National Marine Fisheries Service Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response

Consultation on the "Evaluation and Recommended Determination of a Tribal Resource Management Plan Submitted for Consideration Under the Endangered Species Act's Tribal Plan Limit [50 CFR 223.204] for the Period January 1, 2022 – December 31, 2026" affecting Salmon, Steelhead, and Eulachon in the West Coast Region

NMFS Consultation Number: WCRO-2022-00472
ARN: 151422WCR2022PR00035

Action Agencies:

The National Marine Fisheries Service (NMFS)
Bureau of Indian Affairs (BIA)
U.S. Environmental Protection Agency (EPA)
Northwest Fisheries Science Center (NWFSC)
U.S. Fish and Wildlife Service (USFWS)
U.S. Geological Survey (USGS)

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely To Adversely Affect Species?	Is Action Likely To Jeopardize the Species?	Is Action Likely To Adversely Affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Puget Sound (PS) Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	No	No
PS steelhead (*O. mykiss*)	Threatened	Yes	No	No	No
Hood Canal summer-run (HCS) chum salmon (*O. keta*)	Threatened	Yes	No	No	No
Southern DPS (SDPS) eulachon (*Thaleichthys pacificus*)	Threatened	Yes	No	No	No
Southern Resident (SR) killer whales (*Orcinus orca*)	Threatened	No	No	No	No

Fishery Management Plan That Describes EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Salmon	No	No

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

Issued By:

For Scott Rumsey, Ph.D.
Acting Regional Administrator

Date: June 9, 2022

TABLE OF CONTENTS

List of Acronyms

ARN – Administrative Record Number
BIA – Bureau of Indian Affairs
BPA – Bonneville Power Administration
CFR – Code of Federal Regulation
CHART – Critical Habitat Analytical Review Teams
CWT – Coded Wire Tag
DC – Direct Current
DFO – Department of Fisheries and Oceans
DIDSON – Dual Frequency Identification Sonar
DPS – Distinct Population Segment
DQA – Data Quality Act
EFH – Essential Fish Habitat
EPA – Environmental Protection Agency
ESA – Endangered Species Act
ESU – Evolutionarily Significant Unit
FR – Federal Register
HCS – Hood Canal summer-run
HUC5 – Hydrologic Unit Code (fifth-field)
ITS – Incidental Take StatementMPG – Major Population Group
MSA – Magnuson-Stevens Fishery Conservation and Management Act
NMFS – National Marine Fisheries Service
NOAA – National Oceanic and Atmospheric Administration
NWFSC – Northwest Fisheries Science Center
ODFW – Oregon Department of Fish and Wildlife
PBF – Physical or Biological Features
PCE – Primary Constituent Element
PFMC – Pacific Fishery Management Council
PIT – Passive Integrated Transponder
PS – Puget Sound
RPM – Reasonable and Prudent Measure
S – Southern
SDPS – Southern Distinct Population Segment
SRKW – Southern Resident Killer Whale
TRT – Technical Recovery Team
USFWS – United States Fish and Wildlife Service
USGS –United States Geological Survey
VSP – Viable Salmonid Population
WCR – West Coast Region
WDFW – Washington Department of Fish and Wildlife

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 600.

The Tribal Plan Limit for tribal resource management plans (or otherwise referred to as tribal plans) (50 CFR 223.204) creates a section 4(d) limitation on the ESA section 9 take prohibitions for tribal plans where the Secretary of Commerce (Secretary) has determined that implementing the tribal plan will not appreciably reduce the likelihood of listed salmonid survival and recovery. The purpose of the Tribal Plan Limit is to establish a process whereby the conservation needs of listed species are met while respecting Tribal rights, values, and needs and not abridge any treaties, rights, executive orders, or statutes. The rule recognizes the Secretary's trust responsibilities to the Tribes and reinforces the commitment to government-to-government relations expressed in Secretarial Order 3206. The rule also requires the Secretary, in consultation with the Tribes, to use the best available scientific and commercial data (including any Tribal data and analysis) to determine a tribal plan's impact on the listed species' biological requirements.

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 within two weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. A complete record of this consultation is on file at the Protected Resources Division in Portland, OR.

1.2 Consultation History

On January 12, 2022, The Northwest Indian Fisheries Commission (NWIFC) submitted for review under the Tribal Plan Limit a Puget Sound Tribal Salmon Research Plan (Tribal Plan) on behalf of 18 tribes and tribal organizations in the Puget Sound, WA. The tribes and tribal organizations covered by the Tribal Plan are:

- Jamestown S'Klallam Tribe
- Lower Elwha Klallam Tribe

- Lummi Indian Nation
- Muckleshoot Indian Tribe
- Nisqually Tribe
- Nooksack Tribe
- Point No Point Treaty Council
- Port Gamble S'Klallam Tribe
- Puyallup Indian Tribe
- Sauk-Suiattle Tribe
- Skagit River System Cooperative
- Skokomish Tribe
- Squaxin Island Tribe
- Stillaguamish Tribe
- Suquamish Tribe
- Swinomish Tribe
- Tulalip Tribes
- Upper Skagit Tribe

The Tribal Plan identifies a variety of research and assessment activities intended to provide the technical basis for managing harvest and hatcheries, and conserving and restoring salmon stocks and their habitat. The majority of the research is motivated by a need to improve our understanding of salmonid freshwater and marine survival. Many of the activities are also intended to provide information that would be used to help plan, implement, and monitor habitat protection and restoration efforts. Eulachon are included in the Tribal Plan due to the possibility of encountering them while surveying for salmonids. The following provides a brief summary of the Tribal Plan and sets the context for NMFS' review.

The Tribal Plan contains 37 research projects the various tribal entities anticipate conducting between January 1, 2022 and December 31, 2026 (Table 1). The Tribal Plan describes Tribal research and assessment activities in the Puget Sound region that directly or indirectly affect listed Puget Sound (PS) Chinook salmon, PS steelhead, Hood Canal summer-run (HCS) chum salmon, and southern Distinct Population Segment of eulachon (Southern eulachon). Tribal resource management entities cooperate with the Washington Department of Fish and Wildlife (WDFW) and other state and local agencies in carrying out many of the activities. The Tribal Plan describes only those activities that are principally funded through, and managed by, Tribal governments. This Tribal Plan falls within the regulatory definition of "Tribal Plans" in the Tribal Plan Limit (50 CFR 223.204(b)(1)). As the Tribal Plan Limit specifies, NMFS consulted regularly with the Tribes during development of the Tribal Plan. We provided guidance on research to be covered under the Tribal Plan Limit, exchanged information, and discussed what would be needed to help conserve the listed species.

The proposed research actions also have the potential to affect Southern Resident (SR) killer whales and their critical habitat by diminishing the whales' prey base. We concluded that the proposed activities are not likely to adversely affect SR killer whales or their critical habitat and the full analysis for that conclusion is found in the "Not Likely to Adversely Affect" Determination, section (2.11).

Table 1.

