UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
1201 NE Lloyd Boulevard, Suite 1100
PORTLAND, OR 97232-1274

Refer to NMFS No:
WCRO-2022-01195

August 14, 2023

Jody Weil
Forest Supervisor
Mt. Baker-Snoqualmie National Forest
2930 Wetmore Avenue, Suite 3A
Everett, Washington 98021

Re: Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Nooksack Vegetation Management Project on the Mt. Baker-Snoqualmie National Forest, Mt. Baker Ranger District, Whatcom County, Washington (Fifth Field HUCs: 171100040102, 171100040103, 171100040105 &171100040106 – Twin Lakes, Wells Creek, Canyon Creek and Hedrick Creek-North Fork Nooksack River).

Dear Ms. Weil:

Thank you for your letter of May 10, 2022, requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) for the U.S. Forest Service's (USFS) Nooksack Vegetation Management Project on the Mt. Baker-Snoqualmie National Forest (MBSNF). Thank you, also, for your request for consultation pursuant to the essential fish habitat (EFH) provisions in Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), (16 U.S.C. 1855(b)) for this action.

The enclosed document contains the biological opinion (Opinion) prepared by the NMFS pursuant to section 7 of the ESA on the effects of the proposed action. In this Opinion, the NMFS concludes that the proposed action would adversely affect but is not likely to jeopardize the continued existence of Puget Sound (PS) Chinook salmon and PS Sound steelhead. We also conclude that the proposed action is likely to adversely affect designated critical habitat for both of those species but is not likely to result in the destruction or adverse modification of those designated critical habitats. This opinion also documents our conclusion that the proposed action may affect, but is not likely to adversely affect southern resident (SR) killer whales and their designated critical habitat.

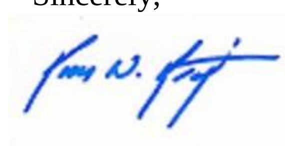
This Opinion includes an incidental take statement (ITS) that describes reasonable and prudent measures (RPMs) the NMFS considers necessary or appropriate to minimize the incidental take associated with this action, and sets forth nondiscretionary terms and conditions that the USFS must comply with to meet those measures. Incidental take from actions that meet these terms and conditions will be exempt from the ESA's prohibition against the take of listed species.

Section 3 of this document includes our analysis of the action's likely effects on EFH pursuant to Section 305(b) of the MSA. Based on that analysis, the NMFS concluded that the action would adversely affect designated freshwater EFH for Pacific Coast Salmon. Therefore, we have provided conservation recommendations that can be taken by the USFS to avoid, minimize, or otherwise offset potential adverse effects on EFH. We also concluded that the action would not adversely affect EFH for Pacific Coast groundfish and coastal pelagic species. Therefore, consultation under the MSA is not required for EFH for Pacific Coast groundfish and coastal pelagic species.

Section 305(b) (4) (B) of the MSA requires Federal agencies to provide a detailed written response to NMFS within 30 days after receiving this recommendation. If the response is inconsistent with the EFH conservation recommendations, the USFS must explain why the recommendations will not be followed, including the scientific justification for any disagreements over the effects of the action and recommendations. 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 request that in your statutory reply to the EFH portion of this consultation you clearly identify the number of conservation recommendations accepted.

Please contact John Jorgensen in the North Puget Sound Branch of the Oregon/Washington Coastal Office at (360) 362-5009, or by electronic mail at john.jorgensen@noaa.gov if you have any questions concerning this consultation, or if you require additional information.

Sincerely,



Kim W. Kratz, Ph.D
Assistant Regional Administrator
Oregon Washington Coastal Office

cc: Richard Vacirca, USFS
Jeremy Gillman, USFS

Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the

Nooksack Vegetation Management Project on the Mt. Baker-Snoqualmie National Forest, Whatcom County, Washington (HUCs: 171100040102, 171100040103, 171100040105 &171100040106 – Twin Lakes, Wells Creek, Canyon Creek and Hedrick Creek-North Fork Nooksack River)

NMFS Consultation Number: WCRO-2022-01195

Action Agency: U.S. Forest Service

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely To Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Chinook salmon (Oncorhynchus tshawytscha) Puget Sound (PS)	Threatened	Yes	No	Yes	No
Steelhead (O. mykiss) PS	Threatened	Yes	No	Yes	No
Killer Whales (Orcinus orca) Southern Resident (SR)	Endangered	No	No	No	No

Affected Essential Fish Habitat (EFH) and NMFS' Determinations:

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
Pacific Coast Groundfish	No	No
Coastal Pelagic Species	No	No

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

Issued By:

Kim W. Kratz, Ph.D
Assistant Regional Administrator
Oregon Washington Coastal Office

Date: August 14, 2023

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LIST OF ACRONYMS

BA – Biological Assessment
BMP – Best Management Practices
CFR – Code of Federal Regulations
DIP – Demographically Independent Population
DPS – Distinct Population Segment
DQA – Data Quality Act
EF – Essential Feature
EFH – Essential Fish Habitat
ESA – Endangered Species Act
ESU – Evolutionarily Significant Unit
FR – Federal Register
FMP – Fishery Management Plan
FSR – Forest Service Road
HAPC – Habitat Area of Particular Concern
HPA – Hydraulic Project Approval
HUC – Hydrologic Unit Code
ITS – Incidental Take Statement
LFH – Listed Fish Habitat
LSR – Late Successional Reserve
MDN – Marine Derived Nutrients
mg/L – Milligrams per Liter
MOU – Memorandum of Understanding
MPG – Major Population Group
MSA – Magnuson-Stevens Fishery Conservation and Management Act
MBSNF - Mount Baker Snoqualmie National Forest
NF – North Fork
NF/MF – North Fork Middle Fork Population
NMFS – National Marine Fisheries Service
NOAA – National Oceanic and Atmospheric Administration
NOS – Normal Operating Season
NTU – Nephelometric Turbidity Units
PAH – Polycyclic Aromatic Hydrocarbons
PBF – Physical or Biological Feature
PCE – Primary Constituent Element
PDC - Project Design Criteria
PFMC – Pacific Fishery Management Council
PS – Puget Sound
PSSTRT – Puget Sound Steelhead Technical Recovery Team
PSTRT – Puget Sound Technical Recovery Team
RR - Riparian Reserve
RPA – Reasonable and Prudent Alternative
RPM – Reasonable and Prudent Measure
SDI – Stand Density Index
SI – Stand Improvement

SPTH – Site Potential Tree Height
USFS – United States Forest Service
VDT – Variable Density Thinning
VRH – Variable Retention Harvest
VSP – Viable Salmonid Population
WCR – West Coast Region (NMFS)
WDFW – Washington State Department of Fish and Wildlife
WDNR – Washington State Department of Natural Resources
WDOE – Washington State Department of Ecology

1. 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) of 1973 (16 USC 1531 et seq.), and implementing regulations at 50 CFR 402, as amended.

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.

On July 5, 2022, the U.S. District Court for the Northern District of California issued an order vacating the 2019 regulations that were revised or added to 50 CFR part 402 in 2019 ("2019 Regulations," see 84 FR 44976, August 27, 2019) without making a finding on the merits. On September 21, 2022, the U.S. Court of Appeals for the Ninth Circuit granted a temporary stay of the district court's July 5 order. On November 14, 2022, the Northern District of California issued an order granting the government's request for voluntary remand without vacating the 2019 regulations. The District Court issued a slightly amended order two days later on November 16, 2022. As a result, the 2019 regulations remain in effect, and we are applying the 2019 regulations here. For purposes of this consultation and in an abundance of caution, we considered whether the substantive analysis and conclusions articulated in the biological opinion and incidental take statement would be any different under the pre-2019 regulations. We have determined that our analysis and conclusions would not be any different.

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 Act (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. A complete record of this consultation is on file at the Oregon Washington Coastal Office.

1.2 Consultation History

Between April 4, 2020 and February 12, 2021, numerous meetings/conference calls and e-mail exchanges occurred between Level-1 team members to refine project details and information needs. On September 15, 2020 a Zoom ArcGIS online tour of the Nooksack Project area was given to USFWS and to the NMFS to display resource conditions to assist in design of the proposed action. On February 12, 2021 a Zoom call took place between USFS and USFWS to review project and proposed mitigations and conservation measures for fish and wildlife.

The USFS provided draft Biological Assessments (BA) to the U.S. Fish and Wildlife Service (USFWS) and to the NMFS July 12, 2021. The USFWS and NMFS provided initial comments on the draft BA August 18 and 19, 2021, respectively. On November 23, 2021 the USFS withdrew the final EA and draft NEPA decision after the road system within the project area was dramatically changed due to flood damage in November. A follow-up Level-1 team conference call was held March 17, 2022 to review the modifications of the proposed action and draft BAs and the comments from the Services. On May 16, 2022, the NMFS received the formal request from the USFS for formal consultation (USFS 2022a) with its enclosed BA (USFS 2022b). Formal consultation for the proposed action was initiated on that date.

On October 27, 2022, the USFS hosted a site tour within the action area to review some of the proposed actions. On the ground review of the project area was primarily focused on the North Fork Nooksack and Canyon Creek sub-watershed.

Between October 27, 2022 and February 13, 2023 numerous meetings, emails and phone calls occurred between NMFS, USFS and the Nooksack Tribe, to discuss the lack of clear and specific language addressing how unstable landforms will be identified and assessed in the mitigation measure of SWF6 (dealing with the identification of unstable landforms). A modification to the BAs Project Design Criteria to include the updated SWF6 mitigation measures was made on February 13, 2023(USFS 2023a).

This Opinion is based on the information in the BA; supplemental materials and responses to NMFS questions; recovery plans, status reviews, viability assessments and critical habitat designations for ESA-listed PS Chinook salmon and PS steelhead; published and unpublished scientific information on the biology and ecology of those species; and relevant scientific and gray literature (see References).

1.3 Proposed Federal Action

Under the ESA, "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). Under the MSA, federal action means any action authorized, funded, or undertaken, or proposed to be authorized, funded or undertaken by a federal agency (50 CFR 600.910).

We considered, under the ESA, whether or not the proposed action would cause any other activities and determined that it would not. The proposed action includes all direct and indirect effects of all project elements considered in this opinion.

The USFS proposes to implement regular forest management practices to decrease stand densities, promote tree growth, restore ecological functions associated with late-seral characteristics, and supply local economies with timber, through the use of timber sales on the Mount Baker Snoqualmie National Forest (MBSNF).

The USFS's Nooksack Vegetation Management Project would take place in the Mt. Baker District of the Mt. Baker-Snoqualmie National Forest (MBSNF). The western boundary of the project area is about 36 miles inland of Puget Sound, and about 5 miles east of Maple Falls, Washington (Figure 1). The project area encompasses about 96,091 acres, approximately 82,982 acres of which are on National Forest System lands. The project is located within sub-watersheds of the North Fork (NF) Nooksack River Basin, which include Canyon Creek, Wells Creek, Hedrick Creek – NF Nooksack, and Twin Lakes sub-basin.

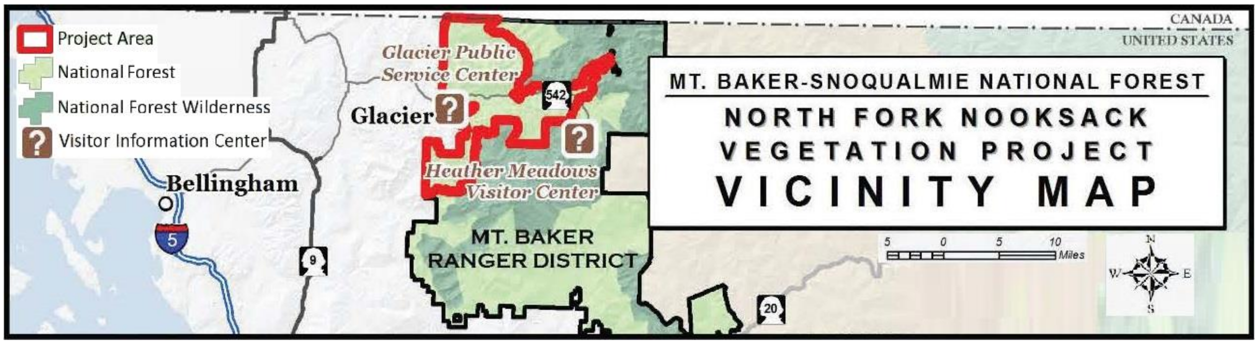


Figure 1. Map of the Nooksack Vegetation Management Project area, which is east of Bellingham, Washington (Adapted from USFS 2022b Figure 1).

Project Elements

The proposed action includes two main components: 1) Vegetation Treatments; and 2) Transportation (Table 1). The USFS estimates that project activities may begin as early as the summer of 2023, and that most project-related activities would be completed within 15 years. Vegetation Treatments would include commercial and non-commercial thinning applications, as well as associated timber yarding and removal. The Transportation component would consist of road work required to complete the proposed vegetation treatments and to haul merchantable timber out of the project area. Road work activities include the reconstruction of previously decommissioned roads, a small amount of new road construction, danger tree removal, and the use and expansion of existing rock sources. Road maintenance and the decommissioning would be done based on the ongoing needs of the project. All project related work would be done in compliance with the Project Design Criteria (PDC) and Mitigation Measures listed in Table 5 of the BA (USFS 2022b). Workers would also comply with all requirements of the Memorandum of Understanding (MOU) between the Washington State Department of Fish and Wildlife (WDFW) and the USFS (USFS 2022c).

Table 1. Estimated total timber harvest and related actions that are likely to be implemented under this program over the next 15 years (USFS 2022b).

Treatment Type	Estimated, Project Totals
Total commercial thinning	1,797 Acres
Commercial thinning within riparian reserves	399 Acres
Total non-commercial thinning	858 Acres
Non-commercial thinning within riparian reserves	268 Acres
Total project toads	67.5 Miles
Temporary roads	17.5 Miles

A. Vegetation Treatments

Riparian Reserves Specifications: The Northwest Forest Plan (NWFP 1994) defines Riparian Reserves (RR) as areas along all streams, wetlands, ponds, lakes, and unstable or potentially unstable areas where the conservation of aquatic and riparian-dependent terrestrial resources receive primary emphasis. The main purpose of the reserves is to protect the health of the aquatic system and its dependent species; the reserves also provide incidental benefits to upland species. These reserves help maintain and restore riparian structures and functions, benefit fish and riparian-dependent non-fish species, enhance habitat conservation for organisms who depend on the transition zone between upslope and riparian areas, improve travel and dispersal corridors for terrestrial animals and plants, and provide for greater connectivity of late-successional forest habitat.

The width of Riparian Reserves is a function of the Site-Potential-Tree-Height (SPTH), and stream type (FEMAT 1993). Stream protection buffers are corridors within the Riparian Reserve (RR) that restrict timber harvest activities in order to help preserve riparian and stream processes. (often referred to as "no-cut buffers"). Commercial thinning treatments and heavy equipment use are not allowed within stream protection buffers.

The stream protection buffers are measured from the edge of bankfull channel width, on both sides of the stream. Table 2 contains RR widths as specified in the NWFP as well as stream protection buffers by stream type.

Table 2. Stream types and definitions, and associated RR widths as delineated by the NWFP, and minimum stream protection buffer widths.

Stream Type	RR (feet)	Stream Protection Buffer (feet)	Stream Type Definition
1	300	150	A waterbody containing ESA-listed fish, or municipal water source
2	300	150	Non-ESA listed fish-bearing streams
3	150	150	Non-fish bearing, perennial streams
4	100	50	Non-fish Intermittent/Ephemeral streams

Vegetation Treatments: Vegetation treatments could occur on up to 2,655 acres and include 1797 acres of commercial thinning and 858 acres of non-commercial thinning. A total of 544 acres would be treated in Riparian Reserves, including 399 acres of commercial thinning and 256 of non-commercial thinning. Commercial thinning would include Variable Retention Harvest (VRH) and Variable Density Thinning (VDT) treatments, non-commercial treatments would include stand improvement (SI) thinning (Figure 2). Thinning treatments could also include small variably sized patches of heavy thinning (gaps) as well as patches of no thinning (skips). The USFS reports that the vegetation treatments are designed to manage forest density, increase growth of desired crop trees, reduce fire severity, improve species composition, stand structure, huckleberry productivity. The proposed treatments are designed to accelerate the development of late-successional and old-growth forest habitats, create space for early seral habitat, and provide connectivity for organisms that utilize both early and late successional forests. Commercial thinning treatments are designed to provide timber and other forest products that contribute to local economies.

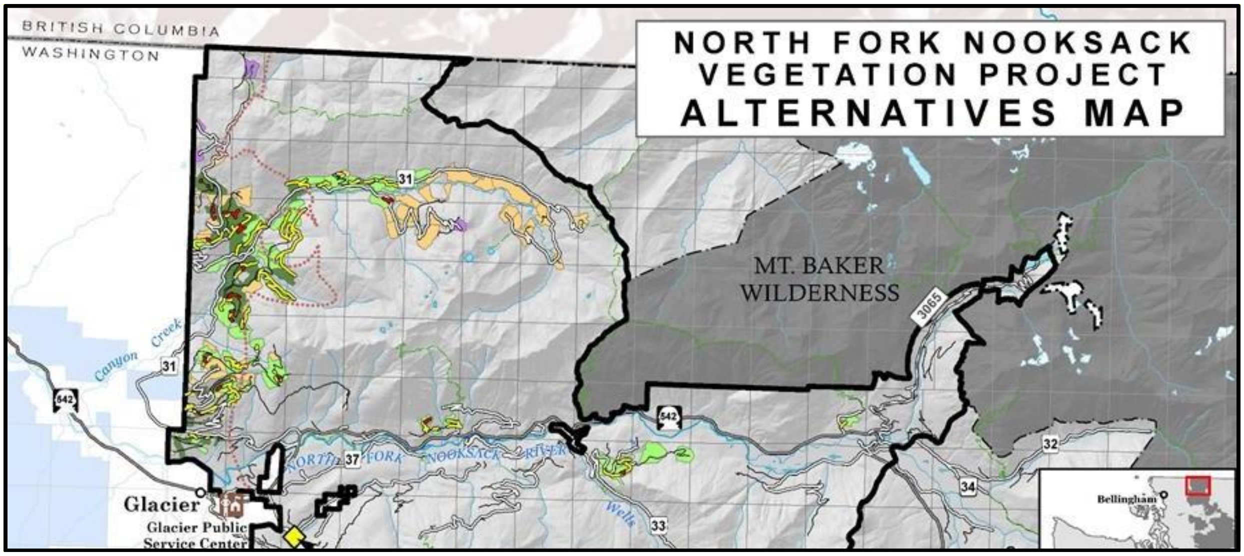


Figure 2. Map of the Nooksack Vegetation Management Project area showing vegetation treatments (Adapted from USFS 2022b Figure 3).

Commercial Thinning: Commercial thinning would occur in forest stands that were previously harvested and are less than 80 years old, including 586 acres using VRH treatments and 1,211 acres using VDT treatments. The BA states that the number of acres actually treated may be less from the number of acres proposed for treatment, given that in recent years only 30% to 50% of the total acres identified for potential commercial thinning were actually treated. Differences in proposed area versus treated area are based on a number of operational constraints (non-merchantable timber, no-cut buffer area, geomorphic and other logging system obstacles), therefore proposed acre values described in this opinion represent the maximum area that could be treated.

VRH treatments could take place on up to 586 acres, with the majority of the treated area occurring in Canyon Creek (451 acres) and remaining areas occurring in NF Nooksack sub-watersheds (135 acres). These thinning treatments are designed to retain 10 to 75% of the pre-harvest area in patches, with the additional retention of some green trees to become snags and logs. The USFS reports that the optimal retention rate is 30%, but this proportion could fluctuate depending on management consideration such as site quality and soil characteristics. Retained trees (individual or aggregated patterns) are selected to provide desired elements of early seral conditions. Non-tree dominated openings are designed to provide habitat conditions (increased sunlight) for preferred early seral forage species. The treatment's ecological objectives are to maintain living and dead biological legacies of pre-disturbed stand conditions by restoring the landscape to a more natural mosaic of structural stages. VRH treatments would only be applied outside of the Northwest Forest Plan Riparian Reserves, only within Matrix land allocations, and harvested trees would have a maximum diameter of 20" DBH in all VRH treatments. About 9.2 total stream miles exist in project area stands planned for VRH treatments, of which 8.7 miles are intermittent, 0.36 miles are perennial and 0.12 miles are fish-bearing.

VDT could take place on up to 1,211 acres and would limit cutting to trees of the most abundant conifer species. Treatments would take place on Matrix land allocations (519 acres) and Late Successional Reserves (692 acres). An estimated 399 of the 1211 acres would be in Riparian Reserves (USFS 2023c). The majority of the treated area (includes all land allocations) would occur in the Canyon Creek Watershed (757 acres), with smaller treatments occurring in Wells Creek (113 acres) and NF Nooksack sub-watersheds (101 acres). VDT has a desired post-harvest stand density index (SDI) of 120-190, this varies slightly between Matrix and Late Successional Reserve (LSR) allocations (USFS 2022e). In LSR a post-harvest SDI target of 150-190 is the stand specific prescription, and in Matrix allocations the post-harvest SDI target is 120-190. VDT thinning treatments within Riparian Reserves would maintain at least 60% canopy cover. No trees greater than 26" DBH would be removed from LSR allocations and in Matrix allocations no trees greater than 20' DBH would be removed. Any trees greater than 26" inches DBH that must be cut for safety or operational reasons would remain on site as coarse woody debris. However, trees (no defined size) that must be cut for safety or operational reasons in the other land allocations could be removed unless they are needed as coarse woody debris. Variable density thinning is used to create spatially heterogeneous habitats by varying the intensity of the thinning. For this project VDT thinning treatments in LSR stands would include varied intensities of skips and gaps and sections. About 28.6 total stream miles exist in project area stands planned for VDT treatments, of which 26.9 miles are intermittent, 0.75 miles are perennial and 0.98 miles are fish-bearing.

Within variable density treatments, gaps would be areas where most of the conifers would be removed, down to 50 trees per acre, the retention of hardwoods and smaller conifers would be based on soil characteristics and desired species for forage. Gaps within LSR could be up to 0.25 acre in size, within Matrix stands gaps could range 0.25 to 3 acres in size, depending on the suitability of locations. Skipped areas would remain uncut and would be implemented as needed in stands that lack these features. In all land allocations, gap treatments would account for no more than 10% of a treated stand, and gap thinning would not occur within 150 feet of any stream. Skipped areas within treated stands could include RR, plant or cultural resource protection buffers, and areas otherwise unsuitable for commercial thinning.

<u>Non-Commercial Thinning:</u> Stand Improvement (SI) treatments, a non-commercial thinning application, are designed to enhance conditions in previously harvested stands. SI treatments would reduce stand densities, increase diameter growth rates, reduce fire severity, and decrease susceptibility to insect predation and disease while enhancing species-specific habitat. Thinning would be done mostly by hand, to remove smaller diameter trees using treatments of varying intensity. Stands would be thinned to an estimated 109 to 222 trees per acre, SI treatments could occur on up to 858 acres in forest stands over the next 15 years, with up to 256 acres of SI treatments within Riparian Reserves. Gaps within Riparian Reserves would be limited to 0.25 to 0.5 acre in size, with tree densities of 20 to 50 trees per acre. Un-thinned patches (skips) would also occur, to promote early wood recruitment. About 25.1 total stream miles exist in project area stands planned for Stand Improvement treatments, of which 24.4 miles are intermittent, 0.55 miles are perennial and 0.11 miles are fish-bearing.

<u>Riparian Reserves and Stream Protection Buffers:</u> As stated in the previous sections, 399 acres of commercial and 256 acres of non-commercial treatments would take place in Riparian Reserves. Commercial thinning would use VDT treatments with a desired post-harvest SDI of

150 to 190, which could reduce canopy cover by 20 to 40%. For all commercial and non-commercial treatments within all land allocations, no thinning would be allowed within stream protection buffers of 150 feet from the banks of any fish-bearing streams and perennial non-fish-bearing streams, and 50 feet from the banks of intermittent and ephemeral non-fish streams (Table 2). No heavy thinning (gaps) would occur within stream protection buffers of any stream.

Yarding: Commercial thinning treatments would remove the merchantable trees that are felled. Ground-based and skyline logging systems would be used to move merchantable trees to landing areas where they would be removed from the forest by truck. Traditional ground-based logging systems would be used where slopes are less than 35%. Where slopes are steeper, some combination of self-leveling or tethered ground-based equipment, or skyline equipment would be used. The limitations described above for stands within riparian reserves apply to commercially thinned stands as well as to non-commercially thinned stands.

Ground-based systems use winches and cables to drag felled trees across the ground, creating skidding corridors. The primary difference between traditional and self-leveling or tethered ground-based equipment is that traditional systems rely largely on gravity to keep the heavy equipment in place, while the latter two systems are designed to prevent the equipment from sliding down-slope. Ground-based skidding and yarding operations shall be conducted with one-end suspension (with cut end elevated of the ground) to minimize soil erosion. Skid roads would be generally limited to less than 12-foot widths and 100-foot spacing wherever possible. Skid roads are not allowed within stream protection zones, and would be located a minimum of 25 feet away from those buffers wherever possible. Existing designated skid roads would be reused where possible. Areas of gouging or soil displacement on steep slopes resulting from yarding systems will be treated to prevent rill and gully erosion and possible sediment delivery to stream courses.

