UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
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April 19, 2019

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NMFS Tracking Number: WCRO-2018-00033

Michelle Capp
District Ranger
Cle Elum Ranger District
Okanogan–Wenatchee National Forest
803 West 2nd Street
Cle Elum, WA 98922

Re: Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson–Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for the Swauk Pine Restoration Project.

Dear Ms. Capp:

Thank you for your letter dated December 17, 2018, requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (U.S.C 1531 et seq.) for the Swauk Pine Restoration Project (Project). In this opinion, NMFS concluded that the proposed action is not likely to jeopardize the continued existence of ESA-listed Middle Columbia River steelhead (*Oncorhynchus mykiss*), or result in the destruction or adverse modification of their critical habitat.

As required by Section 7 of the ESA, NMFS provided an incidental take statement (ITS) with the opinion. The ITS describes reasonable and prudent measures (RPMs) NMFS considers necessary or appropriate to minimize incidental take associated with these actions. The take statement sets forth nondiscretionary terms and conditions, including reporting requirements that the federal agency and any person who performs the action must comply with to carry out the RPMs. Incidental take from actions that meet these terms and conditions will be exempt from the ESA take prohibition.

We also evaluated potential impacts of the action on essential fish habitat (EFH) in accordance with section 305(b)(2) of the Magnuson–Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801 et seq.) and implementing regulation at 50 CFR 600. We concluded that the proposed action would adversely affect Pacific Coast salmon EFH; therefore, the enclosed document also includes our conservation recommendations to address those adverse effects.

Please contact Justin Yeager of the Columbia Basin Branch at (509) 962-8911 x805 or electronic mail at justin.yeager@noaa.gov with any questions or comments concerning this section 7 consultation.

Sincerely,

Michael P. Tehan
Assistant Regional Administrator
Interior Columbia Basin Office
NOAA Fisheries, West Coast Region

Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson–Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation

Swauk Pine Restoration Project

NMFS Consultation Number: WCRO-2018-00033

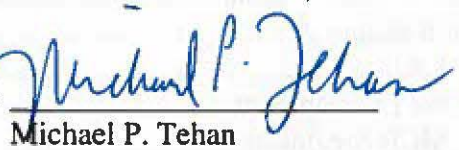
Action Agency: U.S. Forest Service, Okanogan–Wenatchee National Forest

Affected Species and Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species or Critical Habitat?	Is Action Likely To Jeopardize the Species?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Middle Columbia River steelhead	Threatened	Yes	No	No

Fishery Management Plan That Describes EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast salmon	Yes	Yes

Consultation Conducted By: National Marine Fisheries Service, West Coast Region

Issued By: 

Michael P. Tehan
Assistant Regional Administrator

Date: April 19, 2019

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ACRONYM GLOSSARY

4WD	Four-wheel driving
BA	Biological Assessment
BMP	Best Management Practices
CFR	Code of Federal Regulations
dbh	Diameter at breast height
DPS	Distinct Population Segment
DQA	Data Quality Act
EFH	Essential Fish Habitat
EPA	Environmental Protection Agency
ESA	Endangered Species Act
The Forest	Okanogan–Wenatchee National Forest
FR	Federal Register
FSR	Forest System Road
HUC	Hydrologic Unit Code
ICTRT	Interior Columbia Basin Technical Recovery Team
IDT	Interdisciplinary Team
IRA	Inventoried Road Area
ISAB	Independent Scientific Advisory Board
ITS	Incidental Take Statement
MCR	Middle Columbia River
ML	Maintenance Level
MPG	Major Population Group
MSA	Magnuson–Stevens Fishery Conservation and Management Act
NMFS	National Marine Fisheries Service
Opinion	Biological Opinion
PBF	Physical and Biological Feature
PCE	Primary Constituent Element
Project	Swauk Pine Restoration Project
PWA	Potential Wilderness Area
Reclamation	Bureau of Reclamation
RM	River Mile
RPM	Reasonable and Prudent Measure
U.S.C.	United States Code
WUI	Wildland Urban Interface

1.0 INTRODUCTION

This Introduction section provides information relevant to the other sections of this document and is incorporated by reference into Sections 2 and 3 below.

1.1 Background

The National Marine Fisheries Service (NMFS) prepared the biological opinion (opinion) and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) (16 U.S.C. 1531 et seq.), and its implementing regulations at 50 CFR 402.

We also completed an essential fish habitat (EFH) consultation on the proposed action, in accordance with section 305(b)(2) of the Magnuson–Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801 et seq.) and implementing regulations at 50 CFR 600.

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). A complete record of this consultation is on file at the Columbia Basin Branch field office in Ellensburg, Washington.

1.2 Consultation History

The following chronology documents key points of the consultation process that culminated in this opinion for NMFS' listed species:

1) On January 26, 2017, a meeting was held at the Cle Elum Ranger District to describe the proposed action and identify "themes" that warranted further analysis.
2) On February 21, 2017, NMFS provided the U.S. Forest Service (Forest Service) written comments.
3) On October 9, 2018, NMFS attended a field visit to review timber sale prescriptions.
4) On December 19, 2018, NMFS received a biological assessment (BA), with the Forest Service requesting a consultation initiation date of February 7, 2019.
5) On December 22, 2018 through January 25, 2019, the U.S. government shut down due to lack of appropriations.
6) On January 28, 2019, the shutdown ended, NMFS employees resumed work, and we began consultation on that date.

1.3 Proposed Action

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by federal agencies (50 CFR 402.02). For purposes of this consultation, the proposed action proposes to improve terrestrial resilience to disturbances (including wildfires) and to improve function of aquatic ecosystems degraded by past human activities. The project area (6,484 acres) is located on National Forest lands in the Upper Swauk Creek sixth-field

watershed Hydrologic Unit Code (HUC6, 170300010501; 39,175 acres). Actions will take place in the Williams Creek, Lion Gulch, and Cougar Gulch Creek watersheds. National Forest lands comprise 95 percent of the project area (6,191 out of 6,484 acres). Remaining acreage is private land, and will not be treated. All Forest Service land is in the Swauk Late-Successional Reserve. Riparian reserves comprise 19 percent of project area (1,258 out of 6,484 acres).

The proposed action includes vegetation treatments (commercial thinning and a variety of non-commercial treatments), and changes to the transportation system (road and trail). The BA identified a number of aquatic restoration actions that are planned within the project area that were deemed by the Forest Service to be independent, not interrelated or interdependent of the vegetation treatment work within the Swauk Pine Restoration Project (Project). These aquatic restoration projects are unfunded and there is uncertainty as to when they will be completed. When funding is available to implement those projects, the Forest Service will conduct them according to the Aquatic Restoration Biological Opinion (NWR-2013-9664). The non-aquatic restoration actions are included in this opinion and will be discussed in detail below. They include commercial thinning, non-commercial treatments, fuels treatments, and transportation system use and modifications (see Figure 1).

1.3.1 Commercial Thinning and Treatment of Activity Fuels

Commercial thinning is proposed in dry and mesic stands comprising about 21 percent of the project area. A variable density thinning from below will be implemented, with retention of individual trees, clumps of trees, and openings. The emphasis will be on removing mostly smaller-diameter trees, while retaining all old trees and the majority of large trees, snags, and down wood. Logging may occur in winter or summer; however, there are required conditions to operate in either season. The commercial portion of the proposed action is expected to be completed within the first 5 years, but may take up to 10 years to complete.

The logging systems for commercial thinning consist of 1,083 acres of skyline logging and 170 acres of ground-based logging (1,253 total acres). Of the total acreage, 62.5 acres of commercial thinning will occur in riparian reserves. There will be 290 landings, with 10 landings located in riparian reserves. In most skyline areas, cut trees will be yarded uphill, with tops attached, to landings. Skyline corridors and landings will be located after all trees in the unit have been felled, in order to take advantage of natural and created openings for corridors.

Activity fuel refers to the material generated by logging, which can greatly increase fire risk. To reduce this risk and create a more fire-adapted forest, activity fuels in all commercial thinning units will be treated by underburning. Some areas may require pre-treatment to protect residual trees during the underburn. Pretreatments may include firewood removal from existing road prisms or landings for up to two seasons. Burns may be conducted in spring or fall, depending on stand conditions. Fall burning is the season of choice to protect large old trees, because fine roots no longer extend into dry surface duff. For spring burning, additional measures may be considered for protection of large trees, such as pulling fuels back, pre-treating tree wells surrounded by snow, and adjusting tactics. Helicopters may be used for ignition of burns.

Maintenance burns are planned 8 to 10 years after the initial underburn. In activity fuels units, depending on when areas are treated, maintenance burns could occur up to 15 years after the initial underburn is completed. Maintenance burns will be implemented in all commercially thinned stands with a desired future condition of Old Forest Single Story.

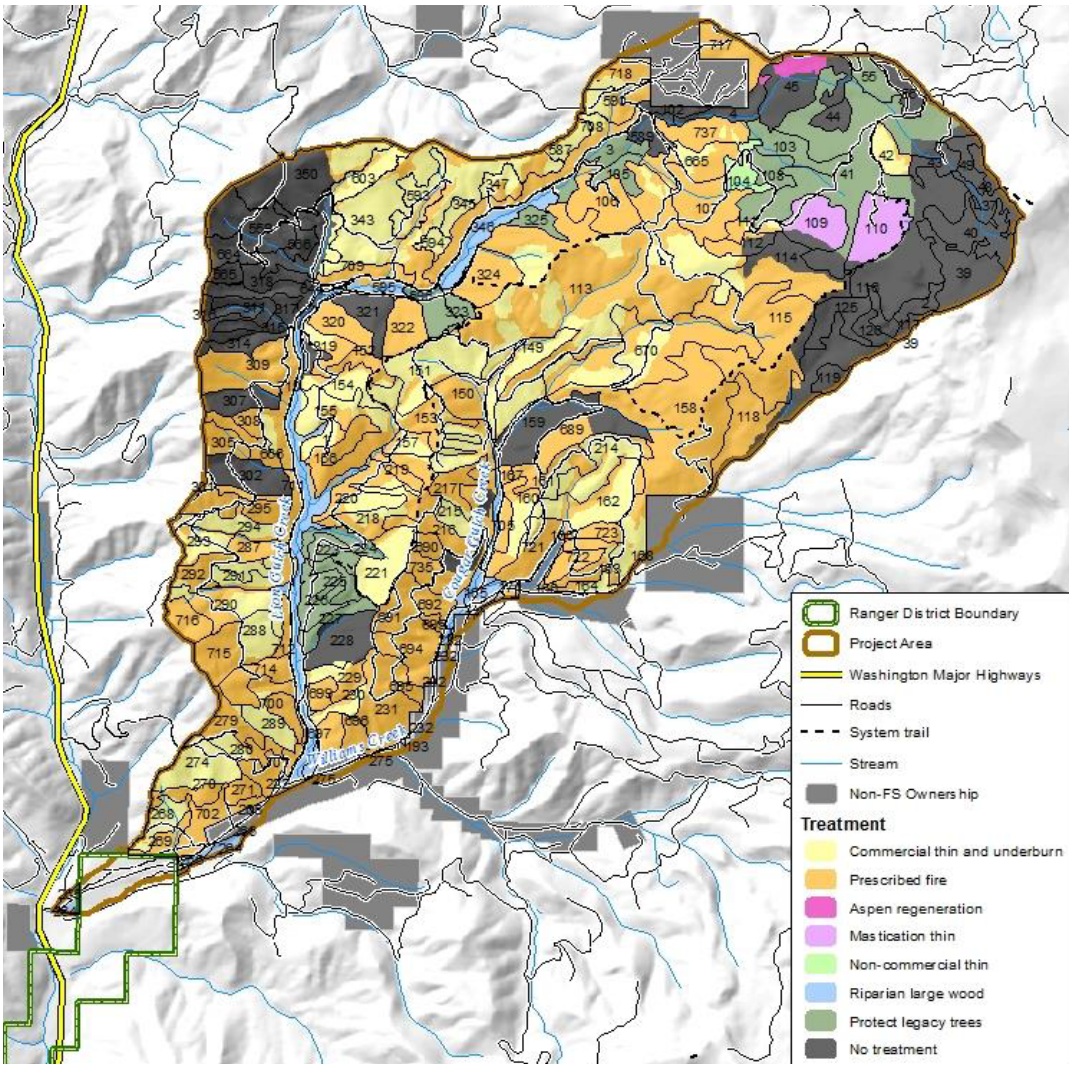

Figure 1. Proposed Vegetation Treatments

1.3.2 Non-Commercial Treatments

An assortment of non-commercial treatments will be implemented across the project area, including aspen regeneration, small tree thinning, legacy tree protection, and tree planting. These treatments have different objectives depending on the treatments, which are detailed below and spatially in Figure 1, above.

Aspen Regeneration (18 acres)

Treatment will entail thinning conifers up to 10 inches diameter at breast height (dbh) within two tree heights from declining aspen trees (to create a fuel bed), and/or concentrating material around declining aspen to ensure a high-intensity burn that will stimulate suckering from roots. If after treatment, fire fails to kill enough co-dominant conifers in the stand, residual conifers may be felled or girdled to maintain no more than 20 percent crown closure around regenerating aspen. All tree felling will be done using chainsaws. Felled trees may function as natural fencing to protect aspen sprouts. After burning, fences may be built to exclude elk, deer, and sheep from the regenerating stand. Fencing will be maintained for at least 10 years.