Tribal Organization	Number of Projects in Program	Number of Listed Species Included in Program
Jamestown S'Klallam Tribe	3	3
Lower Elwha Klallam Tribe	3	3
Lummi Nation	3	2
Muckleshoot Tribe	4	2
Nisqually Tribe	3	2
Nooksack Tribe	0	0
Point No Point Treaty Council	0	0
Port Gamble S'Klallam Tribe	1	3
Puyallup Tribe	2	3
Sauk-Siuattle Tribe	0	0
Skagit River System Cooperative	2	2
Skokomish Tribe	3	3
Squaxin Island Tribe	2	3
Stillaguamish Tribe	3	2
Suquamish Tribe	2	1
Swinomish Tribe	0	0
Tulalip Tribes	4	2
Upper Skagit Tribe	2	2
Total	37	4

Most of the research requests were deemed incomplete to varying extents when they arrived. After numerous phone calls and e-mail exchanges, the applicants revised and finalized their applications. After the applications were determined to be complete, we published notice in the Federal Register on April 11, 2022 (87 FR 21103) asking for public comment on an evaluation and pending determination (EPD) of the Puget Sound Tribal Salmon Research plan. The public was given 30 days to comment on the EPD and that comment period closed on May 11, 2022. The consultation was formally initiated on May 12, 2022. The full consultation histories for the actions are lengthy and not directly relevant to the analysis for the proposed actions and so are not detailed here. A complete record of this consultation is maintained by the PRD and kept on file in Portland, Oregon.

1.3 Proposed Federal Action

Under the ESA, "action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR 402.02). We considered, under the ESA, whether or not the proposed action would cause any other activities and determined that it would not. Under the MSA, "Federal action" means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a Federal Agency (50 CFR 600.910).

The proposed action here is for NMFS to approve the Puget Sound Tribal Salmon Research Plan (Tribal Plan)(2022-2026). NMFS has reviewed the Tribal Plan and determined that it is consistent with the 4(d) limit for Tribal plans (50 CFR 223.204) and adequately minimizes the risk to PS Chinook salmon, PS steelhead, HCS chum salmon, and Southern eulachon. Our review of the Tribal Plan is set out in the March 16, 2022 document entitled "Evaluation and Recommended Determination of a Tribal Resource Management Plan Submitted for Consideration Under the Endangered Species Act's Tribal Plan Limit [50 CFR 223.204] for the Period January 1, 2022–December 31, 2026." The 4(d) limit would apply to the Tribal Plan for five years (through December 31, 2026).

The Tribal Plan contains 37 separate scientific research and monitoring projects. The research and monitoring activities include: (1) observation activities (such as snorkeling, spawning surveys, and habitat surveys) that may harass listed fish; (2) capturing fish with traps, nets, hook and line, and backpack electrofishing equipment; (3) anesthetizing and handling fish to obtain biometric samples, mark or tag fish, and document existing marks and tags; (4) non-lethal sampling for stomach contents and tissue samples; and (5) lethal tissue sampling. During the five-year duration of the Tribal Plan, the Tribes may find it necessary to modify, add, or eliminate studies and, in such cases, the tribes or the NWIFC tribal coordinator would do so through the NOAA APPS website (https://apps.nmfs.noaa.gov/index.cfm). NMFS will evaluate those changes and determine if they meet the requirements of the Tribal Plan Limit and whether the effects remain within the scope of those analyzed in this document. Further, NMFS will require annual reports on each project covered by the Tribal Plan by January 31st of the following year. For each calendar year, each project will also need to reapply for Tribal Plan (2022-2026 inclusion through the NOAA APPS website.

Additionally, to account for the dynamic and potentially increasing scope of research, we increased the requested fish handling and lethal take numbers from the 37 projects by 10%. Although it is difficult to anticipate how much more research may be requested, we believe this 10% buffer would be sufficient to include any changes or additions. Table 7 compares the total requested take, plus the 10% buffer, to the species' estimated abundance.

The activities identified in the Tribal Plan would be funded in part by the Federal agencies including NWFSC, BIA, EPA, USFWS, USGS (and NMFS would authorize them). These agencies are responsible for complying with section 7 of the ESA. Because this consultation examines the actions they propose to fund, it also fulfills their section 7 consultation obligations with respect to the funding, since the funding of the action would not raise any potential for effects on ESA-listed salmonids and eulachon beyond those already raised in consideration of the underlying actions themselves.

Common Elements among the Proposed Permit Actions

Research permits lay out the conditions to be followed before, during, and after the research activities are conducted. These conditions are intended to (a) manage the interaction between scientists and listed salmonids by requiring that research activities be coordinated among permit holders and between permit holders and NMFS, (b) minimize impacts on listed species, and (c) ensure that NMFS receives information about the effects the permitted activities have on the species concerned. All research permits the NMFS' WCR issues have the following conditions:

1. The permit holder must ensure that listed species are taken only at the levels, by the means, in the areas and for the purposes stated in the permit application, and according to the terms and conditions in the permit.

2. The permit holder must not intentionally kill or cause to be killed any listed species unless the permit specifically allows intentional lethal take.

3. The permit holder must handle listed fish with extreme care and keep them in cold water to the maximum extent possible during sampling and processing procedures. When fish are transferred or held, a healthy environment must be provided; e.g., the holding units must contain adequate amounts of well-circulated water. When using gear that captures a mix of species, the permit holder must process listed fish first to minimize handling stress.

4. The permit holder must stop handling listed juvenile fish if the water temperature exceeds 70 degrees Fahrenheit (°F) at the capture site. Under these conditions, listed fish may only be visually identified and counted. In addition, electrofishing is not permitted if water temperature exceeds 64°F.

5. If the permit holder anesthetizes listed fish to avoid injuring or killing them during handling, the fish must be allowed to recover before being released. Fish that are only counted must remain in water and not be anesthetized.

6. The permit holder must use a sterilized needle for each individual injection when passive integrated transponder tags (PIT-tags) are inserted into listed fish.

7. If the permit holder unintentionally captures any listed adult fish while sampling for juveniles, the adult fish must be released without further handling and such take must be reported.

8. The permit holder must exercise care during spawning ground surveys to avoid disturbing listed adult salmonids when they are spawning. Researchers must avoid walking in salmon streams whenever possible, especially where listed salmonids are likely to spawn. Visual observation must be used instead of intrusive sampling methods, especially when the only activity is determining fish presence.

9. The permit holder using backpack electrofishing equipment must comply with NMFS' Backpack Electrofishing Guidelines (June 2000) (NMFS 2000).

10. The permit holder must obtain approval from NMFS before changing sampling locations or research protocols.

11. The permit holder must notify NMFS as soon as possible but no later than two days after any authorized level of take is exceeded or if such an event is likely. The permit holder must submit a written report detailing why the authorized take level was exceeded or is likely to be exceeded.

12. The permit holder is responsible for any biological samples collected from listed species as long as they are used for research purposes. The permit holder may not transfer biological samples to anyone not listed in the application without prior written approval from NMFS.

13. The person(s) actually doing the research must carry a copy of this permit while conducting the authorized activities.

14. The permit holder must allow any NMFS employee or representative to accompany field personnel while they conduct the research activities.

15. The permit holder must allow any NMFS employee or representative to inspect any records or facilities related to the permit activities.