Skyline systems also use winches and cables, with one cable attached to a tail-hold tree or stump at the far end of the skyline corridor, and the other attached to a yarder, with the cable held well above the ground. Felled trees are attached to the cable and suspended above ground while being pulled to the landing area. In full suspension yarding, the entire tree is suspended above ground. In other cases, only the cut end of a tree is elevated and the other end is allowed to drag across the ground as the tree is pulled to the landing area. Skyline yarding would be used where slopes exceed 35%. Full suspension is required when skyline yarding (including lateral yarding) over Class 2 and 3 stream channels. Full suspension over Class 4 streams will occur whenever feasible, however, bump logs within the channel will be utilized if full suspension cannot be achieved. Bump logs are logs placed in the stream to prevent yarded logs from being dragged through the stream. Skyline corridors are gaps between standing trees through which felled trees would be moved by skyline systems. Where feasible, existing skyline corridors would be reused. Skyline corridors would be no closer than 120 feet apart at one end, and no more than 15 feet wide whenever possible. Skyline corridors would be limited to 2 corridors per 1,000 feet of stream (USFS 2023b). Tail trees that are damaged during skyline operations would be retained to contribute to snags or woody debris in the stand.

Timber yarding and hauling would generally occur during the June 1 to October 15 Normal Operating Season (NOS). However, some of this work could occur year-round. For work that would occur outside of the NOS, the USFS would stipulate additional resource protection PDCs to the contractors as circumstances dictate (USFS 2022b).

Landings are cleared areas where cut trees are gathered and limbed before being placed on trucks for removal. They would be between 0.25 and 1.0 acre in size. All planned landing locations must be approved by the Forest Service. Where possible, existing landing areas would be used, and or be at least 150 feet away from all aquatic features. As needed, cross drains and grade breaks would be installed prior to expected seasonal precipitation, and at the end of the project. Also, all new landings would be de-compacted, seeded with native seed, and mulched at the end of the Project.

The limbs and other tree parts that are removed to create logs is called slash. Where the slash is not needed as soil surface cover within harvest units, it would be disposed of in compliance with approved procedures through some combination of piling and burning, chipping and spreading, removal of larger pieces as firewood. Burning would occur in the spring or fall during weather patterns appropriate for dispersion of smoke, and when the threat of fire spreading from pile burning would be minimal. Further, pile size and location specifications are designed to minimize the risk of damage to residual trees in the stand. Landing piles that could create a considerable area of bare soil and not expected to naturally revegetate would be replanted using seed from approved sources.

After logging is complete within a stand, skid roads, landings, and other bare soil areas would be closed and revegetated. Where suitable site conditions exist after harvest, heavy thinning areas and gaps may be seeded with ungulate forage grasses and forbs. Although native forage species would be the first choice, desirable non-invasive non-native seed may be used. Seeding with forage species would also be considered for revegetation needs, such as landing areas and decommissioned roads.

B. Transportation (Hauling, Road Construction, Maintenance and Rock Quarry Operation)

Transportation: Transportation activities would include road use to access forest stands and to remove logs (haul), as well as road construction, reconstruction, maintenance, and decommissioning work that would also include danger tree removal, use of existing rock sources, and water drafting (Figure 3). As with timber work, road maintenance and reconstruction, and log hauling would generally occur during the NOS. However, some road work (i.e. spot rocking or other work that may be required to keep roads in acceptable condition) and log hauling could occur year-round in compliance with the PDC and Mitigation Measures for this project and in compliance with any additional resource protection PDCs that may be stipulated by the USFS (USFS 2022b).

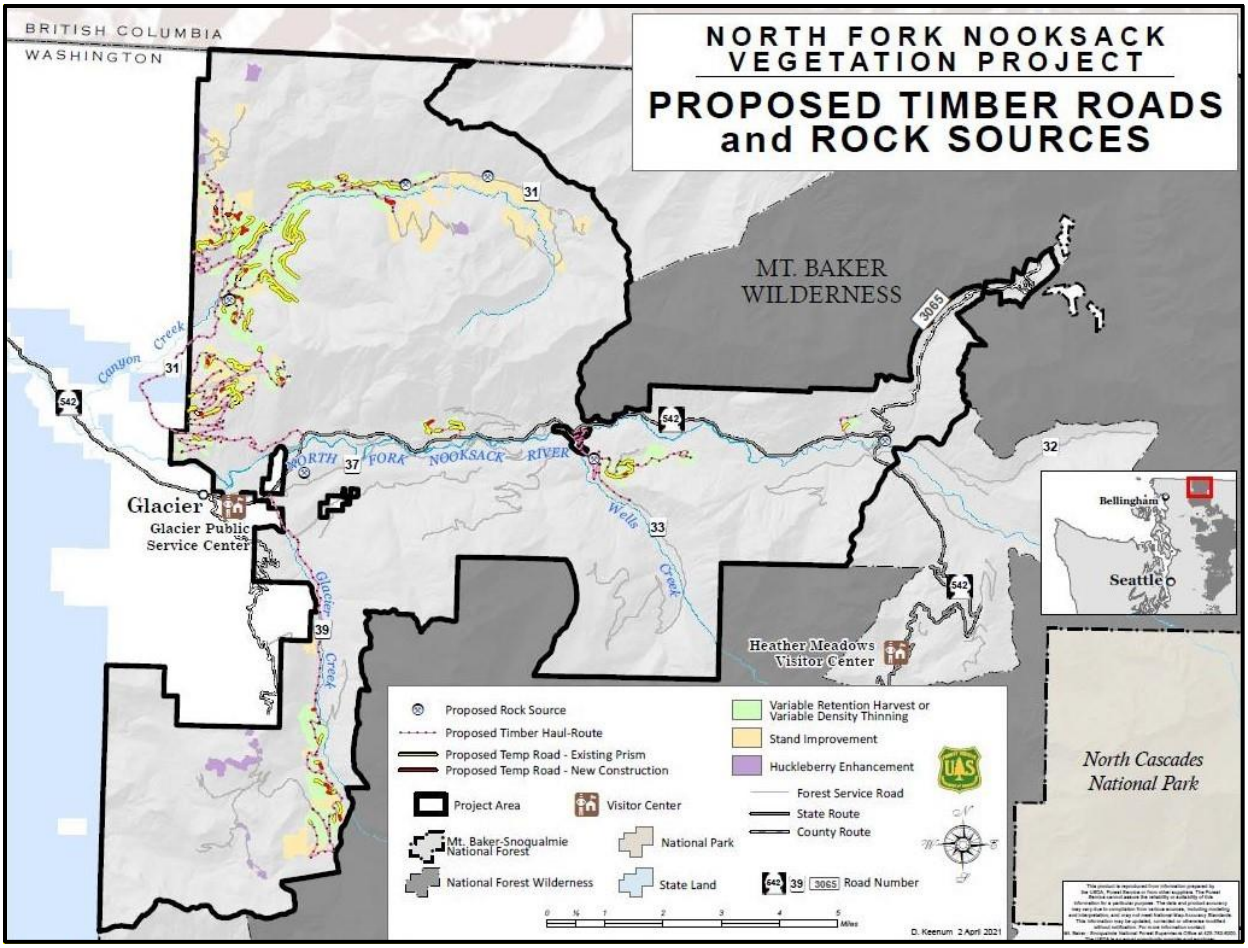


Figure 3. Map of the Nooksack Vegetation Project area showing the roads, and rock sources (Adapted from USFS 2022b Figure 4).

About 67.5 miles of road would be used and maintained over the life of the project. Log hauling trucks would use the Forest Service Roads (FSRs) and temporary roads to transport commercially cut logs out of the forest. The FSRs used for this project would consist of about 50 miles of currently open road that would be maintained as needed over the life of this project. An additional 17.5 miles of currently closed FSRs would be temporarily re-opened to support project activities. The temporarily re-opened FSRs would remain closed to the public, and would be re-closed before the end of the project. Temporary roads would consist of about 12.5 miles of existing unclassified (non-system) road that would be repaired and maintained as needed, 3.5 miles of previously decommissioned road that would be reconstructed, and 1.5 miles of new road that would need to be constructed. No new permanent roads would be constructed, all existing temporary roads would be closed and decommissioned (16 miles) and all new roads (1.5 miles) would be rehabilitated before the end of the project. An estimated 7.9 miles of temporary roads would be utilized in Riparian Reserves, this would include 7.67 miles of existing unclassified and decommissioned roads and approximately 0.25 miles of newly constructed road.

The FSRs would receive routine road maintenance and reconstruction work in accordance with standard timber sale road maintenance specifications and applicable best management practices

(BMPs). Typical work would include the use of heavy equipment to perform some combination of asphalt repair, rock-resurfacing, blading and shaping road surfaces, installation of fill, bridge replacement, ditch clearing or reconstruction, drainage dip or cross drain construction, debris removal, dust abatement, culvert cleaning or replacement, roadside brushing and danger tree removal, removal and installation of road closure devices, and installation of road cross drains. Reconstruction may also include road realignment and widening of select corners and switchbacks to improve safety. The currently open system roads would remain open after the end of this project, but the currently closed system roads would be reclosed when no longer needed.

All temporary roads used for this project would be designed and maintained to minimize soil disturbance, stabilize the roadbed and slopes. Temporary road designs would also include measures to facilitate effective drainage. Temporary roads used for this project would be constructed and or reconstructed and maintained as needed, using methods similar to those identified above for system roads, minus asphalt repair. When no longer needed, temporary roads would be closed and rehabilitated in a manner intended to restore the hydrologic connectivity of the affected area. Based on the situational needs of a particular road, typical rehabilitation work would include the use of heavy equipment and or hand tools to perform some combination of the following treatments: ripping of the roadbed; removal of shoulders, unstable fills, and culverts; restoration of natural contours and slopes; reestablishment of former drainage patterns; installation of water bars; slope stabilization; and revegetation and or scattering slash on the roadbed. Further, the entrance to roads would be blocked once they are closed and rehabilitated.

Any trees located along project-related roads and around trailheads that are determined to present a hazard in accordance with the 2008 Pacific Northwest Region Field Guide for Danger Tree Identification and Response, would be felled. Felled danger trees would generally be left on-site to provide additional course woody debris, particularly within stands where coarse wood amounts are deficient. However, felled trees that are considered economically feasible could be sold and removed from stands where coarse wood amounts aren’t considered deficient.

Crushed rock aggregate would be obtained from existing rock sources within the project boundary. The specific rock sources have not yet been identified, but would be limited to the 7 existing rock sources within the project area (shown in Figure 3). Up to about 1 acre of vegetation removal could occur at each of the 7 rock source sites. Generation and application of crushed rock aggregate would consist mostly of operating a mechanical rock crusher and standard heavy earth-moving equipment such as excavators, trucks, and levelers. Blasting is unlikely, but could occur at some sites. If blasting is needed, it would be done in compliance with the PDC and Mitigation Measures and with the MBSNF Blasting Guidelines for Protection of Fish (MBSNF Blasting Guidelines, Appendix C in USFS 2022b).

Water drafting (removal of water from streams) would be done for roadwork-related dust abatement and for fire protection. Drafting sites would be identified during project implementation, but site selection and drafting methodology would comply with the MOU between USFS and WDFW and consistent with MBSNF Water Drafting Guidelines for the Protection of Aquatic Organism (MBSNF Water Drafting Guidelines; 2022), which includes required measures such as isolating and screening pump intakes, and maintaining adequate in-stream flows for fish.

2. 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, each Federal agency must ensure that its 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 the NMFS and section 7(b)(3) requires that, at the conclusion of consultation, the NMFS provide an opinion stating how the agency's actions would affect listed species and their critical habitats. If incidental take is reasonably certain to occur, section 7(b)(4) requires the NMFS to provide an ITS that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

As described in section 1.2, the USFS determined that the proposed action would adversely affect PS Chinook salmon, PS steelhead, and designated critical habitat for both species (Table 3). Because the proposed action is likely to adversely affect ESA-listed resources under our jurisdiction, the NMFS has proceeded with formal consultation. Additionally, because of the trophic relationship between PS Chinook salmon and SR killer whales, the NMFS analyzed the action's potential effects on SR killer whales and their designated critical habitat in the "Not Likely to Adversely Affect" Determinations section (2.12) of this opinion.

Table 3. ESA-listed species and critical habitats that may be affected by the proposed action.

ESA-listed species and critical habitat likely to be adversely affected (LAA)				
Species	**Status**	**Species**	**Critical Habitat**	**Listed / CH Designated**
Chinook salmon (*Oncorhynchus tshawytscha*) Puget Sound	Threatened	LAA	LAA	06/28/05 (70 FR 37160) / 09/02/05 (70 FR 52630)
Steelhead (O. mykiss) Puget Sound	Threatened	LAA	LAA	05/11/07 (72 FR 26722) / 02/24/16 (81 FR 9252)
ESA-listed species and critical habitat not likely to be adversely affected (NLAA)				
Species	**Status**	**Species**	**Critical Habitat**	**Listed / CH Designated**
Killer Whales (Orcinus orca) Southern Resident (SR)	Endangered	NLAA	NLAA	11/18/05 (70 FR 57565)/ 11/29/06 (71 FR 69054)

2.1 Analytical Approach

This biological opinion includes both a jeopardy analysis and an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "jeopardize the continued existence of" a listed species, which is "to engage in an action that reasonably 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 CFR402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

This biological opinion also relies on the regulatory definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species" (50 CFR 402.02).

The designation(s) of critical habitat for PS Chinook salmon, PS steelhead and SR killer whales use the term primary constituent element (PCE) or essential features. The 2016 final rule (81 FR 7414; February 11, 2016) that revised the critical habitat regulations (50 CFR 424.12) replaced this term with physical or biological features (PBFs). 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 biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

The ESA Section 7 implementing regulations define effects of the action using the term "consequences" (50 CFR 402.02). As explained in the preamble to the final rule revising the definition and adding this term (84 FR 44976, 44977; August 27, 2019), that revision does not change the scope of our analysis, and in this opinion, we use the terms "effects" and "consequences" interchangeably.

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

- Evaluate the range-wide status of the species and critical habitat expected to be adversely affected by the proposed action.
- Evaluate the environmental baseline of the species and critical habitat.
- Evaluate the effects of the proposed action on species and their habitat using an exposure-response approach.
- Evaluate cumulative effects.
- In the integration and synthesis, add the effects of the action and cumulative effects to the environmental baseline, and, in light of the status of the species and critical habitat, analyze whether the proposed action is likely to: (1) directly or indirectly 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, or (2) directly or indirectly result in an alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species.
- 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 is likely to 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' "reproduction, numbers, or distribution" for the jeopardy analysis. 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 function of the PBFs that are essential for the conservation of the species.

Listed Species

Viable Salmonid Population (VSP) Criteria: For Pacific salmonids, we commonly use four VSP Criteria (McElhany et al. 2000) to assess the viability of the populations that constitute the species. These four criteria (spatial structure, diversity, abundance, and productivity) 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.

"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 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 in single genes to complex life history traits.

"Abundance" generally refers to the number of naturally-produced adults that return to their natal 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, we assess the status of the entire species based on the biological status of the constituent populations, 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 summaries that follow describe the status of the ESA-listed species, and their designated critical habitats, that occur within the action area and are considered in this opinion. More detailed information on the biology, habitat, and conservation status and trend of these listed resources can be found in the listing regulations and critical habitat designations published in the Federal Register and in the recovery plans and other sources at: https://www.fisheries.noaa.gov/species-directory/threatened-endangered, and are incorporated here by reference.

General Life History of Anadromous Salmonids: Pacific Salmon and Steelhead are anadromous salmonids. Salmon are semelparous (they spawn once and then die), while steelhead are iteroparous (they have the ability to spawn multiple times). They emerge from a fertilized egg, buried in the gravel of their natal stream, juveniles rear in freshwater habitats, prior to emigrating to the marine environments, where they spend their adult years (1-6 years) growing in the fertile Pacific Ocean. Adults return to freshwater streams to spawn and die as the start of the next generations life cycle (Groot and Margolis 1991). Rearing salmonids rely on numerous biotic and abiotic conditions within natal streams in order to survive and migrate to more fertile nurseries within the Pacific Ocean (Quinn 2005). Salmonid eggs require high dissolved oxygen concentrations and cool water temperatures for optimal growth and metabolism (Brown and Hallock 2009; Groot and Margolis 1991). After hatching, the developing alevins mature and emerge from gravel substrates. During exogenously feeding (after yolk absorption) fry occupy pool margins with cover provided by woody debris and over-hanging banks to avoid predation and excess energy expenditures associated with position maintenance in currented areas (Cederholm et al. 1997; Roni and Quinn 2001). Developing fry and parr typically move downstream during their freshwater development period, occupying different habitats over time to maximize access to food, feeding efficiency, and concealment from predators (Grimm et al. 2005). As young salmonids develop they may also increase their distance from cover and occupy greater water depths where they can find refuge from the current (Bjornn et al. 1991; Keeley and Slaney 1996). Thus, sustaining levels of rearing production in freshwater streams requires suitable habitat structure as well as adequate food availability.

Puget Sound (PS) Chinook Salmon

The PS Chinook salmon evolutionarily significant unit (ESU) was listed as threatened on June 28, 2005 (70 FR 37160). We adopted the recovery plan for this ESU in January 2007. The recovery plan consists of two documents: the Puget Sound salmon recovery plan (SSPS 2007) and the final supplement to the Shared Strategy's Puget Sound salmon recovery plan (NMFS 2006). The recovery plan adopts ESU and population level viability criteria recommended by the Puget Sound Technical Recovery Team (PSTRT) (Ruckelshaus et al. 2002). The PSTRT's biological recovery criteria would be met when all of the following conditions are achieved:

- The viability status of all populations in the ESU is improved from current conditions, and when considered in the aggregate, persistence of the ESU is assured;
- Two to four Chinook salmon populations in each of the five biogeographical regions of the ESU achieve viability, depending on the historical biological characteristics and acceptable risk levels for populations within each region;
- At least one population from each major genetic and life history group historically present within each of the five biogeographical regions is viable;
- Tributaries to Puget Sound not identified as primary freshwater habitat for any of the 22 identified populations are functioning in a manner that is sufficient to support an ESU-wide recovery scenario; Production of Chinook salmon from tributaries to Puget Sound not identified as primary freshwater habitat for any of the 22 identified populations occurs in a manner consistent with ESU recovery; and
- Populations that do not meet the viability criteria for all VSP parameters are sustained to provide ecological functions and preserve options for ESU recovery.

Chinook salmon are divided into two races, stream-types and ocean-types, based on the major juvenile development strategies. Stream-type Chinook salmon tend to rear in freshwater for a year or more before entering marine waters. Conversely, ocean-type juveniles tend to leave their natal streams early during their first year of life, and rear in estuarine waters as they transition into their marine life stage. Both stream- and ocean-type Chinook salmon are present, but ocean-type Chinook salmon predominate in Puget Sound populations.

Chinook salmon are further grouped into “runs” that are based on the timing of adults that return to freshwater. Early- or spring-run chinook salmon tend to enter freshwater as immature fish, migrate far upriver, and finally spawn in the late summer and early autumn. Late- or fall-run Chinook salmon enter freshwater at an advanced stage of maturity, move rapidly to their spawning areas, and spawn within a few days or weeks. Summer-run fish show intermediate characteristics of spring and fall runs, without the extensive delay in maturation exhibited by spring-run Chinook salmon. In Puget Sound, spring-run Chinook salmon tend to enter their natal rivers as early as March, but do not spawn until mid-August through September. Returning summer- and fall-run fish tend to enter the rivers early-June through early-September, with spawning occurring between early August and late-October.

Yearling stream-type fish tend to leave their natal rivers late winter through spring, and move relatively directly to nearshore marine areas and pocket estuaries. Out-migrating ocean-type fry tend to migrate out of their natal streams beginning in early-March. Those fish rear in the tidal delta estuaries of their natal stream for about two weeks to two months before migrating to marine nearshore areas and pocket estuaries in late May to June. Out-migrating young of the year parr tend to move relatively directly into marine nearshore areas and pocket estuaries after leaving their natal streams between late spring and the end of summer.

<u>Spatial Structure and Diversit</u>y: The Puget Sound Chinook salmon ESU includes all naturally spawning populations of Chinook salmon from rivers and streams flowing into Puget Sound including the Straits of Juan De Fuca from the Elwha River, eastward, including rivers and streams flowing into Hood Canal, South Sound, North Sound and the Strait of Georgia in Washington. The ESU also includes the progeny of numerous artificial propagation programs (NWFSC 2015, Ford 2022). The PSTRT identified 22 extant populations, grouped into five major geographic regions, based on consideration of historical distribution, geographic isolation, dispersal rates, genetic data, life history information, population dynamics, and environmental and ecological diversity. The PSTRT distributed the 22 populations among five major biogeographical regions, or major population groups (MPG), that are based on similarities in hydrographic, biogeographic, and geologic characteristics (Table 4).

Hatchery-origin spawners are present in high fractions in most populations within the ESU, with the Whidbey Basin the only MPG with consistently high fractions of natural-origin spawners. Between 1990 and 2019, the fraction of natural-origin spawners has declined in many of the populations outside of the Skagit watershed, and the ESU overall remains at a “moderate” risk of extinction (Ford 2022).

Table 4. Extant PS Chinook salmon populations in each biogeographic region (Ruckelshaus et al. 2006, NWFSC 2015).

Biogeographic Region	Population (Watershed)
Strait of Georgia	North Fork Nooksack River
	South Fork Nooksack River
Strait of Juan de Fuca	Elwha River
	Dungeness River
Hood Canal	Skokomish River
	Mid Hood Canal River
Whidbey Basin	Skykomish River
	Snoqualmie River
	North Fork Stillaguamish River
	South Fork Stillaguamish River
	Upper Skagit River
	Lower Skagit River
	Upper Sauk River
	Lower Sauk River
	Suiattle River
	Upper Cascade River
Central/South Puget Sound Basin	Cedar River
	North Lake Washington/ Sammamish River
	Green/Duwamish River
	Puyallup River
	White River
	Nisqually River

Abundance and Productivity: Available data on total abundance since 1980 indicate that abundance trends have fluctuated between positive and negative for individual populations, but productivity remains low in most populations, and hatchery-origin spawners are present in high fractions in most populations outside of the Skagit watershed. Further, across the ESU, 10 of 22 MPGs show natural productivity below replacement in nearly all years since the mid-1980s, and the available data indicate that there has been a general decline in natural-origin spawner abundance across all MPGs over the most-recent fifteen years. Further, escapement levels for all populations remain well below the PSTRT planning ranges for recovery (Ford 2022). Based on the latest viability assessment, the current information on abundance, productivity, spatial structure and diversity, concluded that the PS Chinook salmon ESU remains at “moderate” risk of extinction, that viability is largely unchanged from the prior review, and that the ESU should remain listed as threatened (Ford 2022).

Limiting Factors. Limiting factors for this species include:

- Degraded floodplain and in-river channel structure
- Degraded estuarine conditions and loss of estuarine habitat
- Riparian area degradation and loss of in-river large woody debris
- Excessive fine-grained sediment in spawning gravel

- Degraded water quality and temperature
- Degraded nearshore conditions
- Impaired passage for migrating fish
- Altered flow regime

<u>Life History of Nooksack Chinook Salmon:</u> Studies indicate that Nooksack spring Chinook salmon adults enter freshwater beginning in March and slowly migrate upstream to spawning areas (Barclay1980, Barclay 1981,). Adults entering freshwater from the North Fork/Middle Fork Nooksack River (NF/MF) population are thought to peak around mid- to late-May based on code wire tag recoveries from 2015-2020 (WDFW 2022a). Spawning in the North Fork is estimated to occur from July-September and generally peaking in August (WDFW 2022a). Nooksack Chinook exhibit three outmigrant life history patterns, these include ocean-type fry, ocean-type parr and stream-type yearlings, based on adult scale pattern analysis (Beamer et al. 2016). Therefore, fish are likely to be present within the mainstem and tributaries all year around.

<u>Contribution of Nooksack Chinook Salmon to the ESU:</u> The PS Chinook salmon that occur in the action area are part of the NF/MF Nooksack River population, which is considered to be genetically distinct from the South Fork Nooksack population. These two distinct populations are located within the same watershed are the only contributors to the Strait of Georgia major population group, which is one of five distinct MPGs contributing to the recovery of the Puget Sound ESU (Table 4). The PSTRT believes the viability of both the NF/MF Nooksack River population and the South Fork (SF) Nooksack River population are vital to the recovery of the PS Chinook ESU (Ford 2011, WDFW 2022a). This increases the need to recover the NF/MF Nooksack River population as the SF Nooksack River population is at a high risk of extinction (Ford 2022).

<u>Status of Nooksack Chinook Salmon:</u> Historically the NF Nooksack River supported an estimated Chinook salmon population of around 26,000 adults (Ruckelshaus 2002, NMFS 2006). From 1984 to 2016 escapement of NF/MF natural-origin spawners ranged from a low of 10 to a high of 498, with an average of 215 spawners (data summarized from WDFW 2022b). A stock re-building program using native broodstock was started at Kendall Creek Hatchery in 1981. From 1999 to 2018 data is available for both Hatchery-origin return (HOR) spawners and natural-origin return (NOR) spawners, during this time period the average annual abundance of HOR spawners was 1557 and NOR spawners was 268. During this 20-year time period NOR spawners on average, contributed less than 20% of natural spawning production to the NF/MF Nooksack River population (data summarized from WDFW 2022a). The North and South Fork Nooksack populations have remained below natural replacement rates since the mid 1980's (NWFSC 2015; Ford 2022). Average productivity estimates for combined NF/MF and SF Nooksack River populations for brood years 2009 through 2013 was 0.71 (WDFW 2022a).

