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-2024-02301

February 12, 2025

Jody Weil
Forest Supervisor
Mt. Baker-Snoqualmie National Forest
1000 SE Everett Mall Way, Suite 410
Everett, Washington 98208

Re: Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Forest Road 7810 MP 0.1 Repairs Project

Dear Ms. Weil:

Thank you for your letter of September 13, 2024, 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 Forest Road 7810 MP 0.1 Repairs Project.

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 is likely to adversely affect but is not likely to jeopardize the continued existence of Puget Sound (PS) Chinook salmon and PS steelhead. NMFS also concluded that the proposed action is likely to adversely affect, but is not likely to result in the destruction or adverse modification of designated critical habitat for both of those species.

As required by section 7 of the ESA, NMFS is providing an incidental take statement (ITS) with the Opinion. The ITS describes reasonable and prudent measures (RPM) NMFS considers necessary or appropriate to minimize the impact of 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.

NMFS also reviewed the proposed action for potential effects on essential fish habitat (EFH) designated under the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1855(b)). This review was pursuant to section 305(b) of the MSA, implementing regulations at 50 CFR 600.920, and agency guidance for use of the ESA consultation process to complete EFH consultation. NMFS concluded that the action would adversely affect EFH designated under the Pacific Coast Salmon Fishery Management Plan. Therefore, we have included the results of that review in this document and provided necessary conservation recommendations to avoid, minimize, mitigate, or otherwise offset the adverse effects of the proposed action on EFH.

Section 305(b) (4) (B) of the MSA requires Federal agencies to provide a detailed written response to NMFS within 30 days after receiving these recommendations. If the response is inconsistent with the EFH conservation recommendations, the Federal action agency must explain why the recommendations will not be followed, including the scientific justification for any disagreements over the effects of the action and the 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 Kaylie Anne Costa, in the Washington Coast/Lower Columbia Branch at (253) 693-0973, or by electronic mail at kaylie.costa@noaa.gov if you have any questions concerning this consultation, or if you require additional information.

Sincerely,

Kathleen Wells
Assistant Regional Administrator
Oregon Washington Coastal Office

cc: Richard Vacirca

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

Forest Road 7810 MP 0.1 Repairs Project
Mt. Baker-Snoqualmie National Forest

NMFS Consultation Number: WCRO-2024-02301

Action Agency: U.S. Forest Service

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	If likely to adversely affect, Is Action Likely to Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	If likely to adversely affect, is Action Likely to Destroy or Adversely Modify Critical Habitat?
Puget Sound Chinook (*O. tshawytscha*)	Threatened	Yes	No	Yes	No
Puget Sound Steelhead Trout (*O. mykiss*)	Threatened	Yes	No	Yes	No

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

Consultation Conducted By: National Marine Fisheries Service
West Coast Region

Issued By:

Kathleen Wells
Assistant Regional Administrator
Oregon Washington Coastal Office

Date: February 12, 2025

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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 U.S.C. 1531 et seq.), as amended, and implementing regulations at 50 CFR part 402.

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

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality 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].

1.2. Consultation History

In 2016, the south abutment of the FR 7810 bridge on the Carbon River was damaged by flooding. Repairs from that damage were made to the North and South abutments of the Carbon River bridge (FSR 7810-0.0) in summer of 2019 under NMFS' Biological Opinion dated December 6, 2018 (WCR-2018-10016).

In February 2020, the south abutment was again damaged by high flows. Emergency consultation notification/correspondence between NMFS and the USFS (Richard Vacirca) occurred on March 27, 2023. NMFS provided four conservation measures that were recommended before and during emergency repairs:

1. Conduct in-water related work consistent with the WDFW-FS HPA MOU (2022), including coordination of in-water work window extension as needed.

2. Divert surface flow around the zone of in-channel excavation to prevent turbidity. Including pumping of residual/subsurface water to a site where that dirty water can then infiltrate prior to re-entering Carbon River.

3. Maintain fish passage/migration around the zone of in-water work.

4. Conduct fish removal/salvage in the zone of in-water work and document species captured. Fish removal will generally be conducted until no fish have been sampled within the work area.

The USFS employed emergency actions consistent with the provided conservation measures in August 2023 to stabilize the south abutment and corresponding road surface. This included replacement of riprap extending the south abutment, which are included in the proposed action, as described below.

On June 18, 2024, USFS and NMFS representatives conducted a field visit to discuss past and interim repair activities and future repair actions.

On September 13, 2024, NMFS received a letter from the USFS, requesting formal consultation for the Forest Road 7810 Mile Post (MP) 0.1 Repair project, along with the final draft of the BA for the proposed actions (USFS 2024). More information was requested on October 7, 2024 regarding the extent of proposed area of aquatic and riparian impacts, requirements for turbidity monitoring, and standard BMPs for the project. The USFS responded on October 8, 2024. NMFS initiated formal consultation was on October 17, 2024.

The Opinion is based on the information in the BA, including appendices; other 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).

Updates to the regulations governing interagency consultation (50 CFR part 402) were effective on May 6, 2024 (89 Fed. Reg. 24268). We are applying the updated regulations to this consultation. The 2024 regulatory changes, like those from 2019, were intended to improve and clarify the consultation process, and, with one exception from 2024 (offsetting reasonable and prudent measures), were not intended to result in changes to the Services' existing practice in implementing section 7(a)(2) of the Act. 89 Fed. Reg. at 24268; 84 Fed. Reg. at 45015. We have considered the prior rules and affirm that the substantive analysis and conclusions articulated in this biological opinion and incidental take statement would not have been any different under the 2019 regulations or pre-2019 regulations.

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 (see 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 (see 50 CFR 600.910). This Opinion includes the emergency stabilization of the FR 7810 bridge that was completed in 2023 as well as the proposed actions consist of acquiring 96 trees and constructing and installing the flow deflectors upstream of the FR 7810 bridge.

<u>2023 Forest Road 7810 MP 0.1 Completed Repairs</u>
Fish removal and relocation were done in accordance with the requirements of the Hydraulic Project Approval (HPA) issued for the project by WDFW and in accordance with guidelines for fish salvage issued by NMFS (NMFS 2000). Prior to emergency repairs, the work area was isolated from fish entering the work zone using a combination of isolation block netting and a cofferdam composed of Super Sacs underlain by a tarp to minimize flows to the fish salvage area

(Figure 1). Approximately 150 linear feet of stream channel was diverted. The work area was isolated using isolation block netting and a cofferdam composed of Super Sacs underlain by a tarp (Figure 1). Following isolation, 2-inch submersible pumps with pump screens composed of 5-gallon buckets with holes throughout were used to remove water from residual pools. The sides and bottom were screened with mesh meeting NMFS flow-through velocity standards. Water was pumped into upland vegetated areas; pumping directly into a stream or wetland was not allowed. Fish were removed by performing numerous seine passes and dipnetting, prior to three full electrofishing passes. Fish and fauna were transported in 5-gallon buckets of clean, stream water fitted with double aerators and released upstream of the cofferdam within 20 minutes. Flow was deflected around the work area so that all fish could migrate past the construction site unencumbered. No fish mortalities occurred and no listed species were captured during this process.

Figure 1. Photos of stream diversion for the emergency bridge repair (Forest Road 7810 MP 0.1 Repairs Project BA).

All in-water work occurred between August and September 25, 2023. At the southeast abutment, riprap was positioned with an excavator around the abutment and bridge approach to extend the revetment and prevent scour and erosion of the bridge in that area (Figure 2). Riprap was also placed extending approximately 20 feet into the stream and covered with 5 feet of conserved streambed material. The emergency stabilization used larger riprap than previous repairs to minimize instability and scour during high water events. The total area of repairs occupied approximately 871 square feet of permanent scour effects and 1,742 square feet of temporary scour effects. The staging area for the riprap used for the repair was within the adjacent upland parking area. After repairs, water was slowly returned to the channel over the course of three hours to minimize turbidity. Seed and mulch were applied above ordinary high water in disturbed areas (Figure 3).

Figure 2. Photos of before (top) and after (bottom) emergency repairs were completed (Forest Road 7810 MP 0.1 Repairs Project BA).

Figure 3. Photo upstream of emergency repairs after seeding and mulch was applied (Forest Road 7810 MP 0.1 Repairs Project BA).

Tree Acquisition Areas

Trees would be acquired at two areas along existing (Figure 4). The first area, Tree Acquisition Area West, extends 150 feet south of Carbon River Road (FR 78) on the south side of the road. No trees are proposed to be removed between the road and the Carbon River and trees will not be removed within 400 feet of the bank of the Carbon River. A 50-foot buffer would be established on both banks of Poch and Tolmie creeks prohibiting tree removal. The second area, Tree Acquisition Area East, is 350 feet wide and is centered on the FR 7810 roadway and would include tree removal on both sides of the road. Trees would not be removed within 250 feet of the bank of the Carbon River.

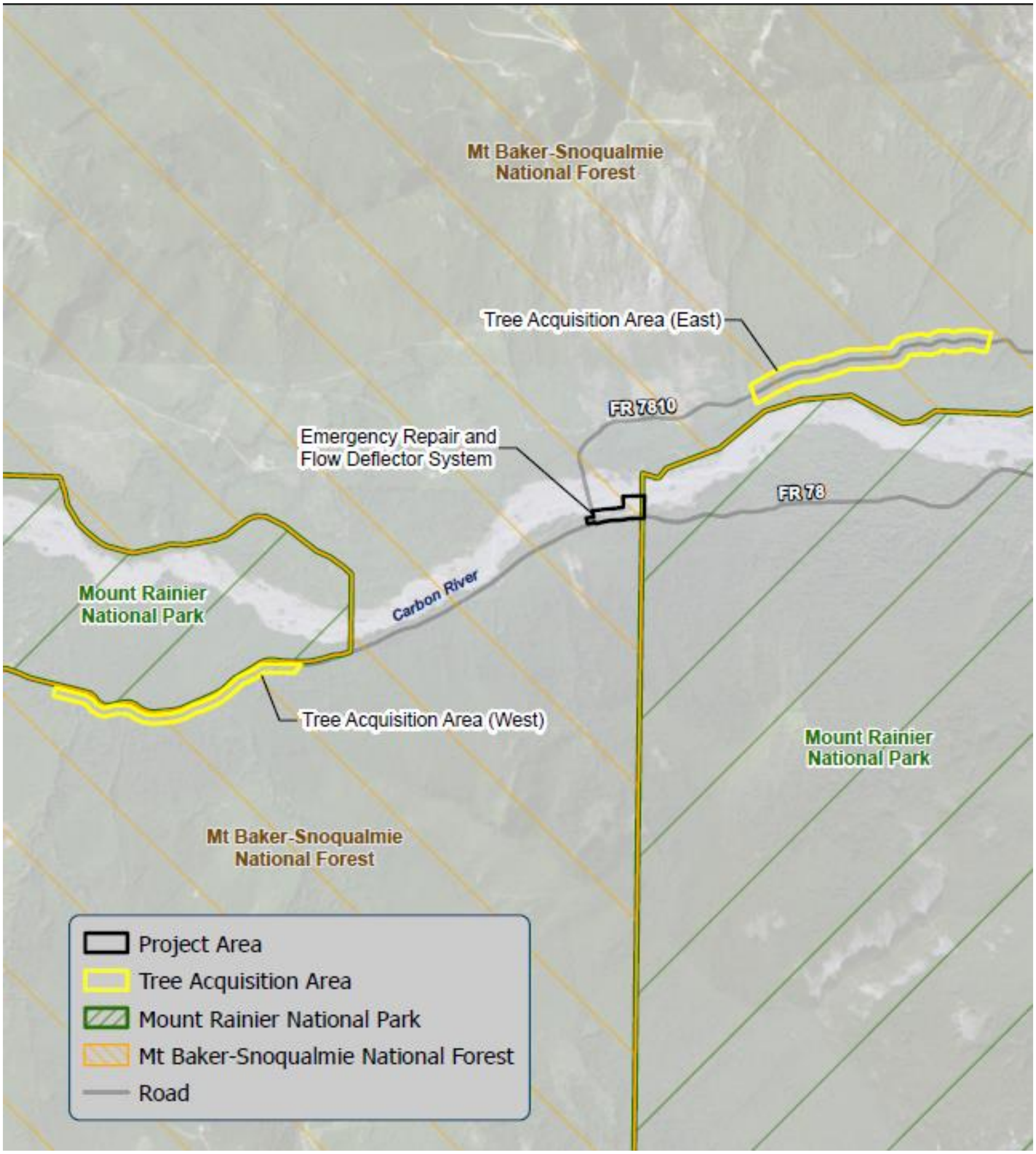

Figure 4. Map adapted from the biological assessment showing the location of the tree acquisition areas in relation to the emergency repair and proposed flow deflector system (Forest Road 7810 MP 0.1 Repairs Project BA).