16. The permit holder may not transfer or assign this permit to any other person as defined in section 3(12) of the ESA. This permit ceases to be in effect if transferred or assigned to any other person without NMFS' authorization.

17. NMFS may amend the provisions of this permit after giving the permit holder reasonable notice of the amendment.

18. The permit holder must obtain all other Federal, state, and local permits/authorizations needed for the research activities.

19. On or before January 31st of every year, the permit holder must submit to NMFS a post-season report in the prescribed form describing the research activities, the number of listed fish taken and the location, the type of take, the number of fish intentionally killed and unintentionally killed, the take dates, and a brief summary of the research results. The report must be submitted electronically on the APPS permit website where downloadable forms can also be found. Falsifying annual reports or permit records is a violation of this permit.

20. If the permit holder violates any permit condition, they will be subject to any and all penalties provided by the ESA. NMFS may revoke this permit if the authorized activities are not conducted in compliance with the permit and the requirements of the ESA or if NMFS determines that its ESA section 10(d) findings are no longer valid.

"Permit holder" means the specific tribe responsible for the permit or any employee, contractor, or agent of the tribe.

Finally, NMFS will use the annual reports to monitor the actual number of listed fish taken annually in the scientific research activities and will adjust permitted take levels if they are deemed to be excessive or if cumulative take levels rise to the point where they are detrimental to the listed species.

2. ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT (ITS)

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, each Federal agency must ensure that its actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, Federal action agencies consult with 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.

This opinion constitutes formal consultation and an analysis of effects solely for the evolutionarily significant units (ESUs) and distinct population segments (DPSs) that are the subject of this opinion.[1] Herein, the NMFS determined that the proposed action of approving the Tribal Plan, including its 37 scientific research permits:

- May adversely affect PS Chinook salmon, PS steelhead, HCS chum salmon, and Southern eulachon; but would not jeopardize their continued existence.
- Is not likely to adversely affect SR killer whales or their designated critical habitat. This conclusion is documented in the "Not Likely to Adversely Affect" Determinations section (Section 2.11).

2.1 Analytical Approach

This biological opinion includes both a jeopardy analysis and an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "jeopardize the continued existence of" a listed species, which is "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

This biological opinion relies on the 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 critical habitat designations for many of the species considered here use the term primary constituent element (PCE) or essential features. The 2016 critical habitat regulations (50 CFR 424.12) replaced this term with physical or biological features (PBFs). The shift in terminology does

[1] An ESU of Pacific salmon (Waples 1991) and a DPS of steelhead (71 FR 834), rockfish, eulachon, etc., are considered to be "species" as the word is defined in section 3 of the ESA.

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

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. The largest hydrologic responses are expected to occur in basins with significant snow accumulation, where warming decreases snow pack, increases winter flows, and advances the timing of spring melt (Mote et al. 2014, Mote 2016). Rain-dominated watersheds and those with significant contributions from groundwater may be less sensitive to predicted changes in climate (Tague et al. 2013, Mote et al. 2014).

During the last century, average regional air temperatures in the Pacific Northwest increased by 1-1.4°F as an annual average, and up to 2°F in some seasons (based on average linear increase per decade; Abatzoglou et al. 2014, Kunkel et al. 2013). Warming is likely to continue during the next century as average temperatures are projected to increase another 3 to 10°F, with the largest increases predicted to occur in the summer (Mote et al. 2014). Decreases in summer precipitation of as much as 30% by the end of the century are consistently predicted across climate models (Mote et al. 2014). Precipitation is more likely to occur during October through March, less during summer months, and more winter precipitation will be rain than snow (ISAB 2007, Mote et al. 2013, 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). 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). The largest increases in winter flood frequency and magnitude are predicted in mixed rain-snow watersheds (Mote et al. 2014).

Overall, about one-third of the current cold-water salmonid habitat in the Pacific Northwest is likely to exceed key water temperature thresholds by the end of this century (Mantua et al. 2009). Higher temperatures will reduce the quality of available salmonid habitat for most freshwater life stages (ISAB 2007). Reduced flows will make it more difficult for migrating fish to pass physical and thermal obstructions, limiting their access to available habitat (Mantua et al. 2010; Isaak et al. 2012). Temperature increases shift timing of key life cycle events for salmonids and species forming the base of their aquatic foodwebs (Crozier et al. 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, Winder and Schindler 2004, Raymondi et al. 2013). Higher temperatures are likely to cause several species to become more susceptible to parasites, disease, and higher predation rates (Crozier et al. 2008; Wainwright and Weitkamp 2013; Raymondi et al. 2013).

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 (McMahon and Hartman 1989; Lawson et al. 2004).

In addition to changes in freshwater conditions, predicted changes for coastal waters in the Pacific Northwest as a result of climate change include increasing surface water temperature, increasing but highly variable acidity, and increasing storm frequency and magnitude (Mote et al. 2014). Elevated ocean temperatures already documented for the Pacific Northwest are highly likely to continue during the next century, with sea surface temperature projected to increase by 1.0-3.7°C (1.8-6.7°F) by the end of the century (IPCC 2014). Habitat loss, shifts in species' ranges and abundances, and altered marine food webs could have substantial consequences to anadromous, coastal, and marine species in the Pacific Northwest (Tillmann and Siemann 2011, Reeder et al. 2013).

Moreover, as atmospheric carbon emissions increase, increasing levels of carbon are absorbed by the oceans, changing the pH of the water. Acidification also affects sensitive estuary habitats, where organic matter and nutrient inputs further reduce pH and produce conditions more corrosive than those in offshore waters (Feely et al. 2012, Sunda and Cai 2012).

Global sea levels are expected to continue rising throughout this century, reaching likely predicted increases of 10-32 inches by 2081-2100 (IPCC 2014). These changes will likely result in increased erosion and more frequent and severe coastal flooding, and shifts in the composition of nearshore habitats (Tillmann and Siemann 2011, Reeder et al. 2013). Estuarine-dependent salmonids such as chum and Chinook salmon are predicted to be impacted by significant reductions in rearing habitat in some Pacific Northwest coastal areas (Glick et al. 2007). Historically, warm periods in the coastal Pacific Ocean have coincided with relatively low abundances of salmon and steelhead, while cooler ocean periods have coincided with relatively high abundances, and therefore these species are predicted to fare poorly in warming ocean conditions (Scheuerell and Williams 2005; Zabel et al. 2006). This is supported by the recent observation that anomalously warm sea surface temperatures off the coast of Washington from 2013 to 2016 resulted in poor coho and Chinook salmon body condition for juveniles caught in those waters (NWFSC 2015). Changes to estuarine and coastal conditions, as well as the timing of seasonal shifts in these habitats, have the potential to affect a wide range of listed aquatic species (Tillmann and Siemann 2011, Reeder et al. 2013).

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 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.