The Final Supplement to the Shared Strategy Plan (NMFS 2006) reports Chinook salmon spawner abundance and productivity recovery targets for the NF/MF Nooksack Population. A low productivity planning target of 1.0 for a spawner abundance of 16,000 adults and a high productivity planning target of 3.4 for a spawner abundance of 3,800 adults.

Puget Sound steelhead

The PS steelhead distinct population segment (DPS) was listed as threatened on May 11, 2007 (72 FR 26722). In 2013, the Puget Sound Steelhead Technical Recovery Team (PSSTRT) identified 32 demographically independent populations (DIPs) within the DPS, based on genetic, environmental, and life history characteristics. Those DIPs are distributed among three geographically-based MPGs; Northern Cascades, Central and South Puget Sound; and Hood Canal and Strait de Fuca (Myers et al. 2015; Table 5). Critical habitat for Puget Sound steelhead DPS was designated by NMFS in 2016 (81 FR 9251, February 24, 2016). NMFS adopted the steelhead recovery plan for the Puget Sound DPS in December, 2019 (NMFS 2019).

Table 5. PS steelhead Major Population Groups (MPGs), and Demographically Independent Populations (DIPs), and DIP Viability Estimates (Modified from Figure 58 in Hard *et al.* 2015).

Geographic Region (MPG)	Demographically Independent Population (DIP)	Viability
Northern Cascades	Drayton Harbor Tributaries Winter Run	Moderate
	Nooksack River Winter Run	Moderate
	South Fork Nooksack River Summer Run	Moderate
	Samish River/Bellingham Bay Tributaries Winter Run	Moderate
	Skagit River Summer Run and Winter Run	Moderate
	Nookachamps River Winter Run	Moderate
	Baker River Summer Run and Winter Run	Moderate
	Sauk River Summer Run and Winter Run	Moderate
	Stillaguamish River Winter Run	Low
	Deer Creek Summer Run	Moderate
	Canyon Creek Summer Run	Moderate
	Snohomish/Skykomish Rivers Winter Run	Moderate
	Pilchuck River Winter Run	Low
	North Fork Skykomish River Summer Run	Moderate
	Snoqualmie River Winter Run	Moderate
	Tolt River Summer Run	Moderate
Central and South Puget Sound	Cedar River Winter Run	Low
	North Lake Washington and Lake Sammamish Winter Run	Moderate
	Green River Winter Run	Low
	Puyallup River Winter Run	Low
	White River Winter Run	Low
	Nisqually River Winter Run	Low
	South Sound Tributaries Winter Run	Moderate
	East Kitsap Peninsula Tributaries Winter Run	Moderate
Hood Canal and Strait de Fuca	East Hood Canal Winter Run	Low
	South Hood Canal Tributaries Winter Run	Low
	Skokomish River Winter Run	Low
	West Hood Canal Tributaries Winter Run	Moderate
	Sequim/Discovery Bay Tributaries Winter Run	Low
	Dungeness River Summer Run and Winter Run	Moderate
	Strait of Juan de Fuca Tributaries Winter Run	Low
	Elwha River Summer Run and Winter Run	Low

In 2015, the PSSTRT concluded that the DPS is at “very low” viability; with most of the 32 DIPs and all three MPGs at “low” viability based on widespread diminished abundance, productivity, diversity, and spatial structure when compared with available historical evidence (Hard *et al*. 2015). Based on the PSSTRT viability criteria, the DPS would be considered viable when all three component MPG are considered viable. A given MPG would be considered viable when: 1) 40% or more of its component DIP are viable; 2) mean DIP viability within the MPG exceeds the threshold for viability; and 3) 40% or more of the historic life history strategies (i.e., summer runs and winter runs) within the MPG are viable. For a given DIP to be considered viable, its probability of persistence must exceed 85%, as calculated by Hard et al. (2015), based on abundance, productivity, diversity, and spatial structure within the DIP.

On December 27, 2019, we published a final recovery plan for PS steelhead (84 FR 71379) (NMFS 2019). The plan indicates that within each of the three MPGs, at least fifty percent of the populations must achieve viability, and specific DIPs must also be viable:

Central and South Puget Sound MPG: Green River Winter-Run; Nisqually River Winter-Run; Puyallup/Carbon Rivers Winter-Run, or the White River Winter-Run; and at least one additional DIP from this MPG: Cedar River, North Lake Washington/Sammamish Tributaries, South Puget Sound Tributaries, or East Kitsap Peninsula Tributaries.

Hood Canal and Strait of Juan de Fuca MPG: Elwha River Winter/Summer-Run; Skokomish River Winter-Run; One from the remaining Hood Canal populations: West Hood Canal Tributaries Winter-Run, East Hood Canal Tributaries Winter-Run, or South Hood Canal Tributaries Winter-Run; and One from the remaining Strait of Juan de Fuca populations: Dungeness Winter-Run, Strait of Juan de Fuca Tributaries Winter-Run, or Sequim/Discovery Bay Tributaries Winter-Run.

North Cascades MPG: Of the eleven DIPs with winter or winter/summer runs, five must be viable: One from the Nooksack River Winter-Run; One from the Stillaguamish River Winter-Run; One from the Skagit River (either the Skagit River Summer-Run and Winter-Run or the Sauk River Summer-Run and Winter-Run); One from the Snohomish River watershed (Pilchuck, Snoqualmie, or Snohomish/Skykomish River Winter-Run); and One other winter or summer/winter run from the MPG at large.

Of the five summer-run DIPs in this MPG, three must be viable representing in each of the three major watersheds containing summer-run populations (Nooksack, Stillaguamish, Snohomish Rivers); South Fork Nooksack River Summer-Run; One DIP from the Stillaguamish River (Deer Creek Summer-Run or Canyon Creek Summer-Run); and One DIP from the Snohomish River (Tolt River Summer-Run or North Fork Skykomish River Summer-Run).

<u>General Life History:</u> PS steelhead exhibit two major life history strategies. Ocean-maturing, or winter-run fish typically enter freshwater from November to April at an advanced stage of maturation, and then spawn from February through June. Stream-maturing, or summer-run fish typically enter freshwater from May to October at an early stage of maturation, migrate to headwater areas, and hold for several months prior to spawning in the following spring. After hatching, juveniles rear in freshwater from one to three years prior to migrating to marine

habitats (two years is typical). Smoltification and seaward migration typically occurs from April to mid-May. Smolt lengths vary between watersheds, but typically range from 4.3 to 9.2 inches (109 to 235 mm) (Myers et al. 2015). Juvenile steelhead are generally independent of shallow nearshore areas soon after entering marine water (Bax et al. 1978, Brennan et al. 2004, Schreiner et al. 1977), and are not commonly caught in beach seine surveys. Recent acoustic tagging studies (Moore et al. 2010) have shown that smolts migrate from rivers to the Strait of Juan de Fuca from one to three weeks. PS steelhead feed in the ocean waters for one to three years (two years is again typical), before returning to their natal streams to spawn. Unlike Chinook salmon, most female steelhead, and some males, return to marine waters following spawning (Myers et al. 2015).

Spatial Structure and Diversity: The PS steelhead DPS includes all naturally spawned anadromous steelhead populations in streams in the river basins of the Strait of Juan de Fuca, Puget Sound, and Hood Canal, Washington, bounded to the west by the Elwha River (inclusive) and to the north by the Nooksack River and Dakota Creek (inclusive). The DPS also includes six hatchery stocks that are considered no more than moderately diverged from their associated natural-origin counterparts (USDC 2014). PS steelhead are the anadromous form of *O. mykiss* that occur below natural barriers to migration in northwestern Washington State (Ford 2022). Non-anadromous ‘‘resident’’ *O. mykiss* (a.k.a. rainbow trout) occur within the range of PS steelhead but are not part of the DPS due to marked differences in physical, physiological, ecological, and behavioral characteristics (Hard et al. 2015). As stated above, the DPS consists of 32 DIPs that are distributed among three geographically-based MPG. An individual DIP may consist of winter-run only, summer-run only, or a combination of both life history types. Winter-run is the predominant life history type in the DPS (Hard et al. 2015).

Abundance and Productivity: Available data on total abundance since the late 1970s and early 1980s indicate that abundance trends have fluctuated between positive and negative for individual DIPs. The long-term abundance of adult steelhead returning to many rivers in Puget Sound has fallen substantially since estimates began for many populations in the late 1970s and early 1980s. Despite relative improvements in abundance and productivity for some DIPs between 2015 and 2019, particularly in the Central and South Puget Sound MPG, low productivity persists throughout the 32 DIPs, with most showing long term downward trends (Ford 2022). Since the mid-1980s, trends in natural spawning abundance have also been temporally variable for most DIPs but remain predominantly negative, well below replacement for most DIPs, and most DIPs remain small (Ford 2022). Over the time series examined, the over-all abundance trends, especially for natural spawners, remain predominantly negative or flat across the DPS, and general steelhead abundance across the DPS remains well below the level needed to sustain natural production into the future (Ford 2022). The PSSTRT concluded that the PS steelhead DPS is currently not viable (Hard et al. 2015). The most recent viability assessment reported a slightly increasing viability trend for the Puget Sound steelhead DPS, but also reported that the extinction risk remains moderate for the DPS, and that the DPS should remain listed as threatened (Ford 2022).

Limiting Factors: Factors limiting recovery for PS steelhead include:

- The continued destruction and modification of steelhead habitat
- Widespread declines in adult abundance (total run size), despite significant reductions in harvest in recent years
- Threats to diversity posed by use of two hatchery steelhead stocks (Chambers Creek and Skamania)
- Declining diversity in the DPS, including the uncertain but weak status of summer run fish
- A reduction in spatial structure
- Reduced habitat quality through changes in river hydrology, temperature profile, downstream gravel recruitment, and reduced movement of large woody debris
- In the lower reaches of many rivers and their tributaries in Puget Sound where urban development has occurred, increased flood frequency and peak flows during storms and reduced groundwater-driven summer flows, with resultant gravel scour, bank erosion, and sediment deposition
- Dikes, hardening of banks with riprap, and channelization, which have reduced river braiding and sinuosity, increasing the likelihood of gravel scour and dislocation of rearing juveniles

Status of Nooksack Steelhead DIP: Historic steelhead abundance is estimated around 30,986 adults for the Nooksack Distinct Independent Population (NMFS 2019). Current natural origin spawner abundance estimates for the DIP are based on available data starting in 2010. A recent status update (Ford 2022) gives 5-year geometric mean natural spawner estimate of 1,745 for 2010 through 2014 and 1,906 for 2015 through 2019. This is an estimated positive change of 9% for the DIP over the last two 5-year evaluation periods. Recovery goals are based on high and low levels of productivity, using recruits to spawner (R/S) ratios. In years of high productivity (R/S = 2.3) recovery abundance goals are 6,500 adults and in years of low productivity (R/S = 1) recovery abundance goals are set at 21,700 adults. (NMFS 2019)

PS Steelhead Within the Action Area: The PS steelhead most likely to occur in the action area would be winter-run fish from the Nooksack DIP (NWFSC 2015; NMFS 2019; Figure 5). In the DIP, returning winter-run adults typically enter freshwater early November through the end of April, and spawn between March and June (Myers et al. 2015). Juveniles are present within the watershed year-round, utilizing streams within the action area for rearing and migration for one to three years before smoltification and seaward migration between April and mid-May (Myers et al. 2015). Distribution of steelhead within the action area has been documented in numerous reaches all the way up to Nooksack Falls as well as up Canyon Creek to RM 9.14 and up Glacier Creek to RM 3.7 (USFS 2022a; WDFW 2022d).

Critical Habitat

This section describes the status of designated critical habitat that would be affected by the proposed action by examining the condition and trends of physical or biological features (PBFs) that are essential to the conservation of the listed species throughout the designated areas. The PBFs are essential because they support one or more of the species' life stages (e.g., sites with conditions that support spawning, rearing, migration and foraging). The project area overlaps with areas that have been designated as critical habitat for PS Chinook salmon and PS steelhead.

The NMFS designated critical habitat for PS Chinook salmon on September 2, 2005 (70 FR 52630). Critical habitat is located in 16 freshwater subbasins and watersheds between the Dungeness/Elwha Watershed and the Nooksack Subbasin, inclusively, as well as in nearshore marine waters of the Puget Sound that are south of the US-Canada border and east of the Elwha River, and out to a depth of 30 meters. Although offshore marine is an area type identified in the final rule, it was not designated as critical habitat for PS Chinook salmon.

The NMFS designated critical habitat for PS steelhead on February 24, 2016 (81 FR 9252). Critical habitat is located in 18 freshwater subbasins between the Strait of Georgia Subbasin and the Dungeness-Elwha Subbasin, inclusively, but includes no marine waters.

The PBFs of salmonid critical habitat include: (1) Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development; (2) Freshwater rearing sites with: (i) Water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; (ii) Water quality and forage supporting juvenile development; and (iii) Natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks; (3) Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival; (4) Estuarine areas free of obstruction and excessive predation with: (i) Water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; (ii) Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels; and (iii) Juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation; (5) Nearshore marine areas free of obstruction and excessive predation with: (i) Water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and (ii) Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and (6) Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation. The PBF for PS Chinook salmon CH are listed in Table 6.

Table 6. Physical or biological features (PBFs) and corresponding life history events of designated critical habitat for PS Chinook salmon and PS steelhead.

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

Major tributary river basins in the Puget Sound basin include the Nooksack, Samish, Skagit, Sauk, Stillaguamish, Snohomish, Lake Washington, Cedar, Sammamish, Green, Duwamish, Puyallup, White, Carbon, Nisqually, Deschutes, Skokomish, Duckabush, Dosewallips, Big Quilcene, Elwha, and Dungeness rivers and Soos Creek. Critical habitat throughout the Puget Sound basin has been degraded by numerous activities, including hydropower development, loss of mature riparian forests, increased sediment inputs, removal of large wood from the waterways, intense urbanization, agriculture, alteration of floodplain and stream morphology (i.e., channel modifications and diking), riparian vegetation disturbance, wetland draining and conversion, dredging, armoring of shorelines, marina and port development, road and railroad construction and maintenance, logging, and mining. Changes in habitat quantity, availability, and diversity, and flow, temperature, sediment load and channel instability are common limiting factors of critical habitat throughout the basin.

Land use practices have likely accelerated the frequency of landslides delivering sediment to streams. Fine sediment from unpaved roads also contributes to stream sedimentation. Unpaved roads are widespread on forested lands in the Puget Sound basin, and to a lesser extent, in rural residential areas. Historical logging removed most of the riparian trees near stream channels. Subsequent agricultural and urban conversion permanently altered riparian vegetation in the river valleys, leaving either no trees, or a thin band of trees. The riparian zones along many agricultural areas are now dominated by alder, invasive canary grass and blackberries, and provide substantially reduced stream shade and LW recruitment (SSPS 2007).

Diking, agriculture, revetments, railroads and roads in lower stream reaches have caused significant loss of secondary channels in major valley floodplains in this region. Confined main channels create high-energy peak flows that remove smaller substrate particles and large wood. The loss of side-channels, oxbow lakes, and backwater habitats has resulted in a significant loss of juvenile salmonid rearing and refuge habitat. When the water level of Lake Washington was lowered 9 feet in the 1910s, thousands of acres of wetlands along the shoreline of Lake Washington, Lake Sammamish and the Sammamish River corridor were drained and converted to agricultural and urban uses. Wetlands play an important role in hydrologic processes, as they store water which ameliorates high and low flows. The interchange of surface and groundwater in complex stream and wetland systems helps to moderate stream temperatures. Thousands of acres of lowland wetlands across the region have been drained and converted to agricultural and urban uses, and forest wetlands are estimated to have diminished by one-third in Washington State (FEMAT 1993; Spence et al. 1996; SSPS 2007).

Loss of riparian habitat, elevated water temperatures, elevated levels of nutrients, increased nitrogen and phosphorus, and higher levels of suspended sediment, presumably from urban and highway runoff, wastewater treatment, failing septic systems, and agriculture or livestock impacts, have been documented in many Puget Sound tributaries (SSPS 2007).

Peak stream flows have increased over time due to paving (roads and parking areas), reduced percolation through surface soils on residential and agricultural lands, simplified and extended drainage networks, loss of wetlands, and rain-on-snow events in higher elevation clear cuts (SSPS 2007). In urbanized Puget Sound, there is a strong association between land use and land cover attributes and rates of coho spawner mortality likely due to runoff containing contaminants emitted from motor vehicles (Feist et al. 1996).

Dams constructed for hydropower generation, irrigation, or flood control have substantially affected PS Chinook salmon populations in a number of river systems. The construction and operation of dams have blocked access to spawning and rearing habitat, changed flow patterns, resulted in elevated temperatures and stranding of juvenile migrants, and degraded downstream spawning and rearing habitat by reducing recruitment of spawning gravel and large wood to downstream areas (SSPS 2007). These actions tend to promote downstream channel incision and simplification (Kondolf 1997), limiting fish habitat. Water withdrawals reduce available fish habitat and alter sediment transport. Hydropower projects often change flow rates, stranding and killing fish, and reducing aquatic invertebrate (food source) productivity (Hunter 1992).

Juvenile mortality occurs in unscreened or inadequately screened diversions. Water diversion ditches resemble side channels in which juvenile salmonids normally find refuge. When diversion head gates are shut, access back to the main channel is cut off and the channel goes dry. Mortality can also occur with inadequately screened diversions from impingement on the screen, or mutilation in pumps where gaps or oversized screen openings allow juveniles to get into the system (WDFW 2009). Blockages by dams, water diversions, and shifts in flow regime due to hydroelectric development and flood control projects are major habitat problems in many Puget Sound tributary basins (SSPS 2007).

The nearshore marine habitat has been extensively altered and armored by industrial and residential development near the mouths of many of Puget Sound's tributaries. A railroad runs along large portions of the eastern shoreline of Puget Sound, eliminating natural cover along the shore and natural recruitment of beach sand (SSPS 2007). Degradation of the near-shore environment has occurred in the southeastern areas of Hood Canal in recent years, resulting in late summer marine oxygen depletion and significant fish kills. Circulation of marine waters is naturally limited, and partially driven by freshwater runoff, which is often low in the late summer. However, human development has increased nutrient loads from failing septic systems along the shoreline, and from use of nitrate and phosphate fertilizers on lawns and farms. Shoreline residential development is widespread and dense in many places. The combination of highways and dense residential development has degraded certain physical and chemical characteristics of the near-shore environment (HCCC 2005; SSPS 2007).

Critical habitat for PS Chinook salmon has been designated in the mainstem of the North Fork Nooksack River up to Nooksack Falls to RM 65.1, up Canyon Creek to RM 3.9, and up other action area tributaries, including Glacier Creek, Hedrick Creek, Wells Creek and Thompson Creek (Figure 4). This critical habitat provides the freshwater spawning, rearing, and migration PCEs.

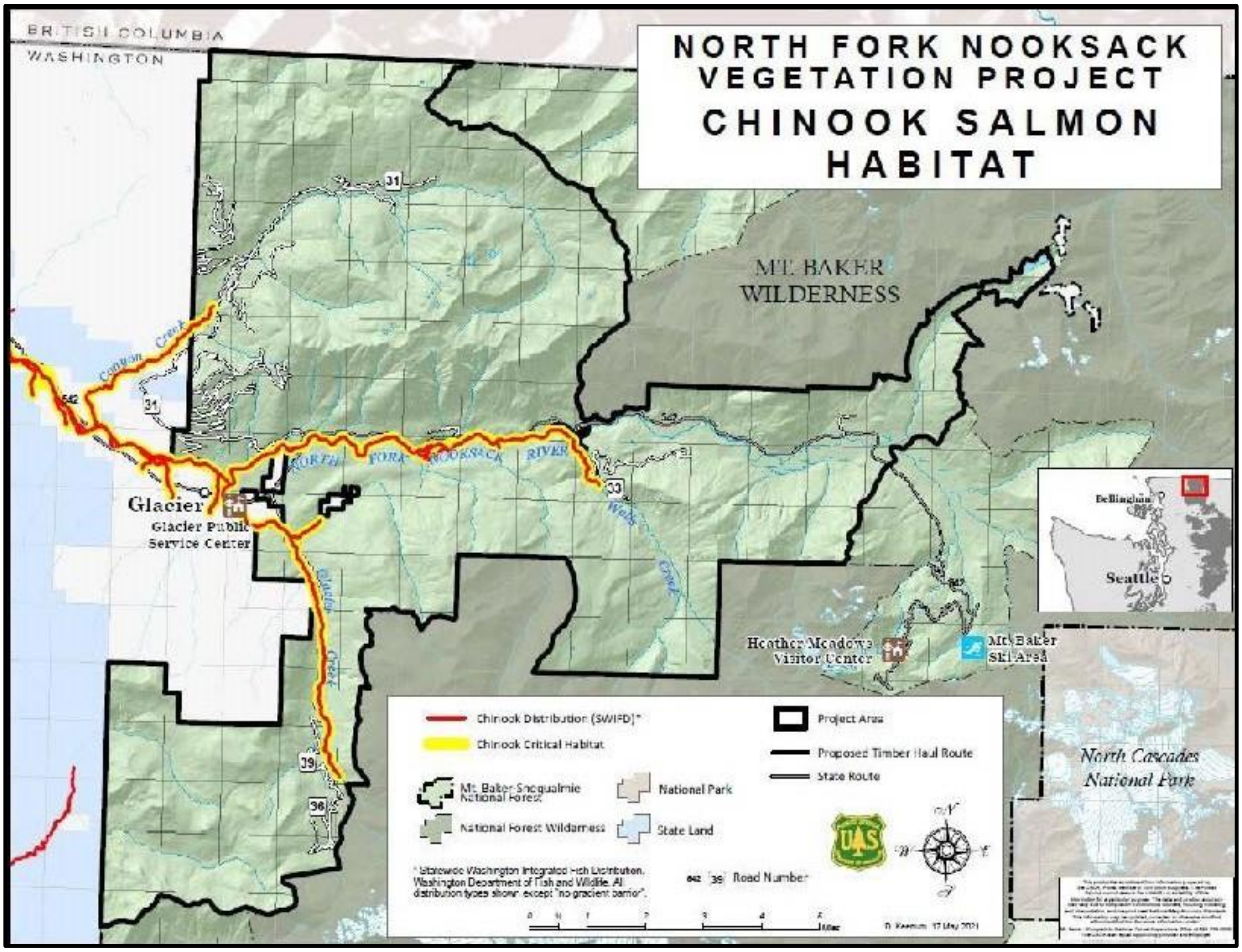


Figure 4. Map of the North Fork Nooksack Vegetation Project area showing the historic distribution and designated critical habitat for Puget Sound Chinook salmon in and downstream of the project area (From USFS 2022b Figure 8).

Critical habitat for PS steelhead has been designated in the mainstem of the North Fork Nooksack River up to Nooksack Falls to RM 65.1, up Canyon Creek to approximately RM 2.2, and up other action area tributaries, including Glacier Creek, Hedrick Creek, and Thompson Creek (Figure 5). This critical habitat provides the freshwater spawning, rearing, and migration PCEs.