Small Diameter Thinning with a Masticator (90 acres)

The desired future condition for these stands is Old Forest Multi-Story. These units are old harvest areas that were regenerated with ponderosa pine, where a mix of Douglas fir and true firs would have been more appropriate. The planted pine trees are performing poorly. Trees are too small to have commercial value and too large for traditional hand thinning and piling. They will be thinned with ground-based mastication machinery, to a density range of 45–80 trees per acre. The treatment will restore more natural cover types of Douglas fir and western larch. After mastication, no other fuel treatment is proposed in these units.

Non-commercial Thin (21 acres)

Small trees will be cut with chainsaws, then hand-piled and burned. Objectives are to support crown expansion and accelerate growth of residual trees and shift species composition to Douglas fir and western larch. Approximately 50–70 trees per acre will be retained, including some clumps of two to six trees. Thinned trees will be up to 10 inches dbh. Existing logs and snags will be retained wherever possible. The stand will not be underburned.

Legacy Tree Protection (509 acres)

Target areas are moist mixed conifer stands where conditions are at or near the desired future condition (dense old forest with multiple layers of trees). Planned treatment is designed to protect legacy trees from wildfire by re-arranging fuels. No more than two legacy trees per acre will be selected for treatment. All trees less than 9 inches dbh within 30 feet of the largest legacy trees (and a smaller radius for smaller trees) will be felled and hand-piled or pulled back and lopped and scattered. In addition, downed wood within 15 feet of legacy trees will be bucked and pulled back from legacy trees to reduce fire residence time. Most piles will be burned, but piles on steeper slopes with heavier fuels may be left unburned. All work will be done by hand and lit during typical fall pile burning weather conditions. No measureable change in overstory canopy is expected, because the only trees felled will be from suppressed tree strata, and these trees are generally all overtopped by larger trees.

Tree Planting

In four ponderosa pine plantations (stands 320, 322, 324, and 106) that are proposed to be underburned, a mix of native trees would be planted (40 to 60 trees per acre) in newly created openings.

1.3.3 Fuels Treatments

Thinning with Fire: Natural Fuels Underburning (2,795 acres)

Burns will be designed for low to mixed severity, with expected mortality of trees at no more than 5 to 10 trees per acre with some group mortality. Mortality in the overstory may result in new openings up to ¼ acre in size. All fire-killed trees will be retained as snags unless they pose a hazard. Burns will also be designed to prevent high severity fire in riparian areas. Pre-treatment may be necessary to limit fire intensity, and may include cutting small trees (less than 8 inches dbh) and limbing lower branches. Conditions for ignition and ignition strategy will be the principle means of limiting fire intensity in riparian reserves.

Thinning will be accomplished with natural fuels underburning in stands that are operationally difficult to reach, or on dry sites dominated by ponderosa pine and bitterbrush (45 percent of project area). Target areas include 436 acres in the Lion Rock Potential Wilderness Area (PWA) and 29 acres in the Lion Rock Inventoried Road Area (IRA).

Maintenance Burning

Maintenance burns are planned in those stands with a desired future condition of Old Forest Single Story. No maintenance burning will occur in areas where the desired future condition is dense, multi-layered old forest. One maintenance burn is planned 10 to 15 years after the final activity fuels burn.

1.3.4 Transportation System Changes

The majority of roads within the project area have existed for more than 60 years. Portions of the road system date back to mining and logging that began after gold was discovered in Swauk Creek in 1873. The project area includes 70.5 miles of road. Of these, 7.2 miles are non-system roads under various private and public jurisdictions that include federal, county, and private entities. There are approximately 10.7 miles of mapped unauthorized roads, including some roads that may be used for mining access. Another 1.9 miles are roads that also share use with trail users (dual use road/trail).

Haul Routes

Commercial haul activities and other vegetative treatments proposed will result in the use of approximately 48 miles of system roads under Forest Service jurisdiction. During the course of treatment activities, approximately 3 miles of roads currently closed and in custodial status as Maintenance Level (ML) 1 roads will be opened and used for log haul. This will result in

increased open-road densities for the duration of the proposed action. The majority of maintenance/reconstruction work will be performed on 24 miles of ML1 and ML2 roads used for commercial haul activities, in particular blading, drainage, and brushing. All or part of haul routes may be treated with lignosulfonate or water for dust abatement, with the most likely areas to be treated located around the town of Liberty. After haul is completed about 1 mile of road will be decommissioned.

Temporary Roads

Implementation of the Project will require construction of temporary roads totaling about nine miles (approximately 23 acres of road bed) to support thinning operations. Eight segments of temporary road (totaling 2.6 miles) are located in sensitive areas and will require engineering evaluation and design.

Temporary roads are not intended for mixed vehicle use (not open to the public), nor are they intended to remain as identifiable facilities after the administrative need for their use has ended. At the completion of harvest and post-harvest activities (treatment of activity fuels, underburning, and firewood removal), all temporary roads will be barricaded to eliminate motor vehicle access, and will be decompacted and/or recontoured as part of post-harvest soil remediation activities to facilitate their return to vegetative productivity. Temporary roads will be seeded unless the adjacent plant community will provide a sufficient seed source for vegetative recovery. If temporary roads are left open for a winter season, they will be closed to public access and best management practices (BMPs) for erosion control will be used.

1.3.5 Timeline and Project Design Criteria.

The Forest Service expects to start some treatments in the second half of 2019. With most transportation and vegetation treatments being implemented within the first 5 years, and all of the thinning and road treatments completed within the first 10 years. The Forest Service expects to complete maintenance burns 10–15 years after the initial underburn (see Table 1).

Table 1. Swauk Pine Restoration Project implementation timeline.

Treatment	Implementation Year										
	1	2	3	4	5	6	7	8	9	10	20-30
Road Maintenance / Reconstruction											
Opening ML1 Roads											
New Temporary Roads											
Commercial Thinning / Log Haul											
Prescribed Fire											
Non-Commercial Thinning											
Definite treatment years											
Range when treatments are likely to occur											

The Project BA includes a list of 42 design criteria and minimization measures of which a subset are aimed at reducing project effects on ESA-listed fish and their designated critical habitat. These include design criteria and minimization measures intended to protect soils and minimize the impacts from road use and timber harvest.

1.3.6 Interrelated and Interdependent Activities

"Interrelated actions" are those that are part of a larger action and depend on the larger action for their justification. "Interdependent actions" are those that have no independent utility apart from the action under consideration (50 CFR 402.02). There are no interdependent or interrelated activities associated with the proposed action.

2.0 ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, federal agencies must ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, federal action agencies consult with NMFS and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provides an opinion stating how the agency's actions would affect listed species and their critical habitat. If incidental take is expected, section 7(b)(4) requires NMFS to provide an ITS that specifies the impact of any incidental taking and includes non-discretionary RPMs and terms and conditions to minimize such impacts.

2.1 Analytical Approach

This opinion includes both a jeopardy analysis and an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "to jeopardize the continued existence of a listed species," which is "to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

This opinion relies on the definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical and biological features (PBFs) essential to the conservation of a species or that preclude or significantly delay development of such features" (81 FR 7214).

The designation of critical habitat for Middle Columbia River (MCR) steelhead uses the term primary constituent element (PCE) or essential features. The new critical habitat regulations (81 FR 7414) replace this term with PBF. The shift in terminology does not change the approach used in conducting a "destruction or adverse modification" analysis, which is the same regardless

of whether the original designation identified PCEs, PBFs, or essential features. In this opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

We use the following approach to determine whether a proposed action is likely to jeopardize listed species, or destroy or adversely modify critical habitat:

1. Identify the range-wide status of the species and critical habitat expected to be adversely affected by the proposed action.
2. Describe the environmental baseline in the action area.
3. Analyze the effects of the proposed action on both species and their habitat using an "exposure-response-risk" approach.
4. Describe any cumulative effects in the action area.
5. Integrate and synthesize the above factors by: (1) reviewing the status of the species and critical habitat; and (2) adding the effects of the action, the environmental baseline, and cumulative effects to assess the risk that the proposed action poses to species and critical habitat.
6. Reach a conclusion about whether species are jeopardized or critical habitat is adversely modified.
7. If necessary, suggest a reasonable and prudent alternative to the proposed action.

2.2 Range-wide Status of the Species and Critical Habitat

This opinion examines the status of each species that would be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02. The opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the current function of the essential PBFs that help to form that conservation value.

2.2.1 Status of the Species

For Pacific salmon, steelhead, and other relevant species, NMFS commonly uses four parameters to assess the viability of the populations that, together, constitute the species: spatial structure, diversity, abundance, and productivity (McElhany et al. 2000). These "viable salmonid population" criteria therefore encompass the species' "reproduction, numbers, or distribution" as described in 50 CFR 402.02. When these parameters are collectively at appropriate levels, they maintain a population's capacity to adapt to various environmental conditions and allow it to sustain itself in the natural environment. These attributes are influenced by survival, behavior, and experiences throughout a species' entire life cycle, and these characteristics, in turn, are influenced by habitat and other environmental conditions.

"Spatial structure" refers both to the spatial distributions of individuals in the population and the processes that generate that distribution. A population's spatial structure depends fundamentally on habitat quality and spatial configuration and the dynamics and dispersal characteristics of individuals in the population.

"Diversity" refers to the distribution of traits within and among populations. These range in scale from DNA sequence variation at single genes to complex life history traits (McElhany et al. 2000).

"Abundance" generally refers to the number of naturally-produced adults (i.e., the progeny of naturally-spawning parents) in the natural environment (e.g., on spawning grounds).

"Productivity," as applied to viability factors, refers to the entire life cycle; i.e., the number of naturally-spawning adults produced per parent. When progeny replace or exceed the number of parents, a population is stable or increasing. When progeny fail to replace the number of parents, the population is declining. McElhany et al. (2000) use the terms "population growth rate" and "productivity" interchangeably when referring to production over the entire life cycle. They also refer to "trend in abundance," which is the manifestation of long-term population growth rate. For species with multiple populations, once the biological status of a species' populations has been determined, NMFS assesses the status of the entire species using criteria for groups of populations, as described in recovery plans and guidance documents from technical recovery teams. Considerations for species viability include having multiple populations that are viable, ensuring that populations with unique life histories and phenotypes are viable, and that some viable populations are both widespread to avoid concurrent extinctions from mass catastrophes and spatially close to allow functioning as metapopulations (McElhany et al. 2000).

The summary that follows describe the status of the ESA-listed species and their designated critical habitats that are considered in this opinion. More detailed information on the status and trends of these listed resources, and their biology and ecology, are in the listing regulations and critical habitat designations published in the Federal Register (FR) (Table 2) and in the most recent 5-year status review (National Marine Fisheries Service 2016), as well as applicable recovery plans and 5-year status reports. These additional documents are incorporated by reference.

Table 2. Listing status, status of critical habitat designations and protective regulations, and relevant Federal Register (FR) decision notices for ESA-listed species considered in this consultation. Listing status: 'T' means listed as threatened; 'E' means listed as endangered.

Species	Listing Status	Critical Habitat	Protective Regulations
Steelhead (*O. mykiss*)			
Middle Columbia River	T 1/05/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160

Middle Columbia River Steelhead

The MCR steelhead Distinct Population Segment (DPS) was listed as threatened on March 25, 1999 (64 FR 14517), and its threatened status was reaffirmed on June 28, 2005 (70 FR 37160). The threatened status once again affirmed during 5-year status reviews on August 15, 2011 (76 FR 50448), and again on May 26, 2016 (81 FR 33468). The DPS is comprised of 17 independent populations within four Major Population Groups (MPGs) in Washington and Oregon. This DPS includes all naturally-spawned populations of steelhead (and their progeny) in streams from above the Wind River, Washington, and the Hood River, Oregon (exclusive), upstream to, and including, the Yakima River, Washington, excluding steelhead from the Snake River Basin. Seven artificial propagation programs are considered part of the DPS: the Touchet River Endemic, Yakima River Kelt Reconditioning Program (in Satus Creek, Toppenish Creek, Naches River, and Upper Yakima River), Umatilla River, and the Deschutes River steelhead hatchery programs.

The life history characteristics for MCR steelhead are similar to those of other inland steelhead DPSs. Most fish smolt at 2 years and spend 1 to 2 years in salt water before re-entering freshwater, where they may remain up to a year before spawning (Howell et al. 1985). All steelhead upstream of The Dalles Dam are summer-run (Reisenbichler et al. 1992) fish that enter the Columbia River from June to August. Adult steelhead ascend mainstem rivers and their tributaries throughout the winter, spawning in the late winter and early spring. Fry emergence typically occurs between May and the end of June.

The proposed project occurs in the Swauk subwatershed, which is a small portion of the Upper Yakima River population of the Yakima MPG. For the rest of the species status section we will focus on the Yakima MPG.

