitute.org

Young, S. 2001. Char sample survey. Washington Department of Fish and Wildlife, Olympia, WA.

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