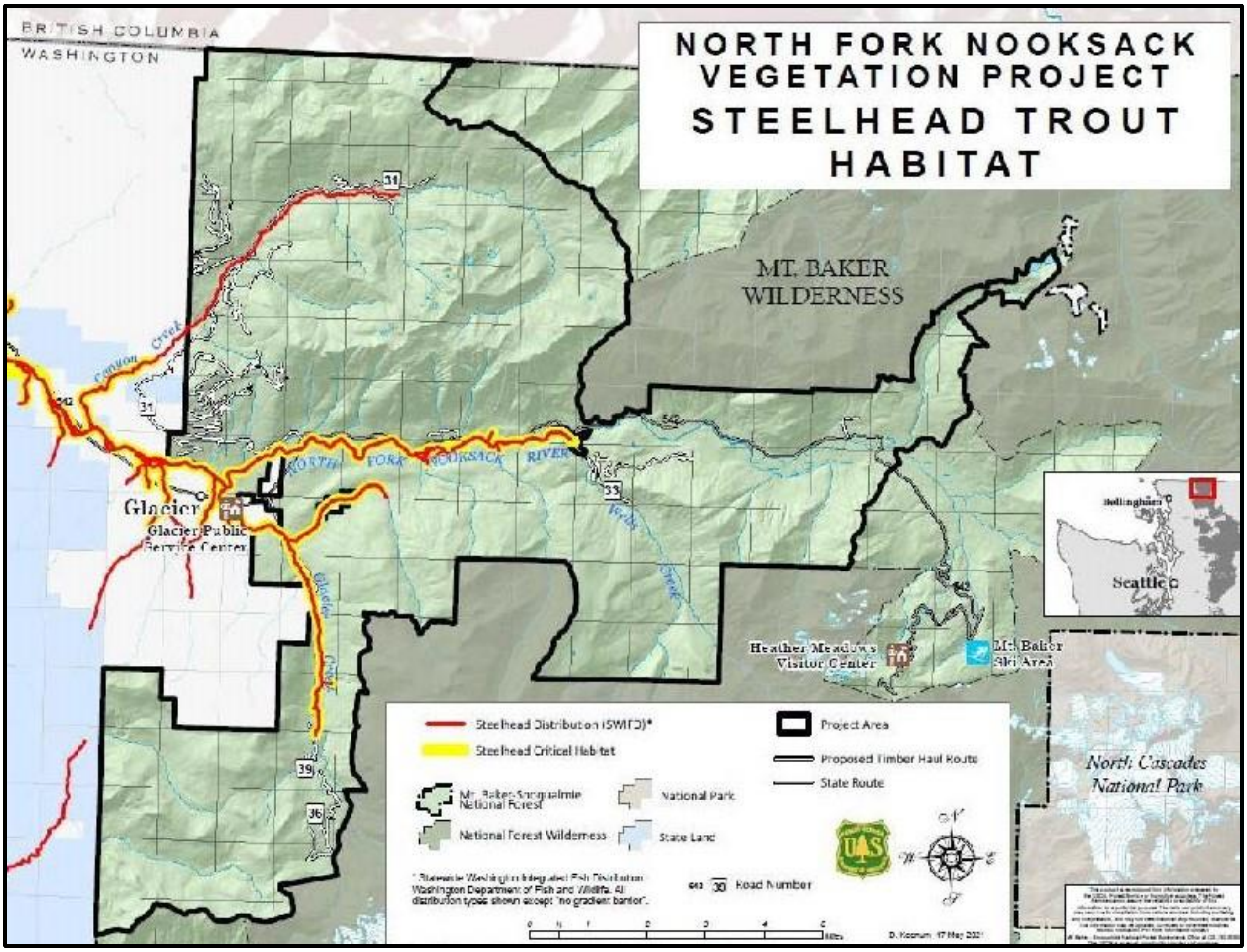


Figure 5. Map of the North Fork Nooksack Vegetation Project area showing the historic distribution and designated critical habitat for Puget Sound steelhead (From USFS 2022b Figure 9).

2.3 Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02).

As described in the Proposed Federal Action Section (1.3), the overwhelming majority of the USFS's vegetation management project would occur within the Canyon Creek watershed, where approximately 74% of proposed thinning treatments are planned. The remaining thinning treatments would take place across the other sub-watersheds of the NF Nooksack (Wells Creek, Hedrick Creek, and Twin Lakes sub-basin; Figures 1 - 3). As described in the Effects of the Action Section (2.5), project-related in-water effects would be limited to stream reaches within about 2 miles downstream of areas where project-related work such as thinning, road work, and log hauling would occur within 200 feet of streams. In the absence of site-specific information, and or information to the contrary, we estimate that elevated water temperatures and increased sediment that could be attributable to the project may extend as far as 2 miles downstream from any stream reach where thinning or transportation activities occur within 200 feet of its banks. The locations where this overlap would occur would typically consist of discontinuous stream segments scattered across the project area. To be conservative, this opinion defines the action area as all stream reaches within the project area, as well as stream reaches outside of the project area that are within 2 miles downstream of any project-related work done within 200 feet landward of those streams. We would expect that project level effects (changes in stream temperature, turbidly and wood recruitment) would be accounted for within this defined action area. Additionally, trophic connectivity between PS Chinook salmon and the SR killer whales that feed on them extends the action area to the marine waters of Puget Sound. The described area overlaps with the geographic ranges of the ESA-listed species and the boundaries of designated critical habitats identified in Table 1. The action area also overlaps with areas that have been designated, under the MSA, as EFH for Pacific Coast salmon, Pacific Coast groundfish, and coastal pelagic species.

2.4 Environmental Baseline

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

The USFS's Nooksack Vegetation Management Project would occur along western slopes of the North Cascade Mountains, within the North Fork Nooksack River watershed. The NF Nooksack originates from glaciers on the Northern slopes of Mt Shuksan and travels approximately 40 miles to the confluence with the other two forks (South Fork and Middle Fork). The river channel in the upper NF Nooksack River (above Nooksack Falls) is characterized by steep gradient and large rock and boulder substrate. In the lower river (below Nooksack Falls), sediment and organic matter, mobilized by high flow events are deposited in lower gradient channels within the flood plain. Anadromous migration is blocked by Nooksack Falls on the mainstem NF at RM 65.1, so Chinook salmon and steelhead production are naturally restricted to the lower NF watershed (USFS 2022b). Although the action area includes the marine waters of Puget Sound, all physically detectable effects of the action would be limited to the North Fork Nooksack watershed, within 2 miles downstream of the project site. Therefore, this section focuses on habitat conditions in the North Fork Nooksack watershed, and does not discuss Puget Sound habitat conditions.

Just below Nooksack Falls (RM 65) the mainstem of the North Fork the channel becomes relatively unconfined and sinuous as it flows within a broad, multi-channel alluvial floodplain until it becomes confined again at about RM 62.5. It remains relatively confined downstream until the confluence with Glacier Creek. All major tributaries within the action area are highly confined by narrow, steep-sloped valley walls, and bedrock outcroppings. Unconfined channels within tributaries are limited to small reaches within alluvial fans as the enter the valley floor.

The first humans to inhabit the area were Native Americans belonging to the Nooksack and Lummi Tribes as well as other regional tribes and bands, who relied on natural resources within the watershed for thousands of years. Written records of permanent Euro-American settlement and land development can be easily traced to the period around the signing of the 1854-55 treaties (Hollenbeck 1987). This period marks the beginning of extensive impacts from mining, timber harvest, and road development.

Gold was discovered on the Nooksack (near Sumas) in 1858, with a large rush starting in the summer of 1897 after a large lode was discovered in Canyon Creek (Schmierer 1983). Mining for gold (mostly placer) took place throughout the upper North Fork and Canyon creek watersheds. After the discovery of coal in Canyon Creek in 1907 (Moen 1969) multiple mining claims and tunnels were established in the upper watershed. Eventually it was deemed that coal and mineral mining was not worth the extraction costs (Schmeirer 1983).

Early logging in the area took place around the turn of the century, typically using oxen teams, flumes, and skid roads to move the logs. By 1909 the Bellingham Bay and British Columbia Railroad had extended a railroad line up the North Fork Nooksack into the present-day town of Glacier, Washington. Soon after the extension, numerous lumber companies constructed spur rail lines which connected to the mainline in order to efficiently move timber out of the upper watershed (Hollenbeck 1987). Timber was harvested in the Canyon Creek watershed as early as 1910, although significant levels of timber harvest did not take place until the 1950's. Peak timber harvest occurred in the 1960's with collector road systems being constructed up Whistler and Kidney Creeks, as well as the upper end of Canyon Creek drainage (USFS 1995).

Salmonid Habitat: Aquatic habitat quality within the basin has been heavily impacted by logging and by road building and use, which have been the primary land management activities across the action area during the last century. In the Canyon Creek Watershed (where the majority of the proposed work would take place), the combination of the timber harvest, stream cleanouts, road construction and landslides and intense flooding has decreased the watershed's capacity to support freshwater spawning and rearing of anadromous salmonids. The unstable, and often steep slopes, a product of the glacial geology of the upper Nooksack Watershed, has exacerbated the negative impacts from past land management actions. In a USFS watershed analysis of Canyon Creek (USFS 1995), the authors state that previous timber management activities (clear cutting, complete removal of riparian vegetation and road building) has reduced stream bank stability, increased sediment loading, led to the removal of large wood and increased stream bed scour. These actions from past management activities continue to restrict watershed processes that create and maintain salmonid habitat.

Marine Derived Nutrients: In addition to physical habitat structure, biologically productive food webs are needed to support the rearing life stages of anadromous salmonids (Bellmore et al. 2013). The productivity of freshwater food webs in anadromous watersheds is highly reliant on the pulsed subsidies of marine derived nutrients (MDN), in the form of dying and dead salmon carcasses (Wipfli et al. 1998, Wipfli et al. 2003, Kohler and Taki 2010, Wipfli and Baxter 2010).

The beneficial nutrients (Carbon, Nitrogen, Phosphorous) accrued in the marine life stages of Pacific Salmon, enable interior, freshwater streams to sustain high levels of trophic productivity, which would otherwise remain naturally oligotrophic (Stockner et al. 2003). Drastic reductions in adult escapements throughout Puget Sound Rivers has led to a severe reduction in pulsed MDN subsidies (Gresh et al. 2000, Anders et al. 2007).

Temperature: There are numerous temperature concerns throughout streams within the action area (NIT 2018). Temperature is highly variable, both temporally and spatially, and its physiological effects are often species and life stage specific. The 7-day average daily maximum temperatures recorded across action area sub-watersheds for 2015-2017 indicates that temperature thresholds for multiple life stages of Chinook salmon and steelhead were occasionally exceeded (NIT 2018).

Climate Change: Climate change has affected the environmental baseline of aquatic habitats across the region and within the action area. Climate change is likely to play an increasingly important role in determining the abundance and distribution of ESA-listed species, and the conservation value of designated critical habitats, in the Pacific Northwest. These changes would not be spatially homogeneous across the Pacific Northwest. Major ecological realignments are already occurring in response to climate change (IPCC WGII, 2022). Long-term trends in warming have continued at global, national and regional scales. Global surface temperatures in the last decade (2010s) were estimated to be 1.09 °C higher than the 1850-1900 baseline period, with larger increases over land ~1.6 °C compared to oceans ~0.88 (IPCC WGI, 2021). The vast majority of this warming has been attributed to anthropogenic releases of greenhouse gases (IPCC WGI, 2021). Globally, 2014-2018 were the 5 warmest years on record both on land and in the ocean (2018 was the 4th warmest) (NOAA NCEI 2022). Events such as the 2013-2016 marine heatwave (Jacox et al. 2018) have been attributed directly to anthropogenic warming in the annual special issue of Bulletin of the American Meteorological Society on extreme events (Herring et al. 2018). Global warming and anthropogenic loss of biodiversity represent profound threats to ecosystem functionality (IPCC WGII 2022). These two factors are often examined in isolation, but likely have interacting effects on ecosystem function.

Updated projections of climate change are similar to or greater than previous projections (IPCC WGI, 2021). NMFS is increasingly confident in our projections of changes to freshwater and marine systems because every year brings stronger validation of previous predictions in both physical and biological realms. Retaining and restoring habitat complexity, access to climate refuges (both flow and temperature) and improving growth opportunity in both freshwater and marine environments are strongly advocated in the recent literature (Siegel and Crozier 2020). Climate change is systemic, influencing freshwater, estuarine, and marine conditions. Other systems are also being influenced by changing climatic conditions. Literature reviews on the impacts of climate change on Pacific salmon (Crozier 2015, 2016, 2017, Crozier and Siegel 2018, Siegel and Crozier 2019, 2020) have collected hundreds of papers documenting the major themes relevant for salmon. Here we describe habitat changes relevant to Pacific salmon and steelhead, prior to describing how these changes result in the varied specific mechanisms impacting these species in subsequent sections.

Forests

Climate change would impact forests of the western U.S., which dominate the landscape of many watersheds in the region. Forests are already showing evidence of increased drought severity, forest fire, and insect outbreak (Halofsky et al. 2020). Additionally, climate change would affect tree reproduction, growth, and phenology, which would lead to spatial shifts in vegetation. Halofsky et al. (2018) projected that the largest changes would occur at low- and high-elevation forests, with expansion of low-elevation dry forests and diminishing high-elevation cold forests and subalpine habitats.

Forest fires affect salmon streams by altering sediment load, channel structure, and stream temperature through the removal of canopy. Holden et al. (2018) examined environmental factors contributing to observed increases in the extent of forest fires throughout the western U.S. They found strong correlations between the number of dry-season rainy days and the annual extent of forest fires, as well as a significant decline in the number of dry-season rainy days over the study period (1984-2015). Consequently, predicted decreases in dry-season precipitation, combined with increases in air temperature, would likely contribute to the existing trend toward more extensive and severe forest fires and the continued expansion of fires into higher elevation and wetter forests (Alizedeh 2021).

Agne et al. (2018) reviewed literature on insect outbreaks and other pathogens affecting coastal Douglas-fir forests in the Pacific Northwest and examined how future climate change may influence disturbance ecology. They suggest that Douglas-fir beetle and black stain root disease could become more prevalent with climate change, while other pathogens would be more affected by management practices. Agne et al. (2018) also suggested that due to complex interacting effects of disturbance and disease, climate impacts would differ by region and forest type.

Freshwater Environments

The following is excerpted from Siegel and Crozier (2019), who present a review of recent scientific literature evaluating effects of climate change, describing the projected impacts of climate change on instream flows:

Cooper et al. (2018) examined whether the magnitude of low river flows in the western U.S., which generally occur in September or October, are driven more by summer conditions or the prior winter's precipitation. They found that while low flows were more sensitive to summer evaporative demand than to winter precipitation, interannual variability in winter precipitation was greater. Malek et al. (2018), predicted that summer evapotranspiration is likely to increase in conjunction with declines in snowpack and increased variability in winter precipitation. Their results suggest that low summer flows are likely to become lower, more variable, and less predictable.

The effect of climate change on ground water availability is likely to be uneven. Sridhar et al. (2018) coupled a surface-flow model with a ground-flow model to improve predictions of surface water availability with climate change in the Snake River Basin. Projections using RCP

4.5 and 8.5 emission scenarios suggested an increase in water table heights in downstream areas of the basin and a decrease in upstream areas.

As cited in Siegel and Crozier (2019), Isaak et al. (2018), examined recent trends in stream temperature across the Western U.S. using a large regional dataset. Stream warming trends paralleled changes in air temperature and were pervasive during the low-water warm seasons of 1996-2015 (0.18-0.35°C/decade) and 1976-2015 (0.14-0.27°C/decade). Their results show how continued warming would likely affect the cumulative temperature exposure of migrating sockeye salmon *O. nerka* and the availability of suitable habitat for brown trout *Salmo trutta* and rainbow trout *O. mykiss*. Isaak et al. (2018) concluded that most stream habitats would likely remain suitable for salmonids in the near future, with some becoming too warm. However, in cases where habitat access is currently restricted by dams and other barriers salmon and steelhead would be confined to downstream reaches typically most at risk of rising temperatures unless passage is restored (FitzGerald et al. 2020, Myers et al. 2018).

Streams with intact riparian corridors and that lie in mountainous terrain are likely to be more resilient to changes in air temperature. These areas may provide refuge from climate change for a number of species, including Pacific salmon. Krosby et al. (2018), identified potential stream refugia throughout the Pacific Northwest based on a suite of features thought to reflect the ability of streams to serve as such refuges. Analyzed features include large temperature gradients, high canopy cover, large relative stream width, low exposure to solar radiation, and low levels of human modification. They created an index of refuge potential for all streams in the region, with mountain area streams scoring highest. Flat lowland areas, which commonly contain migration corridors, were generally scored lowest, and thus were prioritized for conservation and restoration. However, forest fires can increase stream temperatures dramatically in short time-spans by removing riparian cover (Koontz et al. 2018), and streams that lose their snowpack with climate change may see the largest increases in stream temperature due to the removal of temperature buffering (Yan et al. 2021). These processes may threaten some habitats that are currently considered refugia.

Estuarine Environments

Along with warming stream temperatures and concerns about sufficient groundwater to recharge streams, a recent study projects nearly complete loss of existing tidal wetlands along the U.S. West Coast, due to sea level rise (Thorne et al. 2018). California and Oregon showed the greatest threat to tidal wetlands (100%), while 68% of Washington tidal wetlands are expected to be submerged. Coastal development and steep topography prevent horizontal migration of most wetlands, causing the net contraction of this crucial habitat.

Rising ocean temperatures, stratification, ocean acidity, hypoxia, algal toxins, and other oceanographic processes would alter the composition and abundance of a vast array of oceanic species. In particular, there would be dramatic changes in both predators and prey of Pacific salmon, salmon life history traits and relative abundance. Siegel and Crozier (2019) observe that changes in marine temperature are likely to have a number of physiological consequences on fishes themselves. For example, in a study of small planktivorous fish, Gliwicz et al. (2018) found that higher ambient temperatures increased the distance at which fish reacted to prey.

Numerous fish species (including many tuna and sharks) demonstrate regional endothermy, which in many cases augments eyesight by warming the retinas. However, Gliwicz et al. (2018) suggest that ambient temperatures can have a similar effect on fish that do not demonstrate this trait. Climate change is likely to reduce the availability of biologically essential omega-3 fatty acids produced by phytoplankton in marine ecosystems. Loss of these lipids may induce cascading trophic effects, with distinct impacts on different species depending on compensatory mechanisms (Gourtay et al. 2018). Reproduction rates of many marine fish species are also likely to be altered with temperature (Veilleux et al. 2018). The ecological consequences of these effects and their interactions add complexity to predictions of climate change impacts in marine ecosystems.

Perhaps the most dramatic change in physical ocean conditions would occur through ocean acidification and deoxygenation. It is unclear how sensitive salmon and steelhead might be to the direct effects of ocean acidification because of their tolerance of a wide pH range in freshwater (although see Ou et al. 2015 and Wouldiams et al. 2019), however, impacts of ocean acidification and hypoxia on sensitive species (e.g., plankton, crabs, rockfish, groundfish) will likely affect salmon indirectly through their interactions as predators and prey. Similarly, increasing frequency and duration of harmful algal blooms may affect salmon directly, depending on the toxin (e.g., saxitoxin vs domoic acid), but would also affect their predators (seabirds and mammals). The full effects of these ecosystem dynamics are not known but would be complex. Within the historical range of climate variability, less suitable conditions for salmonids (e.g., warmer temperatures, lower stream flows) have been associated with detectable declines in many of these listed units, highlighting how sensitive they are to climate drivers (Ford 2022, Lindley et al. 2009, Williams et al. 2016, Ward et al. 2015). In some cases, the combined and potentially additive effects of poorer climate conditions for fish and intense anthropogenic impacts caused the population declines that led to these population groups being listed under the ESA (Crozier et al. 2019).

Climate Change Effects on Salmon and Steelhead

In freshwater, year-round increases in stream temperature and changes in flow would affect physiological, behavioral, and demographic processes in salmon, and change the species with which they interact. For example, as stream temperatures increase, many native salmonids face increased competition with more warm-water tolerant invasive species. Changing freshwater temperatures are likely to affect incubation and emergence timing for eggs, and in locations where the greatest warming occurs may affect egg survival, although several factors impact inter-gravel temperature and oxygen (e.g., groundwater influence) as well as sensitivity of eggs to thermal stress (Crozier et al. 2020). Changes in temperature and flow regimes may alter the amount of habitat and food available for juvenile rearing, and this in turn could lead to a restriction in the distribution of juveniles, further decreasing productivity through density dependence. For migrating adults, predicted changes in freshwater flows and temperatures would likely increase exposure to stressful temperatures for many salmon and steelhead populations, and alter migration travel times and increase thermal stress accumulation for ESUs or DPSs with early-returning (i.e. spring- and summer-run) phenotypes associated with longer freshwater holding times (Crozier et al. 2020, FitzGerald et al. 2020). Rising river temperatures increase the energetic cost of migration and the risk of *en route* or pre-spawning mortality of adults with long freshwater migrations, although populations of some ESA-listed salmon and steelhead may be able to make use of cool-water refuges and run-timing plasticity to reduce thermal exposure (Keefer et al. 2018, Barnett et al. 2020).

Marine survival of salmonids is affected by a complex array of factors including prey abundance, predator interactions, the physical condition of salmon within the marine environment, and carryover effects from the freshwater experience (Holsman et al. 2012, Burke et al. 2013). It is generally accepted that salmon marine survival is size-dependent, and thus larger and faster growing fish are more likely to survive (Gosselin et al. 2021). Furthermore, early arrival timing in the marine environment is generally considered advantageous for populations migrating through the Columbia River. However, the optimal day of arrival varies across years, depending on the seasonal development of productivity in the California Current, which affects prey available to salmon and the risk of predation (Chasco et al. 2021). Siegel and Crozier (2019) point out the concern that for some salmon populations, climate change may drive mismatches between juvenile arrival timing and prey availability in the marine environment. However, phenological diversity can contribute to metapopulation-level resilience by reducing the risk of a complete mismatch. Carr-Harris et al. (2018), explored phenological diversity of marine migration timing in relation to zooplankton prey for sockeye salmon *O. nerka* from the Skeena River of Canada. They found that sockeye migrated over a period of more than 50 days, and populations from higher elevation and further inland streams arrived in the estuary later, with different populations encountering distinct prey fields. Carr-Harris et al. (2018) recommended that managers maintain and augment such life-history diversity.

Synchrony between terrestrial and marine environmental conditions (e.g., coastal upwelling, precipitation and river discharge) has increased in spatial scale causing the highest levels of synchrony in the last 250 years (Black et al. 2018). A more synchronized climate combined with simplified habitats and reduced genetic diversity may be leading to more synchrony in the productivity of populations across the range of salmon (Braun et al. 2016). For example, salmon productivity (recruits/spawner) has also become more synchronized across Chinook populations from Oregon to the Yukon (Dorner et al. 2018, Kilduff et al. 2014). In addition, Chinook salmon have become smaller and younger at maturation across their range (Ohlberger 2018). Other Pacific salmon species (Stachura el al. 2014) and Atlantic salmon (Olmos et al. 2020) also have demonstrated synchrony in productivity across a broad latitudinal range.

At the individual scale, climate impacts on salmon in one life stage generally affect body size or timing in the next life stage and negative impacts can accumulate across multiple life stages (Healey 2011; Wainwright and Weitkamp 2013, Gosselin et al. 2021). Changes in winter precipitation would likely affect incubation and or rearing stages of most populations. Changes in the intensity of cool season precipitation, snow accumulation, and runoff could influence migration cues for fall, winter and spring adult migrants, such as coho and steelhead. Egg survival rates may suffer from more intense flooding that scours or buries redds. Changes in hydrological regime, such as a shift from mostly snow to more rain, could drive changes in life history, potentially threatening diversity within an ESU (Beechie et al. 2006). Changes in summer temperature and flow would affect both juvenile and adult stages in some populations, especially those with yearling life histories and summer migration patterns (Crozier and Zabel 2006; Crozier et al. 2010, Crozier et al. 2019).

At the population level, the ability of organisms to genetically adapt to climate change depends on how much genetic variation currently exists within salmon populations, as well as how selection on multiple traits interact, and whether those traits are linked genetically. While genetic diversity may help populations respond to climate change, the remaining genetic diversity of many populations is highly reduced compared to historic levels. For example, Johnson et al. (2018), compared genetic variation in Chinook salmon from the Columbia River Basin between contemporary and ancient samples. A total of 84 samples determined to be Chinook salmon were collected from vertebrae found in ancient middens and compared to 379 contemporary samples. Results suggest a decline in genetic diversity, as demonstrated by a loss of mitochondrial haplotypes as well as reductions in haplotype and nucleotide diversity. Genetic losses in this comparison appeared larger for Chinook salmon from the mid-Columbia than those from the Snake River Basin. In addition to other stressors, modified habitats and flow regimes may create unnatural selection pressures that reduce the diversity of functional behaviors (Sturrock et al. 2020). Managing to conserve and augment existing genetic diversity may be increasingly important with more extreme environmental change (Anderson et al. 2015), though the low levels of remaining diversity present challenges to this effort (Freshwater 2019). Salmon historically maintained relatively consistent returns across variation in annual weather through the portfolio effect (Schindler et al. 2015), in which different populations are sensitive to different climate drivers. Applying this concept to climate change, Anderson et al (2015) emphasized the additional need for populations with different physiological tolerances. Loss of the portfolio increases volatility in fisheries, as well as ecological systems, as demonstrated for Fraser River and Sacramento River stock complexes (Freshwater et al. 2019, Munsch et al. 2022).

The past and ongoing anthropogenic impacts described above have reduced the action area's ability to support PS Chinook salmon and PS steelhead. However, numerous tributaries and mainstem reaches within the North Fork Nooksack River watershed remain occupied by both species. Those reaches provide a combination of freshwater migratory, spawning, and rearing habitat, and much of the accessible reaches within the watershed has been designated as critical habitat for both species as well.

2.5 Effects of the Action

Under the ESA, "effects of the action" are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action (see 50 CFR 402.17). A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (see 50 CFR 402.17). In our analysis, which describes the effects of the proposed action, we considered the factors set forth in 50 CFR 402.17(a) and (b).

As described in Section 1.3, the USFS would implement a 15-year project across about 96,091 acres, approximately 82,982 acres of which are on National Forest System lands. The project is located within sub-watersheds of the NF Nooksack River Basin, which includes Canyon Creek, Wells Creek, Hedrick Creek and Twin Lakes sub-basin. In summary, the activities considered in this opinion include vegetation treatments, yarding and transportation activities. Vegetation treatments, commercial and non-commercial thinning would be done across a maximum of 2,655 acres of the National Forest System lands (Figure 2). Yarding would include ground and skyline applications. Skid roads would be generally limited to less than 12-foot widths with 100-foot spacing between roads wherever possible. Skyline corridors would generally be about 120 feet apart at the uphill end, and no more than 15 feet wide whenever possible, corridors would be at least 100 feet apart where they cross no-cut buffers. Transportation activities would include the repair, maintenance, and use of about 67.5 miles of road, including about 16 miles of temporary road that would be constructed or reconstructed, and then closed and rehabilitated when no longer needed for this project. An estimated 7.9 miles of temporary roads would be utilized in Riparian Reserves, this would include 7.67 miles of existing unclassified and decommissioned roads and approximately 0.25 miles of newly constructed road. Transportation activities would also include possible blasting for crushed rock aggregate. (Figure 3).