2.2.1 Status of the Species

For Pacific salmon and steelhead, NMFS commonly uses four parameters to assess the biological viability of the populations that, together, constitute the species: spatial structure, diversity, abundance, and productivity (McElhany et al. 2000). These "viable salmonid population" (VSP) criteria therefore encompass the species' "reproduction, numbers, or distribution" as described in 50 CFR 402.02. We apply the same criteria for other species as well, such as eulachon, but in those instances, they are not referred to as "salmonid" population criteria. When any animal population or species has sufficient spatial structure, diversity, abundance, and productivity, it will generally be able to maintain its capacity to adapt to various environmental conditions and 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 fundamentally on habitat quality and spatial configuration and the dynamics and dispersal characteristics of individuals in the population.

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

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

"Productivity," as applied to viability factors, refers to the entire life cycle; i.e., the number of naturally spawning adults produced per parent. When progeny replace or exceed the number of parents, a population is stable or increasing. When progeny fail to replace the number of parents, the population is declining. McElhany et al. (2000) use the terms "population growth rate" and "productivity" interchangeably when referring to production over the entire life cycle. They also refer to "trend in abundance," which is the manifestation of long-term population growth rate.

For species with multiple populations, once the biological status of a species' populations has been determined, NMFS assesses the status of the entire species using criteria for groups of populations, as described in recovery plans and guidance documents from technical recovery teams. Considerations for species viability include having multiple populations that are viable, ensuring that populations with unique life histories and phenotypes are viable, and that some viable populations are both widespread to avoid concurrent extinctions from mass catastrophes and spatially close enough to allow them to function as metapopulations (McElhany et al. 2000).

For Southern eulachon, the biological recovery criteria identified in the recovery plan rely on the same population viability parameters (i.e., abundance, productivity, spatial structure and temporal distribution, and genetic and life history diversity) (NMFS 2017). However, viability status can't currently be assessed because the lack of information about eulachon distribution, abundance, and response to changes in marine and freshwater conditions have precluded the development of population viability criteria at this time (NMFS 2017). In the absence of sufficient information, the 2017 Recovery Plan for Southern eulachon instead described a set of qualitative conditions that, if met, would indicate that the species is no longer in danger of extinction.

A species' status thus is a function of how well its biological requirements are being met: the greater the degree to which the requirements are fulfilled, the better the species' status. Information on the status and distribution of all the species considered here can be found in a number of documents, but the most pertinent are the status review updates and recovery plans listed in Table 2 and the specific species sections that follow. These documents and other relevant information may be found on the NOAA Fisheries West Coast Region website; the discussions they contain are summarized in the tables below. For the purposes of our later analysis, all the species considered here require functioning habitat and adequate spatial structure, abundance, productivity, and diversity to ensure their survival and recovery in the wild.

Table 2. Listing classification and date, recovery plan reference, most recent status review, status summary, and limiting factors for each species considered in this opinion.

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Viability Assessments	Status Summary	Limiting Factors
Puget Sound Chinook salmon	Threatened 06/28/2005 (70 FR 37160)	SSDC 2007 NMFS 2006	Ford 2022	This ESU comprises 22 populations distributed over five geographic areas. Most populations within the ESU have declined in abundance over the past 7 to 10 years, with widespread negative trends in natural-origin spawner abundance, and hatchery-origin spawners present in high fractions in most populations outside of the Skagit watershed. Escapement levels for all populations remain well below the Technical Recovery Team (TRT) planning ranges for recovery, and most populations are consistently below the spawner-recruit levels identified by the TRT as consistent with recovery.	● Degraded floodplain and in-river channel structure ● Degraded estuarine conditions and loss of estuarine habitat ● Degraded riparian areas 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	Threatened 05/11/2007 (72 FR 26722)	NMFS 2019	Ford 2022	This DPS comprises 32 populations. The DPS is currently at very low viability, with most of the 32 populations and all three population groups at low viability. Information considered during the most recent status review indicates that the biological risks faced by the PS steelhead DPS have not substantively changed since the listing in 2007, or since the 2011 status review. Furthermore, the PS steelhead TRT recently concluded that the DPS was at very low viability, as were all three of its constituent major population groups (MPGs), and many of its 32 populations. In the near term, the outlook for environmental conditions affecting PS steelhead is not optimistic. While harvest and hatchery production of steelhead in Puget Sound are currently at low levels and are not likely to increase substantially in the foreseeable future, some recent environmental trends not favorable to PS steelhead survival and production are expected to continue.	● Continued destruction and modification of habitat ● Widespread declines in adult abundance despite significant reductions in harvest ● Threats to diversity posed by use of two hatchery steelhead stocks ● Declining diversity in the DPS, including the uncertain but weak status of summer-run fish ● A reduction in spatial structure ● Reduced habitat quality ● Urbanization ● Dikes, hardening of banks with riprap, and channelization

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Viability Assessments	Status Summary	Limiting Factors
Hood Canal summer-run chum salmon	Threatened 06/28/2005 (70 FR 37160)	HCCC 2005 NMFS 2007	Ford 2022	This ESU is made up of two independent populations in one major population group. Natural-origin spawner abundance has increased since ESA-listing and spawning abundance targets in both populations have been met in some years. Productivity was quite low at the time of the last review, though rates have increased in the last 5 years, and have been greater than replacement rates in the past 2 years for both populations. However, productivity of individual spawning aggregates shows only two of eight aggregates have viable performance. Spatial structure and diversity viability parameters for each population have increased and nearly meet the viability criteria. Despite substantive gains towards meeting viability criteria in the Hood Canal and Strait of Juan de Fuca summer chum salmon populations, the ESU still does not meet all of the recovery criteria for population viability at this time.	● Reduced floodplain connectivity and function ● Poor riparian condition ● Loss of channel complexity Sediment accumulation ● Altered flows and water quality
Southern DPS of eulachon	Threatened 03/18/2010 (75 FR 13012)	NMFS 2017	Gustafson et al. 2016	The Southern of eulachon includes all naturally-spawned populations that occur in rivers south of the Nass River in British Columbia to the Mad River in California. Sub populations for this species include the Fraser River, Columbia River, British Columbia and the Klamath River. In the early 1990s, there was an abrupt decline in the abundance of eulachon returning to the Columbia River. Despite a brief period of improved returns in 2001-2003, the returns and associated commercial landings eventually declined to the low levels observed in the mid-1990s. Although eulachon abundance in monitored rivers has generally improved, especially in the 2013-2015 return years, recent poor ocean conditions and the likelihood that these conditions will persist into the near future suggest that population declines may be widespread in the upcoming return years	● Changes in ocean conditions due to climate change, particularly in the southern portion of the species' range where ocean warming trends may be the most pronounced and may alter prey, spawning, and rearing success. ● Climate-induced change to freshwater habitats ● Bycatch of eulachon in commercial fisheries ● Adverse effects related to dams and water diversions ● Water quality ● Shoreline construction ● Over harvest ● Predation

Species-specific status information is discussed in more detail below. The abundance numbers presented for each should be viewed with caution, however, as they only address one of several juvenile life stages. Moreover, deriving any juvenile abundance estimate for species with no dam/passage counts is complicated by a host of variables, including the facts that: (1) the available data do not include all populations; (2) spawner counts and associated sex ratios and fecundity estimates can vary widely between years; (3) multiple juvenile age classes (fry, parr, smolt) are present yet comparable data sets may not exist for all of them; (4) it is very difficult to distinguish between non-listed juvenile rainbow trout and listed juvenile steelhead; and (5) survival rates between life stages are poorly understood and subject to a multitude of natural and human-induced variables (e.g., predation, floods, fishing, etc.).