Abundance. Abundance estimates have been recently made for 16 of the 17 extant MCR steelhead populations. Seven of the 16 populations are currently above the average abundance thresholds that the Interior Columbia Basin Technical Recovery Team (ICTRT) identifies as a minimum for low risk. The remaining nine populations are at moderate or high risk of extinction due to low abundance.

The latest Northwest Fisheries Science Center status review (Northwest Fisheries Science Center 2015) characterized two MCR steelhead populations as being at high risk of extinction in terms of abundance. None of those high-risk populations are in the Yakima MPG. However, the Naches River and Upper Yakima River populations are rated at moderate risk. The remaining populations in the Yakima MPG are at low risk of extinction in terms of abundance. Due to relatively high returns for most years since 2001, abundance of Satus Creek and Toppenish Creek populations are greater than the minimum abundance thresholds (Table 3). Upper Yakima and Naches River returns have also improved in recent years (Northwest Fisheries Science Center 2015), though they are still well below minimum abundance thresholds.

Productivity. Based on 20 full brood-year returns of MCR steelhead, most populations have replaced themselves, and a few have not, when only natural production is considered. Relative

population status varies widely across the DPS. Based on a 2007 analysis, productivity is insufficient to meet recovery needs (Interior Columbia Basin Technical Recovery Team 2007a) for most populations. Estimates of required productivity increases required to reach a low risk of extinction depend on assumptions regarding future hydropower operations and ocean conditions.

Table 3. Summary of the MCR steelhead Yakima River Group status and Interior Columbia Basin Technical Recovery Team viability criteria.

	Abundance and Productivity Metrics				Spatial Structure and Diversity Metrics			Rating
Population	Minimum Abundance Target	Natural Spawning Abundance 2005–2014	Productivity (returns-per-spawner) 2005–2014	Integrated Abundance/ Productivity Risk	Natural Process Risk	Diversity Risk	Integrated Spatial Structure/ Diversity Risk	Overall Viability Rating
Naches	1,500	1,244	1.83	Moderate	Low	Moderate	Moderate	Moderate
Satus	1,000	1,127	1.93	Low	Low	Moderate	Moderate	Viable
Toppenish	500	516	2.52	Low	Low	Moderate	Moderate	Viable
Upper Yakima	1,500	246	1.87	Moderate	Moderate	High	High	High Risk

Spatial structure. The ICTRT characterizes the spatial structure risk to MCR steelhead populations as "very low" to "moderate" for all populations, except the Upper Yakima population, which is rated "high." The Naches population has "low" spatial structure risk because seven of the eight historical major spawning areas are occupied. The only unoccupied major spawning area is the upper Tieton River which is currently blocked by Rimrock Dam (Interior Columbia Basin Technical Recovery Team 2005). The distribution across spawning areas of the Upper Yakima population continues to be substantially reduced from historical levels with only 11 of the 14 major spawning areas occupied. Impassable storage dams block Cle Elum and Kachess rivers and the uppermost reach of the Yakima River.

Diversity. The ICTRT (ICTRT 2007b) identified 20 existing populations in four major population groups as described previously. The Yakima River MPG consists of the Satus Creek, Toppenish, Naches, and Upper Yakima populations.

The ICTRT characterizes the Naches population and Upper Yakima populations as having moderate- and high-diversity risk, respectively, mainly because of how the Bureau of Reclamation (Reclamation) manages flows from their storage reservoirs. Both populations have a reduced out-migration window and a shift in the adult in-migration timing, both due to elevated temperatures in the lower river and flow modifications in the early migration season (Interior Columbia Basin Technical Recovery Team 2005). In addition, The Upper Yakima population risk is elevated by flow management that affects rearing conditions in the mainstem Yakima River and passage issues at and below Roza Dam.

Limiting factors. The most significant factors limiting productivity of the MCR steelhead DPS include: (1) mainstem Columbia River hydropower adverse effects (i.e., modified hydrograph, increase in lentic conditions/decrease in riverine conditions—passage barriers, stream temperature, dissolved oxygen problems, and invasive species); (2) riparian degradation and

large wood recruitment; (3) altered floodplain connectivity and function; (4) reduced streamflow; (5) water quality; and (6) predation and competition (National Marine Fisheries Service 2011a).

Recovery plan. In 2009, NMFS adopted a recovery plan for MCR steelhead that was developed by multiple organizations in both Washington and Oregon. Most important for this consultation is the Yakima Steelhead Recovery Plan that is part of the larger recovery plan. This plan outlined specific recovery actions that are intended to reduce threats associated with land and water management activities in the Yakima Basin. Actions specifically called out in this plan include maintaining, upgrading, relocating, or decommissioning forest roads, reducing dispersed recreation impacts, restoring riparian habitat, and relocating campsites, to name a few.

Summary. The MCR steelhead DPS is not currently meeting the viability criteria described in the Mid-Columbia Steelhead Recovery Plan (National Marine Fisheries Service 2009). To achieve viable status for the Yakima MPG, two populations should be rated as viable, including at least one of the two classified as large—the Naches River or the Upper Yakima River—neither of which currently meets viable status. The other two populations out of the four in the Yakima should be rated as maintained.

2.2.2 Status of Critical Habitat

This section examines the status of designated critical habitat affected by the proposed action by examining the condition and trends of PBFs throughout the designated areas. These features are essential to the conservation of the listed species because they support one or more of the species' life stages (e.g., sites with conditions that support spawning, rearing, migration, and foraging).

For salmon and steelhead, NMFS ranked watersheds within designated critical habitat at the scale of the HUC5 in terms of the conservation value they provide to the listed species they support. The conservation rankings are high, medium, or low. To determine the conservation value of each watershed to species viability, NMFS' critical habitat analytical review teams evaluated:

- The quantity and quality of habitat features (e.g., spawning gravels, wood and water condition, side channels).
- The relationship of the area compared to other areas within the species' range.
- The significance of the population occupying that area to the species' viability criteria.

Thus, even a location that has poor quality habitat could be ranked as a high conservation value, if it were essential due to factors such as limited availability (e.g., one of a very few spawning areas), a unique contribution of the population it served (e.g., a population at the extreme end of geographic distribution), or the fact that it serves another important role (e.g., obligate area for migration to upstream spawning areas).

The following table describes the PBFs of the habitat types within the full range of habitat designated as critical for the listed salmonid species. Range-wide, all habitat types are impaired to some degree, even though many of the watersheds comprising the fully designated area are

ranked as providing high conservation value. The proposed action, however, affects only freshwater habitats.

Table 4. Physical and biological features of critical habitats designated for ESA-listed salmon and steelhead species considered in this opinion.

Physical and Biological Features		Species Life History Event
Site Type	**Site Attribute**	
Freshwater spawning	Substrate Water quality Water quantity	Adult spawning Embryo incubation Alevin growth and development
Freshwater rearing	Floodplain connectivity Forage Natural cover Water quality Water quantity	Fry emergence from gravel Fry/parr/smolt growth and development
Freshwater migration	Free of artificial obstruction Natural cover Water quality Water quantity	Adult sexual maturation Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration
Estuarine areas	Forage Free of artificial obstruction Natural cover Salinity Water quality Water quantity	Adult sexual maturation and "reverse smoltification" Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration
Nearshore marine areas	Forage Free of artificial obstruction Natural cover Water quantity Water quality	Adult growth and sexual maturation Adult spawning migration Nearshore juvenile rearing
Offshore marine areas	Forage Water quality	Adult growth and sexual maturation Adult spawning migration Subadult rearing

The PBFs of freshwater spawning and incubation sites include water flow, quality and temperature conditions and suitable substrate for spawning and incubation, as well as migratory access for adults and juveniles (Table 4). These features are essential to conservation because without them the species cannot successfully spawn and produce offspring.

The PBFs of freshwater migration corridors associated with spawning and incubation sites include water flow, quality and temperature conditions supporting larval and adult mobility, abundant prey items supporting larval feeding after yolk sac depletion, and free passage (no obstructions) for adults and juveniles. These features are essential to conservation because they allow adult fish to swim upstream to reach spawning areas and they allow larval fish to proceed downstream and reach the ocean.

Interior Columbia Recovery Domain

Habitat quality in tributary streams in the Interior Columbia Recovery Domain range from excellent in wilderness and roadless areas to poor in areas subject to heavy agricultural and urban

development (National Marine Fisheries Service 2009; Wissmar et al. 1994). Critical habitat throughout much of the Interior Columbia Recovery Domain has been degraded by intense agriculture, alteration of stream morphology (i.e., channel modifications and diking), riparian vegetation disturbance, wetland draining and conversion, livestock grazing, dredging, road construction and maintenance, logging, mining, and urbanization. Reduced summer stream flows, impaired water quality, and reduction of habitat complexity are common problems for critical habitat in developed areas.

Many stream reaches designated as critical habitat in the Interior Columbia Recovery Domain are over-allocated, with more allocated water rights than existing streamflow conditions can support. Withdrawal of water, particularly during low-flow periods that commonly overlap with agricultural withdrawals, often increase summer stream temperatures, block fish migration, strand fish, and alter sediment transport (Spence et al. 1996). Reduced tributary stream flow has been identified as a major limiting factor for MCR steelhead in this area (National Marine Fisheries Service 2007; National Marine Fisheries Service 2011b).

Despite these degraded habitat conditions, the HUCs that have been identified as critical habitat for this species are largely ranked as having high conservation value. Conservation value reflects several factors, including: (1) how important the area is for various life history stages, (2) how necessary the area is to access other vital areas of habitat, and (3) the relative importance of the populations the area supports relative to the overall viability of the DPS.

2.2.3 Climate Change

Climate change has negative implications for salmon, steelhead, and their designated critical habitat in the Pacific Northwest (Independent Scientific Advisory Board 2007; Northwest Fisheries Science Center 2015; Scheuerell and Williams 2005; Zabel et al. 2006). Average annual Northwest air temperatures have increased by approximately 1ºC since 1900, or about 50 percent more than the global average over the same period (Independent Scientific Advisory Board 2007). The latest climate models project a warming of 0.1ºC to 0.6ºC per decade over the next century.

Climate change affects salmon, steelhead, and their habitat throughout the Interior Columbia Basin. Several studies have demonstrated that climate change has the potential to affect ecosystems in nearly all tributaries throughout the region (Battin et al. 2007; Independent Scientific Advisory Board 2007). While the intensity of effects will vary by region (Independent Scientific Advisory Board 2007), climate change is generally expected to alter aquatic habitat (water yield, peak flows, and stream temperature). As climate change alters the structure and distribution of rainfall, snowpack, and glaciations, each factor will in turn alter riverine hydrographs. Given the increasing certainty that climate change is occurring and is accelerating (Battin et al. 2007), NMFS anticipates salmonid habitats will be affected. Climate and hydrology models project significant reductions in both total snow pack and low-elevation snow pack in the Pacific Northwest over the next 50 years (Mote and Salathé 2009), changes that will shrink the extent of the snowmelt-dominated habitat available to salmon. Such changes may restrict our ability to conserve diverse salmon life histories.

The Independent Scientific Advisory Board (ISAB) identified a number of effects climate change would have on Columbia Basin salmon. A few of these include: (1) water temperature increases, and depletion of cold water habitat that could reduce the amount of suitable salmon habitat by about 22 percent by the year 2090 in Washington State; (2) variations in precipitation that may alter the seasonal hydrograph and modify shallow mainstem rearing habitat; and (3) earlier snowmelt and higher spring flows with warmer temperatures that may cause spring Chinook salmon and steelhead yearlings to smolt and emigrate to the ocean earlier in the spring (Crozier et al. 2010; Independent Scientific Advisory Board 2007; O'Neal 2002). In addition, climate impacts in one life stage generally affect body size of timing in the next life stage and can be negative across multiple life stages (Healey 2011; Wade et al. 2013; Wainwright and Weitkamp 2013).

Specifically on the Forest, a 2-day workshop was held to review options for adapting national forests in eastern Washington to climate change (Gaines et al. 2012). Some recommendations from this workshop included protecting cold-water areas, restoring beavers, restoring fish passage, and reducing the impacts of roads on riparian habitats, water quality, water quantity, and flow regimes.

In summary, climate change is expected to make recovery targets for these steelhead populations more difficult to achieve. However, habitat restoration actions can ameliorate the adverse impacts of climate change on steelhead. Examples include restoring connections to historical floodplains, and freshwater and estuarine habitats to provide fish refugia and areas to store excess floodwaters; protecting and restoring riparian vegetation to reduce stream temperature; retiring irrigation water diversions; and purchasing or applying easements to lands that provide important cold water or refuge habitat (Battin et al. 2007; Independent Scientific Advisory Board 2007).

2.3 Action Area

"Action area" means all areas affected directly or indirectly by the federal action and not merely the immediate area involved in the action (50 CFR 402.02). For this consultation, the action area includes all the Forest Service lands across approximately 6,500 acres or half of the entire Williams Creek drainage in the Upper Swauk Creek sixth-field HUC. Because MCR steelhead are mobile and some effects, as described below, carry downstream, the action area for analysis includes the entirety of Williams Creek and two of its tributaries (Lion Gulch and Cougar Gulch) including their headwaters.