As described in Section 2.2, Spring-run PS Chinook salmon and winter-run PS steelhead are present in the mainstem North Fork Nooksack River watershed (below Nooksack Falls) portion of the action area, where spawning and rearing has been documented for both species. Therefore, all life stages of both species occur within that portion of the action area. Additionally, PS Chinook salmon and Steelhead have been documented in Canyon, Glacier and Thompson Creek tributaries.

Spring-run PS Chinook salmon may be present within the North Fork Nooksack watershed as early as April, then spawn between July and September. Nooksack Chinook salmon exhibit three outmigrant life history patterns, these include ocean-type fry, ocean-type parr and stream-type yearlings, based on adult scale pattern analysis (Beamer et al. 2016). Therefore, fish are likely to be present within the mainstem and tributaries all year around.

Winter-run PS steelhead adults are likely to be present within the North Fork Nooksack watershed starting in late November, and then spawn between March and June. Juveniles are present within the NF Nooksack River watershed year-round, utilizing streams within the action area for rearing and migration. They spend one to three years rearing in freshwater streams, before smoltification and seaward migration begin, between April and mid-May. Critical habitat has been designated for both steelhead and chinook within the North Fork Nooksack River watershed portions of the action area (Figures 4 & 5). That critical habitat provides Freshwater Spawning, Rearing, and Migratory PBFs for both species.

For forest management actions like the proposed action, we analyze the effects by considering how project elements are likely to impact important salmonid habitat indicators, and then consider how exposed individuals and the PBFs of their critical habitat are likely to respond to the impacts on those habitat indicators. The habitat indicators considered here are:

1. Stream Temperature;
2. Suspended Sediment and Substrate Embeddedness;
3. Chemicals and Nutrients;
4. Woody Material;
5. Pool Frequency and Quality;
6. Changes in Peak/Base Flows;

7. Drainage Network Increase;
8. Road Density and Location;
9. Disturbance History and Regime
10. Riparian Reserves.

We also analyze how listed fish and the PBFs of their critical habitat are likely to respond to direct exposure to project-related blasting and water drafting.

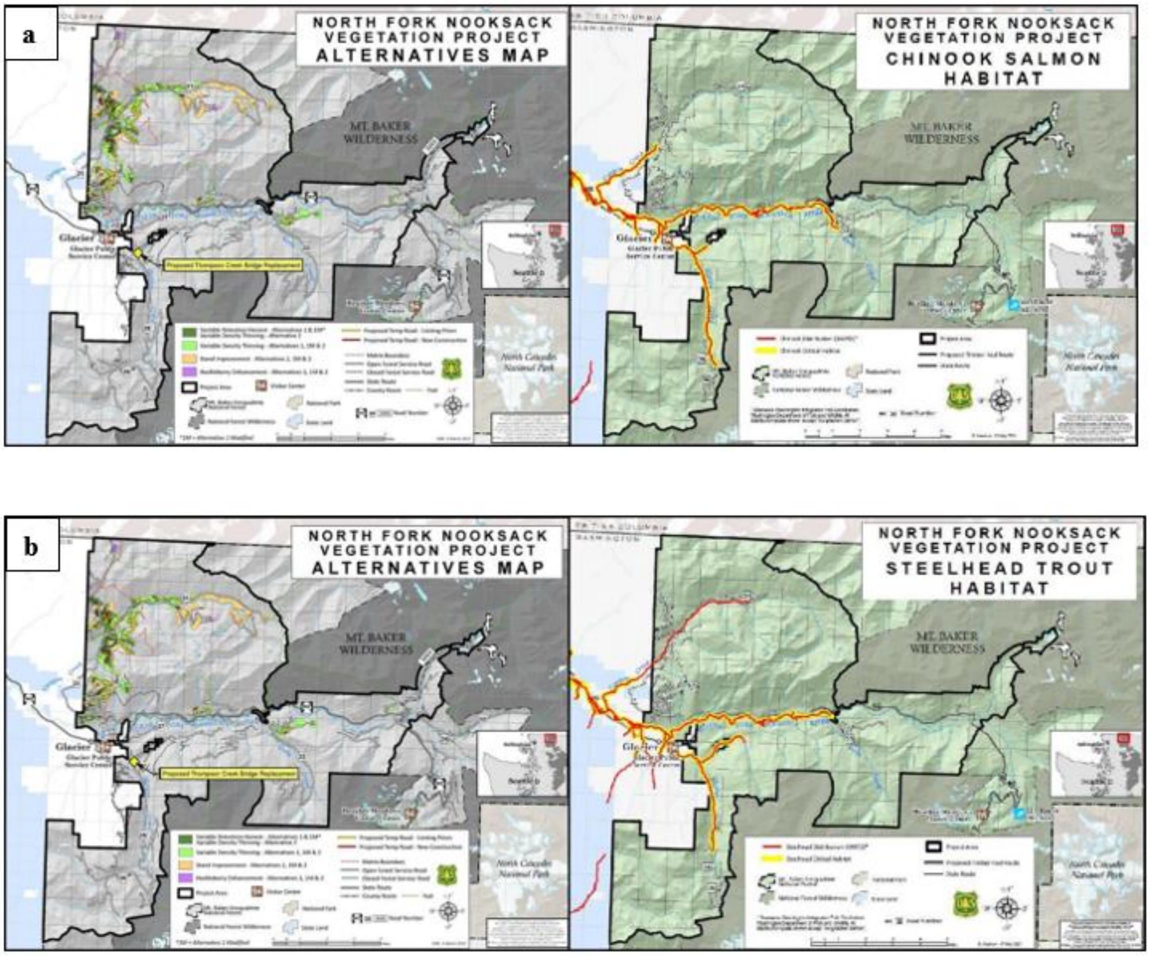
2.5.1 Effects on Listed Species

Stream Temperature

Increased in-stream water temperature caused by the proposed action is likely to adversely affect PS Chinook salmon and PS steelhead. The proposed action components that are most likely to affect stream temperature are tree removal related to forest thinning and road work, and water drafting for roadwork and fire protection.

Forest Thinning: As described in the description of the proposed action, forest thinning would include a mix of commercial and non-commercial thinning across 2,655 acres of National Forest System lands. As described in more detail below, felling trees that cast shadows over streams can affect stream temperatures. Because thinning outside of riparian reserves is extremely unlikely to affect stream shading, the rest of this assessment focuses on thinning within riparian reserves. About 667 of the total acreage across which proposed vegetation treatments would occur is within designated riparian reserves, 399 acres of commercial and 268 acres of non-commercial thinning (USFS 2022e). About 2.8 miles of perennial and 60 miles of intermittent stream exist within the total proposed treatment area. About 1.2 of those stream miles are fish-bearing, and includes some stream reaches that are occupied by and or have been designated as critical habitat for PS Chinook salmon and PS steelhead (Figure 6).

The main differences between the proposed commercial and non-commercial thinning is that commercial thinning would target conifers that are between 7 and 26 inches DBH, while non-commercial thinning would hand-cut seedlings and saplings up to 8 inches DBH, and that commercial thinning would remove merchantable trees from the forest, whereas non-commercial thinning would leave the felled trees. Both would have the same no-cut buffers and distance limits for gap and heavy thinning treatments. Given the sizes of the no-cut buffers and distance limits as well as the estimated canopy reduction as a result of non-commercial thinning, the NMFS considers it very unlikely that the proposed non-commercial thinning would cause measurable effects on stream temperatures. Therefore, the rest of this assessment focuses on the proposed commercial thinning within riparian reserves.



Figures 6a & 6b. Maps of the North Fork Nooksack Vegetation Management Project area comparing the stands to be thinned (blue, red, and yellow areas) with the historic distribution and designated critical habitat for Puget Sound Chinook salmon (a) and steelhead (b) (From USFS 2022b Figures 3,8,9).

Project-related commercial thinning would occur across 399 acres of riparian reserves. Commercial thinning in Riparian Reserves would use VDT treatments and would reduce stand densities to approximately 150 to 190 SDI. Heavy thinning in the form of gaps are possible for 3-10% of the treated area. This means that across the project area, up to 399 acres of riparian reserves may be thinned such that canopy cover could be reduced to 30 to 50% of the existing conditions. Within those 399 acres, up to about 40 acres may be thinned such that all conifers up to 26-inch DBH would be felled within 0.5-acre sized patches, creating gaps of 25-50 trees per acre.

In addition to the planned thinning, the project includes an unquantified number of 0.25- to 1.0-acre sized landings. Where possible, the project would reuse existing landings at least 150 feet away from aquatic resources. However, some new landings are likely, and may be as close as 150 feet from aquatic features if needed. All landing locations must be approved by the Forest

Service. As described in the proposed action, skyline yarding would be limited to 2 corridors per 1,000 feet of stream. Where feasible, existing skyline corridors would be reused. Skyline corridors would be no closer than 120 feet apart at one end, and no more than 15 feet wide whenever possible. Skyline corridors would be limited to two corridors per 1000 feet of stream. The USFS predicts a maximum corridor impact area of 48.5 acres in Riparian Reserve acres, which could result in 25.2 acres of clearing in Stream Protection Buffers (USFS 2023b).

Tree removal within and adjacent to riparian areas in upper watersheds can elevate in-stream water temperatures of the adjacent streams. It can also influence water temperatures at a sub-reach or reach scale, and in some cases may affect water temperature at a watershed scale. The effect reduced riparian vegetation may have on in-stream temperature varies by stream size, season of the year, and the amount of lost vegetation. Water temperatures in small streams are strongly influenced by riparian forest conditions and canopy cover over the stream, especially during summer months. Conversely, the water temperature of large rivers is less affected by riparian vegetation adjacent to the river because most available solar radiation normally reaches the surface of the river, and diel temperature variations are reduced by stream depth and volume of flow (Everest and Reeves 2007).

The primary factors that influence stream shade are the height and density of riparian vegetation (Groom et al. 2011a) and the surrounding terrain, with riparian vegetation typically providing most of the shade (Allen et al. 2007; Allen 2008). Removing trees from riparian areas reduces the amount of shade, which can increase thermal loading to the adjacent streams (Moore and Wondzell 2005). No-cut buffers have been found to reduce stream shade impacts from forest thinning and logging actions. Although the exact relationship between no-cut buffer widths and stream shade impacts is difficult to predict, in general wider no-cut buffers result in lower levels of lost stream shade (Anderson et al. 2007; Park et al. 2008; Science Review Team 2008).

During studies of clearcutting, no-cut buffers between 50 and 99 feet wide (20 to 30 m) were insufficient to prevent substantial loss of shade (Brosofske et al. 1997; Groom et al. 2011b; Kiffney et al. 200; McIntyre et al. 2018). Sweeney and Newbold (2014, p. 576) concluded that riparian buffer widths of 66 feet can increase stream temperatures by about 3.6°F (2°C) as compared to a fully forested watershed. McIntyre et al. (2018) reported a 7-day average maximum daily increase of 1.2°C post treatment below a 50’ un thinned buffer. Conversely, no-cut buffers that over 150 feet wide (46 m) caused very small effects on stream shade (Groom et al. 2011a; Science Team Review 2008), and the effects on shade and temperature were minimal to undetectable for no-cut buffer widths of 151 to 227 feet wide (46-69 m) (Anderson et al. 2007; Groom et al. 2011a and b; Science Team Review 2008). The reduced shade impacts that were observed for the wider no-cut buffers were likely due to the incapability of the trees outside of those buffers to cast shadows beyond the respective buffers’ widths (Leinenbach 2011). Although these studies focused on clearcutting, the results demonstrate that trees as far as 150 feet away from a stream can to contribute to the stream’s shade. In addition to width, increased canopy density within the no-cut buffer appeared to reduce shading impacts, as did increased residual tree density outside of the no-cut buffers (Leinenbach et al. 2013).

Therefore, post-thinning stream shade is highly correlated with the width of no-cut buffers. However, the relationship between no-cut buffers and in-stream temperatures is quite variable, and can be affected by site-specific factors (Caissie 2006). Complicating factors include riparian forest structure and species composition, topography and channel aspect, stream size, substrate type, and discharge. The density of riparian vegetation also affects shade and thermal loading to a stream because the penetration of solar radiation is positively correlated with the number and the size of the gaps in the canopy and between the branches and stems (Brazier and Brown 1973, DeWalle 2010). In some instances, such as narrow streams with dense, overhanging streamside vegetation, or in stands where tree shadows fall away from the stream (i.e. along the north sides of northern latitude streams with an east-west orientation), no-cut buffers as narrow as 30 feet can maintain stream shade (Brazier and Brown 1973). Additionally, inputs of cold water from the streambed, seepage areas along the stream bank, and tributaries can help cool an affected stream if they are sufficiently large relative to the subject stream's discharge (Wondzell 2012).

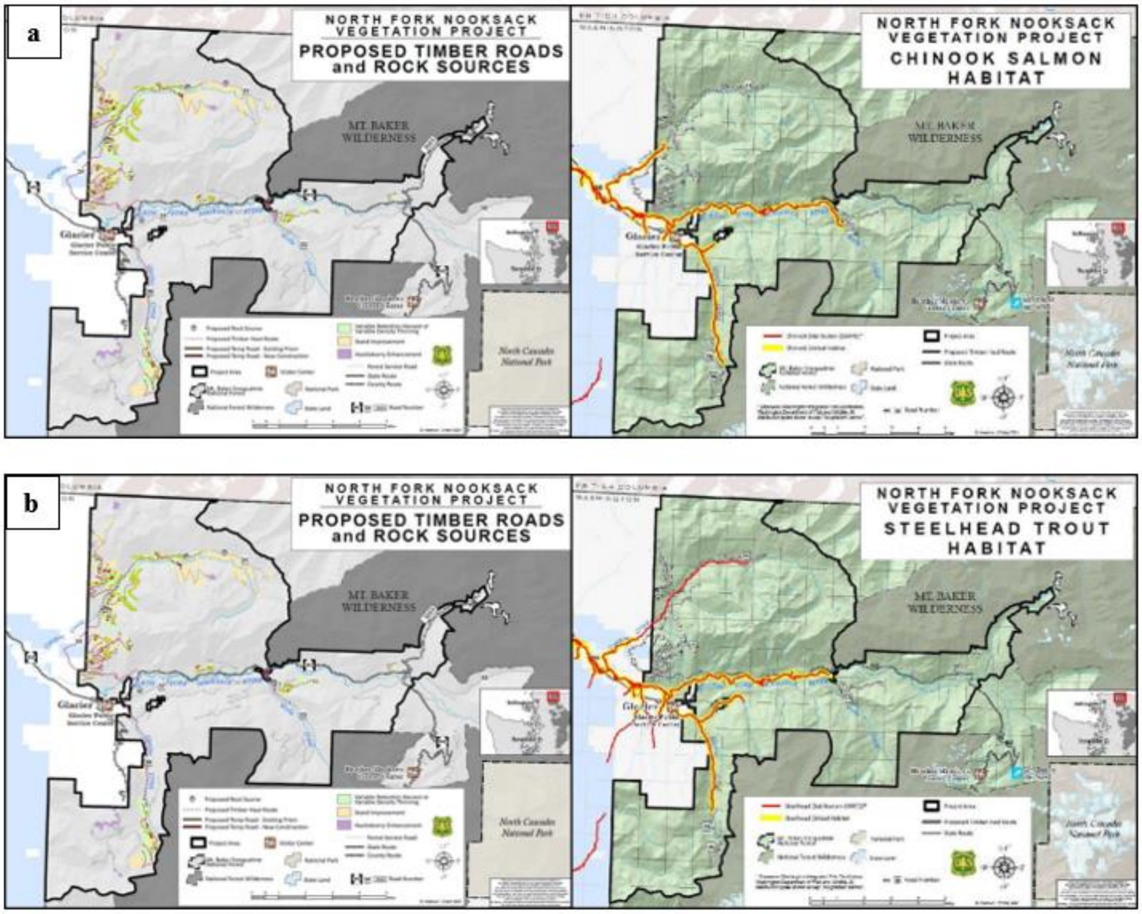
In this opinion we conservatively assume that trees within 200 feet from a stream can contribute to the stream's shade. During the life of the project up to 399 stand acres would be commercially thinned within Riparian Reserves. About 38 miles of perennial and intermittent stream, including about 1.1 miles of fish-bearing stream, exist within the stands to be commercially thinned over the 15-year life of this project. All perennial streams would be protected by 150-foot no-cut stream protection buffers, and all intermittent streams would be protected by a 50-foot no-cut stream protection buffers. The USFS BA reports 61 acres (50 acres in Canyon Creek, 11 acres in Hedrick- NF Nooksack) are within 200 feet of streams that are occupied PS steelhead and or are designated as their critical habitat, and 45 acres (in Canyon Creek) are within 200 feet of streams that are occupied by PS Chinook salmon and or are designated as their critical habitat (Table 14 in USFS 2022b).

The USFS's proposed 150-foot no-cut buffer for all perennial streams is 75% of the 200' that we assume is needed to fully protect against increased in-stream temperatures due to reduced tree shade. A significant literature base reports that reductions in stream temperature beyond 150' is minimal or undetectable (Anderson et al. 2007; Groom et al. 2011a and b; Science Team Review 2008). The exact temperature increase that would be caused by thinning to within 150 feet of a stream is uncertain. However, the information above supports the expectation that detectable increases are unlikely with a 150-foot buffer.

In areas where thinning reduces the riparian buffer to 150 feet adjacent to north-south oriented streams, elevated in-stream temperatures may impact listed fish (Dewalle 2010). The 50-foot buffer for non-fish intermittent streams would likely cause greater temperature increases. Since thinning to within 66 feet of streams is reported to increase in-stream temperatures by as much as 3.6°F (2°C), proposed thinning to within 50 feet of intermittent streams may increase temperatures to at least a similar level of magnitude. In addition to thinning treatments, 15-foot skyline corridors that cross streams would increase the solar gain entering the stream. When non-fish bearing intermittent streams are in close upstream proximity to LFH, the increased in-stream temperatures may transfer downstream to LFH. Increased stream temperatures resulting from the narrow buffers for intermittent streams is less certain because some or all of those streams may be dry during the summer when the effects of solar radiation would be greatest. However, intermittent streams that are wet during the summer would likely experience relatively high increases in water temperatures, which depending on their distance upstream from LFH, may elevate the in-stream temperatures in downstream LFH. Further, project-related elevated in-stream temperatures would continue for decades after thinning, until the riparian vegetation recovers.

The downstream extent of detectable elevated water temperatures that would be attributable to the proposed commercial thinning is uncertain, and is likely to be highly variable in both spatial and temporal scales. The issue is complicated by the high levels of uncertainty about stream reach specifics such as the amount of lost shade, the existing temperatures and flow volumes in the exposed stream reaches, and the temperatures and the flow volumes of downstream tributaries and receiving waters. In the absence of site-specific information, and or information to the contrary, we estimate that elevated water temperatures that could be attributable to the project may extend as far as 2 miles downstream from any stream reach where thinning occurs within 200 feet of its banks. We acknowledge that this may slightly over-estimate the intensity of effects, but believe this estimate to be both reasonable and unlikely to underestimate the potential effects on listed species and critical habitats in the action area.

Transportation: In addition to thinning, project-related road maintenance of existing FSRs and the construction and or reconstruction of temporary roads is likely to cause the removal of some trees and understory vegetation. Some project-related roads are in close proximity to streams that are occupied by and or have been designated as critical habitat for PS Chinook salmon and PS steelhead (Figure 7). Vegetation removal is also likely to occur during the construction and or reconstruction of turnarounds. As with thinning, roadwork-related tree removal that is done within 200 feet of streams may decrease stream shade.



Figures 7a &7b. Maps of the North Fork Vegetation Management Project area comparing the timber roads and rock sources with the historic distribution and designated critical habitat for Puget Sound chinook (a) and steelhead (b) (From USFS 2022b Figures 4,8,9).

There are 2.37 miles of total unpaved road miles (including roads to access stands, haul timber or potential rock sources) within 200-feet of PS Chinook salmon and PS steelhead within the project area. There are about 35 miles of streams that are occupied or have designated Critical Habitat for PS Chinook salmon and PS steelhead within 0.5 miles of an impacted site. During the life of the project about 1.08 miles of unpaved system and non-system roads that would be maintained within 200-feet of a stream that is occupied by and or has been designated as critical habitat for PS Chinook salmon and PS steelhead (USFS 2022b).

Because roadwork-related tree removal would occur in relatively small and widely scattered areas, the magnitude of its effect on stream temperatures is likely to be less than that caused by thinning. However, it may cause slight, localized increased in-stream temperatures that could be additive to the effects of thinning, especially in areas where thinning and roadwork tree removals overlap. As with thinning, temperature impacts from this work would continue for decades until the vegetation recovers.

Water drafting would be done at multiple unidentified streams within the project area. Because most roadwork would occur during the NOS, those withdrawals would most likely occur during summer low-flow periods. However, site selection and drafting work would comply with the protective measures detailed in the MOU between USFS and WDFW (USFS 2017a and b), which includes required measures such as isolating and screening pump intakes, and maintaining adequate in-stream flows for fish (USFS 2023c).

Water drafting would episodically cause temporary reductions of in-stream flow downstream from the withdrawal points. Reduced flows could increase the affected stream's susceptibility to solar-induced temperature increases, or reduce the stream's ability to cool downstream reaches that are exposed to the sun. The intensity of any flow reduction would depend largely on the existing stream flow, the withdrawal rate and volume, and the duration of the withdrawal. The predicted impacts of drafting on stream flows are undescribed by the USFFS. However, as described in a recent opinion for a similar action (NMFS 2018), the water trucks commonly used for this type of work hold about 500 gallons of water, and have maximum pump rates of about 7.5 gal/sec. At maximum speed, a drafting event would last about 1 minute. However, at the lower rates that are commonly used, a drafting event would last about 5 minutes. Given the expectation that water withdrawals would be relatively small, and both spatially and temporally separated, detectable flow reductions would be brief (about 5 minutes at most), becoming quickly undetectable with downstream movement from the site, and of a magnitude too low to cause any detectable effect on in-stream temperatures.

Chinook salmon and steelhead require cool, well-oxygenated water within a relatively narrow range of temperatures. In general, juvenile and adult salmonids prefer water temperatures under 63º F (17º C). At temperature between about 64 and 72º F (18 and 22º C) ecological dominance transitions from salmonids to other species, and salmonids are typically eliminated from locations at temperatures above about 72 to 75º F (22 to 24°C) (Carter 2005). Chronic exposure (more than 7 days) to temperatures above 77º F (25º C) is considered the upper lethal limit for juvenile Chinook salmon. Exposure to temperatures between 70 and 75º F (21 and 23.9º C) is reported as being lethal for steelhead, including adults (Carter 2005).

Adult Chinook salmon typically migrate at temperatures between about 51 and 67º F (10.6 and 19.6º C). However, reduced migratory fitness occurs with prolonged exposure to temperatures above about 63º F (17º C), and temperatures above 70º F (21º C) cause avoidance behaviors that create a thermal barrier against migration for adult Chinook salmon and steelhead (Carter 2005). Most Chinook salmon spawn at temperatures between 42 and 55º F (5 .6 and 12.8º C). Pronounced pre-spawn adult mortality is reported in adult female spring run Chinook salmon when temperatures exceed 55 to 60º F (13 to 15.5º C), and decreased egg survival and inhibited alevin development is reported from females that spawned after exposure to those temperatures. Chinook salmon egg survival is highest between 39 and 54º F (4 and 12º C) (Carter 2005), with a sharp decrease in egg survival above 61º F (16°C) (Jager 2011). The preferred temperature range for steelhead spawning is between 40 and 55º F (4.4 and 12.8º C), with egg survival being highest between 41 and 50º F (5 and 10º C).

Optimal freshwater rearing and growth in juvenile Chinook salmon occurs at temperatures between about 50 and 60º F (10 to 15.6º C). Optimal freshwater rearing and growth in juvenile steelhead occurs at mean weekly average temperatures between about 55 and 63º F (13 to 17º C).

During the summer, when project-related elevated in-water temperatures are most likely to occur, in-migrating adult PS Chinook salmon would be present around May within the North Fork Nooksack mainstem and tributaries. Spawning typically begins in July within the North Fork Nooksack mainstem and tributaries. Also, rearing stream-type juvenile PS Chinook salmon and rearing juvenile PS steelhead are likely to be present within the action area year-round.

As described in the environmental baseline, summer in-stream temperatures above established standards have been documented in multiple stream segments across the project area. Project-related tree loss is likely to cause slight but detectable temperature increases in occupied LFH. It is uncertain exactly when, where, and to what degree action-related elevated in-stream temperatures would exceed any of the thresholds discussed above. However, the NMFS expects that over the decades that the proposed action would reduce stream shading, some PS Chinook salmon and PS steelhead are likely to be exposed to water temperatures that exceed some of the effect's thresholds described above. Further, the exposure risk is likely to increase over time as global climate change continues to increase in-stream temperatures across the region.