During a site visit in September 2023, USFS flagged and inventoried trees to be removed. Within the two areas, 96 total trees would be removed. This will be accomplished in two phases. Phase one would occur as early as late June 2025, which would include removal of 9 trees (12 inches to 18 inches dbh), 3 trees (18 inches to 24 inches dbh), and 9 trees (20 inches to 30 inches dbh) over a two to three-day period. Phase two would occur as early as late June 2026, which would include removal of 75 trees, 20 inches to 26 inches diameter at breast height (dbh) over a two to five-day period. Access would occur using FR 78 (for Tree Acquisition Area West) and FR 7810 (for Tree Acquisition Area East). FR 78 would be used for staging as needed.

In order to remove the trees, an excavator would set up on the road and will use the arm and bucket to dislodge the root bowl from the soil (loosen the soil around the root bowl and push the tree over). The excavator would pull the downed tree to the road while it is supported on its tree limbs (as a way to limit soil disturbance) and use the bucket to lightly rake dislodged soil and organic matter back into the hole left by the root bowl. Most marked trees proposed for removal are located within 50 feet of the FR78 and FR 7810 roadways. The excavator would primarily operate from the road to remove them, and the excavator can travel a short distance into the forest to reach them, if necessary, without additional vegetation cutting. Where needed, the operator would use organic matter (i.e., dead and downed tree limbs) or lightly fluff the soil to hide any excavator track marks left on-site after removal. Stream crossing is not proposed.

<u>Proposed Flow Defector System</u>

Using the trees from the above acquisition, two log deflector structures would be constructed about 400 feet and 750 feet upstream of the FR 7810 bridge in order to direct flows away from the roadway. Each structure would measure approximately 3,500 square feet and would add large wood to the Carbon River, creating aquatic habitat in the form of approximately 32 root wads, 16 individual deflector logs, 6 deflector log bundles (3 logs per bundle), and 58 timber piles.

Prior to construction of the log deflector structures, a cofferdam diversion will be installed approximately 200 feet downstream of the lower deflector, and up to 900 linear feet of stream channel will be diverted, isolated and dewatered. The maximum area that will be dewatered will be 61,000 square feet (1.4 acres) and fish passage to June Creek will be maintained (Richard Vacirca, pers. Comm. October 07, 2024). Qualified fish biologist(s) will utilize seines and dipnets until no longer effective before electrofishing methods are employed. Adjustments to the locations of any block nets and diversion pumps will be made by the contractor and biologists on the site, based on the most effective locations to achieve channel isolation and fish removal.

During the installation of flow deflector structures, crane mats and / or a modular steel truss bridge are proposed to be used to gain access to the area. The maximum riparian area that will be impacted is 500 square feet and no more than 3 small diameter alders will be removed to gain access (Richard Vacirca, pers. Comm. October 07, 2024). Equipment including an excavator, backhoe, front end loader, and small roller will be used for stream diversion by the contractor in accordance with approved water diversion methods and existing river conditions at the site. Following dewatering and fish removal, an excavator will be used to dig down to pier elevation and backfill. A vibratory attachment may be used to lodge pier logs into the ground. The following BMPs have been proposed for the project:

- Remove dirt, plant, and foreign material from vehicles and equipment before entry into Mount Baker-Snoqualmie National Forest. Prevent introduction of noxious weeds and non-native plant species into the work site. Follow applicable Federal land management agency requirements and state requirements. Maintain cleaning and inspection records. Clean hauling vehicles before their initial entry; subsequent entries will not require cleaning unless requested. Notify the CO a minimum of 2 work days before entry to allow for inspection.

- The excavator will only be used within the dewatered reach of the Carbon River.
- Equipment used for the project shall be free of external petroleum-based products while the work is performed around the water.
- Equipment conducting operations in or within 200 feet of wetlands or water shall be checked daily for leaks, and any necessary repairs shall be completed prior to commencing work activities.
- Heavy equipment shall be washed free of deleterious material prior to commencement of work.
- Store chemicals in water-tight containers that are kept closed, sealed, and secured when not being actively used. Store chemicals as far from wetlands and waterways as possible and use approved secondary containment measures.
- No fuel storage containers are allowed on the project site. Deliver fuel to the site only in trucks designed for fuel hauling.
- Temporarily disturbed areas above the ordinary high-water line (OHWL) will be seeded with grass in accordance to USFS standards.
- Disturbed riparian areas will be replanted with poles of willow, cottonwood, and/or alder within the project area.

The in-water work (IWW) period for the Carbon River is July 16 to August 15. According to the BA, at least eight weeks are needed to construct both log deflectors in one season; therefore, the USFS proposes that the in-water work window be extended until September 23.

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 to adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, federal action agencies consult with NMFS, and section 7(b)(3) requires that, at the conclusion of consultation, NMFS 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 NMFS to provide an ITS that specifies the impact of any incidental taking and includes reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

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 CFR 402.02). 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 designations of critical habitat for PS Chinook Salmon and PS steelhead uses 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 rangewide 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 critical 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. Rangewide 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.

One factor affecting the status of ESA-listed species considered in this opinion, and aquatic habitat at large, is climate change. 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 will 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 will 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 will affect tree reproduction, growth, and phenology, which will lead to spatial shifts in vegetation. Halofsky et al. (2018) projected that the largest changes will 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, will 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 will be more affected by management practices. Agne et al. (2018) also suggested that due to complex interacting effects of disturbance and disease, climate impacts will 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 will 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 will 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 will 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.

Marine and 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 will alter the composition and abundance of a vast array of oceanic species. In particular, there will 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 will 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 Williams 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 will also affect their predators (seabirds and mammals). The full effects of these ecosystem dynamics are not known but will be complex. Within the historical range of climate variability, less suitable conditions for salmonids (e.g., warmer temperatures, lower streamflows) 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 will 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 intergravel 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 will 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 will 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 will 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 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).

2.2.1 Status of the Species

In the BA, USFS determined that the proposed actions are likely to adversely affect Puget Sound Chinook Salmon *(Oncorhynchus tshawytscha)* and Puget Sound steelhead (*O. mykiss*) and designated critical habitat for both species (Table 1).

Table 1. ESA-listed marine species that may be affected by the proposed action.

ESA-listed marine species and critical habitat likely to be adversely affected (LAA)				
Species	**Status**	**Species**	**Critical Habitat**	**Listed/CH Designated**
Puget Sound Chinook Salmon (*O. tshawytscha*)	threatened	LAA	LAA	06/28/05 (70 FR 37160) / 09/02/05 (70 FR 52630)
Puget Sound Steelhead (*O. mykiss*)	threatened	LAA	LAA	05/11/07 (72 FR 26722) / 02/24/16 (81 FR 9252)

LAA = Likely to adversely affect

Listed Species

Viable Salmonid Population (VSP) Criteria

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” refers to 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 in decline.

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 (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 geographic area of this proposed action 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.

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 (Shared Strategy for Puget Sound 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 will 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 all the Viable Salmon Population (VSP) parameters are sustained to provide ecological functions and preserve options for ESU recovery.

General Life History: Chinook salmon are anadromous fish that require well-oxygenated water that is typically less than 63º F (17º C), but some tolerance to higher temperatures is documented with acclimation. Adult Chinook salmon spawn in freshwater streams, depositing fertilized eggs in gravel “nests” called redds. The eggs incubate for three to five months before juveniles hatch and emerge from the gravel. Juveniles spend from three months to two years in freshwater before migrating to the ocean to feed and mature. Chinook salmon spend from one to six years in the ocean before returning to their natal freshwater streams where they spawn and then die.

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.

Spatial Structure and Diversity: The PS 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 (MPGs), that are based on similarities in hydrographic, biogeographic, and geologic characteristics (Table 2).

Table 2. Extant PS Chinook salmon populations in each biogeographic region (Ruckelshaus et al. 2002, 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/SouthPuget Sound Basin	Cedar River
	North Lake Washington/ Sammamish River
	Green/Duwamish River
	Puyallup River
	White River
	Nisqually River

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).

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 current information on abundance, productivity, spatial structure and diversity, the most recent 5-year status review 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: Factors limiting recovery for PS Chinook salmon 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
- Severely altered flow regime

Puget Sound Steelhead DPS

We published a recovery plan for Puget Sound steelhead in 2019 (NMFS 2019). In the recovery plan, NMFS and the PSSTRT modified the 2013 and 2015 PSSTRT viability criteria to produce the viability criteria for Puget Sound steelhead, as described below:

- All three MPGs (North Cascade, Central-South Puget Sound, and Hood Canal-Strait of Juan de Fuca) must be viable (Hard et al. 2015). The three MPGs differ substantially in key biological and habitat characteristics that contribute in distinct ways to the overall viability, diversity, and spatial structure of the DPS.
- There must be sufficient data available for NMFS to determine that each MPG is viable.

The recovery plan also established MPG-level viability criteria. The following are specific criteria are required for MPG viability:

- At least 50 percent of steelhead populations in the MPG achieve viability.
- Natural production of steelhead from tributaries to Puget Sound that are not identified in any of the 32 identified populations provides sufficient ecological diversity and productivity to support DPS-wide recovery.
- In addition to the minimum number of viable DIPs (50 percent) required above, all DIPs in the MPG must achieve an average MPG-level viability that is equivalent to or greater than the geometric mean (averaged over all the DIPs in the MPG) viability score of at least 2.2 using the 1–3 scale for individual DIPs described under the DIP viability discussion in the PSSTRT Viability Criteria document (Hard et al. 2015). This criterion is intended to ensure that MPG viability is not measured (and achieved) solely by the strongest DIPs, but also by other populations that are sufficiently healthy to achieve MPG-wide resilience. The Plan allows for an alternative evaluation method to that in Hard et al. (2015) may be developed and used to assess MPG viability.
- The plan also identified specific DIPs in each of the three MPGs which must attain viability NMFS 2019).

Spatial Structure and Diversity**.** The PS steelhead DPS includes all naturally spawned anadromous *O. mykiss* (steelhead) populations originating below natural and manmade impassable barriers from rivers flowing into Puget Sound from the Elwha River (inclusive) eastward, including rivers in Hood Canal, South Sound, North Sound and the Strait of Georgia. Non-anadromous ‘‘resident’’ *O. mykiss* 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. 2007). The Puget Sound steelhead DPS includes five artificial propagation programs: The Green River Natural Program; White River Winter Steelhead Supplementation Program; Hood Canal Steelhead Supplementation Program; the Lower Elwha Fish Hatchery Wild Steelhead Recovery Program; and the Fish Restoration Facility Program (USOFR 2020b).

DIPs can include summer steelhead only, winter steelhead only, or a combination of summer and winter run timing (e.g., winter run, summer run or summer/winter run). Most DIPs have low viability criteria scores for diversity and spatial structure, largely because of extensive hatchery influence, low breeding population sizes, and freshwater habitat fragmentation or loss (Hard et al. 2007). In the Central and South Puget Sound and Hood Canal and Strait of Juan de Fuca MPGs, nearly all DIPs are not viable (Hard et al. 2015). More information on PS steelhead spatial structure and diversity can be found in NMFS' technical report (Hard et al. 2015).