The action area is used by MCR steelhead, and is designated as critical habitat (September 2, 2005; 70 FR 52630). The Swauk Creek major spawning area of the Upper Yakima River population of the Yakima MPG will be effected by proposed actions. This area supports rearing, migration, and spawning. The action area is also designated as EFH for Chinook salmon and coho salmon (Pacific Fishery Management Council 2014).

2.4 Environmental Baseline

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 (50 CFR 402.02).

The Swauk Pine planning area is 6,483 acres in size. It encompasses 234 acres of private land that will not be treated, and 6,242 acres of National Forest land. The planning area is bounded on the south and east by Williams Creek, on the north by the ridge between Lion Gulch Creek and Hurley Creek, and on the west by the ridge between Swauk Creek and Lion Gulch Creek. The Project comprises 2 percent of the Taneum Creek–Yakima River watershed (HUC5, 1703000105), and 16 percent of the Upper Swauk Creek subwatershed (HUC6, 170300010501). It encompasses all of the Lion Gulch and Cougar Gulch drainages and part of the Williams Creek drainage.

National Forest land that is within 1.5 miles of private land is characterized as Wildland Urban Interface (WUI) and is a priority area for treatment to reduce the risk of wildfire spread. Two communities, Liberty and the Liberty Mountain Home Area (unincorporated) are located within the planning area. The planning area also encompasses part of the Lion Rock IRA and part of the Lion Rock PWA.

The main Forest System roads (FSRs) within the project area include the Lion Gulch Road (FSR 9712000), and the Cougar Gulch Road (FSR 9718000). The paved county road to Liberty and FSR 9705000 (Durst Creek Road) provide the most direct means of access from Highway 97. Forest System roads in the planning area total 50 miles (40.5 miles open to public use). In addition, there are 9.8 miles of unauthorized road that are not maintained or needed by the Forest Service. Non-system roads (private, county, and Bureau of Land Management (BLM) roads, public rights-of-way, and non-system roads on National Forest with an authorized use) total 7.2 miles. When all roads are combined (67 miles), the total road density within the planning area is 7.3 miles per square mile.

There is year-round dispersed recreation, include camping, hiking, hunting, four-wheel driving (4WD), horseback riding, and snowmobiling. The area includes 6.4 miles of Forest System jeep trail and 1.9 miles of Forest System road that is dual use (both road and jeep trail). There are also 18 miles of groomed snowmobile trail (FSRs 9712000, 9718000, and 970500). There are no developed campgrounds, but dispersed camping occurs along many roads.

There is a long history of timber harvest, gold mining, and domestic livestock grazing within the planning area. The project area comprises 14 percent of the Swauk Sheep Grazing Allotment, and encompasses almost 20 percent of the approved grazing route. There are approximately 80 active mining claims and 10 active prospecting areas within (or accessed through) the project area.

Current Condition of Aquatic Systems

The watershed is in a highly degraded condition for aquatic resources (U.S. Forest Service 1997). The current condition of the aquatic ecosystem can be attributed to the effects of previous road construction, timber harvest, grazing, mining, dispersed recreation, and motorized trail construction and use.

Past activities have all contributed to landscape scale disturbance, including removal of large wood from streams and floodplains, and removal of large standing trees that could have recruited to streams and floodplains. Most streams in the project area are deficient in large wood in the context of Wenatchee Forest Plan standards (U.S. Forest Service 1990) and NMFS habitat indicators (National Marine Fisheries Service 1996). Thus, these streams are compromised with respect to maintenance of channel morphology and stability, habitat complexity, and floodplain and riparian connectivity. Tree removal has reduced stream shade and impaired water quality (water temperature). Swauk Creek, Williams Creek, Blue Creek, and Iron Creek are all listed by the Washington State Department of Ecology under section 303(d) of the Clean Water Act as impaired for water temperature. Floodplain and channel alterations have degraded conditions in stream channels, floodplains, and shallow aquifers. Several heavily-used dispersed campsites in the riparian reserve of Lion Gulch appear to be expanding every year, causing soil compaction, loss of ground cover, and loss of both understory and overstory vegetation within riparian reserves. Previous attempts to confine use at these sites have failed; users have removed boulders and expanded the footprint of disturbance. User-built trails extend from some sites, crossing streams to access closed roads and unauthorized trails and trails.

Compacted soils resulting from grazing, heavy equipment used for mining and logging, and off-road vehicle use can result in conditions that initiate overland flow. Water moving over the surface soil horizon instead of percolating into the soil profile can cause gully or rill erosion. Although typically rare in a forested environment, these conditions have been observed in Lion Gulch, Cougar Gulch, Williams Creek, Deer Gulch, Durst Creek, Medicine Creek, Hovey Creek, West Fork Iron Creek, and Pipe Creek. There are at least 55 miles of trails in the Swauk watershed. There are also an estimated 182 miles of skid trails, many of which have over time become non-system routes used by recreationists. The overall drainage network is 437 miles in length including intermittent and ephemeral streams. Twenty percent of the trails and skid trails are thought to be routing water to the existing stream network, representing a 10 percent increase in the drainage network. The Swauk Watershed Analysis highlights the fact that road management was listed as the single most important remedial action for improving hydrologic functions for fish and wildlife habitat in this watershed (U.S. Forest Service 1997).

Most pools in the project area lack complexity and adequate cover for fish. Historic and on-going management activities throughout the project area have and continue to reduce pool quality due to channel instability and erosive banks from road and stream interactions, suction dredging, livestock grazing, and lack of large wood. Numerous road-stream crossings increase sediment inputs and alter the routing of fine sediments through the system, often filling pool habitats.

A variety of management activities (livestock grazing, roads, mining, and timber harvest) exacerbate the naturally high background levels of fine sediment production and mobilization in the project area. These on-going disturbances limit the areas available for steelhead to spawn and reduce egg to fry survival. There are limited data for percent fines (greater than 0.033 inches) in the project area, but data from 2002 and 2003 indicate percent fine levels between 24 percent and 37 percent in Lion Gulch surveys. In Swauk Creek between the years of 2000 and 2007, percent fines ranged from 11 percent to 33 percent. Overall, in the Swauk Watershed percent fines are at relatively high levels.

The interdisciplinary team (IDT) identified multiple locations where roads and/or old railroad beds impinge upon floodplains (limiting channel migration, and/or intercepting and rerouting water in a manner that impedes shallow ground water storage in floodplains. The IDT also identified multiple sites where road design, culvert placement, and lack of maintenance is creating barriers to fish passage or affecting water quality by delivering sediment-laden water from road ditches and road surfaces directly to streams. This affects water quality, fish, and aquatic habitat diversity. It also increases the risk of slope failure, surface erosion, gullying, and landslides.

Many other problems were documented in the planning area. FSR 9712113 between Lion Gulch Creek and 4W 332 is exhibiting mass wasting. The road is currently under an emergency closure order, but recent unauthorized use culminated with motorized travel up the middle of the stream channel to a riparian meadow on the opposite side. Streambanks and riparian soils and vegetation were physically damaged by off-road travel in the channel and meadow, causing further erosion and damage to Lion Gulch Creek.

Unauthorized hill climbs are problematic near the junction of 4W 339 and 332, where at least 6 hill climbs totaling more than one mile and a segment of 4W 339 all converge to deliver snowmelt and stormwater runoff with sediment-laden water directly to the stream. Two new hill climbs developed during the planning effort for Swauk Pine. One jeep trail is steep and straight, has eroded down to bedrock, channeling water for hundreds of feet directly to an unnamed tributary to Lion Gulch Creek. Two parallel segments of 4W 339 between the ridge and riparian reserve of Lion Gulch Creek are in a similar condition. Both are steep and deeply rutted, and drain sediment-laden water into the riparian reserve. These road and trail conditions all contribute to the existing degraded conditions in the project area.

2.5 Effects of the Action

Under the ESA, “effects of the action” means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur.

The proposed action includes commercial thinning, non-commercial thinning, fuels treatments, and transportation system modifications in portions of the Swauk watershed. The following

analysis is focused on the general effects of the proposed action on the environment and on the response of MCR steelhead to these effects.

MCR steelhead are known to migrate, spawn, and rear in Swauk Creek and some of its tributaries, including Williams Creek. In 2003 and 2004, the Yakama Nation radio tagged numerous steelhead passing over Roza Dam. They tracked steelhead up to river mile (RM) 19.2 in Swauk Creek and also tracked them moving into Williams Creek (RM 10.6) and First Creek (RM 8.1) (Karp et al. 2009). However, most steelhead remained in Swauk Creek between RM 8.1 and RM 19.2. Juvenile steelhead are known to rear in Williams Creek year-round and rainbow trout have been found in Lion Gulch and Cougar Gulch. Critical habitat in Swauk Creek goes to RM 19.2 and in Williams Creek to RM 2.8.

2.5.1 Effects on the Environment

Stream Temperature

Tree removal through commercial and non-commercial thinning can influence water temperature at multiple levels, including at the sub-reach, reach, and potentially subwatershed scale. Removing trees in riparian areas reduces the amount of shade, which leads to increases in thermal loading to the stream (Moore et al. 2005). The primary factors that influence shade are riparian vegetation (Groom et al. 2011a) and the surrounding terrain (Allen et al. 2007), but often riparian vegetation provides most of the shade (Allen 2008; Allen et al. 2007). Substantial effects on shade in clearcut systems have been observed with no-cut buffers ranging from 66–99 feet (Brosofske et al. 1997; Groom et al. 2011b; Kiffney et al. 2003), and small effects were observed in studies that examined no-cut buffers 150 feet wide (Groom et al. 2011a). For no-cut buffer widths of 150–227 feet, the effects of tree removal on shade and temperature were either not detected or were minimal (Anderson et al. 2007; Groom et al. 2011a; Groom et al. 2011b). The limited response observed in these studies can be attributed to the lack of trees that were capable of casting a shadow of more than 150 feet during most of the day in the summer (Leinenbach et al. 2013). Although clearcuts were used in these studies, the results demonstrate that vegetation that is less than 150 feet away from streams can contribute shade to streams in some situations.

Some of the best available science is found in Environmental Protection Agency (EPA) modeling used to evaluate the effects of thinning prescriptions on stream shade (Leinenbach et al. 2013). The EPA considered the following riparian vegetation attributes when evaluating the effects of riparian management on stream shade conditions: (1) total width of the riparian buffer management zone; (2) width of the no-harvest buffer; (3) density of the vegetation within the no-harvest (expressed as canopy cover); (4) pre-harvest vegetation density within the outer "thinned" buffer; and (5) post-harvest vegetation density within the outer buffer.

While stream shade correlates with the width of no-cut buffers, the relationship is quite variable, depending on site-specific factors such as stream size, substrate type, stream discharge, topography, channel aspect, forest structure, and species composition (Caissie 2006). Inputs of cold water from the streambed, seepage areas on the stream bank, and tributaries can help cool the stream on hot summer days if they are sufficiently large relative to the stream discharge (Wondzell 2012). The density of vegetation in riparian areas affects shade and thermal loading to

a stream due to the penetration of solar radiation through gaps in the canopy and among the branches and stems (Brazier and Brown 1973; DeWalle 2010). In some instances (such as narrow streams with dense, overhanging streamside vegetation, or stands on the north sides of streams with an east-west orientation), no-cut buffers as narrow as 30 feet adjacent to clearcuts can maintain stream shade (Brazier and Brown 1973). Wider buffers, in general will provide increased protection of stream temperature (Anderson et al. 2007; Groom et al. 2011a; Groom et al. 2011b).

Thinning. The Project includes approximately 63 acres of commercial thinning in riparian reserves, of which 35 acres is along perennial streams and 28 acres along intermittent streams. The total acres of riparian reserve in the project area is 1,260, meaning this project will thin around 5 percent of the total riparian reserve acres. All perennial streams have 110-foot, no-cut buffers. Outside of these no-cut buffers, tree removal will be feathered to the upland treatment areas. In these thinning units, the canopy closure will start at around 70 percent outside of the no-cut buffer and will not fall below 40 percent along the outside edge of the riparian reserve. Along intermittent streams, the no-cut buffer varies depending on slope. On ground less than 35 percent slope, a 50-foot riparian no-cut buffer will be implemented. On slopes greater than 35 percent, a no-cut buffer of between 75–100 feet will be implemented. Outside of these buffers, tree removal will be feathered to maintain a minimum of a 40 percent canopy closure.

In general, buffers greater than 150 feet protect stream shade, and will likely prevent thinning activities from increasing stream temperatures (Anderson et al. 2007; Groom et al. 2011a; Groom et al. 2011b; Leinenbach et al. 2013; Moore et al. 2005). However, in units where thinning occurs closer than 150 feet and where those trees provide direct stream shade, we expect increased solar radiation and changes to microclimatic conditions that increase stream temperature. However, for the commercial units in the 35 acres along perennial streams, we only expect slight changes to stream shade or stream temperature. We anticipate that thinning with the units along intermittent streams will reduce shade, particularly where thinning occurs within 50 feet of the stream. Reducing shade along streams that are dry when perennial streams are at their summer maxima is not expected to increase summer water temperatures.