Table 3. Estimated annual abundance of ESA listed fish.

Species	Life Stage	Origin	Abundance
Puget Sound Chinook salmon	Adult	Natural	23,371
		Listed Hatchery	23,232
	Juvenile	Natural	3,728,240
		Listed Hatchery	34,472,500
Puget Sound steelhead	Adult	Natural	19,079
		Listed Hatchery	735
	Juvenile	Natural	2,253,842
		Listed Hatchery	273,500
Hood Canal summer-run chum salmon	Adult	Natural	28,117
		Listed Hatchery	881
	Juvenile	Natural	4,240,958
		Listed Hatchery	150,000
Southern DPS eulachon	Adult	Natural	24,267,210

2.2.1.1 Puget Sound Chinook Salmon

Abundance and Productivity

To estimate the abundance of adult spawners, we took the geometric means of the last five years of adult returns—as estimated by dam counts, radio-tag studies, PIT-stag studies, redd counts, and other methods (Ford 2022). Natural-origin juvenile PS Chinook salmon abundance estimates come from applying estimates of the percentage of females in the population and average fecundity to escapement data. Fecundity estimates for the ESU range from 2,000 to 5,500 eggs per female, and the proportion of female spawners in most populations is approximately 40% of escapement. By applying a conservative fecundity estimate (2,000 eggs/female) to the expected female escapement (both natural-origin and hatchery-origin spawners – 18,641 females), the ESU is estimated to produce approximately 37.3 million eggs annually. Smolt trap studies have researched egg to migrant juvenile Chinook salmon survival rates in the following Puget Sound tributaries: Skagit River, North Fork Stillaguamish River, South Fork Stillaguamish River, Bear Creek, Cedar River, and Green River (Beamer et al. 2000; Seiler et al. 2002, 2004, 2005; Volkhardt et al. 2005; Griffith et al. 2004). The average survival rate in these studies was 10%, which corresponds with those reported by Healey (1991). With an estimated survival rate of 10%, the ESU should produce roughly 3.7 million natural-origin outmigrants annually (Table 3).

Juvenile listed hatchery PS Chinook salmon abundance estimates come from the annual hatchery production goals. Hatchery production varies annually due to several factors including funding, equipment and human performance, fish health, and adult spawner availability. Funding uncertainties and the inability to predict equipment failures, human error, and disease suggest that production averages from previous years is not a reliable indication of future production. For these reasons, abundance is assumed to equal production goals. The combined hatchery production goal for listed PS Chinook salmon is roughly 34 million juveniles annually (Table 3).

Total abundance in the ESU over the entire time series shows that individual populations have varied in increasing or decreasing abundance. Several populations (North Fork and South Fork Nooksack, Sammamish, Green, White, Puyallup, Nisqually, Skokomish, Dungeness and Elwha) are dominated by hatchery returns. Abundance across the ESU has generally increased since the last viability assessment, with only 2 of the 22 populations (Cascade and North Fork and South Fork Stillaguamish) showing a negative change in the 5-year geometric mean for natural-origin spawner abundances (Ford 2022). Fifteen of the remaining 20 populations showed positive change in the 5-year geometric mean natural-origin spawner abundances. These same 15 populations have relatively low natural spawning abundances of < 1000 fish, so some of these increases represent small changes in total abundance.

Across the Puget Sound ESU, 10 of 22 Puget Sound populations show natural productivity below replacement in nearly all years since the mid-1980's. In recent years, only five populations have had productivities above zero: Lower Skagit, Upper Skagit, Lower Sauk, Upper Sauk, and Suiattle. All five populations are in the Whidbey Basin of the Skagit River. The overall pattern continues the decline reported in the 2015 Status Review (Ford 2022).

None of the 22 Puget Sound populations meet minimum viability abundance targets. The populations closest to meeting the planning targets (Upper Skagit, Upper Sauk, and Suiattle) need to increase substantially just to meet the minimum viability abundance target. The Lower Skagit population is the second most abundant population, but its natural-origin spawner abundance is only 10% of the minimum viability abundance target.

Spatial Structure and Diversity

The PS Chinook salmon ESU is made up of naturally spawned Chinook salmon originating 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. The PS Chinook salmon ESU is composed of 31 historically quasi-independent populations, 22 of which are extant. The populations are distributed in five geographic regions, or major population groups, identified by the Puget Sound Technical Recovery Team (PSTRT) based on similarities in hydrographic, biogeographic, and geologic characteristics of the Puget Sound basin (PSTRT 2002). The ESU also includes Chinook salmon from twenty-five artificial propagation programs (85 FR 81822).

Spatial structure and diversity can be evaluated by assessing the proportion of natural-origin spawners versus hatchery-origin spawners on the spawning grounds. From approximately 1990 to 2018, the proportion of PS Chinook salmon natural-origin spawners showed a declining trend. Considering populations by their MPGs, the Whidbey Basin is the only MPG with consistently high-fraction natural-origin spawner abundance: six out of 10 populations. All other MPGs have either variable or declining spawning populations that have high proportions of hatchery-origin spawners.

All PS Chinook salmon populations continue to remain well below the TRT planning ranges for recovery escapement levels. Most populations also remain consistently below the spawner-recruit levels identified by the TRT as necessary for recovery. Across the ESU, most populations have increased somewhat in abundance since the last 5-year review in 2016, but have small negative trends over the past 15 years (Ford 2022). Productivity remains low in most populations. Hatchery-origin spawners are present in high fractions in most populations outside the Skagit watershed, and in many watersheds, the fraction of spawner abundances that are natural-origin have declined over time. Habitat protection, restoration, and rebuilding programs in all watersheds have improved stream and estuary conditions despite record numbers of humans moving into the Puget Sound region in the past two decades.

2.2.1.2 Puget Sound Steelhead

Abundance and Productivity

To estimate the abundance of adult spawners, we took the geometric means of the last five years of adult returns—as estimated by dam counts, radio-tag studies, PIT-stag studies, redd counts, and other methods (Ford 2022). Natural-origin juvenile PS steelhead abundance estimates are calculated from the estimated abundance of adult spawners and estimates of fecundity. For this species, fecundity estimates range from 3,500 to 12,000 eggs per female; and the male to female ratio averages 1:1 (Pauley et al. 1986). By applying a conservative fecundity estimate of 3,500 eggs to the expected escapement of females (9,728 females), 34.05 million eggs are expected to be produced annually. With an estimated survival rate of 6.5% (Ward and Slaney 1993), the DPS should produce roughly 2.21 million natural-origin outmigrants annually (Table 3).

Juvenile listed hatchery PS steelhead abundance estimates come from the annual hatchery production goals (WDFW 2021). The combined hatchery production goal for listed PS steelhead is roughly 274 thousand juveniles annually (Table 3).