Abundance and Productivity. The viability of the PS steelhead DPS has improved somewhat since the PSSTRT concluded that the DPS was at very low viability, as were all three of its constituent MPGs, and many of its 32 DIPs (Hard et al. 2015). Increases in spawner abundance have been observed in a number of populations over the last five years; however, these improvements were disproportionately found within the South and Central Puget Sound and Strait of Juan de Fuca and Hood Canal MPGs, and primarily among smaller populations. The recent positive trends among winter-run populations in the White, Nisqually, and Skokomish rivers improve the demographic risks facing those populations. The abundance, productivity, spatial structure, and diversity of Elwha River steelhead winter and summer-runs has dramatically improved following the removal of the Elwha River dams. Improvements in abundance have not been as widely observed in the Northern Puget Sound MPG. The declines of summer and winter-run populations in the Snohomish Basin are especially concerning. These populations figure prominently as sources of abundance for the MPG and DPS (NMFS 2019). Additionally, the decline in the Tolt River summer-run steelhead population was especially alarming given that it is the only summer-run population for which we have long-term abundance estimates. The demographic and diversity risks to the Tolt River summer-run DIP are very high. In fact, all summer-run steelhead populations in the North Cascades MPG are likely at a very high demographic risk. In spite of improvements in some areas (i.e., Elwha River population following dam removal), most populations are still at relatively low abundance levels, with about a third of the DIPs unmonitored and presumably at very low levels (Table 3) (Ford 2022).

Abundance information is unavailable for approximately one-third of the DIPs, disproportionately so for summer-run populations. In most cases where no information is available it is assumed that abundances are very low. Some population abundance estimates are only representative of part of the population (index reaches, etc.). Where recent five-year abundance information is available, 30 percent (6 of 20 populations) are less than 10 percent of their high productivity recovery targets (lower abundance target), 65 percent (13 of 20) are between 10 and 50 percent, and 5 percent (1 of 20) are greater than 50 percent of their low abundance targets (Table 3). A key element to achieving recovery is recovering a representative number of both winter- and summer-run steelhead populations, and the restoration of viable summer-run DIPs is a long-term endeavor (NMFS 2019b). Fortunately, the relatively rapid reestablishment of summer-run steelhead in the Elwha River does provide a model for potentially re-anadromizing summer-run steelhead sequestered behind impassable dams.

Table 3. Recent (2015-2019) 5-year geometric mean of raw wild spawner counts for Puget Sound steelhead populations and population groups compared with Puget Sound Steelhead Recovery Plan high and low productivity recovery targets (NMFS 2019). (SR) – Summer-run. Abundance is compared to the high productivity individual DIP targets. Colors indicate the relative proportion of the recovery target currently obtained: red (<10 percent), orange (10 percent>x<50 percent), yellow (50 percent>x<100 percent), green (>100 percent). "*" denotes an interim recovery target.

Major Population Group	Demographically Independent Population	Recent Abundance (2015-2019)	Recovery Target	
			High Productivity	Low Productivity
Northern Cascades	Drayton Harbor Tributaries	N/A	1,100	3,700
	Nooksack River	1,906	6,500	21,700
	South Fork Nooksack River (SR)	N/A	400	1,300
	Samish River & Independent Tributaries	1,305	1,800	6,100
	Skagit River	7,181	15,000 *	
	Sauk River	N/A		
	Nookachamps River	N/A		
	Baker River	N/A		
	Stillaguamish River	487	7,000	23,400
	Canyon Creek (SR)	N/A	100	400
	Deer Creek (SR)	N/A	700	2,300
	Snohomish/Skykomish River	690	6,100	20,600
	Pilchuck River	638	2,500	8,200
	Snoqualmie River	500	3,400	11,400
	Tolt River (SR)	40	300	1,200
	North Fork Skykomish River (SR)	N/A	200	500
Central and South Sound	Cedar River	N/A	1,200	4,000
	North Lake Washington Tributaries	N/A	4,800	16,000
	Green River	1,282	5,600	18,700
	Puyallup/Carbon River	136	4,500	15,100
	White River	130	3,600	12,000
	Nisqually River	1,368	6,100	20,500
	East Kitsap Tributaries	N/A	2,600	8,700

Major Population Group	Demographically Independent Population	Recent Abundance (2015-2019)	Recovery Target	
			High Productivity	Low Productivity
	South Sound Tributaries	N/A	6,300	21,200
Strait of Juan de Fuca	Elwha River	1,241	2,619	
	Dungeness River	408	1,200	4,100
	Strait of Juan de Fuca Independent Tributaries	95	1,000	3,300
	Sequim and Discovery Bay Tributaries	N/A	500	1,700
	Skokomish River	958	2,200	7,300
	West Hood Canal Tributaries	150	2,500	8,400
	East Hood Canal Tributaries	93	1,800	6,200
	South Hook Canal Tributaries	91	2,100	7,100

There are a number of planned, ongoing, and completed actions that will likely benefit steelhead populations in the near term, but have not yet influenced adult abundance. Among these, the removal of the diversion dam on the Middle Fork Nooksack River, the Pilchuck Dam removal, passage improvements at Mud Mountain Dam, the ongoing passage program in the North Fork Skokomish River, and the planned passage program at Howard Hanson Dam. Additionally, fish passage above three dams on the Skagit River are currently under consideration (Seattle City Light 2023). Dam removal in the Elwha River, and the resurgence of the endemic winter and summer-run steelhead populations have underscored the benefits of restoring fish passage. The Elwha River scenario is somewhat unique in that upstream habitat is in pristine condition and smolts emigrate into the Strait of Juan de Fuca and not Puget Sound or Hood Canal.

Improvements in spatial structure can only be effective if done in concert with necessary improvements in habitat. Habitat restoration efforts are ongoing, but land development and habitat degradation concurrent with increasing human population in the Puget Sound corridor results in a continuing net loss of habitat. Recovery efforts in conjunction with improved ocean and climatic conditions have resulted in improved viability status for the majority of populations in this DPS; however, absolute abundances are still low, especially summer-run populations, and the DPS remains at high to moderate risk of extinction. However, since 2015, fifteen of the 21 populations indicate small to substantive increases in abundance, although most steelhead populations remain small. From 2015 to 2019, nine of the 21 steelhead populations had fewer than 250 natural spawners annually, and 12 of the 21 steelhead populations had 500 or fewer natural-origin spawners (Ford 2022).

Limiting Factors. In our 2013 proposed rule designating critical habitat for this species (USOFR 2013), we noted that the following factors for decline for PS steelhead persist as limiting factors:

- 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

2.2.2 Status of the 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 proposed project would affect critical habitat for PS Chinook salmon and PS steelhead.

Puget Sound Chinook Salmon Critical Habitat: In summary, critical habitat throughout the Puget Sound basin has been degraded by numerous management activities, including hydropower development, loss of mature riparian forests, increased sediment inputs, removal of large wood, 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 in areas of critical habitat.

Puget Sound Steelhead Critical Habitat: The NMFS designated critical habitat for PS steelhead on February 24, 2016 (81 FR 9252). That critical habitat is located in 18 freshwater subbasins between the Strait of Georgia Subbasin and the Dungeness-Elwha Subbasin, inclusively. No marine waters were designated as critical habitat for PS steelhead.

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 and PS steelhead CH are listed in Table 4.

Table 4. Physical or biological features (PBFs) and corresponding life history events of designated critical habitat for PS Chinook salmon and PS steelhead. Although nearshore and offshore marine areas were identified in the FRs, no offshore marine areas were designated as critical habitat for PS Chinook salmon, and neither was designated as critical habitat for 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

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.

Landslides can occur naturally in steep, forested lands, but inappropriate land use practices likely have accelerated their frequency and the amount of sediment delivered to streams. Fine sediment from unpaved roads has also contributed 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 large wood recruitment (Shared Strategy for Puget Sound 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. Forest wetlands are estimated to have diminished by one-third in Washington State (FEMAT 1993; Shared Strategy for Puget Sound 2007; Spence et al. 1996).

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

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 (e.g., Elwha River dams block anadromous fish access to 70 miles of potential 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 (Shared Strategy for Puget Sound 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 headgates 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 (Shared Strategy for Puget Sound 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 (Shared Strategy for Puget Sound 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 (Hood Canal Coordinating Council 2005; Shared Strategy for Puget Sound 2007).

In summary, critical habitat throughout the Puget Sound basin has been degraded by numerous management activities, including hydropower development, loss of mature riparian forests, increased sediment inputs, removal of large wood, 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 in areas of critical habitat.

Climate change alters critical habitat throughout the region, though these changes have not been homogenous across the region, nor are they likely to be in the future. Recent air temperatures in all but two years since 1998 ranked above the 20th century average (Mote et al. 2013). Warming is likely to continue during the next century as average air temperatures are projected to increase another 3 to 10 °F (1.7 to 5.6 °C), with the largest increases predicted to occur in the summer (Mote et al. 2014). Earlier snowmelt will cause lower stream flows in late spring, summer, and fall, and water temperatures will be warmer (ISAB 2007; Mote et al. 2014). By the end of the century, about one-third of the current cold-water salmonid habitat in the Pacific Northwest is likely to exceed key water temperature thresholds (Mantua et al. 2010) and over that same time throughout the Puget Sound region, stream temperatures are expected to increase by approximately 5.4 °C-18 °C (Kunkel et al. 2013). Temperature increases shift timing of key life cycle events for salmonids and species forming the base of their aquatic foodwebs (Crozier 2011; Tillmann and Siemann 2011; Winder and Schindler 2004). Higher stream temperatures will also cause decreases in dissolved oxygen and may also cause earlier onset of stratification and reduced mixing between layers in lakes and reservoirs, which can also result in reduced oxygen (Meyer et al. 1999; Raymondi et al. 2013; Winder and Schindler 2004). Higher temperatures are likely to cause several species to become more susceptible to parasites, disease, and higher predation rates (Crozier et al. 2008; Raymondi et al. 2013; Wainwright and Weitkamp 2013).

Additionally, climate models consistently predict decreases in summer precipitation by as much as 30% by the end of the century (Mote et al. 2014). Reduced flows will make it more difficult for migrating fish to pass physical and thermal obstructions, limiting their access to available habitat (Isaak et al. 2012; Mantua et al. 2010). Models consistently predict increases in the frequency of severe winter precipitation events (i.e., 20-year and 50-year events), in the western United States (Dominguez et al. 2012). Therefore, precipitation is more likely to occur during October through March, and winter precipitation is expected to fall as rain more than as snow, which could lead to increased flooding and high flow events in both frequency and intensity (ISAB 2007; Mote et al. 2013; Mote et al. 2014). As more basins become rain-dominated and prone to more severe winter storms, higher winter stream flows may increase the risk that winter or spring floods in sensitive watersheds will damage spawning redds and wash away incubating eggs (Goode et al. 2013). Earlier peak stream flows will also alter migration timing for salmon smolts, and may flush some young salmon and steelhead from rivers to estuaries before they are physically mature, increasing stress and reducing smolt survival (Lawson et al. 2004; McMahon and Hartman 1989).

The adaptive ability of these threatened and endangered species is depressed due to reductions in population size, habitat quantity and diversity, and loss of behavioral and genetic variation. Without these natural sources of resilience, systematic changes in local and regional climatic conditions due to anthropogenic global climate change will likely reduce long-term viability and sustainability of populations in many of these ESUs (NWFSC 2015). New stressors generated by climate change, or existing stressors with effects that have been amplified by climate change, may also have synergistic impacts on species and ecosystems (Doney et al. 2012). These conditions will possibly intensify the climate change stressors inhibiting recovery of ESA-listed species in the future.