Based on the best available information, the NMFS has concluded that project-related elevated stream temperatures are likely to adversely affect PS Chinook salmon and PS steelhead through some combination of: Reduced adult migratory fitness and spawning success (Carter 2005); Reduced fitness and increased mortality of eggs and alevin (Jager 2011); and Elevated stress, reduced growth, and increased susceptibility to disease in rearing juveniles (Marine 1992; Marine and Cech 2004; McCullough et al. 2001; Reeves et al. 1987).

The annual numbers of individuals of either species that may be adversely affected by project-related elevated temperature is unquantifiable with any degree of certainty. However, the project detectable effects are not expected to extend more than 2 miles downstream from the impacted reaches. Therefore, the numbers of affected fish would comprise such small subsets of their respective cohorts, that their loss is very unlikely to cause detectable population-level effects.

Suspended Sediment and Substrate Embeddedness

Increased in-stream suspended sediment and substrate embeddedness is likely to adversely affect PS Chinook salmon and PS steelhead. The proposed action components that are most likely to affect suspended sediment and substrate embeddedness are forest thinning and roads.

Suspended sediments in small streams are often highly variable, being strongly influenced by the underlying geology of a site. However, studies have documented increased sediment delivery following timber harvest and road work. Ground disturbance and subsequent erosion associated with timber harvesting, road work, and road use (timber hauling) can cause increased sediment transport to streams (Beschta 1978; Furniss et al. 1991; Gomi et al. 2005; Haupt 1959; McClelland et al. 1997; Megahan 1987; Robison et al. 1999; Swanson and Dyrness 1975; Swanston and Swanson 1976). The increased sediments can degrade water quality and aquatic habitat conditions at multiple scales, including up to the watershed scale. The effects increase with increased road area and length of unbuffered stream reaches in headwater streams, and may persist for several years to decades following harvest (Gomi et al. 2005).

Forest Thinning: The planned forest thinning is described in the description of the proposed action and above under Stream Temperature. In summary, it would include the cutting of trees within about 288 acres of riparian reserves. Living tree roots help stabilize soil. Cutting trees kills the roots, which increases the probability of slope failure as those roots decompose, particularly on steep slopes (Robison *et al*. 1999; Swanston and Swanson 1976). Depending on the intensity of the failure and its proximity to streams, slope failure can deliver large quantities of sediment to stream networks. The occurrence probability is related to the harvest type and intensity, soil properties, geology, unit slope, and precipitation level. When large areas are clearcut, the slope would become less stable over time as the tree roots decompose and their effectiveness in stabilizing the soils decreases. This effect may be reduced, and eventually offset in areas where enough trees are left scattered across the stand, because the remaining trees are likely to experience rapid growth from decreased competition and their increased root mass would improve their ability to stabilize the soils.

Timber felling and yarding disturbs soils and increases the potential for sediment transport to area stream channels. Logging alone does not appear to increase surface erosion significantly (Likens et al. 1970, Megahan et al. 1995). However, the use of heavy machinery to transport cut logs causes soil compaction, leading to increased surface erosion and increased fine sediment delivery to streams (Williamson and Neilson 2000). Yarding activities can disturb soils when the trees are dragged across the ground (Hassan et al. 2005; Rashin et al. 2006). Yarding practices that limit the damage to shrub and herbaceous ground cover, and reduce the exposure of bare soil can reduce sediment transport to streams. Full suspension skyline yarding is very effective because the logs are suspended above the ground throughout much or all of the yarding process. Lifting the heavy end of trees being yarded, and protecting skid trails with slash can also reduce soil impacts.

Sediment delivery to streams typically begins as overland sheet flow. Conduits such as skid trails, roads, ditches, rills, and or gullies increase the probability of delivery by channelizing the flow (Bilby et al. 1989; Croke and Mocker 2001), particularly if riparian buffer strips are not left between disturbed areas and stream channels (Gomi et al. 2005; Rashin et al. 2006). Several studies document the importance of streamside buffer strips to reduce sediment delivery, and show that their effectiveness increases with the presence herbaceous vegetation and slash (Belt et al. 1992), and with increased width. Vegetated buffers of 40 to 100 feet wide are very effective against sediment transport (Burroughs and King 1989, Corbett and Lynch 1985, Gomi et al. 2005). Lakel et al. (2010) report that buffer widths of as little as 25 feet can reduce sediment transport to streams, and Rashin et al. (2006) concluded that a 33-foot wide vegetated buffer is likely to prevent sediment delivery to streams from about 95% of harvest-related erosion features. However, it is important to note that buffer strips are generally less effective against channelized flows.

The 150- and 50-ft no-cut buffers described earlier very likely would prevent timber harvest-related sediment transport to adjacent streams. However, the 50-foot wide no-cut buffer for some intermittent streams may be insufficient to completely prevent suspended sediment within channelized flows from reaching the adjacent streams, especially where skyline corridors penetrate stream protection buffers. It is uncertain whether or not any increased sediment loading to intermittent streams would be detectable in downstream LFH. However, information to demonstrate sufficient spatial separation between LFH and intermittent streams with 50-foot wide no-cut buffers is unavailable. Therefore, this assessment assumes that some timber harvest-related sediment transport may be sufficient to affect PS Chinook salmon and PS steelhead in downstream LFH.

Transportation: Project-related transportation activities would include the repair, maintenance, and use of about 67.5 miles of road, including about 17.5 miles of currently closed FSRs would be temporarily re-opened to support project activities. The temporarily re-opened FSRs would remain closed to the public, and would be re-closed before the end of the project. Temporary roads would consist of about 12.5 miles of existing unclassified (non-system) road that would be repaired and maintained as needed, 3.5 miles of previously decommissioned road that would be reconstructed, and 1.5 miles of new road that would need to be constructed. No new permanent roads would be constructed, all existing temporary roads would be closed and decommissioned (16 miles) and all new roads (1.5 miles) would be rehabilitated before the end of the project. An estimated 7.9 miles of temporary roads would be utilized in Riparian Reserves, this would include 7.67 miles of existing unclassified and decommissioned roads and approximately 0.25 miles of newly constructed road. Some of which is in close proximity to streams that are occupied by and or have been designated as critical habitat for PS Chinook salmon and PS steelhead (Figure 7). The project also includes the generation of crushed rock aggregate for road work, which would be obtained from existing rock sources.

Around 50 miles of project-related road is unpaved, and some or all of the roads would require some level of on-going maintenance over the life of the project. Additionally, an unquantified number of landings would be reopened and or constructed adjacent to these roads. Most roadwork would be limited to the June 1 to October 15 NOS, but some maintenance work and hauling is expected to occur year-round on some subset of these roads.

Sediment delivery to streams from the erosion of unpaved roads, cut-banks, and ditches is well documented (Croke and Mockler 2001; Gucinski et al. 2001; Johnson and Bestcha 1980; Madej 2001; Montogomery 1994; Reid et al.1981), ranging from chronic input of small amounts of fine sediments to catastrophic mass failures of roads during large storms (Gucinski et al. 2001). A road’s design and placement on the landscape heavily influences its potential for sediment delivery to adjacent streams (Gucinski et al. 2001). Sediment delivery from surface erosion typically occurs through direct connections such as ditches, rills, or gullies (Bilby et al. 1989; Croke and Mockler 2001). Erosion rates can vary greatly, based primarily on surface material, traffic levels, storm intensity, and road slope (Bilby et al. 1989; MacDonald et al. 2001; Reid et al. 1981; Ziegler et al. 2001). Reid and Dunne (1984) reported that surface erosion of relatively well-maintained gravel forest roads on the Olympic Peninsula was heavily influenced by the intensity of traffic, especially by logging trucks. The authors reported that heavily used gravel roads generated up to 300 tons of sediment per mile per year, whereas lightly used gravel roads averaged about 6 tons, and abandoned roads averaged about 0.8 tons.

In a review of several sediment transport studies, Dube et al. (2004) found that sediment transport distances from forest roads ranged between 30 and 550 feet, with sediment moving less than 150 feet in most cases. To be conservative, they use an assumed sediment transport distance of 200 feet in the road surface erosion model they developed for the State of Washington. The USFS's BA and the assessment in this opinion presume that a sediment transport distance of 200 feet would be appropriate for this action, and protective of listed fish. In a review of sediment transport studies within recently-logged sub-basins, Gomi et al. (2005) reports that it may take 3 to 6 years after roads are closed and rehabilitated before sediment loading from those roads returns to baseline levels, and that landslides triggered by failed roads may occur as much as 20 years after harvest. Therefore, where project-related roads are within 200 feet of streams, project-related roadwork and traffic (especially hauling) is likely to cause increased sediment loading in those streams every year of this 15-year project, and for up to 6 years beyond.

The specific sources of crushed rock aggregate for road work are not yet identified, but would be limited to 7 rock sources within the project area (Figure 7). The generation of crushed rock aggregate would include the use of mechanical rock crushers and standard heavy earth-moving equipment such as excavators, trucks, and levelers. The BA indicates that rippable material for pit run would be used primarily, and the need for blasting is unlikely. If blasting is needed, it would be done in compliance with the PDC and Mitigation Measures and with the MBSNF Blasting (USFS 2022b Table 5-SWF 40 and Appendix C). Rock crushing, and heavy equipment operation at these sites would create fine sediments that can be transported to streams by stormwater runoff. Of the 7 potential rock sources, none are within 200 feet of fish-bearing streams. Therefore, it is unlikely that detectable levels of sediment from rock sources would enter streams.

An estimated 7.9 miles of temporary roads would be utilized in Riparian Reserves, this would include 7.67 miles of existing unclassified and decommissioned roads and approximately 0.25 miles of newly constructed road. The construction, reconstruction and decommissioning of roads to be done within riparian reserves would create new fine sediments, as well as leave behind loosened and unstable substrate within the streambeds and unstable material from the former road prisms that would be subject to increased erosion and downstream transport by stormwater runoff and stream flows. Most of the erodible sediments are expected to be mobilized within the first storm season following culvert removal (Foltz et al. 2008), but could persist for 2 to 3 years after the removal (Lachance et al. 2008).

In general, once mobilized, fine sediments tend to stay suspended for long distances within the relatively fast flowing waters of upper watershed streams. However, they eventually settle to the streambed in areas where flows are sufficiently slow. The exact downstream extent where project-related elevated turbidity and increased sedimentation would be detectable is uncertain, and is likely to be highly variable, both spatially and temporally. The issue is complicated by high levels of uncertainty about road and stream reach specifics such as roadbed conditions, traffic type and volumes, the distance between the road and the stream, the existence of water control structures, and the type and density of vegetation that may separate the road from the stream. It is further complicated by variability in the amounts of precipitation that would mobilize the sediments and the adjacent stream's volume and flow rates.

Fine sediments are typically detectable up to 0.5 mile downstream from culvert replacement and removal projects (Bilby 1985; Duncan 1987; Foltz et al. 2008; Lachance et al. 2008). Although the sediment transport caused by in-stream culvert replacement and removal work is not identical to what may be caused by project-related thinning and transportation activities, it is a reasonable analog that is more likely to slightly overestimate the range of detectable sediment transport for those activities than to underestimate it. Therefore, the USFS BA and this biological opinion estimate that the extent of detectable sediment transport from project-related thinning and transportation activities would be limited to 0.5 mile downstream from the point of input.

Exposure to action-related elevated suspended sediment and substrate embeddedness is reasonably certain to affect juvenile and adult Chinook salmon and steelhead that occupy the action area. Exposure is most likely to occur annually over several months during the wet season, which overlaps with spawning, egg incubation, fry emergence, and rearing by stream-type juveniles. Exposure to elevated suspended sediment would likely include behavioral disturbances and possible injury, while substrate embeddedness may reduce spawning success and could reduce available forage for juveniles (Newcombe and MacDonald 1991).

Of the 7 potential rock source sites, none are within 200 feet of streams that are within 0.5 mile upstream of streams that are occupied by and or have been designated as critical habitat for PS Chinook salmon and PS steelhead (USFS 2022b). PS Chinook salmon and or PS steelhead would not be exposed to sediments created by this activity if any of those 7 sites are used for this project.

About 2.4 miles of stream that is occupied by and or has been designated as critical habitat for PS Chinook salmon and PS steelhead would be within 200 feet of project-related roads used during the life of the project. About 35.5 stream miles that is occupied by and or has been designated as critical habitat for PS Chinook salmon and PS steelhead would be within 0.5 miles downstream from the impact (21 miles within NF-Nooksack – Hedrick sub-watershed, 2 miles within the Wells Creek sub-watershed, and about 12 miles within the Canyon Creek sub-watershed).

Suspended sediments are often measured by the opacity it causes (turbidity) and or by its concentration (total suspended sediments (TSS)). Turbidity is typically expressed in Nephlometric Turbidity Units (NTU), and TSS is typically expressed in milligrams per liter (mg/L). (mg/L). Depending on the particle sizes, NTU values roughly equal the number of mg/L (i.e. 10 NTU = ~ 10 mg/L TSS, and 1,000 NTU = ~ 1,000 mg/L TSS) (Campbell Scientific Inc. 2008; Ellison et al. 2010). Therefore, the two units of measure can be easily compared.

Water quality is considered adversely affected by suspended sediments when turbidity is increased by 20 NTU for a period of 4 hours or more (Berg and Northcote 1985; Robertson et al. 2006). The effects on fish exposed to suspended sediments are somewhat species and size dependent. In general, severity typically increases with sediment concentration and duration of exposure, and decreases with the increasing size of the fish.

Bjornn and Reiser (1991) report that adult and larger juvenile salmonids appear to be little affected by the high concentrations of suspended sediments that may be mobilized during storm and snowmelt runoff episodes. However, empirical data from numerous studies report the onset of minor physiological stress in juvenile and adult salmon after one hour of continuous exposure to suspended sediment concentration levels between about 1,100 and 3,000 mg/l, or to three hours of exposure to 400 mg/l, and seven hours of exposure to concentration levels as low as 55 mg/l (Newcombe and Jensen 1996). The authors reported that serious non-lethal effects such as major physiological stress and reduced growth were reported after seven hours of continuous exposure to 400 mg/l and 24 hours of continuous exposures to concentration levels as low as about 150 mg/l.

No specific information is available to describe the intensity and duration of the turbidity plumes that are likely to be caused by the proposed forest thinning and runoff from project-related roads. However, over the life of this project, action-related elevated turbidity in occupied LFH is very likely to periodically exceed the lower thresholds identified by Newcombe and Jensen (1996), and occasionally also exceed higher thresholds. Further, the sediments would increase substrate embeddedness in areas where they settle out of the water. Again, no specific information is available to describe the intensity of the substrate embeddedness that is likely to be caused by the proposed action. The distance of sediment travel, and the locations where sediments would settle out and accumulate would vary based largely on the relationship between stream morphology and in-stream flows that would be driven by the intensity of storm events. Embeddedness would likely be relatively high in stream reaches where flows tend to slow downstream of input points. Depending on the intensity of subsequent storm events, sediments may continue to accumulate in certain areas, or become remobilized and move farther downstream. Therefore, sediments that enter intermittent and perennial streams upstream from LFH, may eventually, if not immediately, reach that habitat.

Behavioral disturbance: Most exposed individuals would likely first respond to increased suspended sediments by attempted avoidance of the turbidity plume. For juveniles, the avoidance behavior may cause abandonment of preferred shelter and forage resources. Displaced juveniles may experience decreased growth and fitness and reduced likelihood of survival due to increased energetic expenditures caused by foraging in suboptimal habitat and increase intra-species competition. Displaced individuals may also experience increased exposure to predators. Juveniles that remain within the area of increased turbidity may experience reduced feeding efficiency due to reduced visibility. Depending on the intensity and duration of the elevated turbidity, the exposure could cause decreased growth and fitness and reduced likelihood of survival in some individuals.

Injury: Prolonged exposure to relatively low levels of suspended sediments can cause physiological stress in fish that may reduce growth rates and increase the susceptibility to disease in exposed individuals. Exposure to high levels of suspended sediment can cause gill irritation or abrasion that can reduce respiratory efficiency or lead to infection. Compromised gill function would reduce fitness and may increase mortality. At very high levels, suspended sediments can clog gills, which may cause direct mortality. Although it is unlikely that suspended sediment concentrations would reach levels sufficient to kill or permanently injure exposed individuals, some rearing and migrating juveniles are likely to experience some level of reduced fitness that may reduce their likelihood of long-term survival.

Reduced spawning success: Sediment-free rocks and gravel are critically important habitat for salmon spawning. Salmon eggs and alevins depend on a steady supply of well-oxygenated water flowing through the interstitial spaces between sediment-free gravels during the months-long period between spawning and the emergence of the fry from those gravels. Suspended sediments are likely to settle into the interstitial spaces between rocks and gravel when they eventually settle out of the water. High levels of sediment settling onto existing salmonid redds (nests), has the potential to fill-in the interstitial spaces between the gravel and smother the eggs or alevin within those redds. If sedimentation concentrations and or persistence are high enough, the gravels may become embedded enough that the spawning habitat may be unavailable for future generations of returning adults.

Reduced forage: The preferred freshwater forage species for rearing juvenile salmon are small aquatic invertebrates, such as mayflies, caddisflies, and stoneflies. These aquatic insects live in the well-oxygenated interstitial spaces between the rocks and gravel in stream. As gravel sedimentation increases, the invertebrate composition and density in the affected reach typically transitions away from the preferred forage species to non-preferred, less available species such as aquatic worms and other borrowing species. Reduced forage availability is likely to increase competition, and may reduce growth and likelihood of survival for some of the individuals that rear in the impacted reaches. Over time, gravel embeddedness may significantly reduce the affected reach's ability to support rearing juvenile salmonids.

The most likely effects on adult Chinook salmon and steelhead that are exposed to project-related elevated suspended sediments would be relatively mild behavioral effects such as avoidance of the plume and mild gill flaring (coughing) that would not affect the fitness of the exposed individuals. Given their small size and relatively high sensitivity to the stressors described above, some of the rearing and migrating juvenile Chinook salmon and steelhead that would be exposed to project-related elevated suspended sediments are likely to experience behavioral and physiological effects that would reduce their overall fitness and may reduce their likelihood of survival. Additionally, it is likely, that some eggs and interstitial juveniles of both species may be injured or killed by sedimentation of gravels.

The annual numbers of individuals of either species that would be impacted by suspended sediments and substrate embeddedness is unquantifiable with any degree of certainty. However, given the relatively small amount of occupied habitat that would be affected, the numbers of fish that would be annually affected by this stressor would comprise such small subsets of their respective cohorts, that their loss would cause no detectable population-level effects.

Chemicals and Nutrients

Exposure to project-related chemicals and nutrients is likely to adversely affect PS Chinook salmon and PS steelhead. Most project components, particularly forest thinning, road work, and timber hauling, involve the use of heavy equipment near streams. Many of the fuels, lubricants, and other fluids used by that equipment are petroleum-based fluids that contain Polycyclic Aromatic Hydrocarbons (PAHs) and other substances that are known to be injurious to fish. Although the project includes PDCs intended to reduce the risk and intensity of discharges and spills, those measures would not eliminate the risk. Therefore, it is very likely that some contaminants would be leaked or spilled onto forest roads and landings by log trucks and other equipment, and onto the forest floor by the saws and other equipment used to cut and yard trees. Although direct discharge to the streams is relatively unlikely, toxic fluids are likely to enter the streams when the dusts and sediments that have absorbed the spills are eventually carried to streams by runoff during the wet season.

Chinook salmon and steelhead can uptake contaminants directly through their gills, and through dietary exposure (Karrow et al. 1999; Lee and Dobbs 1972; McCain et al. 1990; Meador et al. 2006; Neff 1982; Varanasi et al. 1993). Many of the pollutants that may enter the water column due to project activities can cause effects in exposed fish that range from avoidance of an affected area, to reduced growth, altered immune function, and immediate mortality in exposed individuals. The intensity of effects depends largely on the pollutant, its concentration, and or the duration of exposure (Brette et al. 2014; Feist et al. 2011; Gobel et al. 2007; Incardona et al. 2004, 2005, and 2006; Mcintyre et al. 2012; Meadore et al. 2006; Sandahl et al. 2007; Spromberg et al. 2015). Over the 15-year long life of this project, some juvenile Chinook salmon and or steelhead are likely to be directly exposed to petroleum-based pollutants, and or contaminated prey resources, at concentrations capable of causing reduced growth, increased susceptibility to infection, and increased mortality.

Timber harvest can cause a release of carbon, nitrogen, phosphorus, and sulfur through burning of slash and decomposition that may also reach stream through erosion and runoff (Vitousek 1983). Riparian buffers as small as 62 feet wide can decrease nutrient flow to streams by 48 to 95% (Jordan et al. 1993; Lowrance et al. 1984; Snyder et al. 1995). Based on this information, the planned 50-foot stream protection buffer would likely be inadequate to capture all project-related nutrient flow, and a small increase in nutrient flow to the streams is likely to occur.

The release of nutrients into streams from decomposition and forest fires are natural process that stimulate stream food webs, it is therefore difficult to determine if fish within the action area would be negatively impacted. The annual numbers of individuals that would be affected by exposure to chemical and nutrients is unquantifiable with any degree of certainty. However, based on the expected infrequency and small volumes of discharge, and the relatively small amount of occupied habitat that may be affected the numbers of fish that would be annually affected by this stressor would comprise such small subsets of their respective cohorts, that their loss would cause no detectable population-level effects.

Woody Material

Reduced in-stream wood recruitment due to the proposed commercial thinning is likely to adversely affect PS Chinook salmon and PS steelhead. In-stream wood (tree trunks and root wads) enhances the habitat quality for salmonids. Riparian trees that die and fall into streams and or their floodplains and wetlands influence stream channel complexity and stability. They help retain sediments, and create pools, undercut banks, and off-channel habitat. They deflect and slow stream flows and increase hydraulic complexity. They also stabilize stream channels, improve productivity, and provide cover for fish (Bilby and Bisson 1998; Bisson et al. 1987; Gregory et al. 1987; Hicks et al. 1991; Murphy 1995; Ralph et al. 1994).

Streamside wood recruitment to streams tends to be relatively even throughout a drainage network, whereas episodic landslides tend to create large concentrations of wood at tributary junctions. Streamside-derived wood can provide the largest key pieces to streams, and contribute to gravel storage that converts bedrock reaches to alluvial reaches, creates smaller, more numerous pools, and increases habitat complexity (Bigelow et al. 2007; Montgomery et al. 1996). Large wood in episodic landslides also contributes to habitat complexity and ecological productivity (Bigelow et al. 2007). It also reduces the speed and run-out distance of debris flows on valley floors (Lancaster et al. 2003). Both types of wood delivery are necessary for functioning and productive stream ecosystems.

Coarse sediment retention by wood is also important because it helps to create and maintain alluvial aquifers that help moderate stream temperatures through hyporheic exchange. Also, sediment storage in upstream reaches reduces the downstream transport of fine sediments that can embed gravels and smother redds. Wood and other obstructions attenuate peak flows, which reduces the movement of spawning substrate and bed scour that can destroy redds.

Empirical data and modeling studies suggest that streamside riparian wood input rates vary by stand type and age, but rates decline exponentially with distance from the stream (Gregory et al. 2003; McDade et al. 1990; Van Sickle and Gregory 1990). Studies indicate that about 95% of instream wood from streamside sources typically comes from distances within about 150 feet of the stream. Shorter distances may occur in young, short stands, while longer distances may occur in older and taller stands (Spies et al. 2013). Studies suggest that 50-foot no-cut buffers on intermittent streams would likely protect about 40 to 50% of existing wood recruitment, respectively (McDade et al. 1990; Spies et al. 2013). The FS BA indicates that 50-foot no-cut protection buffers on intermittent streams could in the short term negatively affect wood recruitment to connected streams with listed fish and critical habitats. Although the planned thinning may accelerate the growth of large diameter trees over the long term (Spies et al. 2013), use of the planned 50-foot no-cut buffers in commercially thinned stands next to intermittent streams is likely to reduce wood recruitment to adjacent streams for the next several decades.

Inadequate in-stream wood is a primary limiting factor for salmonid production in almost all watersheds west of the Cascade Mountains (NMFS 2013; ODFW and NMFS 2011). The FS BA reports that in-stream woody debris is currently “functioning at risk” within the Upper North Fork Nooksack River and Canyon Creek sub watershed The BA further reports that the planned thinning and transportation would negatively affect this indicator, which is supported by the information described above. The trees that would be removed would typically be 7 to 26 inches DBH. Although trees of this size may be too small to be retained in larger streams and rivers, they would likely have contributed positively to salmonid habitat quality within the action area.

The reduced wood recruitment to the streams within the action area is likely to sufficiently reduce habitat quality for rearing juveniles such that some individuals would experience fitness impacts that may reduce their likelihood of survival. The reduced wood recruitment is also likely to reduce spawning habitat quality sufficiently enough to reduce the spawning success for some adults, and or to cause the loss of some eggs and alevin. The annual numbers of individuals that would be affected by reduced wood recruitment is unquantifiable with any degree of certainty. However, based on the relatively small amount of occupied habitat that may be affected, the numbers of fish and eggs that would be affected annually by this stressor would comprise such small subsets of their respective cohorts, that their loss would cause no detectable population-level effects.

Pool Frequency and Quality

Reduced pool frequency and quality due to the proposed action is likely to adversely affect PS Chinook salmon and PS steelhead. Pools are important habitat features for juvenile and adult salmonids because they often provide deep cool water that act as thermal refugia during periods of high in-stream temperatures. They also often provide pockets of reduced flow velocity that can provide shelter during high flow events.