The Forest Service is proposing 290 landings, of which 10 are proposed to be constructed within riparian reserves. For skyline units, the majority of the landings will be located on existing roads. Eight of the proposed 10 landings located in riparian reserves will serve skyline-yarding systems. Two ground-based logging system landings are proposed within riparian reserves of Lion Gulch (one new construction), outside of steelhead critical habitat. The dimensions for these landings will be approximately 100 feet by 100 feet (0.23 acres). The no-treatment buffers prescribed for riparian reserves are expected to eliminate much of the risk of landings being located in close proximity to streams with the potential to affect canopy closure and therefore water temperature. However, burn piles placed at the perimeter of landings in proximity to the riparian exclusion areas could pose a threat to mature tree canopy cover when the piles are burned. Most landings will be located on the outside edge of riparian reserves; however, a couple will be located outside of no-cut buffers of either 110 feet on perennial streams or a minimum of 75 feet on intermittent streams. We expect that these landings will reduce canopy cover over a small area leading to only minor reductions in shade and increased solar radiation that could lead to increased stream

temperatures. However, even if the shade reduction is small, the overall effect will still be additive with other components of the proposed action that may increase stream temperature.

Fuels treatments. The Forest Service proposes to implement prescribed underburning across 4,047 acres (1,252 acres of underburn in commercial units and 2,795 acres in natural fuels underburn). Approximately 448 acres of this will occur in riparian reserves. Non-commercial material will be piled with machines and placed outside of the no-cut buffers. Pile burning and prescribed broadcast burning will occur during high moisture conditions in the fall or spring when conditions are favorable for controlling flame length. The implementation of BMPs will reduce the likelihood of the fuels treatments from reducing overstory shade. Thus, fuels treatment are not likely to affect stream temperature by reducing shade.

Transportation system. The proposed action proposes to use 10 miles of road in close proximity to stream channels, many of which are fish bearing (Williams Creek, Cougar Gulch, and Lion Gulch). The Forest proposes to construct or reconstruct approximately 2 miles of road in riparian reserves (0.4 miles along fish-bearing streams and 1.6 miles along intermittent streams). All but 0.12 miles (a jeep trail that will be reconstructed for haul and then narrowed and returned to a jeep trail) will be hydrologically closed (ML1) or decommissioned after use. In most cases, the approximately nine miles of temporary road construction and reconstruction will be located in upland locations where effects to stream temperatures from the removal of canopy cover are not expected. At the end of their use, the roads will be decompacted and/or recontoured and seeded within a year or two after use. New openings in riparian reserves from temporary road construction will amount to approximately 7 acres at eight locations in the project area. All road segments in riparian reserves could potentially affect stream shade through reduction of canopy cover and increased solar radiation. For streams that are in close proximity to MCR steelhead or their critical habitat, it is likely that the increases in stream temperature will contribute to stream warming, although the change is expected to be small because of the minimal changes to tree canopy and increase solar radiation.

Suspended Sediment and Substrate Embeddedness

Timber harvest and road building can increase sediment supply to streams via increased mass wasting (primarily landslides) (Furniss et al. 1991; Spence et al. 1996) or surface erosion (most commonly from road surfaces and skid trails) (Beschta 1978; Furniss et al. 1991; Gomi et al. 2005; Keppeler 2012; Reid et al. 2010; Spence et al. 1996). Riparian vegetation and downed wood can reduce sediment delivery to the stream network in several ways by providing physical barriers, trapping sediments, and stabilizing soil. However, vegetation is less effective at regulating channelized erosion from roads and ditch lines, where most surface erosion derives.

Thinning. Timber harvest kills the roots of trees, which increases the probability of slope failure, particularly on steeper slopes. This also increases the potential of sediment delivery to the stream network. The occurrence probability is related to the harvest intensity, soil properties, geology, unit slope, and precipitation level. Depending on the prescription used, commercial harvest will greatly reduce the number of living trees within the treated stands. As the roots of harvested trees

die and decompose, their effectiveness in stabilizing soils will decrease over time, potentially resulting in sediment transport to stream channels.

Yarding can compact, expose, and displace soils. Compacted soils slow the infiltration of water, leading to increased surface runoff. Exposed soils are susceptible to displacement from runoff that delivers sediment to streams. The type and extent of soil exposure plays a role in the amount of sediment displacement, with small, patchy or discontinuous exposure yielding little displacement, compared to extensive, continuous exposure. Slope also plays a critical factor in sediment delivery. Compacted surfaces that lead to stream channels may also play an important role in delivery of sediment from treatment units to the river.

Several studies document that buffer strips can reduce erosion and sediment delivery. Vegetated buffer areas ranging in width from 40 to 100 feet appear to prevent sediment from reaching streams (Burroughs and King 1989; Gomi et al. 2005; Sweeney and Newbold 2014). Lakel (2010) concluded that streamside management zones (buffers) between 25 and 100 feet were effective in trapping sediment before it could enter streams. Sweeney (2014) also concluded that stream buffers up to 30 feet wide were shown to trap about 65 percent of sediments delivered by overland flow, while 90-foot buffers where expected to trap about 85 percent of sediments and a larger fraction of finer silts and clays.

The proposed project has 1,253 acres of commercial thinning with the majority (1,083 acres) using a skyline logging system on slopes greater than 35 percent. The other 170 acres will use a ground-based logging system. Of the total acres, only 62.5 acres of commercial thinning is located in riparian reserves. No harvest units are directly adjacent to critical habitat; however, one skyline unit is within a quarter mile. Approximately 5 acres (approximately 12.5 percent) of riparian reserve thinning will use ground-based equipment, whereas the remainder will use skyline equipment with less ground disturbance but will occur on steeper slopes (greater than 35 percent). The use of 110-foot, no-cut buffers on perennial streams and 50–100-foot, no-cut buffers on intermittent streams, depending on the slope, are expected to minimize sediment deposition to the stream network from vegetation treatments. For these reasons, the no-cut buffers are likely to ensure that the effects of erosion and sedimentation due to thinning and yarding will only cause a small increase in suspended sediment and substrate embeddedness to the stream network. However, the total amount (1,083 acres) of steep slope logging that is concentrated over these small drainages may lead to future slope failures and mass wasting events that are more difficult to predict.

The Forest Service proposes to use 290 landings, of which some are existing. Of those 290 landings, 10 are located within riparian reserves. Landings are generally approximately 10,000 square feet or 100 by 100 feet, but can vary. All landings located in riparian reserves will be outside of the no-cut buffers (110 feet on perennial streams) and on flatter terrain. Therefore, it is not expected that landings will contribute significant amounts of sediment to the stream network.

Fuels treatments. Prescribed fire treatments will be conducted when conditions are conducive for low-severity fire behavior in riparian reserves. The desired burn pattern for activity fuels reduction and natural fuels treatments is for higher tree retention on lower slopes adjacent to

valley bottoms and less tree retention on upper slopes and ridgelines. This will be accomplished by excluding direct ignition in the no-treatment buffers (110 feet in perennial streams) but allowing low-intensity backing fires in the no-treatment buffers. Pre-treatment of fuels such as limbing larger trees and thinning smaller trees by hand may be necessary to accomplish low-intensity burn objectives.

The fuels treatments also include burning landing piles at the 290 landings, of which 10 are located in riparian reserves. The landing piles that are burned in proximity (within 100 feet) to stream channels pose a greater risk of introducing sediment to streams because they often burn at high-intensity due to concentrated fuel loads, and can consume duff and litter that protect soil from erosion and produce water-repelling soils that increase soil erosion from the site. Consideration for the location of landing piles will be employed to reduce the risk of sediment delivery to stream channels. To minimize the risk to fish in Williams Creek, Lion Gulch, and Cougar Gulch, landings located within the riparian reserves of these streams will be located outside of the no-cut buffer (110 feet in perennial streams), with a low likelihood of overland sediment delivery.

Transportation system. Roads within the project area represent the largest erosion source (bare soil) contributing sediment to the stream network. Sediment deposition into streams impair aquatic habitat by filling in pools and infiltrating spawning habitat for salmonids. The most significant sources of road-derived fine sediment are at road-stream crossings and along native surface roads (Furniss et al. 1991; Gucinski et al. 2001).

The link between unpaved forest roads and increased fine sediment delivery into streams has been well established over the past three decades (Croke and Mockler 2001; Madej 2001; Montgomery 1994; Reid and Dunne 1984; Spence et al. 1996). The effects of roads range from chronic and long-term contributions of fine sediment into streams to catastrophic mass failures of road cuts and fills during large storms (Gucinski et al. 2001). Road surface erosion rates are primarily a function of storm intensity, surfacing material, road slope, and traffic level (Bilby et al. 1989; MacDonald et al. 2001; Reid et al. 1981). The direct effects of roads, such as increased sedimentation and increased risk of slides and debris flows, are much affected by road design and placement on the landscape (Gucinski et al. 2001). For all types of surface erosion, sediment delivery to streams is through direct surface water connections such as ditches, rills, or gullies (Bilby et al. 1989; Croke and Mockler 2001).

Road density for the Swauk Pine Project area is estimated at 7.3 miles per square mile. This high road density increases the risk for erosion and sediment delivery to streams and transport downstream to critical habitat. In the project area, the Forest Service estimated the existing road system delivers 50 tons (approximately 70 yards) of sediment on average each year. The proposed action will increase the road density in the project area to 7.9 miles per square mile during project activities. Post project, the road density will return to approximately 7 miles per square mile after 10 years.

For the purposes of commercial log haul, the proposed action includes new temporary road construction followed by decommissioning after use, reconstruction of unauthorized roads

followed by decommissioning and/or conversion to off-highway vehicle trail, as well as heavy road maintenance (blading, ditch cleanout, installing drainage dips, and brushing). Timber haul activities on 48 miles of roads are expected to contribute additional sediment to the stream system, above baseline levels. These road activities will disturb road surfaces and/or soils connected to or in proximity to streams (in some cases), with a high probability of delivering sediment to the stream network and occupied fish habitat.

The Forest Service proposes to construct approximately 9 miles of temporary native-surfaced roads, and reconstruct approximately 3 miles of currently closed road. The majority of maintenance/reconstruction work will occur on 24 miles of ML1 and ML2 roads used for timber harvest and haul activities. These activities may include replacing culverts, reconditioning failing ditches, removing trees from the roadbed, reshaping the roadbed, grading, adding cross drainage culverts, applying surfacing rock material, repairing roadbed slumps or settlements, constructing turnouts or truck turnarounds, and establishing ditches. Approximately 2 miles of reconstructed road is located in the riparian reserve (0.4 miles fish-bearing, 1.6 miles intermittent); after use, these sections will be hydrologically closed (ML1) or decommissioned. The construction of new temporary roads will likely contribute additional sediment to the stream network.

While pre-haul and regular maintenance requirements can lessen the impact of road-generated sediment, localized effects could last for several years, and occur at different locations throughout the project area (i.e., not all road activities are expected to occur at the same time). Upon completion of harvest haul activities, all temporary and unauthorized roads will be decommissioned and erosion and sediment delivery rates are expected to return to pre-project levels after a few years. During project activities, when newly constructed and reconstructed roads are open and log haul is occurring, we expect sediment pulses resulting from snowmelt, thundershowers, or any rain event where runoff occurs. These events are expected to occur at various times over the life of the 10-year project. We expect the majority of the effects from sediment-generating activities to occur in the first couple of years as temporary roads are constructed, roads reopened and reconstructed, and log haul is occurring. Although we cannot estimate a specific amount of sediment that will enter the stream system, we do know the proposed action will increase the number of open roads and trails (approximately 25-mile increase), road density (9 percent increase), riparian road density (7 percent increase), road/stream crossings (1.4 percent increase), and increase the number of vehicles using the road during log haul for the duration of the project (approximately 10 years). These increases are likely to contribute sediment above baseline conditions and contribute to already high levels of sediment and turbidity in project area streams. We expect both occasional sediment pulses and chronic sediment deliveries from project activities that will lead to increased sediment levels in Williams Creek and its tributaries downstream to Swauk Creek.

Large Wood

Removal of trees within one site potential tree height of a stream has the greatest potential to affect recruitment of woody material (FEMAT 1993). For near-stream riparian inputs, multiple studies suggest that stream wood input rates decline exponentially with distance from the stream

and vary by stand type and age (McDade et al. 1990; Pollock and Beechie 2014; Van Sickle and Gregory 1990).

Thinning. Commercial thinning slightly reduces large wood recruitment to streams. On perennial streams, the no-cut buffer of 110 feet is expected to maintain at least 90 percent of wood recruitment, based on work by McDade (1990) in Oregon and Washington. Along intermittent streams, the no-cut buffers are as little as 50 feet. The proposed action will commercially thin trees in these areas using a "thin from below" prescription across 63 acres of riparian reserve (out of the roughly 1,260 acres of total riparian reserve). This prescription emphasizes retaining large (greater than 20 inches dbh) trees and only removing the smaller understory trees. While the prescription may improve forest health and reduce the intensity of wildfire, it will also reduce wood recruitment to stream channels proximal to the 63 acres (35 acres perennial, 28 acres intermittent) of riparian reserve from which trees will be harvested. Although the reduction of large wood when considered at the scale of the project area (roughly 1,260 acres) will be small, we expect it to reduce the number of pieces of large wood reaching streams in the project area, including Williams Creek and its tributaries.