Critical habitat within the action area

For PS Chinook salmon, critical habitat has been designated up to River Mile (RM) 22.7. The FR 7810 bridge is located at RM 23, and the project area extends downstream to RM 22.5 (accounting for downstream migration of turbidity and resuspended sediments); therefore, the project falls within the designated critical habitat of PS Chinook salmon.

For PS steelhead, critical habitat has been designated in the Carbon River up to about RM 22.5. The FR 7810 bridge is located at RM 23, and the project area extends downstream to RM 22.5

(accounting for downstream migration of turbidity and resuspended sediments); therefore, the project falls within the designated critical habitat.

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 section 1.3, the project is located in the Carbon River at the FR 7810 bridge immediately northwest of Mount Rainier National Park. The emergency bridge repairs occurred on the South bank of the bridge. For tree acquisition, the first area, Tree Acquisition Area West, extends 150 feet south of Carbon River Road (FR 78) on the south side of the road, approximately 1.5 miles west-southwest of the bridge. Trees will not be removed within 400 feet of the Carbon River. A 50-foot buffer will be established on both banks of Poch and Tolmie creeks prohibiting tree removal. The second area, Tree Acquisition Area East, is 350 feet wide and is centered on the FR 7810 roadway, approximately 1-mile northeast of the bridge, and will include tree removal on both sides of the road. Trees will not be removed within 250 feet of the Carbon River. The two log deflector structures will be positioned about 400 feet and 750 feet upstream of the FR 7810 bridge.

The upstream extent of the action area is defined as the stream channel of the Carbon River approximately 1,300 feet upstream of the FR 7810 bridge to account for water diversion and fish salvage for the two proposed deflectors that will be placed 400 feet and 750 feet upstream of the bridge (as well as potential log storage and staging areas near the streambank). The downstream extent of the action area is defined as the stream channel of the Carbon River 0.5 mile downstream of the FR 7810 bridge to account for turbidity and resuspended sediments during in-water work. Laterally, the action area is defined as the riverbed of the Carbon River and the area between the Carbon River and FR 7810.

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 impacts to listed species or designated critical habitat from federal agency activities or existing federal agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR 402.02).

An analysis of the baseline conditions in upper Carbon River 6th-field watershed according to the NMFS Matrix of Pathways and Indicators is presented in Table 5. According to the BA, this matrix evaluates habitat in terms of seven broad classes of habitat features (pathways), each of which has a related set of specific metrics (indicators) that are rated based on their functional condition. The environmental baseline information for the watershed is based on the 1998 Carbon River Watershed Analysis (MBSNF 1998), the BA of the Wonderland Trail re-establishment along the Carbon River (upstream of the project) (Chestnut 2021), and water quality status from the Washington Department of Ecology (WDOE) (WDOE 2023). Overall, the Carbon River has a high natural sediment load and turbidity due to glacial inputs. Other water quality indicators, such as water temperature and contaminant load, have not been consistently monitored. There are no water quality impairment 303d listings noted for the Carbon River (WDOE 2023). Furthermore, the Carbon River's drainage basin is largely undeveloped; therefore, there are few potential sources of contamination or human-made hydrologic alterations. It is important to note that past logging on private and USFS lands have reduced the riparian zone by at least 50% (MBSNF 1998).

Table 5. Summary of the environmental baseline in the upper Carbon River watershed (Forest Road 7810 MP 0.1 Repairs Project BA)

Pathway	Indicator	Baseline Conditions	Rationale/Comments
Water Quality	Temperature	Functioning Properly	Not 303d-listed
	Sediment/Turbidity	Functioning Properly	High natural levels of turbidity from glacial sources are present in the Carbon River
	Chemical Contamination & Nutrients	Functioning Properly	Not 303d-listed
Habitat Access	Physical Barriers	Functioning at Risk	Culverts on several tributary streams present partial or full barriers to fish passage
Habitat Elements	Substrate	Properly Functioning	The action area is in a highly braided portion of the Carbon River with substantial volumes of cobble and gravel
	Large Woody Debris	Functioning at Risk	Past logging on private and USFS lands in the watershed has reduced the old-growth riparian zone to less than 50%
	Pool Frequency/Quality	Functioning at Risk	Pool habitat is potentially limited due to consistently high sediment generation converted to bedload from the Carbon Glacier
	Large Pools	Functioning at Risk	Pool habitat is potentially limited in the Carbon River due to increasing bedload from Carbon Glacier
	Off-channel Habitat	Functioning at Risk	Side-channel habitats are constrained or directly impacted by the location of Carbon River Road in several areas, including the action area
	Refugia	Functioning at Risk	Refugia habitats are present but are currently reduced due to passage barriers and constrictions caused by Carbon River Road
Channel Conditions & Dynamics	Width/Depth Ratio	Functioning at Risk	Width/depth ratio has increased in Carbon River due to rapid channel widening in response to peak flood events and increasing bedload from Carbon Glacier
	Streambank Condition	Functioning at Risk	Rapid channel widening and bank erosion in response to peak flood

Pathway	Indicator	Baseline Conditions	Rationale/Comments
			events and increasing bedload from the Carbon Glacier has occurred.
	Floodplain Connectivity	Functioning at Risk	Bank armoring with riprap well below the ordinary high-water mark is present in several locations in the project reach
Flow/Hydrology	Peak/Base Flows	Functioning at Risk	Peak flow events may be increasing due to the effects of Carbon Glacier recession and climate change
	Drainage Network	Functioning at Risk	There has been a moderate increase in the drainage network. The road density in the upper watershed is 1.33 miles/miles^2 (mi/mi^2) (MBSNF 1998)
Watershed Conditions	Road Density/Location	Functioning at Risk	There is a low road density overall (<2 mi/mi^2), but the presence of valley bottom roads have caused chronic flood damage and sediment delivery to tributary streams (USFWS 2004)
	Disturbance History	Functioning at Risk	Past logging on private and MBSNF lands in the watershed has reduced the old-growth riparian zone to less than 50%, but recent clearcuts are less than 15%
	Riparian Areas	Functioning at Risk	Past logging on private and MBSNF lands in the watershed has reduced the old-growth riparian zone to less than 50% (MBSNF 1998)

The project area consists of the floodplain of the river, the road (FR 78), the bridge (FR 7810), and a narrow band of mid-successional West Cascades conifer forest. In many locations, similar to the project area, FR 78 parallels the Carbon River and is part of the historical river floodplain. In the project area and downstream, the river is highly braided and aggrades in response to glacial inputs. Between 1990 and 1996, the active channel widened by up to 100 feet in several locations. The channel has a bedload consisting of large rubble, boulders, and pockets of fine sorted materials and is characterized as dynamic and unstable (WCC 1999). According to MBSNF 1998, sediment loading from forest management and logging-related activities is not significant compared to the natural glacial sediment load.

Past road repairs have been conducted at this site as well as in nearby reaches of the Carbon River. In 2019, the same south abutment was previously repaired from damages associated with high flows on the Carbon river. The NMFS previously consulted on these repairs (WCR-2018-10016), which are considered as part of the environmental baseline.

The emergency repairs for the FR 7810 MP 0.1 bridge completed in 2023 are included in proposed action and are therefore not part of the environmental baseline.

More recently, in 2022 the National Park Service (NPS) requested an emergency consultation for road work on a failed road section of Carbon River Road just upstream of the 7810-road bridge and within Mount Rainier National Park. The first phase repairs occurred from August-October 2022 and according to the biological opinion (WCRO-2023-02955), the emergency work fish salvage resulted in the relocation of five *O. mykiss*. The first phase of this project, as described in WCRO-2023-02955, are part of the environmental baseline. The proposed final repair to the site is anticipated to occur in summer 2025.

Puget Sound Chinook Salmon

Only fall-run Chinook Salmon populate the Carbon River (WDFW SalmonScape). The 2022-2023 Puyallup Fishing Report states "Puyallup River Fall Chinook typically enter the Lower Puyallup River in June, and…[t]he majority of tributary spawning activity occurs from September through late October, with the exception of some lower tributaries which may have fish present into early November." Chinook Salmon spawning typically occurs in the lower reaches and tributaries of the Carbon River. Suitable spawning habitat for Chinook salmon is present in the upper Carbon River along channel margins and pool tailouts. Several decades ago, adult spring run Chinook Salmon were observed near RM 23.0 (WCC 1999). There have been documented occurrences of yearling life histories of Chinook within the system, indicating that some juveniles remain in the area for a year or more (see WCRO-2023-01955). The upper limit of potential Chinook salmon distribution within the Carbon River has not been clearly defined.

PS Chinook salmon critical habitat has been designated up to River Mile (RM) 22.7. The FR 7810 bridge is located at RM 23, and the project area extends downstream to RM 22.5 (accounting for downstream migration of turbidity and resuspended sediments).

The Federal Register designation of critical habitat for PS Chinook notes (69 FR 74572) "all occupied areas [of the Puyallup Evolutionary Significant Unit (ESU)] contain spawning, rearing, or migration PCEs [Primary Constituent Elements] for this ESU and identified several management activities that may affect the PCEs, including agriculture, channel modifications/diking, dams, forestry, irrigation impoundments and withdrawals, urbanization. Of the five watersheds reviewed by the Team, habitat areas in all were rated as having high conservation value to the ESU."

PS Chinook salmon in the Puyallup basin, which includes the Carbon River, has experienced critically low returns since the 1990s that are mostly dominated by hatchery returns (Ford 2022; NMFS Puget Sound Recovery Plan 2007) (Figure 5). Redd counts conducted by the Puyallup Tribe, show very low adult red counts at the most recent recorded samplings in 2017 and 2018 (Marks 2023)(Figure 6). According to the NMFS Puget Sound Recovery Plan in 2007, key environmental factors need to be addressed to prevent further decline of, and risk of extinction to, Puyallup fall Chinook salmon.

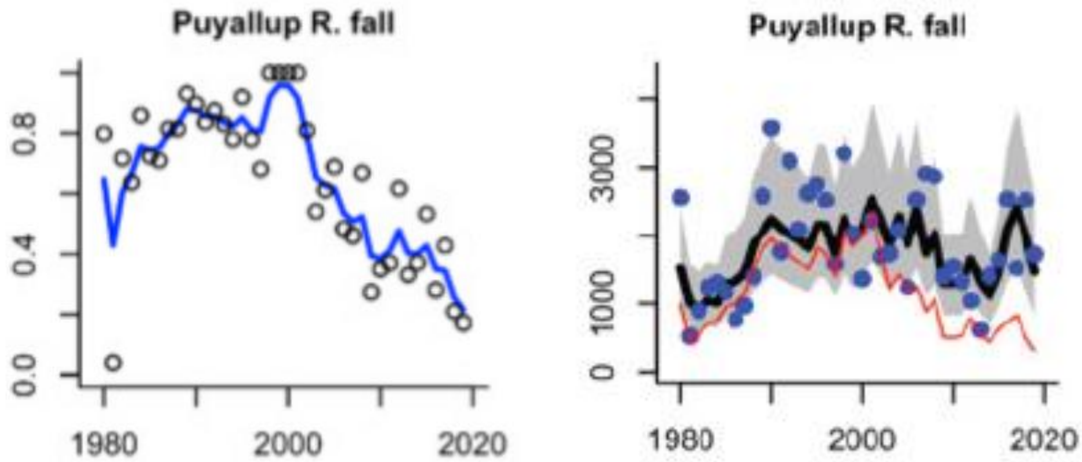

Figure 5. Left - Estimated fraction of natural-origin spawning fall Chinook from 1980 to 2020 in the White and Puyallup Rivers. Right – Predicted spawning abundance 1980 to 2020 with the gray band showing the 95% confidence interval, the black line is the smooth estimated total, and the red line is the natural population (Ford 2022).