The USFS's BA reports that the pool frequency habitat indicator is currently "functioning at risk" within the Upper Nooksack River, and "functioning at unacceptable risk" within the Canyon Creek sub-watershed. It also reports that the pool quality habitat indicator is currently "functioning at risk" within the Upper Nooksack River, and "functioning at unacceptable risk" within the Canyon Creek sub-watershed. Pool formation and quality, and stream width to depth ratios are directly related to the presence of in-stream wood, in-stream substrate, and in-stream sediment. Across the project area, and the proposed action is expected to slightly worsen all three features.

Reduced wood recruitment would negatively impact hydrological functions involved with pool formation as well as with the retention of sediments. Increased input of fine sediments would act synergistically with reduced in-stream wood, and would likely reduce pool depths due to in-filling. In areas where excessive sediment aggradation occurs, the stream channels could become wider and shallower. The NMFS believes that these effects would be manifested across the watershed over several years as increased sediment loading continues to enter the streams, and the removed trees that may have eventually recruited to the streams would fail to enter the water to replace the current in-stream wood that is likely to migrate downstream over time.

The resulting reduction in pool frequency and quality within the action area is likely to sufficiently reduce habitat quality for rearing juveniles such that some individuals would experience fitness impacts that may reduce their likelihood of survival. The reduced pool frequency and quality may also sufficiently reduce habitat quality for migrating adults such that some individuals may experience reduced spawning success. The annual numbers of individuals that would be affected by reduced pool frequency and quality is unquantifiable with any degree of certainty. However, based on the relatively small amount of occupied habitat that may be affected, the numbers of fish that would be annually affected by this stressor would comprise such small subsets of their respective cohorts, that their loss would cause no detectable population-level effects.

Changes in Peak and Base Flows

Changes in peak and base flows due to the proposed action is likely to adversely affect PS Chinook salmon and PS steelhead. Forest management activities, particularly timber thinning and forest roads, can affect the rate that water is stored or discharged within a watershed. They can increase both peak and base in-stream flows, and may also cause peak discharges to occur earlier in the year than would normally occur (Jones and Grant 1996; Satterlund and Adams 1992). The intensity of these effects depends largely on the type of activity (i.e. the type of thinning and road design), the proportion of the basin that has been altered, and the affected area's location within a watershed (Grant et al. 2008).

Changes in peak flows are highly variable, but are typically undetectable until about 20% of a basin is harvested. Grant et al. (2008) report no measurable flow changes when less than 19% of the watershed is clearcut. Stednick (1996) suggests that flow changes are not measurable when less than 25% of the watershed is clearcut. In catchments where 20 to 40% of the trees were cut, peak flows increased 20 to 90% (King 1989; Troendle and King 1985). In another study, Van Haveren (1988) reported that 100% clearcutting resulted in a 50% increase in peak flow. Spence et al. (1996) recommend that for salmonid conservation, no more than 15 to 20% of a watershed be in a hydrologically immature state at any given time.

The intensity of flow change tends to diminish over time (Grant et al. 2008; Jones 2000; Jones and Grant 1996). Jones and Post (2004) report that the greatest flow increases due to thinning generally occur in the first 1 to 5 years after cutting. Moore and Wondzell (2005) estimate that flows generally recover to pre-harvest conditions after about 10 to 20 years, but Jones and Post (2004) report that significant flow changes have been detected in some Pacific Northwest forests up to 35 years afterward. Thinning typically increases total water yield due to reduced evapotranspiration (Duncan 1986; Harr 1976; Harr et al. 1975; Hetherington 1982; Jones 2000; Keppler and Zeimer 1990) and decreased water interception (Reid and Lewis 2007). Flow increases appear to be proportional to the amount of timber that is cut within the watershed (Bosch and Hewlett 1982; Grant et al. 2008; Keppler and Zeimer 1990).

The project site is located in the transient snow zone (TSZ) where rain-on-snow events are common in the winter months. Grant et al. (2008) concludes that watersheds located within the transient snow zone are the most sensitive to peak flow changes. The authors also report that altered flows are most detectable within small drainage areas (up to about 2,470 acres), with the ability to detect changes diminishing as the size of the drainage area approaches the sub-watershed scale because the magnitude of increase is typically less than the inter-annual variability. Grant et al. (2008) recommend using the equivalent clear-cut area (ECA) within a sub-watershed as an index to determine if timber harvest may cause increased peak flows. The USFS estimates that the project-related treatments would increase ECA by a range of 0.6 to 7.0% (depending on sub-watershed) over the life of the project, and that it would have insignificant effects on flow at the sub-watershed scale and above. The USFS also reports that the peak/base flows habitat indicator is currently "functioning at risk" within the Upper North Fork Nooksack River and Canyon Creek sub-watersheds (USFS 2022b).

In addition to thinning, forest roads can cause hydrologic effects that can increase in-stream flows. Roads that are directly connected to streams by drainage ditches, and overland flow from cross-drain culverts and stream crossings increase the amount of runoff routed directly to stream channels (Wemple et al. 1996). The existing road network within the project area is estimated at about 50 miles. The 17.5 miles of temporary road that would be constructed and or reconstructed for this project would increase total road length 35%. About 7.9 miles of the temporary road would be within riparian reserves where they might increase direct runoff to stream. Temporary road sections would be constructed only when needed, and then be closed and rehabilitated afterward. As such, temporary roads are expected to only minimally increase in-stream flows. However, the ones that do affect in-stream flows may continue to do so for years after they are decommissioned, while the native vegetation regrows and natural hydraulic processes return to pre-project levels.

As described earlier, water drafting for road construction and fire protection would episodically cause very short-term and isolated minor decreases in in-stream flows. The magnitude of those withdrawals is not expected to cause any measurable effect on either of the mechanisms considered above that may cause changes in peak and base flows.

In summary, thinning coupled with the slightly increased drainage network associated with temporary roads, is likely to cause localized increases in base and peak flows within the action area.

The degree to which increased flows would act independently and or synergistically with increased suspended sediments and reduced in-stream wood to reduce habitat quality for Chinook salmon and steelhead is unknown. Exposure to the increased flows is likely to cause fitness impacts in rearing juvenile salmonids that must expend more energy to remain within a specific stream reach. It may displace some juveniles from preferred habitat, including forcing premature downstream migration at times that are suboptimal for growth and survival. Increased flows can cause fitness impacts in migrating adults that must swim against the flow, and may increase in-channel substrate movement and scour that injure or kill developing eggs and alevins in redds (Hicks et al. 1991; Hooper 1973). The annual numbers of individuals that would be affected by increased flows is unquantifiable with any degree of certainty. However, based on the small amount of occupied habitat that may be affected, the numbers of fish and eggs that would be annually affected by this stressor would comprise such small subsets of their respective cohorts, that their loss would cause no detectable population-level effects.

Drainage Network Increase

The proposed action would slightly increase the drainage network within the action area through thinning, and by the construction or reconstruction of temporary roads, landings, and yarding corridors. As described above, under the assessments of Suspended Sediment and Substrate Embeddedness and Changes in Peak and Base Flows, those project components, both individually and in combination, would slightly and temporarily increase the drainage network in localized areas. Because the impacts this would have on listed species has already been captured and described above, it is not restated here.

Road Density and Location

The proposed action would temporarily increase the road density within the action area through the construction or reconstruction of 17.5 miles of temporary roads that would be closed and rehabilitated prior to the end of this action. No new permanent roads would be constructed, and an additional 3.9 miles of existing road would be closed and rehabilitated. As described above, under the assessments of Suspended Sediment and Substrate Embeddedness and Changes in Peak and Base Flows, the construction and use of the 17.5 miles of temporary roads would slightly and temporarily increase sediment input to streams and slightly and temporarily increase peak and base flows in localized areas. Because the impacts this would have on listed species has already been captured and described above, it is not restated here.

Disturbance History and Regime

The proposed action would thin forest stands and conduct related work that would cause new disturbances that would add slightly to the disturbance history and regime within the project area. As described in the environmental baseline section above, the project area has a long history of disturbance from forestry and other land management activities. The USFS BA reports that the Disturbance History habitat indicator is currently “functioning at risk” within the Canyon Creek sub-watershed. The watershed-level effects of the proposed action on Disturbance History habitat indicator would be minor because: (1) The project is designed to reduce over-all canopy cover within thinned stands to no more than about 60%, which is considered the lower limit of hydrologically mature conditions; (2) Thinning would target relatively immature trees that are within previously disturbed stands; and (3) All new roads would be temporary, designed to minimize hydrological connections to the stream network, and they would be decommissioned or obliterated when no longer needed. Additionally, to the extent that the proposed action is successful in promoting future tree growth, the treated stands are expected to develop more late-seral characteristics that are more similar to historic forest conditions than the current environmental baseline. As above, any effects that increased disturbance would have on listed species have already been captured and described in the assessments above, and they are not restated here.

Riparian Reserves

The proposed action would commercially thin about 288 acres of riparian reserves within the project area. Over the near to midterm, the proposed action would adversely affect those riparian reserves by thinning within 150 feet of perennial, and 50 feet of intermittent stream banks, as well as by the construction or reconstruction of temporary roads, landings, and yarding corridors within some riparian areas. Over the long term, to the extent that the proposed action is successful in promoting future tree growth, the riparian reserves within treated stands are expected to develop more late-seral characteristics that are more similar to historic forest conditions than the current environmental baseline, including a general increase in the height and diameter of the trees within the riparian reserves.

As described above, under the assessments of Stream Temperature, Suspended Sediment and Substrate Embeddedness, Woody Material, Pool Frequency and Quality; and Changes in Peak and Base Flows, those project components, both individually and in combination, would slightly reduce the quality of the riparian reserves in localized area across the project area. As above, any effects that the impacts on riparian reserves would have on listed species have already been captured and described in the assessments above, and they are not restated here.

Direct exposure to blasting: Potential project-related blasting is not likely to adversely affect (NLAA) PS Chinook salmon and PS steelhead. As discussed under Suspended Sediment and Substrate Embeddedness, the project would include blasting during road decommissioning and possibly during crushed rock aggregate production. In addition to blasting's expected impacts on the habitat indicators identified above, blasting has the potential to directly affect listed fish through exposure to concussive forces and high intensity sound. Fish responses to blasting exposure depend on numerous factors, especially proximity and charge size, and can range from mild behavioral disturbances to immediate mortality.

Of the 7 potential rock source sites where blasting may be needed, none are within 200 feet of fish-bearing streams or designated critical habitat for PS Chinook salmon and or PS steelhead. Where possible, project-related blasting would use safe (NLAA) distances and charge weights per the MBSNF Blasting Guidelines, as well as other related PDC and Mitigation Measures identified in the USFS's BA for this project. Further, the USFS would contact the Services if any necessary blasting would exceed the NLAA threshold in the Blasting Guidelines, to determine if reinitiation of consultation would be warranted. Based on the best available information, the NMFS expects that PS Chinook salmon and PS steelhead that may be exposed to project-related blasting would experience no more than very brief and mild behavioral disturbances that would cause no fitness impacts nor alter normal behaviors.

Direct exposure to water drafting: Project-related water drafting is not likely to adversely affect PS Chinook salmon and PS steelhead. As discussed under Stream Temperature and Changes in Peak and Base Flows, the project would include removal of water directly from multiple unidentified streams within the project area, and may include spawning and rearing habitat. In addition to its expected impacts on the habitat indicators identified above, water drafting can directly affect listed fish through entrainment or impingement of individuals with the pumping equipment, and by dewatering occupied stream reaches.

Site selection and drafting work would comply with the protective measures detailed in the MOU between USFS and WDFW (USFS 2022c and d), which includes required measures such as isolating and screening pump intakes, and maintaining adequate in-stream flows for fish (USFS 2023c). Further, no drafting would occur during the spawning seasons for PS Chinook salmon and PS steelhead. Based on the best available information, the NMFS considers it extremely unlikely that any individuals of either species would be exposed to entrainment or impingement or to dewatered stream reaches. At most, any individuals that may be exposed to water drafting operations would experience no more than very brief and mild behavioral disturbances that would cause no fitness impacts nor alter normal behaviors.

2.5.2 Effects on Critical Habitat

This assessment considers the intensity of expected effects in terms of the change they would cause in affected Physical or Biological Features (PBFs) from their baseline conditions, and the severity of each effect, considered in terms of the time required to recover from the effect. Ephemeral effects are those that are likely to last for hours or days, short-term effects would likely last for weeks, and long-term effects are likely to last for months, years or decades.

Critical Habitat for Puget Sound Chinook Salmon and Puget Sound Steelhead: The proposed action, including full application of the planned conservation measures and BMPs, is likely to adversely affect designated critical habitat for PS Chinook salmon and PS steelhead. The expected effects would be limited to impacts on freshwater PBFs as described below.

1. Freshwater spawning sites:
    a. Water quantity – The proposed action would cause long term minor adverse effects on this attribute. Forest thinning and road work would cause relatively small and localized increases in base and peak flows during the winter. The increased flows would be undetectable at the watershed scale, but may persist for up to 20 years after project completion. Water drafting would cause very small, episodic, and very brief temporary decreases in water quantity that would be undetectable within yards downstream of the drafting site.
    b. Water quality – The proposed action would cause long term minor adverse effects on this attribute. Forest thinning and road work would cause slightly increased summer water temperatures in localized areas. Forest thinning, road work, and hauling would cause slightly increased input of fine sediments, and equipment leaks and spills would introduce low levels of petrochemicals into stream waters. Detectable effects are not expected to exceed 2 miles downstream of locations where thinning or roads are within 200 feet of streams, but may persist for up to 20 years after project completion.
    c. Substrate – The proposed action would cause long term minor adverse effects on this attribute. Project-related sediment increases may cause localized low-level substrate in-filling and embedment. Increased flows, combined with reduced woody debris may slightly increase substrate movement and scour. Some of these effects may extend up to 0.5 mile downstream from locations where thinning or roads are within 200 feet of streams, and persist for up to 20 years after project completion.

2. Freshwater rearing sites:
    a. Floodplain connectivity – The proposed action would cause long term minor adverse effects on this attribute. The roads that would be maintained and used as part of the proposed action, including some of the 17.5 miles of temporary road that would be opened, would prevent natural channel migration past them where they border and or cross streams. Although not specifically identified or quantified by the FS, some of these locations are likely to be within designated salmonid critical habitat. Streambank armoring that protects some of those roads locks the physical conditions at the sites in a simplified state with reduced edge habitat features such as undercut banks and alcoves. It also prevents the formation of off-channel habitat at those locations. The altered hydrology at the site may also impact bank habitat forming processes within the nearest bends in the affected streams. Reduced wood recruitment due to the planned riparian thinning would also cause some deleterious effects on bank habitat forming processes and flood plain connectivity. The effects from reduced wood recruitment are likely to persist for up to 20 years past the end of the project. Road-related impacts would persist for the life of the roads, most of which are considered permanent.
    b. Forage – The proposed action would cause long term minor adverse effects on this attribute. Increased suspended sediment input would cause minor reductions in the production of aquatic macroinvertebrate prey organisms. Conversely, increased solar

radiation reaching streams, and concurrent increased streamside understory vegetation, may increase the availability of macroinvertebrate prey organisms in some areas. Detectable effects would likely be minor and largely limited to in-stream areas immediately adjacent to sites where roads or thinning are within 200 feet of the stream, and no more than 2 miles downstream. However, the effects would persist for decades.

c. Natural cover – The proposed action would cause long term minor adverse effects on this attribute. The maintenance of roadside bank armoring would permanently prevent the formation of edge habitat features such as undercut banks along their lengths. Reduced wood recruitment would slightly reduce the availability of in-stream wood, and the removal of bankside riparian vegetation in some areas would remove overhanging vegetation and in-stream leaf litter that can provide in-water cover. These effects would persist for decades.
d. Water quantity – Same as above.
e. Water quality – Same as above.

3. <u>Freshwater migration corridors:</u>
   a. Free of obstruction and excessive predation – The proposed action would cause long term minor adverse effects on this attribute. Increased suspended sediments and increased summer water temperatures may delay or alter migration for some adults. Increased in-stream flows during the winter may prematurely displace some rearing juveniles. The forced early migration would, in effect, obstruct their continued rearing within the affected area. The maintenance of roadside bank armoring, especially if riprap is used, would provide conditions that are preferred by predatory species such as sculpins and trout, which increases the risk of predation for juvenile salmonids. These effects would persist for decades.
   b. Water quantity – Same as above.
   c. Water quality – Same as above.
   d. Natural Cover – Same as above.

4. <u>Estuarine areas</u> – None in the action area.

5. <u>Nearshore marine areas</u> – None in the action area.

6. <u>Offshore marine areas</u> – None in the action area.

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 and 402.17(a)). 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.

The current condition of ESA-listed species and designated critical habitat within the action area are described in the status of the species and critical habitat and the environmental baseline sections above. The contribution of non-federal activities to those conditions include past and on-going forest management, agriculture, urbanization, road construction, water development, recreation, and restoration activities. Those actions were driven by a combination of economic conditions that characterized traditional natural resource-based industries, general resource demands associated with settlement of local and regional population centers, and the efforts of conservation groups dedicated to river restoration and use of natural amenities, such as cultural inspiration and recreational experiences.

The majority of the action area is within federal lands in the upstream portion of the affected watershed catchment areas. However, the action area also includes some non-federal lands (Figure 1). Within the federal lands, the most common private activity likely to occur within the action area is unmanaged recreation, including fishing. Although the USFS manages recreational activities to some degree (i.e., campgrounds, trailheads, off-road-vehicle trails), a considerable amount of dispersed unmanaged recreation occurs. Expected impacts to salmon and steelhead from this type of recreation include impacts to water quality such as minor releases of suspended sediment and wastes, short-term barriers to fish movement, and minor changes to habitat structures. Streambanks, riparian vegetation, and spawning redds can be disturbed wherever human use is concentrated. Recreational fishing within the action area is expected to continue to be subject to WDFW regulations. The level of take of ESA-listed salmon and steelhead within the action area from angling is unknown, but is expected to remain at current or lower levels as the State enacts increasingly protective regulations.

Within the non-federal lands, agriculture, forest management, mining, road construction, urbanization, water development, and recreation are all likely to continue and increase in the future as the human population continues to grow across the region.

Across the state, the economic and environmental significance of a natural resource-based economy is declining as the region shifts toward an economic model based more on high technology, mixed manufacturing, and marketing. Nonetheless, resource-based industries and agriculture are likely to continue, especially in more rural areas. Within the action area, agriculture, forest management, and urbanization are likely to continue affecting environmental conditions for decades to come.

The intensity of these influences depends on many social and economic factors, and therefore is difficult to predict. Further, the adoption of more environmentally acceptable practices and standards may gradually reduce some negative environmental impacts over time. Interest in restoration activities has increased as environmental awareness rises among the public. State, tribal, and local governments have developed plans and initiatives to benefit ESA-listed PS Chinook salmon and PS steelhead within the watersheds of the action area. However, the implementation of plans, initiatives, and specific restoration projects are often subject to political, legislative, and fiscal challenges that increase the uncertainty of their success.

2.7 Integration and Synthesis

The Integration and Synthesis section is the final step in in assessing the risk that the proposed action poses to species and critical habitat. 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 biological opinion as to whether the proposed action is likely to: (1) appreciably reduce 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 as a whole for the conservation of the species.

As described in more detail above at Section 2.4, climate change is likely to increasingly affect the abundance and distribution of the ESA-listed species considered in the Opinion. It is also likely to increasingly affect the PBFs of designated critical habitats. The exact effects of climate change are both uncertain, and unlikely to be spatially homogeneous. However, climate change is reasonably likely to cause reduced instream flows in some systems, and may impact water quality through elevated in-stream water temperatures and reduced dissolved oxygen, as well as by causing more frequent and more intense flooding events.

Climate change may also impact coastal waters through elevated surface water temperature, increased and variable acidity, increasing storm frequency and magnitude, and rising sea levels. The adaptive ability of listed-species is uncertain, but is likely reduced due to reductions in population size, habitat quantity and diversity, and loss of behavioral and genetic variation. The proposed action would cause direct and indirect effects on the ESA-listed species and critical habitats considered in the Opinion well into the foreseeable future. However, the action's effects on water quality, substrate, and the biological environment are expected to be of such a small scale that no detectable effects on ESA-listed species or critical habitat through synergistic interactions with the impacts of climate change are expected.

2.7.1 ESA-listed Species

PS Chinook salmon and PS steelhead are both listed as threatened, based on declines from historic levels of abundance and productivity, loss of spatial structure and diversity, and an array of limiting factors as a baseline habitat condition. Both species will be affected over time by cumulative effects, some positive – as recovery plan implementation and regulatory revisions increase habitat protections and restoration, and some negative – as climate change and unregulated or difficult to regulate sources of environmental degradation persist or increase. Overall, to the degree that habitat trends are negative, the effects on viability parameters of each species are also likely to be negative. In this context we consider how the effects of the proposed action's impacts on individuals would affect the listed species at population and ESU/DPS scales.

PS Chinook Salmon: The long-term abundance trend of the PS Chinook salmon ESU is slightly negative. Reduced or eliminated accessibility to historically important habitat, combined with degraded conditions in available habitat due to land use activities appear to be the greatest threats to the recovery of PS Chinook salmon. Commercial and recreational fisheries also continue to impact this species.

The most recent Biological Viability Assessment reported a general decline in natural-origin spawner abundance across all PS Chinook salmon MPGs over the most-recent fifteen years. It also reported that escapement levels remain well below the PSTRT planning ranges for recovery for all MPGs, and concluded that the PS Chinook salmon ESU remains at "moderate" risk of extinction (Ford 2022).

The proposed action would take place within sub-watersheds of the NF Nooksack River Basin. The PS Chinook salmon most likely to occur in the action area would be spring-run fish from the Nooksack River population. The total abundance trend for PS Chinook salmon in the Nooksack River population has been slightly negative. Natural productivity has been below replacement in all years since the mid-1980's, with natural-origin spawners accounting for less than 20% of the total population from 1999 through 2018. It is important to note that the PSTRT believes the NF/MF population must achieve viability in order to recover the ESU. This is due to the Strait of Georgia MPG containing only two populations (North and South Fork Nooksack River). The South Fork population is at a high risk of extinction due to decades of extremely low escapement of natural spawners. Therefore, the recovery of the both the MPG and ESU are highly reliant on the increased viability of the North Fork population.

The environmental baseline within the action area has been degraded by the effects of past and on-going forest management, road building and maintenance activities. The proposed action would cause a combination of impacts that would slightly reduce the functional levels of habitat features within small stream sections across the action area. Of highest concern to the NMFS is the project's potential to further degrade environmental baseline indicators currently functioning at some level of risk (discussed above), specifically elements of water quality and habitat complexity. These elements are important to sustaining the natural production of salmonids in their freshwater life stages.

Project related effects would last over the 15-year life of the action, and are likely to persist at diminishing levels for up to about 20 years after the project is complete. Both individually and collectively, those impacts would annually cause altered behaviors, reduced fitness, and mortality in very low numbers of juveniles and eggs, and may slightly reduce the migratory fitness and spawning success for very low numbers of adults.

Based on the best available information, the scale of the direct and indirect effects of the proposed action, when considered in combination with the degraded baseline, cumulative effects, and the impacts of climate change, would be too small to cause detectable effects on any of the characteristics of a viable salmon population (abundance, productivity, distribution, or genetic diversity) for the affected PS Chinook salmon populations. Therefore, the proposed action would not appreciably reduce the likelihood of survival and recovery of this listed species.

<u>PS Steelhead:</u> The long-term abundance trend of the PS steelhead DPS is negative, especially for natural spawners. Abundance information is unavailable for about 1/3 of the DIPs. In most cases where no information is available, it is assumed that abundances are very low. Although

most DIPs for which data are available experienced improved abundance over the last five years, 95% of those DIPs are at less than half of their lower abundance target for recovery. The extinction risk for the Puget Sound steelhead DPS is considered moderate. Reduced or eliminated accessibility to historically important habitat, combined with degraded conditions in available habitat due to land use activities appear to be the greatest threats to the recovery of PS steelhead. Fisheries activities also continue to impact this species (Ford 2022).

The proposed action would take place within sub-watersheds of the NF Nooksack River Basin. The PS steelhead most likely to occur in the action area would be winter-run fish from the Nooksack DIP. The abundance trend of the Nooksack DIP increased slightly in the most recent 5-year viability assessment, although limited available data only allows for about a decade of trend analysis (starting in 2010). Current abundance (2015-2019) estimates for the Nooksack population are around 10% of target abundance for the DIP (Ford 2022).

The environmental baseline within the action area has been degraded by the effects of past and on-going forest management, road building and maintenance activities. The majority of the impacts from the proposed actions are anticipated to occur within the Canyon Creek sub-watershed. As described for PS Chinook, our concern is the project's potential to further degrade environmental baseline indicators, which are currently functioning at some level of risk (discussed above), specifically elements of water quality and habitat complexity.
The proposed action would cause a combination of impacts that would slightly reduce the functional levels of habitat features within small stream sections across the action area. The effects would last over the 15-year life of the action, and are likely to persist at diminishing levels for up to about 20 years after the project is complete. Both individually and collectively, those impacts would annually cause altered behaviors, reduced fitness, and mortality in very low numbers of juveniles and eggs, and may slightly reduce the migratory fitness and spawning success for very low numbers of adults.