Abundance information is unavailable for approximately one-third of the populations, and this is disproportionately true for summer-run populations. In most cases where no information is available, we assume that abundances are very low. Increases in spawner abundance were observed in a number of populations over the last 5 years (Ford 2022). These improvements were disproportionately found in the South and Central Puget Sound, Strait of Juan de Fuca, and Hood Canal MPGs, and primarily among smaller populations. The apparent reversal of strongly negative trends among winter-run populations in the White, Nisqually, and Skokomish rivers decreased (to some degree) the demographic risks those populations face. Certainly, improvement in the status of the Elwha River steelhead (winter- and summer-run) following the removal of the Elwha dams reduced the demographic risk for the population and MPG to which it belongs. Improvements in abundance were not as widely observed in the Northern Puget Sound MPG. Foremost among the declines were summer- and winter-run populations in the Snohomish Basin. In particular, the only summer-run population with a long-term dataset, declined 63% during the 2015-2019 period with a negative 4% trend since 2005 (Ford 2022).

Spatial Structure and Diversity

The PS steelhead DPS is composed of naturally spawned anadromous *Oncorhynchus mykiss* (steelhead) 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. Steelhead are found in most of the larger accessible tributaries to Puget Sound, Hood Canal, and the eastern Strait of Juan de Fuca. Surveys of the Puget Sound (not including the Hood Canal) in 1929 and 1930 identified steelhead in every major basin except the Deschutes River (Hard et al. 2007). This DPS also includes hatchery steelhead from five artificial propagation programs (85 FR 81822).

Although PS steelhead populations include both summer- and winter-run life-history types, winter-run populations predominate. For the PS steelhead DPS, Myers et al. (2015) identified three MPGs with 27 populations of winter-run steelhead and nine populations of summer-run steelhead. Summer-run stock statuses are mostly unknown; however, most appear to be small, averaging less than 200 spawners annually (Hard et al. 2007). Summer-run stocks are primarily concentrated in the northern Puget Sound and the Dungeness River (Myers et al. 2015).

A number of fish passage actions have improved access to historical habitat in the past 10 years. The removal of dams on the Elwha, Middle Fork Nooksack, and Pilchuck rivers, as well as the fish passage programs recently started on the North Fork Skokomish and White rivers will provide access to important spawning and rearing habitat. While there have been some significant improvements in spatial structure, it is recognized that land development, loss of riparian and forest habitat, loss of wetlands, and demands on water allocation all continue to degrade the quantity and quality of available fish habitat.

The recovery plan for PS steelhead (NMFS 2019) recognizes that production of hatchery fish of both run types—winter run and summer run—has posed a considerable risk to diversity in natural steelhead in the Puget Sound DPS. Overall, the risk posed by hatchery programs to naturally spawning populations has decreased during the last 5 years with reductions in production (especially with non-local programs) and the establishment of locally-sourced broodstock. Unfortunately, while competition and predation by hatchery-origin fish can swiftly be diminished, it is unclear how long the processes of natural selection will take to reverse the legacy of genetic introgression by hatchery fish.

The Northwest Fisheries Science Center (NWFSC) found that the PS steelhead DPS viability has improved since Hard et al. (2015) concluded it was at very low viability (Ford 2022). Perhaps more importantly, improvements were noted in all three of the DPS's MPGs and many of its 32 demographically independent populations (DIPs) (Ford 2022). However, in spite of improvements, where monitoring data exists, most populations remain at low abundance levels.

2.2.1.3 Hood Canal Summer-run Chum Salmon

Abundance and Productivity

To estimate the abundance of adult spawners, we took the geometric means of the last five years of adult returns—as estimated by dam counts, radio-tag studies, PIT-stag studies, redd counts, and other methods (Ford 2022). Natural-origin juvenile HCS chum abundance estimates are calculated from the estimated abundance of adult spawners and estimates of fecundity. For this species, fecundity estimates average 2,500 eggs per female and the proportion of female spawners is approximately 45% of escapement in most populations WDFW/PNPTT 2000). By applying fecundity estimates to the expected escapement of females (both natural-origin and hatchery-origin spawners – 13,049 females), the ESU is estimated to produce approximately 32.6 million eggs annually. For HCS chum salmon, freshwater mortality rates are high with no more than 13% of the eggs expected to survive to the juvenile migrant stage (Quinn 2005). With an estimated survival rate of 13%, the ESU should produce roughly 4.24 million natural-origin outmigrants annually (Table 3).

Juvenile listed hatchery HCS chum abundance estimates come from the annual hatchery production goals (WDFW 2021). Two artificial propagation programs are currently listed as part of the ESU (50 CFR 223.102); however, only one program is currently active. The combined hatchery production goal for listed HCS chum is 150 thousand juveniles annually (Table 3).

Managers have been estimating total spawner and natural spawner returns for this ESU since 1974. The estimates are based on spawning ground surveys and genetic stock identification (Ford 2022). For the two populations that comprise this ESU, 15-year trends in log natural-origin spawner abundance over two time periods (1990 – 2005 and 2004 – 2019) show strongly positive trends in both populations in the first time period, but trends have decreased to close to zero in the most recent

15-year period (Ford 2022). Since 2016, abundances for both populations have sharply decreased. This decline began in 2017 for the Strait of Juan de Fuca population and in 2018 for the Hood Canal population. Despite substantive gains towards meeting viability criteria in the Hood Canal and Strait of Juan de Fuca summer chum salmon populations, the ESU still does not meet all of the recovery criteria for population viability at this time (Ford 2022).

Productivity for this ESU had increased at the time of the last 5-year review (NWFSC 2015). However, productivity has declined for both populations in the last several years (Ford 2022). Productivity rates have varied above and below replacement rates since at least 1975 and have averaged very close to zero (1:1 replacement) over the last 15 years.

Spatial Structure and Diversity

The species comprises all naturally spawned populations of summer-run chum salmon in Hood Canal and its tributaries as well as populations in Olympic Peninsula rivers between Hood Canal and Dungeness Bay, Washington. Two artificial propagation programs are included in this ESU: Lilliwaup Creek Fish Hatchery Program and Tahuya River Program (85 FR 81822). Spatial structure and diversity measures for the Hood Canal summer chum recovery program include the reintroduction and sustaining of natural-origin spawning in multiple small streams where summer chum spawning aggregates had been extirpated.

The hatchery contribution varies greatly among the spawning aggregations within each population. It is highest in the Strait of Juan de Fuca population, ranging from 8.4 to 62.8% in the Strait of Juan de Fuca population, and 5.8 to 40.2% in the Hood Canal population. The hatchery contribution also decreased over the last several years as hatchery programs were terminated (Ford 2022). Supplementation ended by 2011 in the Strait of Juan de Fuca population, and by 2017 in the Hood Canal population.

As mentioned in the NWFSC's viability assessment, Lestelle et al. (2018) suggests the Hood Canal population is at negligible risk of extinction, provided that the exploitation rate remains very low (Ford 2022). The Strait of Juan de Fuca population has a much higher risk of extinction, even with an exploitation rate of zero (Lestelle et al. 2018, as cited in Ford 2022). As noted above, since 2017, both populations have experienced much lower returns, and Lestelle (2020, as cited in Ford 2022) showed considerably reduced population performance under a changing ocean climate.