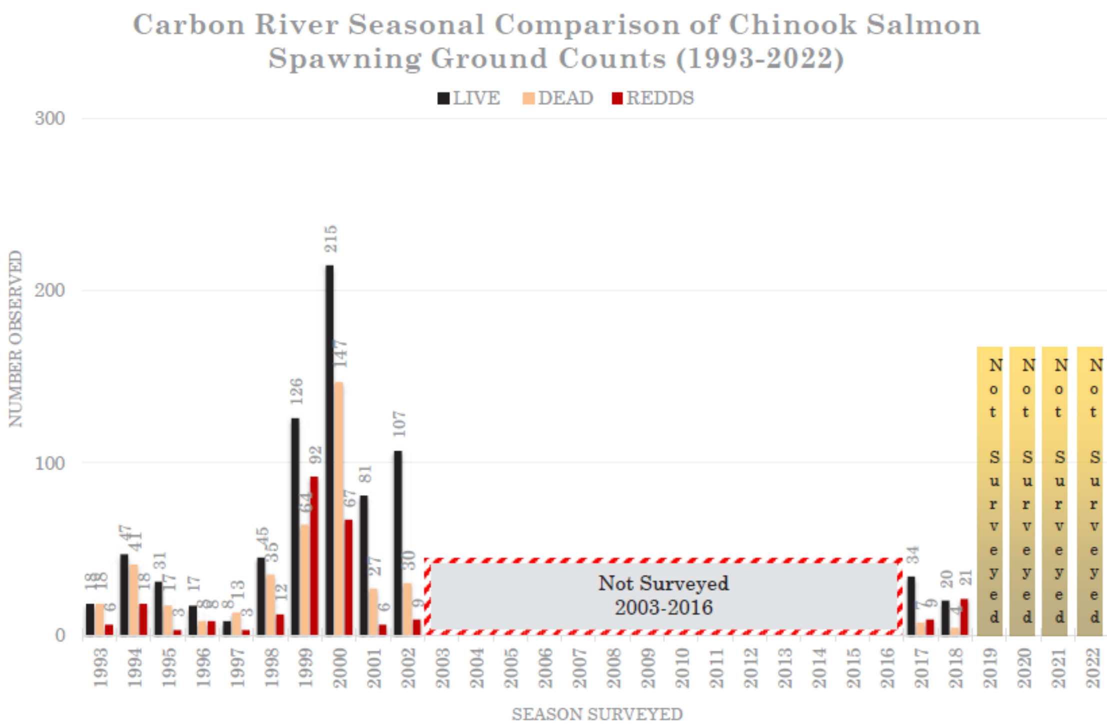

Figure 6. Yearly comparison of Chinook salmon spawning ground counts conducted by the Puyallup Tribe from 1993 to 2022 (Marks 2023).

Puget Sound Steelhead

Winter-run steelhead are present in the Puyallup basin (WDFW SalmonScape). The 2022-2023 Puyallup Fishery Report details that the "main run of hatchery origin winter steelhead…enters the Puyallup River in November, with the peak of the run occurring in mid-December… [a]lthough, most fish don't start migrating towards the upper reaches until March. The winter run continues through June, with peak migration occurring in mid-to late April, through early May." Eggs, alevins and fry are present for many months following spawning and juvenile steelheads rear in freshwater for typically 1-3 years before migrating to marine waters. Natural spawner counts have shown large declines in the Carbon River in the past few decades. Abundances for the Puyallap winter-run steelhead remain in the low hundreds, continuing to show some demographic risk (Ford 2022).

PS steelhead critical habitat has been designated in the Carbon River up to about RM 22.5. The FR 7810 bridge is located at RM 23, and the project area extends downstream to RM 22.5.

The Federal Register designation of critical habitat for PS steelhead notes (69 FR 74572) all "occupied areas in the overall Puyallup River subbasin contain spawning, rearing, or migration PCEs [principal constituent elements] for this DPS [distinct population segment]," and that "all of the occupied watersheds in the Puyallup subbasin were of high conservation value to the DPS."

Climate change

Prominent glaciers on Mount Rainier are retreating at an accelerated rate (Figure 7). Geologists reported glacial volume on Mt. Rainier has likely decreased by as much as 18% from 2003-to 2009, a loss of approximately 3% per year, which is a rate loss of nearly 10 times that of any past scientific reporting (Beason et al. 2009) This contributes heavily to aggradation, increased flooding risks, and channel widening in the Puyallup River basin. The close proximity of Carbon River Road to the upper reaches of the Carbon River further exacerbates climate impacts such as increased temperatures by limiting riparian forest development. Temperature projections for Washington State under a high emissions scenario (RCP 8.5) show that average temperatures could rise as much as 9.4°F above current levels by 2100 (Dalton et. al, 2013). The magnitude and timing of future climate related impacts remains uncertain but projections suggest warming will occur across all four seasons in the Pacific Northwest, with the highest impacts seen in summer months (Puyallup Tribe of Indians, 2016).

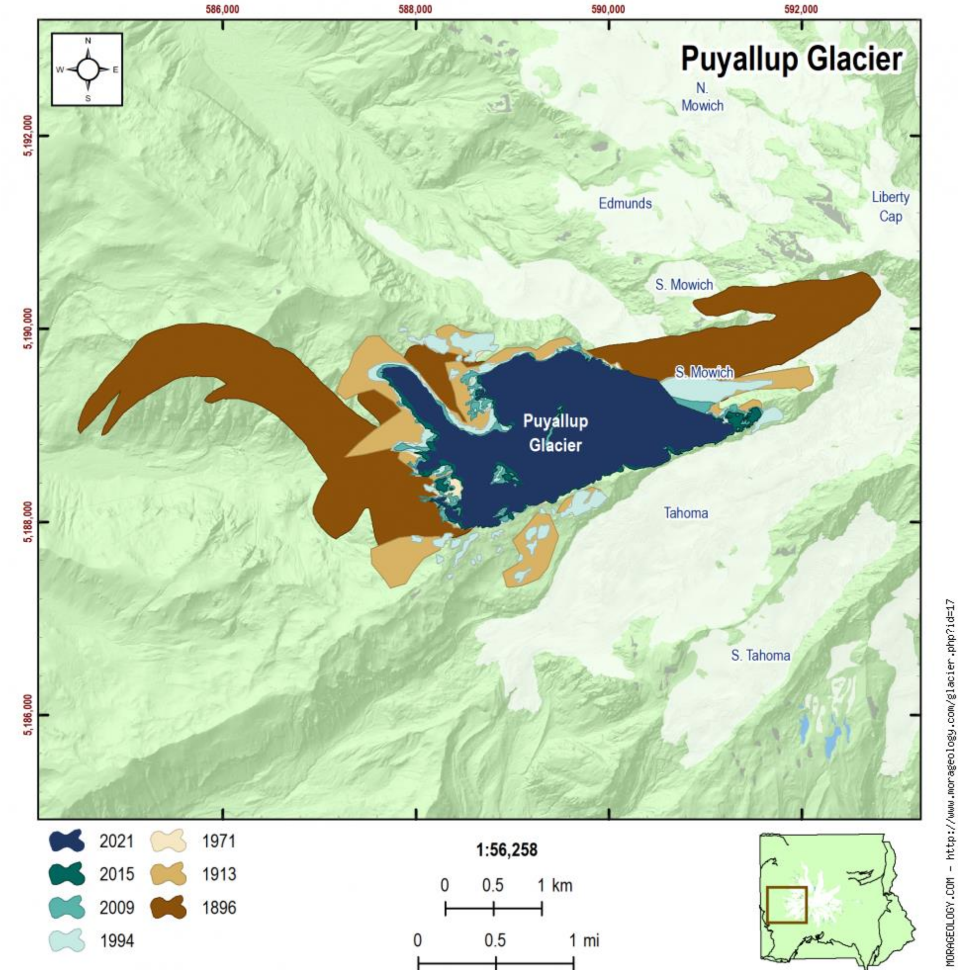

Figure 7. Change in extent of the Puyallup Glacier from 1896 to 2021 (https://www.morageology.com/glacier.php?id=17)

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 but that are not part of the action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (see 50 CFR 402.02).

The Puyallup and Carbon River PS Chinook DPS (fall run), the Puyallup and Carbon River PS steelhead DPS (winter run), and possibly PS steelhead summer-run strays from other watersheds within the Central and South MPG would be affected by the proposed action. Construction is likely to cause direct effects through fish salvage activities, construction-related noise, and water quality impacts. These effects of construction will be temporary, and will not impact more than two cohorts (returning adults and young of year) of the affected populations. Indirect effects caused by impacts to riparian vegetation would also be observed. Long term impacts associated with extending the useful life of the bridge structure for several decades beyond its remaining lifespan will occur.

Adult Chinook present in the action area would likely be present in June-October. Eggs, alevins and fry are present for many months following spawning. Juvenile Chinook could be present year-round. The winter run for steelhead continues through June, with peak migration occurring in mid-to late April, through early May. This is the time adult steelhead would most likely be in the action area. Eggs, alevins and fry are present for many months following spawning. During emergency work fish salvage performed just upstream in August of 2022, five *O. mykiss* were relocated (WCRO-2023-01955). Whether a juvenile O. mykiss out-migrates or stays a resident “rainbow” has many determining factors such as physiology, genetics, timing, and environmental factors such as temperature - and these are not all well-understood (Kendall et al. 2015). At this project location there are no barriers preventing steelhead from migrating. Therefore, any *O. mykiss* at this location could have a marine component of their life cycle (i.e. be a PS steelhead).

Based on timing, construction would affect the following species life stages within the action area: Adult Chinook, migrating and spawning (overlaps entirely with spawning season); Chinook eggs, alevins, and fry that are present for many months following spawning; Chinook juveniles which could be present year-round; steelhead sub-adults that have not yet out-migrated (due to life history plasticity); steelhead eggs, alevins, and fry.

2.5.1 Effects on Listed Species

Construction-related Fish Salvage

For the emergency repair work, approximately 150 linear feet of stream channel was diverted. The work area was isolated using isolation block netting and a cofferdam composed of Super Sacs underlain by a tarp (Figure 1). Following isolation, 2-inch submersible pumps with pump screens composed of 5-gallon buckets with holes throughout were used to remove water from residual pools. The sides and bottom were screened with mesh meeting NMFS flow-through velocity standards. Water was pumped into upland vegetated areas; pumping directly into a stream or wetland was not allowed. Fish were removed by performing numerous seine passes and dipnetting, prior to three full electrofishing passes. Fish and fauna were transported in 5-gallon buckets of clean, stream water fitted with double aerators and released upstream of the cofferdam within 20 minutes. No listed fish were captured and no mortalities were observed. Flow was deflected around the work area so that all fish could migrate past the construction site unencumbered.

For the installation of the new flow deflector system, up to 900 linear feet of stream channel would be diverted, isolated, and dewatered, not to exceed a total area of 1.4 acres. Actions associated with dewatering the work area has the potential to harm juvenile Chinook salmon and steelhead. Dewatering the area will also kill invertebrates inhabiting this reach, thus reducing forage in an area up to 61,000 square feet (1.4 acres).

For the installation of the log-structures for the flow deflector systems, biologists would follow the same isolation, dewatering, and fish capture procedures as were followed for the emergency repairs, minimizing any harm to juvenile salmonids. During in-water work, flow would be rerouted towards the center of the river channel, allowing fish residing in the river to use the entire northern half of the river to pass upstream and downstream of the construction site; therefore, passage will be maintained throughout the project.