Fuels treatments. The prescribed underburning treatments are not expected or intended to reduce the number of large trees that could contribute to instream large wood. If large trees are killed by the fuels treatments they would be expected to be recruited to the stream sooner.

Transportation system. Modifications and changes to the transportation system will likely have localized effects to wood recruitment. Temporary road construction in riparian reserves is expected to remove trees from approximately 7 acres. All of these acres are along intermittent streams, meaning the riparian reserves are relatively narrow (150 feet) and greater reductions in wood recruitment are expected. These reductions all occur above critical habitat for MCR steelhead, so it is not likely to have direct effects. However, the contributions of wood to intermittent streams can have effects on other stream habitat features that contribute to overall watershed health, including sediment deposition, pool formation, refugia, and floodplain connectivity, among others.

Change in Peak Flows and Increase in Drainage Network

Forest management can affect the extent and timing of water storage and discharge in a watershed. Many studies have shown that timber harvest and forest roads increase peak flows in small basins (Wemple and Jones 2003; Wemple et al. 1996). While tree harvest may contribute to increases in small peak flows, there is less evidence that harvest alone has significant effects on larger peak flows. The effect of tree harvest on peak flows is due to a reduction in interception of soil moisture and increases in subsurface water routing to adjacent streams (Jones 2000; Wemple et al. 1996). Road and ditch networks have been identified as having the most significant effect on water routing and peak flows (Grant et al. 2008). Where roads occur in and near harvest units, the road network may facilitate this routing (Grant et al. 2008).

The Forest Service proposes to construct approximately 9 miles of temporary native-surfaced roads and reopen and reconstruct approximately 3 miles of existing ML1 closed roads.

Approximately 2 miles of reconstructed road is located in riparian reserves (0.4 miles fish bearing, 1.6 miles intermittent). Some of these roads will cross intermittent streams and contribute to increases in the drainage network. Most of the new temporary roads and road reopening are expected to be closed within 2 years; however, certain conditions (weather) may prevent a timely closure. After haul, about a mile of road will be decommissioned. Because of the increases in drainage network from the proposed action and the existing high levels of road density (7.3 miles per square mile), existing skid trails, and compaction; the proposed action will add to an already degraded baseline and expand the drainage network for the life of the project (approximately 10 years). We expect these changes in the drainage network to increase peak flows slightly in Williams Creek and its tributaries. Post project, road mileage will be slightly reduced, which will slightly reduce the drainage network. Overall, the Forest Service will maintain a very high road density in the Williams Creek drainage.

2.5.2 Effects on MCR Steelhead

The proposed action will result in increases in stream temperature, sediment delivery, turbidity, and peak flows. The proposed action will also reduce instream large wood.

Juvenile MCR steelhead will be exposed to small increases in stream temperatures, typically in July and August. This is particularly critical in the project area because these streams already approach the maximum thermal tolerance level for salmonids during the summer. Thus, small increases in temperature are likely to be highly detrimental to salmonids. The increases in stream temperature will increase the risk of reduced growth, reduced competitive success of juveniles in relation to non-salmonid fish, increased disease virulence, and reduced disease resistance (Marine and Cech 2004; McCullough et al. 2001; Reeves et al. 1987). Increased stream temperatures are expected to affect fish in Lion Gulch, Cougar Gulch, and parts of Williams Creek. Juvenile steelhead in these affected streams will likely suffer a reduction in size upon out-migration, which makes these fish more vulnerable to predation, or a reduction in fitness, which reduces the likelihood of long-term survival of individual fish.

The exposure of juvenile and adult steelhead to increased turbidity and changes in substrate character from sediment generated by the proposed action is reasonably certain to elicit significant responses from a relatively small number of steelhead occupying the area. Steelhead would likely respond to the increased suspended sediment by attempting to move to locations with lower concentrations of fine sediment. Failure to avoid increased suspended sediment is likely to result in gill irritation or abrasion, which can reduce respiratory efficiency or lead to infection and a reduction in juvenile feeding efficiency due to reduced visibility.

An increase in suspended sediments (turbidity) and deposition of fine sediments can adversely affect fish and filter feeding macro-invertebrates downstream from the proposed action. At moderate levels, turbidity has the potential to reduce primary and secondary productivity; at higher levels, turbidity may interfere with feeding and may injure and even kill both juvenile and adult fish (Berg and Northcote 1985; Spence et al. 1996). However, Bjornn and Reiser (1991) found that adult and larger juvenile salmonids appear to be little affected by the high concentrations of suspended sediments that may be experienced during storm and snowmelt runoff episodes. Fine sediment deposition may clog substrate interstices and thereby diminish

intragravel flows. In addition, fine sediments may act as a physical barrier to fry emergence (Redding et al. 1987). Eggs deposited in gravel with a high percentage of fine sediment have a lower survival to emergence (Spence et al. 1996).

Exposure duration is a critical determinant of the occurrence and magnitude of physical or behavioral effects caused by turbidity (Newcombe and Jensen 1996). Salmonids have evolved in systems that periodically experience short-term pulses (days to weeks) of high suspended sediment loads, often associated with flood events, and are adapted to such seasonal high pulse exposures. However, research indicates that chronic exposure can cause physiological stress responses that can increase maintenance energy and reduce feeding and growth (Servizi and Martens 1991). In a review of 80 published reports of fish responses to suspended sediment in streams and estuaries, Newcombe and Jensen (1996) documented increasing severity of ill effects with increases in dose (concentration multiplied by exposure duration).

The most critical life stage that will experience increases from fine sediment deposition from project activities are incubating eggs. Steelhead eggs are in the gravel from mid-March to late June. This also coincides with snowmelt runoff and higher turbidity levels. We expect increased levels of turbidity and resulting levels of fine sediment deposition in spawning gravels in Lion Gulch, Cougar Gulch, and in Williams Creek. For those incubating eggs that are present in those areas, we would expect decreases in survival to emergence, particularly with the extremely high road densities in the project area. We expect these negative effects to last only during the few years of timber harvest and then for several years after, as roads and skid trails recover.

Commercial thinning treatments on 63 acres of riparian reserve will reduce wood delivery to the action area. This will remove wood, both large and small, which will slow the creation of complex rearing habitats. Wood functions to create complex rearing habitats by trapping sediment, streambed aggradation, sorting spawning gravels, formation of pools, improving pool frequency and quality, and improving connectivity to off-channel and floodplain habitats. The proposed action will reduce the creation of potential rearing habitat for juvenile MCR steelhead in portions of Williams Creek, Lion Gulch, and Cougar Gulch for potentially the next several decades. MCR steelhead use pools, woody debris, and off-channel and floodplain habitats for velocity refuge, foraging, and predator avoidance. Reducing the creation of complex rearing habitat will reduce the habitat carrying capacity in those creeks in the action area affected by thinning.

2.5.3 Effects on Critical Habitat

Designated critical habitat within the action area for MCR steelhead considered in this opinion consists of freshwater spawning sites, freshwater rearing sites, and freshwater migration corridors and their essential PBFs as listed below. The effects of the proposed action on these features are summarized as a subset of the habitat-related effects of the action that were discussed more fully above.

1. Freshwater spawning sites
    a. Substrate—The proposed action will cause an increase in suspended sediment and fine sediment deposition from timber hauling and roadwork.

b. Water quality—The proposed action will cause an increase in suspended sediment from timber hauling and roadwork, and a small increase in stream temperature from timber harvest. These changes are likely to extend downstream to the confluence of Williams Creek with Swauk Creek.
c. Water quantity—The proposed action is not expected to reduce water quantities.

2. Freshwater rearing sites

    a. Floodplain connectivity—The proposed action will not reduce floodplain connectivity.
    b. Forage—The proposed action will increase suspended sediment that will cause minor reductions in the production of invertebrates.
    c. Natural cover—Reductions in wood recruitment potential and delivery of wood to the stream will occur in the action area, reducing the creation of cover habitat (pools, access to floodplains and off-channel habitats) and rearing potential for MCR steelhead. The negative effects on natural cover will change the quality and function of this PBF in the action area for several decades.
    d. Water quality—The proposed action will cause an increase in suspended sediment from timber hauling and roadwork, and a small increase in stream temperature from timber harvest. These changes are likely to extend downstream to the confluence of Williams Creek with Swauk Creek.
    e. Water quantity—The proposed action is not expected to reduce water quantities.

3. Freshwater migration corridors

    a. Free of artificial obstruction—The proposed action will not create any artificial obstruction.
    b. Natural cover—Reductions in wood recruitment potential and delivery of wood to the stream will occur in the action area, reducing the creation of cover habitat (pools, access to floodplains and off-channel habitats) and rearing potential for MCR steelhead. The negative effects on natural cover will change the quality and function of this PBF in the action area for several decades.
    c. Water quality—The proposed action will cause an increase in suspended sediment from timber hauling and roadwork, and a small increase in stream temperature from timber harvest. These changes are likely to extend downstream to the confluence of Williams Creek with Swauk Creek.
    d. Water quantity—The proposed action is not expected to reduce water quantities.

2.6 Cumulative Effects

"Cumulative effects" are those effects of future state or private activities, not involving federal activities, that are reasonably certain to occur within the action area of the federal action subject to consultation (50 CFR 402.02). 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.

Some continuing non-federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action

area's future environmental conditions caused by global climate change that are properly part of the environmental baseline vs. cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the environmental baseline (Section 2.4).

Lands interspersed with the action area includes 293 acres of non-Forest Service lands and includes BLM lands and private lands. NMFS is not aware of any specific future actions that are both reasonably certain to occur in the action area and that would likely contribute to cumulative effects on salmon or steelhead. For this description of cumulative effects, NMFS assumes that future non-federal activities in the area of the proposed action will continue into the future at present or increased intensities.

NMFS searched for information on future state, tribal, local, or private actions that were reasonably certain to occur in the action area. Most activities that occur across the action area either are on federal land or require some type of federal permit, which will require some type of future ESA consultation. In addition, most future state or tribal actions would likely have some form of federal funding or authorization and therefore would also be reviewed by NMFS.

2.7 Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of 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 (Section 2.5) to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), taking into account the status of the species and critical habitat (Section 2.2), to formulate the agency's opinion as to whether the proposed action is likely to: (1) reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated or proposed critical habitat for the conservation of the species.

The status of MCR steelhead is driven by the risk of extinction from low abundance and low to moderate risks of extinction due to low productivity, spatial structure, and diversity for most populations. The MCR steelhead DPS is not currently meeting the viability criteria described in the Mid-Columbia Steelhead Recovery Plan (National Marine Fisheries Service 2009). To achieve viable status, two populations should be rated as viable, including at least one of the two classified as large—the Naches River or the Upper Yakima River, neither of which currently meets viable status. The Critical Habitat Analytical Review Team rated the Middle Upper Yakima Watershed (HUC5, 1703000103), where the proposed action will occur, as having a high conservation value to the MCR steelhead DPS (National Marine Fisheries Service 2005).

The information presented in the environmental baseline section (Section 2.4) details that the habitat quality in tributary streams in the Interior Columbia Recovery Domain range from excellent in wilderness and roadless areas to poor in areas subject to heavy agricultural and urban development (National Marine Fisheries Service 2009; Wissmar et al. 1994). The Swauk Watershed and environs have been highly modified by timber management, grazing, road building, recreation, mining, and other activities. Reduced summer stream flows, impaired water quality (high water temperature), and reduction of habitat complexity are a few of the problems.

The cumulative effects of state and private actions within the action area are anticipated to continue at approximately the same level that they are now occurring. It is likely that the overall pattern of state and private development, especially in WUI, will continue and contribute adversely, in some areas, to the condition of riparian habitat.

As noted in section 2.2, climate change is likely to affect all three species covered in this opinion. The ISAB identified a number of effects climate change would have on Columbia Basin salmon. A few of these include: (1) water temperature increases, and depletion of cold water habitat that could reduce the amount of suitable salmon habitat by about 22 percent by the year 2090 in Washington State; (2) variations in precipitation that may alter the seasonal hydrograph and modify shallow mainstem rearing habitat; and (3) earlier snowmelt and higher spring flows with warmer temperatures that may cause steelhead yearlings to smolt and emigrate to the ocean earlier in the spring (Independent Scientific Advisory Board 2007; O'Neal 2002). Specifically on the Okanogan–Wenatchee National Forest (Gaines et al. 2012), recommendations included protecting cold-water areas, restoring beavers, restoring fish passage, and reducing the impacts of roads on riparian habitats, water quality, water quantity, and flow regimes. Climate change is expected to make recovery targets for these salmon populations more difficult to achieve. However, habitat restoration actions can at least partially address the adverse impacts of climate change on salmon.