Overall, natural-origin spawner abundance has increased since ESA-listing and spawning abundance targets in both populations have been met in some years. Productivity had increased at the time of the last 5-year review (NWFSC 2015), but has declined for the last 3 to 4 years. Productivity of individual spawning aggregates shows only two of eight aggregates have viable performance. Spatial structure and diversity viability parameters have improved and nearly meet the viability criteria for both populations. Despite substantive gains towards meeting viability criteria, the ESU still does not meet all of the recovery criteria for population viability at this time, however. Overall, the Hood Canal summer chum salmon ESU remains at moderate risk of extinction with viability largely unchanged since the 2015 viability assessment.

2.2.1.4 Southern Distinct Population Segment of Eulachon

Abundance and Productivity

There are no reliable fishery-independent, historical abundance estimates for Southern eulachon. Beginning in 2011, Oregon Department of Fish and Wildlife (ODFW) and Washington Department of Fish and Wildlife (WDFW) began instituting annual eulachon monitoring surveys in the Columbia River where spawning stock biomass (SSB) is used to estimate spawner abundance (NMFS 2017). In addition, WDFW has retrospectively estimated historical SSB in the Columbia River for 2000–2010 using pre-2011 expansions of eulachon larval densities (Gustafson et al 2016). Spawning stock biomass estimates have also been collected for the Fraser River since 1995 (DFO 2022). There are currently no additional data available for abundance trends in other watersheds, and at this time there are not sufficient data to develop viability criteria or assess the productivity of this DPS (NMFS 2017).

In recent years abundance estimates of Southern eulachon in the Columbia River have fluctuated from a low of just over 4 million in 2018 to over 96 million in 2021. The geometric mean spawner abundance over the past 5 years is just over 23.5 million, though this is almost certainly an underestimate as surveys were cut short in 2020. These estimated abundance levels are an improvement over estimated abundance at the time of listing (Gustafson et al 2010), but a decline from the average abundances at the time of the last status review (Gustafson et al 2016). Since 2018 annual abundance has been increasing, although the mean abundance estimated in 2021 was only about half of the peak annual estimate from the past 20 years (i.e., 185,965,200 in 2014). The situation in the Klamath River is also more positive than it was at the time of the 2010 status review with adult eulachon presence being documented in the Klamath River in the spawning seasons of 2011–2014, although it has not been possible to calculate estimates of SSB in the Klamath River (Gustafson et al. 2016). The Fraser River population has been at low levels most years since 2004 although recent years have shown higher spawning numbers which may signal a positive trend (DFO 2022). SSB estimations of eulachon in the Fraser River from the years 2016 through 2020 have ranged from a low of an estimated 861,125 fish in 2017 to a high of 15,352,621 fish in 2020 (DFO 2022, estimate based on report weight assuming 11.16 fish per pound).

Structure and Diversity

The Southern of eulachon is comprised of fish that spawn in rivers south of the Nass River in British Columbia to, and including, the Mad River in California. There are many subpopulations of eulachon within the range of the species. At the time the species was evaluated for listing the Biological Review Team (BRT) partitioned the Southern of eulachon into geographic areas for their threat assessment, which did not include all known or possible eulachon spawning areas (Gustafson et al 2010). We now know eulachon from these excluded areas (e.g., Elwha River, Naselle River, Umpqua River, and Smith River) may have (or had) some important contribution to the overall productivity, spatial distribution, and genetic and life history diversity of the species (NMFS 2017). We currently do not have the data necessary to determine whether eulachon are one large metapopulation, or comprised of multiple demographically independent populations. Therefore, we consider the four subpopulations identified by the BRT (i.e., Klamath River, Columbia River, Fraser

River, and British Columbia coastal rivers) as the minimum set of populations comprising the DPS. Large, consistent spawning runs of eulachon have not been documented in Puget Sound river systems, and therefore eulachon spawning in these watersheds are not considered part of an independent subpopulation. However, eulachon have been observed regularly in many Washington rivers and streams, as well as Puget Sound (Monaco et al. 1990, Willson et al. 2006; as cited in Gustafson et al. 2010).

Genetic analyses of population structure indicate there is divergence among basins, however, it is less than typically observed in most salmon species. The genetic differentiation among some river basins is also similar to the levels of year-to-year genetic variation within a single river, suggesting that patterns among rivers may not be temporally stable (Beecham et al 2005). Eulachon in both Alaska and the Columbia basin show little genetic divergence within those regions, which is also the case among some British Columbia tributaries. However, there is greater divergence between regions, with a clear genetic break that appears to occur in southern British Columbia north of the Fraser River (Gustafson 2016, NMFS 2017). A 2015 genetic study of single nucleotide polymorphism (SNP) markers in eulachon from several geographic regions concluded there may be three main groups of subpopulations; a Gulf of Alaska group, a British Columbia to SE Alaska group, and a southern Columbia to Fraser group (Candy et al 2015; as cited in NMFS 2017).

2.2.2 Status of the Species' Critical Habitat

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

For most salmon and steelhead, NMFS's critical habitat analytical review teams (CHARTs) ranked watersheds within designated critical habitat at the scale of the fifth-field hydrologic unit code (HUC5) in terms of the conservation value they provide to each ESA-listed species that they support (NMFS 2005). The conservation rankings were high, medium, or low. To determine the conservation value of each watershed to species viability, the CHARTs evaluated the quantity and quality of habitat features, the relationship of the area compared to other areas within the species' range, and the significance to the species of the population occupying that area. Even if a location had poor habitat quality, it could be ranked with a high conservation value if it were essential due to factors such as limited availability, a unique contribution of the population it served, or is serving another important role.

A summary of the status of critical habitats, considered in this opinion, is provided in Table 4, below.

Table 4. Critical habitat, designation date, federal register citation, and status summary for critical habitat considered in this opinion.