Captured fish would experience stress and may experience trauma and mortality. Capture and handling of fish causes physiological stress responses (Moberg 2000). Contact with nets may cause scale and skin damage. Electrofishing causes effects that range from increased respiratory action to mortality under certain conditions (Dalbey 1996; Emery 1984; Snyder 2003). Depending on the pulse train used, and the intensity and duration of exposure, muscular contractions may cause a lactic acid load and oxygen debt in muscle tissues (Emery 1984), it can cause internal hemorrhage and spinal fractures in 12 to 54% of the exposed fish, and acute mortality in about 2% (Dalbey 1996). Severe interruption of motor function can stop respiration, and combinations of lactic acid load and oxygen debt may be irreversible, causing delayed mortality in apparently healthy fish. To reduce the effects of electrofishing, the USFS's contractors would use electrofishing only after multiple net passes within the isolation area yield no fish. Small fish can also experience physical trauma if care is not taken during the various handling and transfer processes once captured. The primary contributing factors to stress and mortality from handling are: (1) Water temperature difference between the stream and the holding buckets; (2) dissolved oxygen levels; (3) the amount of time that fish are held out of the water; and (4) physical trauma. Stress from handling increases rapidly if water temperature exceeds 18ºC (64ºF), or if dissolved oxygen is below saturation.

<u>Construction-related Noise</u>

Impacts on fish exposed to noise depend on the frequency, intensity, context, and duration of the exposure as well as the hearing characteristics of the fish. At low levels, effects may include the onset of behavioral disturbances such as acoustic masking (Codarin et al. 2009), startle responses and altered swimming (Neo et al. 2014), abandonment or avoidance of the area of acoustic effect (Picciulin et al. 2010; Sebastianutto et al. 2011; Xie et al. 2008) and increased vulnerability to predators (Simpson et al. 2016). Higher intensities and/or longer exposure durations can lead to increased stress, temporary or permanent hearing damage, and/or mortality (Graham and Cooke 2008; Scholik and Yan 2002). The area was dewatered during the emergency repairs. Only residual water is proposed to remain in the area for the installation of the flow deflectors and the excavator and vibratory attachment would only be used in the dewatered portion of the river. Therefore, most likely effects of exposure to construction-related noise would be temporary minor behavioral effects. The exposure may delay the migration of adults past the project sites but would cause no measurable effects on the fitness of exposed adults, and avoidance of the areas is unlikely to affect access to or from spawning habitat due to the project location and the timing of the work. Juveniles in close proximity are likely to experience behavioral disturbance, such as acoustic masking, startle responses, altered swimming patterns, avoidance, and increased risk of predation and may also experience some level of auditory- and non-auditory tissue injury, which could reduce their likelihood of survival. The number of individuals of either species that may be impacted by this stressor is unquantifiable with any degree of certainty. However, only five *O. mykiss* were captured during the 2022 NPS Carbon River Road Repair (WCRO-2023-01955) and no listed fish were captured during the emergency actions associated with this project. Therefore, the numbers of fish that may be affected by this stressor would comprise such small subsets of their respective cohorts, that their loss would cause no detectable population-level effects.

Construction-related Water Quality Impacts

Exposure to construction-related degraded quality would cause minor effects in PS Chinook salmon and PS steelhead. Water quality would be temporarily affected by increased turbidity that may also reduce dissolved oxygen (DO) levels. Therefore, high levels of turbidity having lethal or sublethal effects may occur (Newcombe and Jensen 1996). The high natural ambient levels of turbidity from glacial melt common to Carbon River would be expected to provide a buffer to such effects. Also, the stream is naturally cold, reducing dissolved effects to minimal levels. Water quality effects due to construction activities may cause individuals to alter their behavior temporarily, but no mortality is anticipated, and population effects are insignificant.

Turbidity and sediment-related impacts

Turbidity plumes are likely to be caused by the mobilization of bottom sediments during in water-work for the emergency repairs and for the installation of flow deflector structures. Activities likely to cause turbidity plumes include installation and removal of work area isolation barriers, abutment repairs, and possible project site runoff. Water will be returned slowly to dewatered areas to minimize turbidity. Therefore, plumes would likely be localized and short-lived, and consist of low concentrations of total suspended solids (TSS). Erosion resulting from tree removal in the two designated areas may discharge sediments and debris into the Carbon River Mainstem, Tolmie Creek, and Poch Creek. Discharge of sediments would be minimized or avoided by the 250-foot buffer from the Carbon River riverbank in Tree Acquisition Area East, the 400-foot buffer from the Carbon River riverbank in Tree Acquisition Area West, and the 50-foot buffer established on either streambank of Poch and Tolmie Creeks. Additionally, tree removal would not result in trees being dragged through a stream channel. Therefore, discharge of sediments from tree removal would likely be insignificant.

In-water work during construction will physically disturb sediments in the dewatered area. Both installing the riprap for the emergency repairs and installing the flow deflector structures can physically destroy redds and invertebrates in the stream sediment. During the installation of flow deflector structures crane mats, a modular steel truss bridge, or a combination of crane mats and modular steel truss bridges may be used to gain access to the area. Crane mats would decrease sediment mobilization.

Salmonids require gravels with low concentration of fine sediments for successful spawning and incubation (Spence et al. 1996). Chronic turbidity during emergence and rearing of young could have lethal and sublethal impacts (Sigler et al. 1984). 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. At concentration levels of about 700 to 1,100 mg/l, minor physiological stress is reported in juvenile salmon only after about three hours of continuous exposure (Newcombe and Jensen 1996).

Although the turbidity levels during the emergency repairs in August and September of 2023 are unknown, should any PS Chinook salmon or PS steelhead be exposure to project-related turbidity, the duration of their exposure would likely be measured in minutes, and the plume concentrations would most likely be too low to cause more than temporary, non-injurious behavioral effects such as avoidance of the plume, mild gill flaring (coughing), and slightly reduced feeding rates. The background turbidity of the Carbon River at the project's location is extremely high, ranging from 325 Nephelometric Turbidity Unit (NTU) to 435 NTU in 2022 (DEA 2024). Because of this, turbidity effects on individuals during construction of the flow deflector structures are also considered minimal compared to background levels.

Dissolved Oxygen (DO)

Mobilization of anaerobic sediments can decrease dissolved oxygen (DO) levels (Hicks et al. 1991). The impact on DO is a function of the oxygen demand of anaerobic sediments that may be present, the amount of material suspended in the water, the duration of suspension, and the water temperature. Impacts tend to be more severe lower in the water column, which is problematic as changes to DO levels within the gravels can cause delayed emergence, reduced growth, and/or reduced survival in embryos and larvae of salmonids (Bjornn and Reiser 1991; Carter 2005; WDOE 2002). Adult and juvenile salmon avoidance of low DO areas has been observed (Whitmore 1960). Avoidance could drive fish from preferred forage areas or from shelter and thereby increase the risk of predation. Reduced DO can also affect swimming performance in salmonids (Bjornn and Reiser 1991), which may reduce an affected fish's ability to forage and to escape predation. Although mortality can be caused, this requires sustained low DO levels below 3.9 mg/L for days or weeks in order to reach 50% mortality (WDOE 2002). In glacier fed streams, DO is typically highest in summer and fall due to increased contributions of snow and glacial melt increasing gas exchange (Canadell et al. 2021).

The majority of sediment mobilization would occur behind the work area isolation barriers that would exclude fish. Very little of the sediment-affected water is likely to leak past the barrier. All Washington State water quality criteria would be followed, including monitoring DO levels, which will prevent harmful levels from occurring (WAC 173-201A-200)(WDOE 2006). Further, well-oxygenated water in the stream flow outside of the barriers (especially during the approved extended in-water work window in late summer) would quickly dilute the small volumes of affected water that may leak past the barriers. This suggests that DO reductions would likely be too small and short-lived to cause detectable effects on the fitness or normal behaviors in fish that may be exposed to the affected water.

Toxic Materials

Toxic materials can be introduced to the stream environment through construction related spills and discharges. Some of the petroleum-based fuels, lubricants, and other fluids used by construction-related equipment contain Polycyclic Aromatic Hydrocarbons (PAHs). Sediment contaminants can include metals, pesticides, PAHs, Polychlorinated Biphenyls (PCBs), phthalates, and other organic compounds. PS Chinook salmon and PS 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). Depending on the pollutant, its concentration, and/or the duration of exposure, exposed fish may experience effects that can range from avoidance of an affected area, to reduced growth, altered immune function, and mortality (Brette et al. 2014; Feist et al. 1996; Göbel et al. 2007; Incardona et al. 2005; Incardona et al. 2006; Lundin et al. 2021; Lundin et al. 2019; McIntyre et al. 2012; Sandahl et al. 2007).

The project includes many measures to reduce the risk and intensity of construction-related discharges. Non-toxic and/or biodegradable lubricants and fluids will be used. In the unlikely event of a construction-related spill or discharge, the amount of material released would likely be very small, and it would be cleaned up quickly. Also, many of the fuels and lubricants that are used for this type of work have low residence times in water as they have high evaporation rates. Therefore, the in-water presence of construction-related contaminants would be very infrequent, very short-lived, and at concentrations too low to cause detectable effects on fitness or normal behaviors in exposed fish.

Construction-related Reduced Riparian Vegetation

Reduced riparian vegetation can alter biological and chemical processes at the project site. Chemical processes involve inputs of thermal energy and organic matter, as well as linkages to terrestrial food webs, the retention and export of nutrients and nutrient cycling in the aquatic food web, and gas exchange (Beechie et al. 2010). Biological processes include aquatic and riparian plant and animal growth, and community development and succession, which establish the biodiversity and influence the life histories of aquatic and riparian organisms (Harman 2012). The emergency repairs likely did not have a large effect on riparian vegetation as the same areas were previously covered with riprap during the 2018 repairs. Construction of the flow deflector structures could remove up to 500 square feet of riparian vegetation. Reducing riparian vegetation allows increased sunlight to reach the stream, which can raise temperatures and reduce dissolved oxygen. Riparian impacts at the project site are unlikely to cause any detectable shade-related effects because the sun is always to the south of the site, and the affected area is on the north side of the river. Therefore, the existing vegetation provides very little over-water shade at any time of the year.

Reduced riparian vegetation decreases the amount of terrestrial-origin leaf litter, insects, and woody debris to streams. Many terrestrial insects are forage for salmonids, while vegetative matter often provides cover. Terrestrial organic matter is also important to nutrient cycling in aquatic food webs that support aquatic algae and invertebrates that are important resources for juvenile salmonids. Therefore, riparian impacts would slightly reduce the input of terrestrial-origin organic matter until the riparian vegetation returns to pre-construction levels of growth. Due to the very small size of the affected area and the diluting effects of flowing water, the impacts on aquatic food webs attributable to the planned actions would likely be too small to cause detectable effects on the fitness or normal behaviors for any life stage of Chinook salmon and steelhead in the action area.

Structure-related Impacts

Physical, chemical, and biological processes interact to form and maintain riverine habitats (Fischenich 2003). Physical processes involve the interaction of hydrological forces with the substrate and objects in the streambed that drive geomorphic adjustments in the channel, floodplain, and riparian habitats. Chemical processes involve inputs of organic matter, retention and export of nutrients and thermal energy, nutrient cycling in the aquatic food web, linkages to terrestrial food webs, and gas exchange (Beechie et al. 2010). Biological processes include aquatic and riparian plant and animal growth, and community development and succession, which establish the biodiversity and influence the life histories of aquatic and riparian organisms (Harman 2012). The emergency repairs caused or continued maintaining habitat conditions that are likely to cause indirect adverse effects on PS Chinook salmon and PS steelhead through alteration of hydrological and biological processes. Since many of the trees that would be cut would have been unlikely to be recruited to the Carbon River, the flow deflector structures once installed will increase large wood presence; and therefore, likely have a positive impact on the riverine environment.