Increased sediment delivery and increased summer water temperatures are reasonably certain to cause a decrease in the rate of egg survival, and the fitness of juveniles. The proposed action will contribute modestly to previously identified limiting factors, and significantly disrupt normal behavioral patterns, which will create or increase the risk of injury to MCR steelhead. Significant disruption will occur to the following biological processes and behaviors: egg incubation, feeding, and rearing. Increased stream temperatures are likely to affect fish in Lion Gulch, Cougar Gulch, and parts of Williams Creek. Juvenile steelhead in these affected streams will likely suffer a reduction in size upon out-migration, which makes fish more vulnerable to predation, or a reduction in fitness, which reduces the likelihood of long-term survival of individual fish. Increased sediment to streams could affect migrating and spawning adult steelhead, incubating eggs, pre-emergent fry, and rearing and migrating juveniles. The effects from sedimentation and suspended sediment are likely to be relatively short-term (approximately 10 years). However, the addition of fine sediment in spawning gravels or onto incubating eggs will likely lead to reduced egg survival during that time. Due to conservation measures proposed by the Forest Service and the location of the action, most activities will only have a small and localized effect exposing only a small number of individuals. Thus, the effects are not likely to cause a biologically meaningful effect at the population scale in terms of abundance, diversity or spatial structure. The incubating eggs and juveniles that are likely to be injured or killed due to the action are too few to cause measurable effects on the long-term abundance or productivity of the affected population, primarily because only a small proportion of individuals from the upper Yakima River population will be exposed. Karp (2009) observed that in all years, fewer than 16 percent of the upper Yakima River population entered Swauk Creek and, of these, not more than 5 percent entered Williams Creek. It is not clear if any steelhead spawned in the action area during the four years assessed by Karp (2009). Based on these data, it does not appear that the effects of the proposed action will reduce the productivity or survival of MCR steelhead, even

when combined with a degraded environmental baseline and additional pressure from cumulative effects and climate change.

Based on our analysis, adverse effects from the proposed action will cause a slight temporary decline in the quality and function of PBFs in the action area. The quality of the PBFs at the watershed scale is not likely to decline as a result of the proposed action, due to the minor to moderate intensity and localized nature of effects from increased sediment and temperature, and decreased large wood. The effects of the proposed action will not impede the ability of this critical habitat to play its intended conservation role because, although the reduction in quality of PBFs caused by the proposed action makes the affected habitat less than ideal for MCR steelhead, the effects of the action will not render the habitat unusable or incapable of supporting migration, spawning, or rearing.

Given the above, the proposed action will not be likely to meaningfully change the limiting factors, will have no discernible effect on population viability, and will not impede recovery of the MCR steelhead DPS. Therefore the proposed action will not appreciably reduce the likelihood of both the survival and recovery of the MCR steelhead DPS.

2.8 Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' opinion that the proposed action is not likely to jeopardize the continued existence of MCR steelhead, or destroy or adversely modify their designated critical habitat.

2.9 Incidental Take Statement

Section 9 of the ESA and federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a 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 further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be

prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

2.9.1 Amount or Extent of Take

In the opinion, NMFS determined that the proposed action was reasonably certain to result in incidental take as follows:

- injury to juveniles from increased suspended sediment from timber harvest, roadwork, and timber hauling on roads
- injury to juveniles from increased stream temperature from timber harvest

The distribution and abundance of fish that occur within an action area are affected by habitat quality, competition, predation, and the interaction of processes that influence genetic, population, and environmental characteristics. Additionally, there is no way to count or observe the number of fish exposed to the effects of the proposed action over the period of time during which these effects will occur (10 years). In such circumstances, NMFS cannot provide an amount of take that would be caused by the proposed action and instead uses an indicator of the extent of take.

The indicator for the extent of take from increases in suspended sediment is the number of miles of aggregate-surfaced roads that could deliver sediment to streams during timber hauling and the number of miles of new temporary road in riparian reserves. This indicator is proportional to the effects from timber hauling and temporary roads, because more road miles used for hauling increases the amount of suspended sediment delivery to streams. Thus, the extent of take indicator that will be used as a reinitiation trigger for this pathway is 48 miles of timber haul roads, 8.9 miles of temporary road construction, 8.5 miles of temporary road decommissioning, and 1 mile of road decommissioning.

The indicator for the extent of take from increases in stream temperature and reduction of large wood is the total number of acres of riparian reserve harvest adjacent to perennial streams. These indicators are proportional to the effects from timber harvest because some timber harvest units will have trees removed within 150 feet of streams, which reduces shade and large wood. Thus, the extent of take indicator that will be used as the reinitiation triggers for this pathway is the number of acres of riparian reserve harvest adjacent to perennial streams (35 acres).

Although the surrogates are largely coextensive with the proposed action, they nevertheless function as effective reinitiation triggers, because they can be measured and monitored as the roads are constructed and used during the timber sale portion of the project, and then again as the roads are decommissioned. If at any time the level or method of take exempted from take prohibitions and quantified in this opinion is exceeded, reinitiation of consultation will be required.

2.9.2 Effect of Take

In the opinion, NMFS determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the species, or destruction or adverse modification of critical habitat.

2.9.3 Reasonable and Prudent Measures

"Reasonable and prudent measures" are nondiscretionary measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 CFR 402.02).

The Forest Service shall:

- Minimize the likelihood of incidental take resulting from adverse effects to water quality from shade reduction, increased suspended sediment, and fine sediment deposition.
- Complete monitoring and reporting to confirm that the take exemption for the proposed action is not exceeded, and that the terms and conditions in this ITS are effective in minimizing incidental take.

2.9.4 Terms and Conditions

The terms and conditions described below are non-discretionary, and the Forest Service or any applicant must comply with them in order to implement the RPMs (50 CFR 402.14). The Forest Service or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this ITS (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse.

1. The following term and condition implements RPM 1:
    a. Temporary Roads. The Forest Service will design temporary roads to maximize resource protection and minimize clearing widths. They will also fully decommission the temporary road prior to closure of the timber sale. The decommissioning will include actions that include the removal of temporary stream crossings and culverts, elimination of ditches, decompaction of the road prism, out-sloping the roadbed, removal of ruts and berms, obliteration of the road entrance.
    b. Fine Sediment. The Forest Service shall offset any additions of fine sediment resulting from project activities in Lion Gulch, Cougar Gulch, and/or Williams Creek by incorporating activities to reduce an equal amount of fine sediment to these streams in the project area. These may include road decommissioning, road maintenance, soil decompaction, and trail decommissioning, among others.
    c. Erosion and Sediment Control. When potential or active erosion is detected at any road or timber landing, the Forest Service shall apply appropriate erosion or sediment control measures to stabilize the area. These may include, but are not limited to, hydraulic mulching, hydroseeding, soil binders, geotextiles or

other erosion control blankets, wood mulching, silt fences, check dams, fiber rolls, spot rocking or regrading the road, using straw bales or other sediment catching materials or devices, and looking for opportunities to reroute water/sediment to stable soils.

2. The following term and condition implements RPM 2:

    a. Monitoring. The Forest Service shall develop and carry out an annual monitoring plan to collect the following information:
        i. A list of any temporary roads built in riparian reserves that includes the length, duration of opening, decommissioning type, and any BMPs used in the road.
        ii. The total number and square footage of landings in riparian reserves and restoration techniques used to rehabilitate them.
        iii. A total count of the number of miles of aggregate-surfaced roads are used for log hauling.
        iv. A total count of the number of acres harvested in riparian reserves by catchment that includes Lion Gulch, Cougar Gulch, and Williams Creek.
    b. Reporting. Submit each annual monitoring report to NMFS by December 31 each year until all timber sale action are complete, at the address below:
        National Marine Fisheries Service
        Columbia Basin Branch
        Attn: Swauk Pine WCRO-2018-00033
        304 South Water Street, Suite 201
        Ellensburg, WA 98926

2.10 Conservation Recommendations

Section 7(a)(1) of the ESA directs federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02).

> The Forest Service should reduce its existing road mileage footprint across the project area in an effort to reduce fine sediment levels in Williams Creek and its tributaries. We recommend the Forest Service reduce their road density to less than 3 miles per square mile at a minimum.

Please notify NMFS if the Forest Service carries out this recommendation so that we will be kept informed of actions that are intended to improve the conservation of listed species or their designated critical habitats.

2.11 Reinitiation of Consultation

This concludes formal consultation for the Project.

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

3.0 MAGNUSON–STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT RESPONSE

Section 305(b) of the MSA directs federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. The MSA (section 3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH.

This analysis is based, in part, on the EFH assessment provided by the Forest Service and descriptions of EFH for Pacific coast salmon (Pacific Fishery Management Council 2014) contained in the fishery management plans developed by the Pacific Fishery Management Council and approved by the Secretary of Commerce.

3.1 Essential Fish Habitat Affected by the Project

The proposed action and action area are described in the BA and this opinion. The project area includes habitat which has been designated as EFH for various life stages of Chinook salmon (*O. tshawytscha*), and coho salmon (*O. kisutch*).

3.2 Adverse Effects to Essential Fish Habitat

See Section 2.4 of the opinion for a description of the adverse effects on anadromous species habitat for Pacific salmon. The effects of the action on Pacific Coast salmon are similar to those described above in the ESA portion of the document.

NMFS concludes that the proposed action will have adverse effects on EFH designated for Pacific Coast salmon in freshwater habitats where Forest Service program activities occur. Based on information provided by the action agency and the analysis of effects presented in the ESA portion of this document (Section 2.4), we conclude that the proposed action will have the following adverse effects on EFH for Pacific Coast salmon.

Specifically, NMFS has determined that the action will adversely affect EFH as follows:

- Freshwater EFH quantity and quality, including salmon spawning habitat will be reduced from increased sedimentation/substrate embeddedness at the site scale.
- Freshwater EFH quality, including salmon spawning habitat will be reduced from increased stream temperatures at the site scale.
- Freshwater EFH quality, including salmon spawning habitat will be reduced from decreased inputs of large wood at the site scale.

3.3 Essential Fish Habitat Conservation Recommendations

NMFS believes that the following conservation measures are necessary to avoid, mitigate, or offset the impact of the proposed action on EFH:

1. The Forest Service should follow Term and Condition #1 above (Section 2.9.4) in the ESA portion of this document to offset adverse effects to EFH from the proposed action.
2. The Forest Service should follow Term and Condition #2 to report the measures implemented in item "1" above.

Fully implementing these EFH recommendations would protect, by avoiding or minimizing adverse effects described in section 3.2 above.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, the Forest Service must provide a detailed response in writing to NMFS within 30 days after receiving EFH Conservation Recommendations. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH Conservation Recommendations, unless NMFS and the federal agency have agreed to use alternative time frames for the federal agency response. The response must include a description of measures proposed by the agency for avoiding, mitigating, or offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with the Conservation Recommendations, the federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(k)(1)).

In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how

many are adopted by the action agency. Therefore, we ask that in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

3.5 Supplemental Consultation

The Forest Service must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH conservation recommendations (50 CFR 600.920(l)).

4.0 DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The DQA specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these DQA components, documents compliance with the DQA, and certifies that this opinion has undergone pre-dissemination review.

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are the Forest Service. Other interested users could include potential users of the Okanogan–Wenatchee National Forest as well as people interested in the conservation of MCR steelhead. Individual copies of this opinion were provided to the Forest Service.

4.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

4.3 Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards, including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01 et seq., and the MSA implementing regulations regarding EFH, 50 CFR 600.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this opinion [and EFH consultation, if applicable] contain more background on information sources and quality.

Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA [and MSA implementation, if applicable], and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

5.0 REFERENCES

Allen, D. 2008. Development and application of a process-based, basin-scale stream temperature model. Ph.D Dissertation. University of California, Berkeley, Berkeley, California.

Allen, D., W. Dietrich, P. Baker, F. Ligon, and B. Orr. 2007. Development of a Mechanistically Based, Basin-Scale Stream Temperature Model: Applications to Cumulative Effects Modeling.

Anderson, P. D., D. J. Larson, and S. S. Chan. 2007. Riparian buffer and density management influences on microclimate of young headwater forests of western Oregon. Forest Science 53(2):254-269.

Battin, J., and coauthors. 2007. Projected impacts of climate change on salmon habitat restoration. Proceedings of the National Academy of Sciences of the United States of America 104(16):6720-6725.

Berg, L., and T. G. Northcote. 1985. Changes in territorial, gill-flaring, and feeding behavior in juvenile coho salmon (*Oncorhynchus kisutch*) following short-term pulses of suspended sediment. Canadian Journal of Fisheries and Aquatic Sciences 42:1410-1417.

Beschta, R. L. 1978. Long-term patterns of sediment production following road construction and logging in the Oregon Coast Range. Water Resources Research 14(6):1011-1016.

Bilby, R. E., K. Sullivan, and S. H. Duncan. 1989. The Generation and Fate of Road-Surface Sediment in Forested Watersheds in Southwestern Washington. Forest Science 35(2):453-468.

Bjornn, T. C., and D. W. Reiser. 1991. Habitat requirement of salmonids in streams. Pages 83-137 *in* Influences of forest and rangeland management on salmonids fishes and their habitats. American Fisheries Society.