Based on the best available information, the scale of the direct and indirect effects of the proposed action, when considered in combination with the degraded baseline, cumulative effects, and the impacts of climate change, would be too small to cause detectable effects on any of the characteristics of a viable salmon population (abundance, productivity, distribution, or genetic diversity) for the affected PS steelhead populations. Therefore, the proposed action would not appreciably reduce the likelihood of survival and recovery of this listed species.

2.7.2 Critical Habitat

Critical habitat was designated for PS Chinook salmon and PS steelhead to ensure that specific areas with PBFs that are essential to the conservation of those listed species are appropriately managed or protected. These critical habitats will be affected over time by cumulative effects, some positive – as restoration efforts and regulatory revisions increase habitat protections and restoration, and some negative –as climate change and unregulated or difficult to regulate sources of environmental degradation persist or increase. Overall, to the degree that trends are negative, the effects on the PBFs of these critical habitats are also likely to be negative. In this context we consider how the proposed action's impacts on the attributes of the action area's

PBFs would affect these designated critical habitats' abilities to support the conservation of their respective species as a whole.

Critical Habitat for PS Chinook Salmon and PS Steelhead

Past and ongoing land and water use practices have degraded salmonid critical habitat throughout the Puget Sound basin. Hydropower and water management activities have reduced or eliminated access to significant portions of historic spawning habitat. Timber harvests, agriculture, industry, urbanization, shoreline development, and point and non-point stormwater and wastewater discharges have adversely altered floodplain and stream morphology in many watersheds, diminished the availability and quality of estuarine and nearshore marine habitats, and reduced water quality across the region.

Global climate change is expected to increase in-stream water temperatures and alter stream flows, possibly exacerbating impacts on baseline conditions in freshwater habitats across the region. Rising sea levels are expected to increase coastal erosion and alter the composition of nearshore habitats, which could further reduce the availability and quality of estuarine habitats. Increased ocean acidification may also reduce the quality of estuarine habitats. In the future, non-federal land and water use practices and climate change are likely to increase. The intensity of those influences on salmonid habitats is uncertain, as is the degree to which those impacts may be tempered by adoption of more environmentally acceptable land use practices, by the implementation of non-federal plans that are intended to benefit salmonids, and by efforts to address the effects of climate change.

The PBFs of salmonid critical habitat that would be affected by the proposed action are freshwater spawning sites, rearing sites, and migration corridors free of obstruction and excessive predation. As described above, the proposed action would cause long-term minor adverse effects on water quality, substrate, floodplain connectivity, forage, natural cover, and freedom from obstruction and excessive predation up to 2 miles downstream of locations where thinning or action-related roads are within 200 feet of streams.

Based on the best available information, the scale of the proposed action's effects, when considered in combination with the degraded baseline, cumulative effects, and the impacts of climate change, would be too small to measurably reduce the quality or functionality of the freshwater PBFs from their current levels. Therefore, the critical habitat would maintain its current level of functionality, and retain its current ability for PBF to become functionally established, to serve the intended conservation role for PS Chinook salmon and PS steelhead.

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, the effects of other activities caused by the proposed action, and cumulative effects, it is the NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of PS Chinook salmon or PS steelhead, nor is it likely to destroy or adversely modify designated critical habitat for either of these species.

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). "Harass" is further defined by interim guidance as to "create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering." "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 incidental take statement (ITS).

2.9.1 Amount or Extent of Take

In the biological opinion, the NMFS determined that incidental take is reasonably certain to occur as follows:

Harm of PS Chinook salmon and PS steelhead from exposure to:

- Elevated water temperature,
- Increased suspended sediment and substrate embeddedness,
- Introduction of chemicals and increased nutrients,
- Reduced in-stream woody material,
- Reduced pool frequency and quality, and
- Increased peak and base flows.

The NMFS cannot predict with meaningful accuracy the number of PS Chinook salmon and PS steelhead that are reasonably certain to be harmed by exposure to project-related habitat impacts. The distribution and abundance of the 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. These biotic and environmental processes interact in ways that may be random or directional, and may operate across far broader temporal and spatial scales than are affected by the proposed action. Thus, the distribution and abundance of fish within the action area cannot be attributed entirely to habitat conditions, nor can the NMFS precisely predict the number of fish that are reasonably certain to be injured or killed if their habitat is modified or degraded by the proposed action. Additionally, the NMFS knows of no device or practicable technique that would yield reliable counts of individuals that may experience these impacts. In such circumstances, the NMFS uses the causal link established between the activity and the likely extent and duration of changes in habitat conditions to describe the extent of take as a numerical level of habitat disturbance. The most appropriate surrogates for take are action-related parameters that are directly related to the magnitude of the expected take.

For this action, the acreage of riparian reserves to be thinned, the planned treatment limits, and the number of miles of road to be used in support of the project are the best available surrogates for the extent of take of PS Chinook salmon and PS steelhead from exposure to habitat impacts. These surrogates are applicable because an increase in any of them is likely to increase the amount of habitat that would be exposed to project-related impacts on the habitat indicators that were discussed in the Effects of the Action section and identified at the beginning of this subsection, and or to increase the intensity of the impacts on those habitat indicators.

Thinning additional riparian areas would increase the amount of stream area that would be exposed. Reducing the no-cut buffer widths would increase the intensity of the impacts, as would increasing the amount of gap and heavy-thin treatment within a stand. Increased road mileage, especially within riparian reserves, would likely increase the amount of stream that would be exposed. Exposing more habitat would likely expose more individuals, while increasing the intensity of the impacts would increase the severity of the effects on the exposed individuals, and it many also increase the number of exposed individuals because the downstream extent of effects may also be increased.

In summary, the extent of Puget Sound Chinook salmon and Puget Sound steelhead take for this action is defined as:

- Total commercial thinning of up to 1797 acres, including up to 399 acres within Riparian Reserves.
- Total non-commercial thinning of up to 858 acres, including up to 268 acres within Riparian Reserves.
- Commercial thinning within Riparian Reserves would create stand density indices between about 150 to 190, retain a minimum canopy cover of 30%, and comply with the other limits identified in the description of the proposed action section of this opinion.
- Commercial thinning outside Riparian Reserves would create stand density indices between about 80 to 190, retain a minimum canopy cover of 10%, and comply with the other limits identified in the description of the proposed action section of this opinion.
- Minimum no-cut buffers of 150 feet for all fish-bearing streams and for all perennial streams regardless of fish bearing status.
- Gap thinning of no more than 10% of the area within individual stands, done no closer than 150 feet from any stream.
- Maintenance and use of no more than 67.5 miles of road, to include the maintenance and reconstruction of no more than 17.5 miles of temporary road, of which no more than 1.5 miles of new construction.

Exceedance of any of the exposure limits described above would constitute an exceedance of authorized take that would trigger the need to reinitiate consultation. Although some of these take surrogates could be construed as partially coextensive with the proposed action, they nevertheless function as effective reinitiation triggers because the USFS has authority to conduct periodic compliance inspections and take actions to address non-compliance. Therefore, exceedance of the surrogates would be apparent in a timely manner, and consultation could be reinitiated well before the project is completed.

2.9.2 Effect of the Take

In the Opinion, the 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" (RPMs) 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 USFS shall:

1. Minimize incidental take of PS Chinook salmon and PS steelhead from exposure to thinning-related habitat impacts.
2. Minimize incidental take of PS Chinook salmon and PS steelhead from exposure to road-related habitat impacts.
3. Implement monitoring and reporting to confirm that the take exemption for the proposed action is not exceeded.

2.9.4 Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the Federal action agency must comply (or must ensure that any applicant complies) with the following terms and conditions. The USFS and project-related timber sale purchasers and contractors have 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. To implement RPM Number 1, Minimize incidental take of PS Chinook salmon and PS steelhead from exposure to thinning-related habitat impacts, the USFS shall require the timber sale purchaser to:
    a. Comply with the PDCs and mitigation identified in the USFS BA as well as all requirements of the MOU between WDFW and the USFS for the 2021-2025 HPA,
    b. Develop and comply with USFS-approved spill prevention and control measures commensurate with both equipment and oil and petroleum-based products that are used on-site, as described in. Measures shall include at a minimum:
        i. Maintaining all equipment operating on the project to conditions free of abnormal leakage of lubricants, fuel, coolants, and hydraulic fluid;
        ii. The timber sale purchaser shall not service tractors, trucks, or other equipment on National Forest lands where servicing is likely to result in pollution delivery to soil or water resources;

iii. The timber sale purchaser shall furnish oil-absorbing mats and other certified containment and pollution prevention equipment and materials for application on-site for all stationary equipment or equipment being lightly serviced to prevent leaking or spilled petroleum-based products from contaminating soil and water resources;
iv. The timber sale purchaser will confirm via USFS timber sale inspection use of spill prevention and control measures; and
v. The timber sale purchaser shall remove from National Forest lands and properly dispose of all contaminated soil, vegetation, debris, or equipment or equipment generated product resulting from use, servicing, repair, or abandonment of equipment.

2. To implement RPM Number 2, Minimize incidental take of PS Chinook salmon and PS steelhead from exposure to road-related habitat impacts, the USFS shall require the timber sale purchaser to:
   a. Comply with the PDCs and mitigation identified in the USFS BA as well as all requirements of the MOU between WDFW and the USFS for the 2021-2025 HPA,
   b. Develop and comply with USFS-approved spill prevention and control measures as described above a 1.b.

3. To implement RPM Number 3, implement a monitoring and reporting program to confirm that the take exemption for the proposed action is not exceeded, the USFS shall collect and report details about the take of listed fish. That plan shall:
   a. Require the USFS to maintain and submit work logs commensurate with normal timber sale administration to verify that all take indicators are monitored and reported. When advantageous, the inclusion of maps, drawings, and photographs is encouraged. Minimally, the logs should include:
      i. A chronological record of work that identifies and or describes the dates, location(s) (i.e. road number and mile marker(s), stand number(s)), and general type(s) of work (i.e. road construction/maintenance, cutting, yarding, hauling, etc.). It is assumed that some dates would include multiple types of work at multiple locations. Each should be appropriately described.
      ii. The nearest stream. Give its name if applicable, and describe it (perennial/intermittent, fish-bearing, expected/confirmed listed fish, critical habitat, etc.) and its distance from the work. Provide methods used to classify each stream type (as fish or non-fish bearing, perennial/intermittent, etc.).
      iii. For road-related work (roads, turnarounds, bridges, etc.):
         1. Briefly identify/describe the work (i.e. grubbing, grading, rocking, paving, bridge repair, embankment repair, etc.);
         2. Document USFS site inspections and or condition verifications;
         3. Identify the BMP and conservation measures that were applied and describe their efficacy; and
         4. Summarize discrete projects when work is completed (i.e. when construction/obliteration of a specific temporary road segment is complete, at the end of resurfacing a system road segment, when a turnaround is complete, etc.). Include total road length and briefly describe the end conditions.

iv. For thinning-related work:
    1. Briefly identify/describe the work (landing construction, treatment type, yarding type, loading, hauling, slash management, etc.);
    2. Identify the no-cut buffer(s), BMP, and conservation measures that were applied and describe their efficacy;
    3. Summarize the thinning within each stand when treatment is complete. Quantify the number and size(s) of the Gap and skip areas;
    4. Describe the locations of the Gap and Heavy Thin areas relative to the nearest stream and to each other;
    5. Quantify the total acreage and percentage of each treatment type relative to the stand size; and
    6. Describe the retained canopy cover within the General- and Heavy-Thin areas, and for the stand overall.

b. Require the USFS to establish procedures for the submission of logs, maps, photographs, and other pertinent documentation, which will be submitted in annual monitoring reports to NMFS.

c. Require the USFS to implement an inspection plan commensurate with normal timber sale administration verify compliance with the terms and conditions of this opinion. Minimally:
   i. The USFS shall conduct a monthly average of 4 work site inspections, that will include the spectrum of stand treatments, roadwork, and associated hauling actions;
   ii. The USFS shall verify, as needed, any near-stream landing and or turnaround reconstruction or hazard tree removal; and
   iii. The USFS shall document the date, type of inspection, location, type of work site, and the results of the inspection.

d. Require the USFS to submit annual electronic monitoring reports to NMFS over the life of the project. Submit reports for each calendar year's work by February 15 of the following year. Send the reports to: projectreports.wcr@noaa.gov. Be sure to include Attn: WCRO-2022-01195 in the subject line.

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).

1. The USFS should require the timber sale purchaser to develop and comply with a Spill Prevention Control and Countermeasure Plan (SPCCP) regardless of the total volume of the material they would have on-site, and to require the purchaser to obtain USFS approval of that plan prior to the commencement of any work on the national forest.
2. The USFS should implement a water quality monitoring plan for the Canyon Creek watershed, designed to detect the intensity and downstream extent of project-related in-stream increased temperature, suspended sediment and substrate embeddedness.

3. The USFS should implement a habitat monitoring plan for the Canyon Creek watershed, designed to detect changes in large wood recruitment from stream protection buffers.
4. The USFS should accelerate fish passage barrier corrections in the project area within 5 years of project activity.
5. The USFS should enhance stream habitats in the project area where deficient habitat conditions exist from historic land use practices.
6. The USFS should abandon stream-adjacent or parallel roads in the project area where feasible.

2.11 Reinitiation of Consultation

This concludes formal consultation for the U.S Forest Service's North Fork Nooksack Vegetation Project on the Mt. Baker-Snoqualmie National Forest, in Whatcom County, Washington.

Under 50 CFR 402.16(a): "Reinitiation of consultation is required and shall be requested by the Federal agency or by the Service where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and: (1) If the amount or extent of taking specified in the incidental take statement is exceeded; (2) If new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) If the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion or written concurrence; or (4) If a new species is listed or critical habitat designated that may be affected by the identified action."

2.12 Not Likely to Adversely Affect Determinations

This assessment was prepared pursuant to section 7(a)(2) of the ESA, implementing regulations at 50 CFR 402 and agency guidance for preparation of letters of concurrence.

Under the ESA, "effects of the action" means the direct and indirect effects of an action on the listed species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action (50 CFR 402.02). The applicable standard to find that a proposed action is not likely to adversely affect listed species or critical habitat is that all of the effects of the action are expected to be discountable, insignificant, or completely beneficial. Beneficial effects are contemporaneous positive effects without any adverse effects to the species or critical habitat. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are those that are extremely unlikely to occur.

As described in Section 1.2 and below, the NMFS has concluded that the proposed action is not likely to adversely affect SR killer whales, and their designated critical habitat. Detailed information about the biology, habitat, and conservation status and trends of SR killer whales can be found in the listing regulations and critical habitat designations published in the Federal Register, as well as in the recovery plans and other sources at: https://www.fisheries.noaa.gov/species-directory/threatened-endangered, and are incorporated here by reference.

The effects analysis in this section relies heavily on the descriptions of the proposed action and project site conditions discussed in Sections 1.3 and 2.4, and on the analyses of effects presented in Section 2.5.

2.12.1 Effects on Listed Species

SR killer whales

The proposed action will cause no direct effects on SR killer whales or their critical habitat because all project activity would take place in freshwater, over 54 miles upstream of the marine waters where SR killer whales and their designated critical habitat occur, and project-related impacts would be limited to stream reaches that are no more than 2 miles downstream of the project area.

However, the project may indirectly affect SR killer whales through trophic routing within the food web, by affecting the quantity and quality of prey available to SR killer whales. We therefore analyze that potential here but conclude that the effects on SR killer whales would be insignificant for at least two reasons.

First, as described in Section 2.5, the action would annually affect extremely low numbers of Chinook salmon. The exact Chinook salmon juvenile to adult ratios are not known. However, even under natural conditions, individual juvenile Chinook salmon have a very low probability of surviving to adulthood (Bradford 1995). We note that human-caused habitat degradation and other factors such as hatcheries and harvest exacerbate natural causes of low survival such as natural variability in stream and ocean conditions, predator-prey interactions, and natural climate variability (Adams 1980, Quinones et al., 2014). However, based on the best available information, the annual numbers of project-affected juveniles would be too low to influence any VSP parameters for the population.

Second, as described in Sections 1.3, 2.2, and 2.5, the only PS Chinook populations that would be affected by the project would be the North Fork Nooksack population which consists of a small natural-origin spawning population. Consequently, the population makes up a very small portion of the adult Chinook that are available to SR killer whales in marine waters. Therefore, based on the best available information, the proposed action is extremely unlikely to cause any detectable reduction in adult Chinook salmon availability to SR killer whales in marine waters, and as such is not likely to adversely affect SR killer whales through trophic impacts.

2.12.2 Effects on Critical Habitat

This assessment considers the intensity of expected effects in terms of the change they would cause in affected physical or biological features (PBFs) from their baseline conditions, and the severity of each effect, considered in terms of the time required to recover from the effect. Ephemeral effects are those that are likely to last for hours or days, short-term effects would likely to last for weeks, and long-term effects are likely to last for months, years or decades.

SR killer whale Critical Habitat: Designated critical habitat for SR killer whales includes marine waters of the Puget Sound that are at least 20 feet deep. The expected effects on SR killer whale critical habitat from completion of the proposed action, including full application of the conservation measures and BMP, would be limited to the impacts on the PBFs as described below.

1. Water quality to support growth and development:
   The proposed action would cause no detectable effects on this attribute.

2. Prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development, as well as overall population growth:
   The proposed action would cause long-term undetectable effects on this attribute. Action-related impacts would annually injure or kill extremely low numbers of individual juvenile Chinook salmon (primary prey). However, the numbers of affected juvenile Chinook salmon would be too small to cause detectable effects on the numbers of available adult Chinook salmon in marine waters. Therefore, it would cause no detectable reduction in prey availability and quality.

3. Passage conditions to allow for migration, resting, and foraging:
   The proposed action would cause no detectable effects on this attribute.

For the reasons expressed immediately above, the NMFS has concluded that the proposed action is not likely to adversely affect ESA-listed SR killer whales and their designated critical habitat.

3. 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. Under the MSA, this consultation is intended to promote the conservation of EFH as necessary to support sustainable fisheries and the managed species' contribution to a healthy ecosystem. For the purposes of the MSA, EFH means "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity", and includes the physical, biological, and chemical properties that are used by fish (50 CFR 600.10). 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) of the MSA also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH. Such recommendations may include measures to avoid, minimize, mitigate, or otherwise offset the adverse effects of the action on EFH [CFR 600.905(b)].

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

3.1 Essential Fish Habitat Affected by the Project

The project site is located in the upper North Fork Nooksack watershed (Figure 1). The waters and substrate of the North Fork Nooksack are designated as freshwater EFH for various life-history stages of Pacific Coast Salmon, which within the North Fork Nooksack watershed include Chinook, coho, and pink salmon. Due to trophic links between PS Chinook salmon and SR killer whales, the project's action area also overlaps with marine waters that have been designated, under the MSA, as EFH for Pacific Coast Salmon, Pacific Coast Groundfish, and Coastal Pelagic Species. However, the action would cause no detectable effects on any components of marine EFH. Therefore, the action's effects on EFH would be limited to impacts on freshwater EFH for Pacific Coast Salmon, and it would not adversely affect marine EFH for Pacific Coast Salmon, or EFH for Pacific Coast groundfish and coastal pelagic species.

Freshwater EFH for Pacific Coast Salmon is identified and described in Appendix A to the Pacific Coast salmon fishery management plan (PFMC 2014), and consists of four major components: (1) spawning and incubation; (2) juvenile rearing; (3) juvenile migration corridors; and (4) adult migration corridors and holding habitat.

Those components of freshwater EFH for Pacific Coast Salmon depend on habitat conditions for spawning, rearing, and migration that include: (1) water quality (e.g., dissolved oxygen, nutrients, temperature, etc.); (2) water quantity, depth, and velocity; (3) riparian-stream-marine energy exchanges; (4) channel gradient and stability; (5) prey availability; (6) cover and habitat complexity (e.g., large woody debris, pools, aquatic and terrestrial vegetation, etc.); (7) space; (8) habitat connectivity from headwaters to the ocean (e.g., dispersal corridors); (9) groundwater-stream interactions; and (10) substrate composition.

As part of Pacific Coast Salmon EFH, five Habitat Areas of Particular Concern (HAPCs) have been defined as: 1) complex channels and floodplain habitats; 2) thermal refugia; 3) spawning habitat; 4) estuaries; and 5) marine and estuarine submerged aquatic vegetation. The action area provides the spawning HAPC, and also likely provides the complex channels and floodplain habitats, and the thermal refugia HAPCs for Pacific Coast Salmon.

3.2 Adverse Effects on Essential Fish Habitat

The ESA portion of this document (Sections 1 and 2) describes the proposed action and its adverse effects on ESA-listed species and critical habitat, and is relevant to the effects on EFH. Based on the analysis of effects presented in Section 2.5 the proposed action will cause minor short- and long-term adverse effects, and minor long-term beneficial effects on EFH for Pacific Coast Salmon species as summarized below.

1. Water quality: – The proposed action would cause long term minor adverse effects on on this attribute. Forest thinning and road work would cause slightly increased summer water temperatures in localized areas. Forest thinning, road work, and hauling would cause slightly increased input of fine sediments, and equipment leaks and spills would introduce low levels of petrochemicals into stream waters. Detectable effects are not expected to exceed 2 miles downstream of locations where thinning or roads are within 200 feet of streams, but may persist for up to 20 years after project completion.

2. Water quantity, depth, and velocity: – The proposed action would cause long term minor adverse effects on this attribute. Forest thinning and road work would cause relatively small and localized increases in base and peak flows during the winter. The increased flows would be undetectable at the watershed scale, but may persist for up to 20 years after project completion. Water drafting would cause very small, episodic, and very brief temporary decreases in water quantity that would be undetectable within yards downstream of the drafting site.

3. Riparian-stream-marine energy exchanges: – No changes expected.

4. Channel gradient and stability: – No changes expected.

5. Prey availability: – The proposed action would cause long term minor adverse effects on this attribute. Increased suspended sediment input would cause minor reductions in the production of aquatic macroinvertebrate prey organisms. Conversely, increased solar radiation reaching streams, and concurrent increased streamside understory vegetation, may increase the availability of macroinvertebrate prey organisms in some areas. Detectable effects would likely be minor and largely limited to in-stream areas immediately adjacent to sites where roads or thinning are within 200 of streams, and no more than 2 miles downstream. However, the effects would persist for decades.

6. Cover and habitat complexity: – The proposed action would cause long term minor adverse effects on this attribute. The project would remove riparian vegetation that would slightly reduce the availability of in-stream wood, and the remove overhanging vegetation and in-stream leaf litter that can provide in-water cover. The maintenance of roads and roadside bank armoring would prevent natural channel migration and the formation of edge habitat features such as undercut banks. These effects would occur in localized areas, but would persist for decades.

7. Space: – No changes expected.

8. Habitat connectivity from headwaters to the ocean: – No changes expected.

9. Groundwater-stream interactions: – The proposed action would cause long term minor adverse effects on this attribute. Forest thinning and road work would cause relatively small increases in overland runoff that would cause a commensurate reduction in groundwater flows. The effect would occur in localized areas, but would persist for decades.

10. <u>Connectivity with terrestrial ecosystems:</u> – The proposed action would cause long term minor adverse effects on this attribute through the removal of riparian vegetation that would slightly reduce the availability of in-stream wood, overhanging vegetation, and in-stream leaf litter and deposition of terrestrial invertebrates. These effects would occur in localized areas, but would persist for decades.

11. <u>Substrate composition:</u> – The proposed action would cause long term minor adverse effects on this attribute through slightly reduced availability of in-stream wood, slightly increased flows, and slightly increased input of fine sediments that would reduce the availability, and increase the embeddedness of preferred gravels. These effects would occur in localized areas, but would persist for decades.

3.3 Essential Fish Habitat Conservation Recommendations

NMFS determined that the following conservation recommendations are necessary to avoid, minimize, mitigate, or otherwise offset the impact of the proposed action on EFH.

The proposed action includes conservation measures, BMP, and design features to reduce project-related impacts on the quantity and quality of EFH for Pacific Coast Salmon. With the exception of the following conservation recommendation to reduce impacts on water quality, the NMFS knows of no other reasonable measures to further reduce effects on EFH.

1. Follow terms and conditions 1-3 as presented in the ESA portion of this document to minimize adverse effects to water quality and monitor program effects.
2. Implement the conservation recommendations presented as part of the ESA portion of this document.
3. Repair or replace fish passage barriers to MSA-listed species throughout the project area (if present).
4. Enhance EFH by increasing complexity to degraded stream reaches.
5. Provide reconnection to floodplain off-channel habitats where artificially isolated by roads and berms.
6. Abandon or relocate roads adjacent to streams.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, the USFS must provide a detailed written response in to the NMFS within 30 days after receiving an EFH Conservation Recommendation. 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 the NMFS' EFH Conservation Recommendations unless the 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, minimizing, mitigating, or otherwise 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 the 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, the 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 USFS 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. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The Data Quality Act (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 user of this Opinion is the USFS. Other users could include WDFW, the government and citizens of Whatcom County, and Native American tribes. Individual copies of this Opinion were provided to the USFS. The document will be available at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. The format and naming adhere to conventional standards for style.

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 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, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

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