Bank stabilization structures, such as the riprap added during the emergency repairs, replace dynamic natural processes with a set of semi-permanent conditions that prevent natural channel migration past the structure and alter fundamental channel and aquatic habitat formation processes (Cramer 2012). Revetments redirect water flows, which often increase erosion upstream and/or downstream of the revetment. Due to the short bridge relative to the stream width at the project site, water flows also continue to cut into the stabilization structure so the revetments will likely continue require periodic maintenance and repair to prevent bank or bridge failure, which has already been demonstrated as the last repair to the same abutments was conducted only 5 years prior to the emergency repairs included in this BO. This continual process leads to an ever-steepening bank, and a simplified aquatic habitat with reductions in velocity diversity, depth diversity, substrate diversity, large wood recruitment and retention, stream bank roughness, and edge habitat features such as undercut banks and alcove habitats (Fischenich 2003). Altered flows may also cause unexpected changes in the physical processes upstream and downstream from the structure that alter sediment recruitment and transport in the streambed and may discourage the formation of complex off-channel habitats within the affected stream reaches. Also, because the revetments are intended to prevent bank and bridge failure, it is doubtful that the affected banks would contribute to large wood to the river over decadal or century time scales, which would impact natural streambed and bank formation processes.

Due to the complex relationships between the processes that are involved, it is virtually impossible to predict and quantify the exact effects that this action’s revetments would have on stream hydrology, geomorphology, and habitat forming processes. The riprap will prevent channel migration and likely continue to alter upstream and downstream erosion and deposition patterns in a manner that would not likely have occurred in the absence of the revetments. These impacts are likely to reduce the affected reaches’ abilities to support salmonid spawning and rearing. Given the small size of the revetments, the influence on channel dynamics and channel forming processes are expected to be relatively small. Therefore, the resulting negative effects on habitat forming processes is also expected to be relatively small, and the revetments’ influence on those processes will likely decrease with distance from the sites. However, over the life of these structures, low numbers of individual PS Chinook salmon and PS steelhead are likely to be adversely affected by the altered conditions.

<u>Biological Impacts</u>

The impacts the emergency bridge repairs had on in-stream chemical and biological processes likely include increased water temperatures, reduced input of terrestrial-origin organic material, simplified aquatic habitat, and increased exposure to predators.

The riprap added during the emergency repairs alters habitat conditions at the site location, and possibly in other areas within the affected stream reaches. Separate from the construction-related removal of riparian vegetation discussed earlier, the emergency repairs will continue to greatly limit or prevent the growth of riparian vegetation in the areas of added riprap. Juvenile Chinook salmon are consistently more abundant along natural banks with wood, cobble, boulder, aquatic plants, and/or undercut bank cover compared than they are along rip rap banks (Beamer and Henderson 1998; Peters et al. 1998). In a study of 667 bank stabilization structures of various designs in Washington State, fish densities were generally positively correlated with increased amounts of large woody debris and overhead vegetation within 30 cm of the water surface. Fish densities under those conditions were also consistently higher than those at the control sites. Conversely, fish densities at sites that were stabilized by rip rap alone were consistently lower than at control sites (Peters et al. 1998). Based on these studies, it is likely that some rearing and migrating juvenile salmonids will selectively avoid the riprap habitat in favor of more suitable habitat. The simplified bankside habitat that is created by a rip rap revetment is often preferred by predatory species such as sculpins. Sculpins are highly sedentary benthic fish that prey on salmonid eggs and juveniles. They prefer fast flowing, well oxygenated water, and unembedded rock and cobble substrate provide nesting cavities (Edwards and Cunjak 2007). Additionally, tree removal would decrease the amount of large wood available to enter the stream but since many of the removed trees are being placed directly into the Carbon River to install the flow deflector structures this is unlikely to have detectable impacts on Chinook salmon or steelhead. The flow deflector structures would have positive biological impacts of increasing habitat complexity and large in channel wood is essential for the creation of dynamic habitat which supports salmonid spawning and rearing.

Given the small sizes of the affected areas, the site location and orientation relative to the surrounding landscapes and riparian vegetation, and the high rates of water exchange past the affected area, the impacts on water temperatures and input of terrestrial-origin organic material that would be caused by the absence of vegetation along these revetments would likely be too small to cause detectable effects on individual PS Chinook salmon and PS steelhead at the project site. The number of individuals of either species that may be adversely affected by structure-related impacts is unquantifiable with any degree of certainty. However, based on the small size and locations of the planned revetments as well as the addition of the flow deflector structures made of large wood, the numbers of affected fish would comprise such small subsets of their respective cohorts, that their loss would cause no detectable population-level effects.

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 Primary 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 is likely to adversely affect designated critical habitat for PS Chinook salmon and PS steelhead at the project site. The essential PBFs of critical habitat for both species are listed below. The expected effects on those PBFs from completion of the planned project, including full application of the conservation measures and BMPs, would be limited to the impacts on freshwater PBFs as described below.

1. Freshwater Spawning Sites –
    a. Water quantity- No changes expected.
    b. Water quality - The proposed action would cause long term minor adverse effects on water quality. Construction would briefly increase suspended solids, and may slightly reduce DO and introduce contaminants. Impacts on riparian vegetation may slightly increase water temperatures for decades.
    c. Substrate- The proposed action would cause long-term minor adverse effects on substrate. The revetment would permanently prevent erosion of the bank and is likely to slightly alter erosion, sediment transport and deposition, and movement of large wood within the nearest bends in the river, which may reduce the reach's ability to support PS Chinook salmon and PS steelhead spawning.
2. Freshwater Rearing Sites
    a. Floodplain connectivity – The proposed action would cause long term minor adverse effects on floodplain connectivity. The revetments would permanently prevent natural channel migration past them, which is likely to lock the physical conditions at the sites in simplified states with steep banks and reduced edge habitat features such as undercut banks and alcove habitats. The altered hydrology at the sites may also impact bank habitat forming processes within the nearest bends in the respective rivers.
    b. Forage – The proposed action would cause long term minor adverse effects on forage. The simplified aquatic habitats created by revetments are typically less supportive of salmonid foraging than natural banks. Also, impacts on riparian vegetation at the sites would decrease input of terrestrial insects and leaf litter that support aquatic food webs. Detectable effects would likely be minor and limited to the area immediately adjacent to the revetments, but the effects would persist for decades.
    c. Natural cover – The proposed action would cause long term minor adverse effects on natural cover. The revetments would permanently prevent the formation of edge habitat features such as undercut banks along their lengths. The installation of flow deflector structures will impact up to 500 square feet of riparian vegetation. Impacts on riparian vegetation would remove overhanging vegetation and slightly reduce the availability of woody debris and leaf litter that can provide in-water cover. The flow deflector structures will likely provide some cover for PS Chinook and PS steelhead. These effects would persist for decades.
    d. Water quantity – No changes expected.
    e. Water quality – Same as above.
3. Freshwater Migration Corridor
    a. Free of obstruction and excessive predation – The proposed action would cause long term minor adverse effects on obstruction and predation. The revetments would alter the migratory behavior of some juvenile salmonids in that they would abandon edge habitat to avoid the revetments. Additionally, the revetments would create conditions that are preferred by predatory species such as sculpins, which would increase the risk of predation for juvenile salmonids that do not avoid the

revetments. The flow deflector structures may provide some additional habitat for fish to avoid predation. These effects would persist for decades.

   b. Water quantity – No changes expected.
   c. Water quality – Same as above.
   d. Natural Cover – Same as above.

4. Estuarine Areas – None in the action area.
5. Nearshore Marine Areas – None in the action area.
6. Offshore Marine Areas – 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]. 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 earlier in the discussion of environmental baseline (Section 2.4).

The current condition of ESA-listed species and designated critical habitats within the action area are described in the Status of the Species and Critical Habitats and 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, 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.

NMFS is unaware of any specific future non-federal activities that are reasonably certain to affect the action area. However, NMFS is reasonably certain that future non-federal actions such as the previously mentioned activities are all likely to continue and increase in the future as the human population continues to grow across the region. Continued habitat loss and degradation of water quality from development and chronic low-level inputs of non-point source pollutants will likely continue into the future. Recreational and commercial use of river waters within the action area is also likely to increase as the human population grows.

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 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.

PS steelhead and PS Chinook are listed as threatened under the ESA. Puyallup and Carbon River fall Chinook salmon show natural productivity below replacement in nearly all years since the mid-1980s. Due to increased hatchery production, this population has also experienced a massive declination in the fraction of natural origin spawners since the early 2000s (80% in the late 90s to 30% from 2015-2019) (Ford 2022). Carbon River Fall Chinook (only Carbon River, not its tributaries) surveyed by the Puyallup Tribe most recently resulted in very low adult and redd counts, with 9 redds in 2017 and 21 redds in 2018 (see Figure 7 in the Environmental Baseline section). At natural mean spawner counts of 735 (2015-2019), the Puyallup/Carbon River steelhead are well below their target recovery population numbers at about (4,500-high productivity; 15,100-low productivity). And 2022 brought the lowest steelhead returns to the system in 80 years. The mainstem Carbon River steelhead redd count was three (3) for 2023 (See Figure 7 above). The proposed action will extend the life of the existing bridge structure and corresponding road prism, which continues to disconnect the river from its historic riparian and floodplain (NMFS 2019).

Though natural populations of PS Chinook salmon and PS steelhead are present within the Puyallup system, the populations are drastically depressed and far from reaching recovery goals set forth in NMFS' recovery plans (NMFS 2019; Shared Strategy for Puget Sound 2007). See baseline section above for numeric details. Extensive loss of habitat due to dams, land use changes, and degraded conditions associated with those land use changes has depressed both species in the Puyallup basin. The second growth forest adjacent and upstream of the project site provide conditions for both species, but downstream conditions, especially levies and dikes in the lower Puyallup and logging in the lower Carbon River are the largest factors contributing to low salmonid numbers within the upper reaches of the Carbon River. Climate change also poses major threats to listed species in the Puyallup Basin as increasing atmospheric temperatures cause increased risk of flooding from glacial melt, increased stream temperatures, and changing precipitation patterns. 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.

For our analysis, we add the project's effects on species and designated critical habitat. This project is likely to adversely affect two cohorts of PS Chinook and PS steelhead via construction effects that injure or kill eggs and larval fish in redds, juvenile fish, or adult fish present during dewatering of the worksite, and decrease health or fitness of additional fish during construction by via disturbance and impact from in-channel equipment and movement of materials. These impacts include increased turbidity and decreased water quality during dewatering and flow deflector construction, substrate impacts, disturbance to riparian vegetation, and hydrological impacts. Utilizing non-toxic and/or biodegradable lubricants and fluids will reduce the risk of major water quality impacts. The flow deflector structures may also increase habitat complexity (thus reducing predation) and reduce the intensity or frequency of future bridge repairs. Replanting of riparian vegetation will also decrease impacts.

As described above, the proposed action would cause short- and long-term minor adverse effects on water quality, substrate, floodplain connectivity, forage, natural cover, and freedom from obstruction and excessive predation. There are 3 types of take associated with the proposed action, and two of those (in-water construction and fish relocation) would possibly result in direct mortality. The final form of take is possible harm resulting from dewatering the area for flow deflector construction/installation. While we anticipate some reductions in abundance in each of the affected populations we do not believe the level of this reduction from effects of the proposed action would cause any meaningful impact on the remaining viability parameters for PS Chinook salmon or PS steelhead (abundance, productivity, spatial structure, or diversity), nor would they appreciably diminish the conservation value of critical habitat for these species. Factors that support this conclusion include:

1. Proposed mitigation measures including utilizing non-toxic and/or biodegradable lubricants and fluids, constructing structures of large wood which can increase habitat complexity, and working in a time of year that will decrease impacts on listed species, and replanting riparian vegetation.
2. The small number of fish that could be affected during construction.
3. The relatively small size of the project site on the Carbon River just upstream of high-quality salmonid habitat

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 the cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of PS Chinook salmon or PS steelhead or 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). "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

The recommendations provided by NMFS during the emergency response in 2023 function in place of terms and conditions with respect to the incidental take caused by the emergency response, and are incorporated here as terms and conditions of this consultation. Thus, to the extent that the emergency response action was performed in compliance with those recommendations, the associated incidental take is considered exempt from the ESA take prohibition.