Brazier, J., and G. Brown. 1973. Buffer strips for stream temperature control. Forest Research Laboratory, Oregon State University, Corvallis, Oregon.

Brosofske, K. D., J. Chen, R. J. Naiman, and J. F. Franklin. 1997. Harvesting effects on microclmatic gradients from small streams to uplands in Western Washington. Ecological Applications 7(4):1188-2000.

Burroughs, E. R., and J. G. King. 1989. Reduction of soil erosion on forest roads. U.S. Forest Service, INT-264, Ogden, Utah.

Caissie, D. 2006. The thermal regime of rivers: a review. Freshwater Biology 51(8):1389-1406.

Croke, J., and S. Mockler. 2001. Gully initiation and road-to-stream linkage in a forested catchment, southeastern Australia. Earth Surface Processes and Landforms 26(2):205-217.

Crozier, L. G., R. W. Zabel, E. E. Hockersmith, and S. Achord. 2010. Interacting effects of density and temperature on body size in multiple populations of Chinook salmon. Journal of Animal Ecology 79(2):342-349.

DeWalle, D. R. 2010. Modeling Stream Shade: Riparian Buffer Height and Density as Important as Buffer Width. Journal of the American Water Resources Association 46(2):323-333.

FEMAT. 1993. Forest Ecosystem Management: An Ecological, Economic, and Social Assessment. U.S. Department of Agriculture; U.S. Department of the Interior Portland, Oregon.

Furniss, M. J., T. D. Roelofs, and C. S. Yee. 1991. Road construction and maintenance. Pages 297-323 *in* Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication.

Gaines, W. L., D. W. Peterson, C. A. Thomas, and R. J. Harrod. 2012. Adaptations to Climate Change: Colville and Okanogan-Wenatchee National Forests. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, Oregon.

Gomi, T., R. D. Moore, and M. A. Hassan. 2005. Suspended sediment dynamics in small forest streams of the Pacific Northwest. Journal of the American Water Resources Association 41(4):877-898.

Grant, G. E., S. L. Lewis, F. J. Swanson, J. H. Cissel, and J. J. McDonnell. 2008. Effects of forest practices on peak flows and consequent channel response: a state-of- science report for eastern Oregon and Washington. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, Oregon.

Groom, J. D., L. Dent, and L. J. Madsen. 2011a. Stream temperature change detection for state and private forests in the Oregon Coast Range. Water Resources Research 47.

Groom, J. D., L. Dent, L. J. Madsen, and J. Fleuret. 2011b. Response of western Oregon (USA) stream temperatures to contemporary forest management. Forest Ecology and Management 262(8):1618-1629.

Gucinski, H., M. H. Brookes, M. J. Furniss, and R. R. Ziemer. 2001. Forest roads: A synthesis of scientific information. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, PNW-GTR-509, Portland, Oregon.

Healey, M. 2011. The cumulative impacts of climate change on Fraser River sockeye salmon (*Oncorhynchus nerka*) and implications for management (vol 68, pg 718, 2011). Canadian Journal of Fisheries and Aquatic Sciences 68(5):953-953.

Howell, P., and coauthors. 1985. Stock assessment of Columbia River anadromous salmonids Volume I: chinook, coho, chum and sockeye salmon stock summaries. Bonneville Power Administration, Portland, Oregon.

Independent Scientific Advisory Board. 2007. Climate change impacts on Columbia River Basin fish and wildlife, Portland, OR.

Interior Columbia Basin Technical Recovery Team. 2005. Draft Current Status Assessment.

Interior Columbia Basin Technical Recovery Team. 2007a. Required survival rate changes to meet technical recovery team abundance and productivity viability criteria for Interior Columbia River Basin salmon and steelhead populations.

Interior Columbia Basin Technical Recovery Team. 2007b. Viability criteria for application to Interior Columbia Basin salmonid ESUs. Northwest Fisheries Science Center.

Jones, J. A. 2000. Hydrologic processes and peak discharge response to forest removal, regrowth, and roads in 10 small experimental basins, western Cascades, Oregon. Water Resources Research 36(9):2621-2642.

Karp, C., W. Larrick, M. Johnston, and T. Dick. 2009. Steelhead movements in the Upper Yakima River Basin, Fall 2002–Spring 2006. Bureau of Reclamation.

Keppeler, E. T. 2012. Sediment Production in a Coastal Watershed: Legacy, Land Use, Recovery, and Rehabilitation. Redwood science symposium: coast redwood forests in a changing California, Santa Cruz, California.

Kiffney, P. M., J. S. Richardson, and J. P. Bull. 2003. Responses of periphyton and insects to experimental manipulation of riparian buffer width along forest streams. Journal of Applied Ecology 40(6):1060-1076.

Lakel, W. A., and coauthors. 2010. Sediment Trapping by Streamside Management Zones of Various Widths after Forest Harvest and Site Preparation. Forest Science 56(6):541-551.

Leinenbach, P., G. McFadden, and C. Torgersen. 2013. Effects of Riparian Management Strategies on Stream Temperature. Science Review Team Temperature Subgroup. U.S. Environmental Protection Agency, Seattle, U.S. Geological Survey, Seattle, Bureau of Land Management, Portland, Oregon.

MacDonald, L. H., R. W. Sampson, and D. M. Anderson. 2001. Runoff and road erosion at the plot and road segment scales, St John, US Virgin Islands. Earth Surface Processes and Landforms 26(3):251-272.

Madej, M. A. 2001. Development of channel organization and roughness following sediment pulses in single-thread, gravel bed rivers. Water Resources Research 37(8):2259-2272.

Marine, K. R., and J. J. Cech. 2004. Effects of high water temperature on growth, smoltification, and predator avoidance in Juvenile Sacramento River Chinook salmon. North American Journal of Fisheries Management 24(1):198-210.

McCullough, D., S. Spalding, D. Sturdevant, and M. Hicks. 2001. Summary of Technical Literature Examining the Physiological Effects of Temperature on Salmonids. U.S. Environmental Protection Agency.

McDade, M. H., F. J. Swanson, W. A. Mckee, J. F. Franklin, and J. Vansickle. 1990. Source Distances for Coarse Woody Debris Entering Small Streams in Western Oregon and Washington. Canadian Journal of Forest Research-Revue Canadienne De Recherche Forestiere 20(3):326-330.

McElhany, P., M. H. Ruckelshaus, M. J. Ford, T. C. Wainwright, and E. P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. U.S. Department of Congress, NOAA Technical Memorandum NMFS-NWFSC-42.

Montgomery, D. R. 1994. Road surface drainage, channel initiation, and slope instability. Water Resources Research 30(6):1925-1932.

Moore, R. D., D. L. Spittlehouse, and A. Story. 2005. Riparian microclimate and stream temperature response to forest harvesting: A review. Journal of the American Water Resources Association 41(4):813-834.

Mote, P. W., and E. P. Salathé. 2009. Future climate in the Pacific Northwest. Climate Impacts Group, University of Washington, Seattle, Washington.

National Marine Fisheries Service. 1996. Making endangered species act determinations of effect for individual or grouped actions at the watershed scale. The National Marine Fisheries Service, Environmental and Technical Services Division, Habitat Conservation Branch.

National Marine Fisheries Service. 2005. Final assessment of NOAA Fisheries' critical habitat analytical review teams for 12 evolutionarily significant units of West Coast salmon and steelhead. National Marine Fisheries Service, Portland, Oregon.

National Marine Fisheries Service. 2007. 2007 Report to Congress, Pacific Coastal Salmon Recovery Fund FY 2000–2006. National Marine Fisheries Service, Seattle, Washington.

National Marine Fisheries Service. 2009. Middle Columbia River Steelhead Distinct Population Segment ESA Recovery Plan. National Marine Fisheries Service, Northwest Region.

National Marine Fisheries Service. 2011a. 2011 Report to Congress, Pacific Coastal Salmon Recovery Fund 2000-2010. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Seattle, Washington.

National Marine Fisheries Service. 2011b. Biennial Report to Congress on the Recovery Program for Threatened and Endangered Species October 1, 2008–September 30, 2010. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Washington, D.C.

National Marine Fisheries Service. 2016. 2016 5-Year Review: Summary & Evaluation of Middle Columbia River Steelhead.

Newcombe, C. P., and J. O. T. 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.

Northwest Fisheries Science Center. 2015. Status Review Update for Pacific Salmon and Steelhead Listed Under the Endangered Species Act: Pacific Northwest. NOAA, Northwest Fisheries Science Center.

O'Neal, K. 2002. Effects of Global Warming on Trout and Salmon in U.S. Streams. Defenders of Wildlife, Washington, D.C.

Pacific Fishery Management Council. 2014. Pacific Coast Salmon Management Plan Appendix A: Identification and description of essential fish habitat, adverse impacts, and recommended conservation measures for salmon, Portland, Oregon.

Pollock, M. M., and T. J. Beechie. 2014. Does Riparian Forest Restoration Thinning Enhance Biodiversity? The Ecological Importance of Large Wood. Journal of the American Water Resources Association 50(3):543-559.

Redding, J. M., C. B. Schreck, and F. H. .Everest. 1987. Physiological effects on coho salmon and steelhead of exposure to suspended solids. Transactions of the American Fisheries Society 116:737-744.

Reeves, G. H., F. H. Everest, and J. D. Hall. 1987. Interactions between the Redside Shiner (*Richardsonius-Balteatus*) and the Steelhead Trout (*Salmo-Gairdneri*) in Western Oregon--the Influence of Water Temperature. Canadian Journal of Fisheries and Aquatic Sciences 44(9):1603-1613.

Reid, L. M., N. J. Dewey, T. E. Lisle, and S. Hilton. 2010. The incidence and role of gullies after logging in a coastal redwood forest. Geomorphology 117(1-2):155-169.

Reid, L. M., and T. Dunne. 1984. Sediment production from forest road surfaces. Water Resources Research 20(11):1753-1761.

Reid, L. M., T. Dunne, and C. J. Cederholm. 1981. Application of sediment budget studies to the evaluation of logging road impact. Journal of Hydrology: New Zealand 20:49-62.

Reisenbichler, R. R., J. D. McIntyre, M. F. Solazzi, and S. W. Landino. 1992. Genetic variation in steelhead of Oregon and Northern California. Transactions of the American Fisheries Society 121:158-169.

Scheuerell, M. D., and J. G. Williams. 2005. Forecasting climate-induced changes in the survival of Snake River spring/summer Chinook salmon (*Oncorhynchus tshawytscha*). Fisheries Oceanography 14(6):448-457.

Servizi, J. A., and D. W. Martens. 1991. Effect of temperature, season, and fish size on acute lethal suspended sediments to Coho salmon (*Oncorhynchus kisutch*). Canadian Journal of Fisheries and Aquatic Science 48:493-497.

Spence, B. C., G. A. Lomnicky, R. M. Hughes, and R. P. Novitzki. 1996. An ecosystem approach to salmonid conservation. ManTech Environmental Research Services Corporation, Corvallis, Oregon.

Sweeney, B. W., and J. D. Newbold. 2014. Streamside Forest Buffer Width Needed to Protect Stream Water Quality, Habitat, and Organisms: A Literature Review. Journal of the American Water Resources Association 50(3):560-584.

U.S. Forest Service. 1990. Land and Resource Management Plan, Wenatchee National Forest. Forest Service, Wenatchee, Washington.

U.S. Forest Service. 1997. Swauk Watershed Analysis. Wenatchee National Forest, Cle Elum Ranger District.

Van Sickle, J., and S. V. Gregory. 1990. Modeling Inputs of Large Woody Debris to Streams from Falling Trees. Canadian Journal of Forest Research-Revue Canadienne De Recherche Forestiere 20(10):1593-1601.

Wade, A. A., and coauthors. 2013. Steelhead vulnerability to climate change in the Pacific Northwest. Journal of Applied Ecology 50(5):1093-1104.

Wainwright, T. C., and L. A. Weitkamp. 2013. Effects of Climate Change on Oregon Coast Coho Salmon: Habitat and Life-Cycle Interactions. Northwest Science 87(3):219-242.

Wemple, B. C., and J. A. Jones. 2003. Runoff production on forest roads in a steep, mountain catchment. Water Resources Research 39(8).

Wemple, B. C., J. A. Jones, and G. E. Grant. 1996. Channel network extension by logging roads in two basins, Western Cascades, Oregon. Water Resources Bulletin 32(6):1195-1207.

Wissmar, R. C., and coauthors. 1994. Ecological health of river basins in forested regions of Eastern Washington and Oregon. U.S. Department of Agriculture, Forest Service, PNW-GTR-326.

Wondzell, S. M. 2012. Hyporheic Zones in Mountain Streams: Physical Processes and Ecosystem Functions. USDA, USFS, Rocky Mountain Research Station, Fort Collins, Colorado.

Zabel, R. W., M. D. Scheuerell, M. M. McClure, and J. G. Williams. 2006. The interplay between climate variability and density dependence in the population viability of Chinook salmon. Conservation Biology 20(1):190-200.