2.9.1 Amount or Extent of Take

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

- Take in the form of harm from fish relocation
- Take in the form of harm from elevated turbidity
- Take in the form of injury of death from increased rip rap

We cannot predict with meaningful accuracy the number of Chinook salmon or steelhead that are reasonably certain to be injured or killed annually by exposure to any of these stressors. The distribution and abundance of the fishes that occur within an action area can be affected by habitat quality, competition, and predation. They can also be affected by 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 broader temporal and spatial scales than are affected by the proposed action. Additionally, NMFS is not aware of any device or practicable technique that would yield reliable counts of individuals that may experience these impacts. In such circumstances, we use 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 parameters related to the proposed action that are directly related to the magnitude of the expected take.

Harm, injury, or death from rip rap bridge armoring: ESA-listed species present in the action area may be harmed due to the proposed action. Specifically, juvenile Chinook salmon and steelhead are likely to be in the action area following completion of the bridge. The best available incidental take surrogate associated with predation is the amount of rip rap used to armor the bridge. The amount of take from exposure to predation increases with the volume of rip rap used to support the bridge. Therefore, this surrogate is proportional to the extent of take associated with this project. The total of rip rap for this proposed action is 871 square feet. These metrics can also be monitored allowing the surrogate to serve as a clear reinitiation trigger.

Exceedance of any of the exposure limits described above would constitute an exceedance of authorized take that would trigger the need to re-initiate the consultation.

2.9.2 Effect of the Take

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

2.9.3 Reasonable and Prudent Measures

"Reasonable and prudent measures" refer to those actions the Director considers necessary or appropriate to minimize the impact of the incidental take on the species (50 CFR 402.02).

The USFS shall:

1. Reduce harm and mortality to PS Chinook salmon and PS steelhead from fish salvage.
2. Minimize incidental take of PS Chinook salmon and PS steelhead from exposure to turbidity and sediment-related impacts.

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

1) The following terms and conditions implement reasonable and prudent measure 1:
    a) Ensure that dewatered area is as small as necessary to complete the remaining in-water work.
    b) Ensure that diversions by either pump or gravity methods will not exceed 3 cubic feet per second (cfs).
    c) Maintain a downstream water flow rate of at least 90 percent of the upstream water flow rate.
    d) Comply with the following protective measures and BMPs applicable to Fish Capture and Release (from NMFS 2013).
    e) Complete fish salvage with contractor with 3 years' experience running fish salvages in Washington and holds appropriate state and/or federal permits and certifications.
    f) If practicable, before dewatering, allow listed fish to migrate out of the work area, herd them out of the area with barrier nets, or carefully remove them from the exclusion area

with hand or dip-nets, seining, or minnow traps; otherwise carefully remove fish as the area is slowly dewatered.

g) Conduct fish capture activities during periods of the day with the coolest air and water temperatures possible, normally early in the morning to minimize stress and injury of species present.
h) Monitor the nets frequently enough to ensure they stay secured to the banks and free of organic accumulation.

2) The following terms and conditions implement reasonable and prudent measure 2:
    a) The applicant must minimize stream crossings and confine construction impacts to the minimum area and duration necessary to complete the project.
    b) Follow all Washington State turbidity criteria (WAC 173-201A-200).
    c) If monitoring indicates that turbidity exceeds the Washington State criteria, suspend work and identify additional best management practices to employ to reduce turbidity upon resuming work.
    d) Do not allow turbid water to leave project limits or enter into wetlands and waterways. Pump turbid water from work areas to a temporary storage and treatment site or into upland areas at least 100 feet from surface waters to allow turbid water to disperse and filter through vegetation prior to re-entering the stream channel.
    e) Upon project completion, slowly re-water the construction site to prevent loss of surface water downstream as the construction site streambed absorbs water and to prevent a sudden release of suspended sediment. Monitor downstream during re-watering to maintain sufficient stream flow and prevent stranding of aquatic organisms.
3) The following terms and conditions implement reasonable and prudent measure 3:
    a) USFS should maintain and submit fish salvage logs to verify that all take indicators are monitored and reported. Minimally, the logs should include:
        i) The identity (name, title, organization), qualification, and contact information of the persons conducting fish salvage, and the person completing the report;
            (1) The location, date, time, and air and water temperatures;
            (2) The method(s) of capture and handling procedures that were used; and
            (3) The species and quantities of captured fish, and their disposition at release (i.e. alive with no apparent injuries, alive with apparent minor/serious injuries, dead with/without apparent injuries).
            (4) Dates of initiation and completion of in-water work.
            (5) Turbidity Monitoring/Sampling records.
            (6) Habitat conditions before and after the action is completed
            (7) The total area dewatered.
            (8) Measurements and photographs that ascertain the post-construction size and configuration of the flow deflector structures
    b) The applicant must report any exceedance of take covered by this opinion immediately.
    c) Prepare and submit reports (at projectreports.wcr@noaa.gov, refer to WCRO-2024-02301, that summarize the effects of construction, fish relocation, and dewatering activities, and post-construction monitoring/site performance within 60 days of project completion.

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. Establish a long-term monitoring plan to better understand species/redd presence in the upper Carbon River by utilizing approaches such as eDNA analyses to overcome low visibility.
2. Consider relocation of the FS 7810 road away from the Carbon River if the bridge needs future repairs, which would prevent additional impacts listed species and allow for a more naturally-functioning floodplain habitat.

2.11. Reinitiation of Consultation

This concludes formal consultation for the Forest Road 7810 MP 0.1 Repairs Project.

Under 50 CFR 402.16(a): "Reinitiation of consultation is required and shall be requested by the federal agency, where discretionary federal 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."

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 associated physical, chemical, and biological 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 may result from actions occurring within EFH or outside of it and may include direct, indirect, site-specific or habitat-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 (50 CFR 600.905(b))].

3.1. EFH Affected by the Proposed Action

The action area is documented EFH for Pacific Coast Salmon. This EFH is identified and described in Appendix A to the Pacific Coast salmon fishery management plan (PFMC 2014). EFH salmonid species that occur within the action area include Chinook, Pink, and Coho salmon. The proposed action and action area for this consultation are described in Section 1 (ESA Biological Opinion) of this document. This consultation includes the emergency stabilization of the FR 7810 bridge that was completed in 2023, which is located in the Carbon River, one of the largest tributaries of the Puyallup River. Additionally, the proposed actions consist of acquiring 96 trees for the use in creating a flow deflector system upstream of the FR 7810 bridge and future use for the Mount Rainier ERFO Repairs Project, and creating and installing the flow deflectors upstream of the FR 7810 bridge.

We evaluated the action area for potential Habitat Areas of Particular Concern (HAPCs) for salmon. HAPCs are areas identified with increased scrutiny, study, or mitigation planning compared to surrounding areas because they represent high priority areas for conservation, management, or research and are necessary for healthy ecosystems and sustainable fisheries.

The following HAPCs are present within the action area:

Complex Channels and Floodplains: Both complex channels and floodplains provide valuable habitat for all Pacific salmon species. Complex channels consist of meandering, island-braided, pool-riffle and forced pool-riffle channels. Complex floodplain habitats consist of wetlands, oxbows, side channels, sloughs and beaver ponds, and steeper, more constrained channels with high levels of large woody debris (LWD). Densities of spawning and rearing salmon are highest in areas of high-quality, naturally-functioning floodplain habitat and in areas with LWD, compared to anthropogenically modified floodplains. Complex floodplain habitats are dynamic systems that change over time. As such, the habitat-forming processes that create and maintain these habitats (e.g., erosion and aggradation, input of large wood from riparian forests) should be considered integral to the habitat.

Thermal Refugia: Thermal refugia typically include cool water tributaries, lateral seeps, side channels, tributary junctions, deep pools, areas of groundwater upwelling, and other mainstem river habitats that are cooler than surrounding waters. Spatial scales can range from entire tributaries (e.g., spring-fed streams), to stream reaches, to highly localized pockets of water only a few square meters in size embedded within larger rivers. Thermal refugia provide areas to escape high water temperatures and are critical to salmon survival, especially during hot, dry summers in California, Idaho, and eastern Oregon and Washington. Thermal refugia also provide important holding and rearing habitat for adults and juveniles. Thermal refugia are susceptible to blockage by artificial barriers. Reduced flows can also reduce or eliminate access to refugia. Loss of structural elements such as large wood can also influence the formation of thermal refugia.

Spawning Habitat: Salmon spawning habitat is typically defined as low gradient stream reaches (<3%), containing clean gravel with low levels of fine sediment and high inter gravel flow. Many spawning areas have been well defined by historical and current spawner surveys, and detailed maps exist for some watersheds. Spawning habitat is especially sensitive to stress and degradation by a number of land- and water-use activities that affect the quality, quantity, and stability of spawning habitat (e.g., sediment deposition from land disturbance, streambank armoring, water withdrawals).

3.2. Adverse Effects on EFH

The ESA portion of this document (Sections 1 and 2) describes the adverse effects of the proposed action on ESA-listed species and critical habitats, and is relevant to the effects on EFH for Pacific Coast Salmon. Based on the analysis of effects presented in Section 2.5, NMFS determined the proposed action will cause small scale long-term adverse effects on EFH including complex channels and flood plains, thermal refugia, and spawning habitat of Pacific Coast Salmon.

1. Complex Channels and Floodplains: Carbon River has a highly complex and braided channel at the project site with lots of alluvial input from the Carbon Glacier but low levels of large woody debris, since logging in the past has removed large wood inputs. Temporary construction, including dewatering a potentially large area, would eliminate channel habitat accessible to salmonids for as long as the dewatering dam remains (estimated 10 weeks).

2. Thermal Refugia: The Carbon River is a glacially fed stream with cold temperatures, particularly at this project site, in the upper reaches (near the glacier). Disturbance of riparian vegetation will decrease shading over the water and contribute to warmer water in the Carbon River. While this will likely not exceed threshold temperatures for harm to salmonids, it could contribute slightly to increased temperature downstream, in areas already naturally warmer and on the cusp of healthy salmonid thermal regimes.

3. Spawning Habitat: The Carbon river, particularly farther downstream has historically and currently provides high-quality spawning habitat for salmonids and June creek has known Coho spawning. Adult and juvenile Chinook have been documented near the action area and *O. mykiss* adults have been captured just upstream. Glacial melt water obscures the visibility so surveying for these species and their redds is difficult. The Puyallup Tribe (2023) documents the Carbon as having “The Carbon River drainage provides excellent spawning and rearing opportunities for salmon, steelhead and bull trout. However, the majority of spawning for all species within this drainage, with the exception of bull trout, occurs within the lower 11 miles of the mainstem Carbon River and lower 12.6 miles of South Prairie Creek”(Marks 2023). Disturbance and dewatering during construction will adversely affect EFH spawning habitat by eliminating a portion of the Carbon River usable for spawning and possibly destroying redds. Disturbance may prevent Coho from traveling upstream into June creek to spawn.

3.3. EFH Conservation Recommendations

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

1. The USFS should consider relocation of the FS 7810 road away from the Carbon River if the bridge needs future repairs, which would prevent additional impacts to EFH for Pacific Coast Salmon and allow for a more naturally-functioning floodplain habitat for EFH species.
2. Ensure survival of on-site riparian plantings. Replant areas that fail and maintain at least an 80% plant survival at 5 years from construction.
3. Report to projectreports.wcr@noaa.gov, refer to WCRO-2024-02301 and cc kaylie.costa@noaa.gov and the WDFW area habitat biologist if any Chinook salmon are identified during construction, since this would constitute a new documented slightly upstream of the current documented extent.

3.4. Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, USFS must provide a detailed response in writing to 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 NMFS' EFH conservation recommendations unless NMFS and the federal agency have agreed to use alternative time frames for the federal agency response. The response must include a description of the 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 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)).

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.

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 and FHWA. Other interested users could include WDFW, King County, Pierce County, and the citizens of those counties. 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.

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.

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 part 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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