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
Puget Sound Chinook salmon	09/02/2005 70 FR 52630	Critical habitat for Puget Sound Chinook salmon includes 1,683 miles of streams, 41 square mile of lakes, and 2,182 miles of nearshore marine habitat in Puget Sounds. The Puget Sound Chinook salmon ESU has 61 freshwater and 19 marine areas within its range. Of the freshwater watersheds, 41 are rated high conservation value, 12 low conservation value, and eight received a medium rating. Of the marine areas, all 19 are ranked with high conservation value. Primary constitute elements relevant for this consultation include: 1) Estuarine areas free of obstruction with water quality and aquatic vegetation to support juvenile transition and rearing; 2) Nearshore marine areas free of obstruction with water quality conditions, forage, submerged and overhanging large wood, and aquatic vegetation to support growth and maturation; 3) Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.
Puget Sound steelhead	02/24/2016 81 FR 9252	Critical habitat for Puget Sound steelhead includes 2,031 stream miles. Nearshore and offshore marine waters were not designated for this species. There are 66 watersheds within the range of this DPS. Nine watersheds received a low conservation value rating, 16 received a medium rating, and 41 received a high rating to the DPS.
Hood Canal summer-run chum salmon	09/02/2005 70 FR 52630	Critical habitat for Hood Canal summer-run chum salmon includes 79 miles and 377 miles of nearshore marine habitat in HC. Primary constituent elements relevant for this consultation include: 1) Estuarine areas free of obstruction with water quality and aquatic vegetation to support juvenile transition and rearing; 2) Nearshore marine areas free of obstruction with water quality conditions, forage, submerged and overhanging large wood, and aquatic vegetation to support growth and maturation; 3) Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.
Southern DPS of eulachon	10/20/2011 76 FR 65324	Critical habitat for eulachon includes portions of 16 rivers and streams in California, Oregon, and Washington. All of these areas are designated as migration and spawning habitat for this species. In Oregon, we designated 24.2 miles of the lower Umpqua River, 12.4 miles of the lower Sandy River, and 0.2 miles of Tenmile Creek. We also designated the mainstem Columbia River from the mouth to the base of Bonneville Dam, a distance of 143.2 miles. Dams and water diversions are moderate threats to eulachon in the Columbia and Klamath rivers where hydropower generation and flood control are major activities. Degraded water quality is common in some areas occupied by Southern eulachon. In the Columbia and Klamath river basins, large-scale impoundment of water has increased winter water temperatures, potentially altering the water temperature during eulachon spawning periods. Numerous chemical contaminants are also present in spawning rivers, but the exact effect these compounds have on spawning and egg development is unknown. Dredging is a low to moderate threat to eulachon in the Columbia River. Dredging during eulachon spawning would be particularly detrimental.
Southern resident killer whale	11/29/2006 71 FR 69054	Critical habitat consists of three specific marine areas of inland waters of Washington: 1) the Summer Core Area in Haro Strait and waters around the San Juan Islands; 2) Puget Sound; and 3) the Strait of Juan de Fuca. These areas comprise approximately 2,560 square miles of marine habitat. Based on the natural history of the Southern Residents and their habitat needs, NMFS identified three PBFs, or physical or biological features, essential for the conservation of Southern Residents: 1) Water quality to support growth and development; 2) prey species of sufficient quantity, quality, and availability to support individual growth, reproduction and development, as well as overall population growth; and 3) passage conditions to allow for migration, resting, and foraging Water quality in Puget Sound, in general, is degraded. On September 19, 2019 NMFS proposed to revise the critical habitat designation for the SRKW DPS under the ESA by designating six new areas along the U.S. West Coast (84 FR 49214). Specific new areas proposed along the U.S. West Coast include 15,626.6 square miles (mi\2\) (40,472.7 square kilometers (km\2\)) of marine waters between the 6.1-meter (m) (20 feet (ft)) depth contour and the 200-m (656.2 ft) depth contour from the U.S. international border with Canada south to Point Sur, California. The proposed rule to revise critical habitat designation was based on new information about the SRKW's habitat use along the coast.

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). For the purposes of this opinion, the action area includes all river reaches accessible to listed Chinook salmon, steelhead, chum salmon, and eulachon in sub-basins of the Puget Sound. Additionally, the action area includes some marine waters off the West Coast of the contiguous United States, including Puget Sound nearshore waters, that are accessible to listed Chinook salmon, steelhead, chum salmon, and eulachon.

In most cases, the proposed research activities would take place in individually very small sites. For example, the researchers might electrofish a few hundred feet of river, deploy a beach seine covering only a few hundred square feet of stream, or operate a screw trap in a few tens of square feet of habitat. Many of the proposed research activities would take place in designated critical habitat. More detailed habitat information (i.e., migration barriers, physical and biological habitat features, and special management considerations) for species considered in this opinion may be found in the Federal Register notices designating critical habitat (Table 4). As noted earlier, the proposed actions could affect the killer whales' prey base (Chinook salmon) and those effects are described in the Not Likely to Adversely Affect section (2.11).

2.4 Environmental Baseline

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

The environmental baseline for this opinion is therefore the result of the impacts that many activities (summarized below and in the species' status sections) have had on the various listed species' survival and recovery. In many cases, the action area under consideration covers individual animals that could come from anywhere in the various listed species' entire ranges (see Section 2.3). As a result, the effects of these past activities on the species themselves (that is, effects on abundance, productivity, etc.) cannot be tied to any particular population and are therefore displayed individually in the species status section summaries above (see Section 2.2).

Thus, for some of the work being contemplated here, the impacts that previous Federal, state, and private activities in the action area have had on the species are indistinguishable from those effects summarized below and in the previous section on the species' rangewide status. The same is true with respect to the species' habitat: for much of the contemplated work, the environmental baseline is the result of these activities' rangewide effects on the PBFs that are essential to the conservation of the species.

2.4.1 Summary for all Listed Species

2.4.1.1 Factors Limiting Recovery

The best scientific information presently available demonstrates that a multitude of factors, past and present, have contributed to the decline of west coast salmonids. NMFS' status reviews, Technical Recovery Team publications, and recovery plans for the listed species considered in this opinion identify several factors that have caused them to decline, as well as those that prevent them from recovering (many of which are the same). Very generally, these include harvest and hatchery practices and habitat degradation and curtailment caused by human development and resource extraction. NMFS' decision to list the species identified a variety of factors that were limiting their recovery. None of these documents identifies scientific research as either a cause for decline or a factor preventing their recovery. See Table 2 for summaries of the major factors limiting recovery of the listed species and how various factors have degraded PBFs and harmed listed species considered in this opinion. Also, please see section 2.2 for information regarding how climate change has affected and is affecting species and habitat in the action areas. Climate change was not generally considered a relevant factor when the species were listed and the critical habitat designated, but it is now.

As a general matter, all the species considered in this opinion have at least some biological requirements that are not being met in the action areas. The listed species are still experiencing the impact of a variety of past and ongoing Federal, state, and private activities in the action areas and that impact is expressed in the limiting factors described above and in the species status sections—all of which, in combination, are currently keeping the species from recovering and actively preventing them from having all their biological requirement met in the action area.

For detailed information on how various factors have degraded PBFs and harmed listed species, please see the references listed in the species and critical habitat status sections.

2.4.1.2 Research Effects

Although not identified as a factor for decline or a threat preventing recovery, scientific research and monitoring activities have the potential to affect the species' survival and recovery by killing listed salmonids—whether intentionally or not. For the year 2022, NMFS has issued numerous research section 10(a)(1)(A) scientific research permits allowing listed species to be taken and sometimes killed. NMFS has also issued numerous authorizations for state and tribal scientific research programs under ESA section 4(d). Table 5 displays the total take for the ongoing research authorized under ESA sections 4(d) and 10(a)(1)(A).

Table 5. Total authorized take of the ESA listed species for scientific research and monitoring already approved for 2022 *Not including* the research covered in this Biological Opinion.

Species	Life Stage	Origin	Authorized Handling Take	Authorized Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Puget Sound Chinook salmon	Adult	Natural	519	23	2.221	0.098
		Listed Hatchery	870	33	3.745	0.142
	Juvenile	Natural	353,644	7,445	9.486	0.200
		Listed Hatchery	271,502	12,239	0.788	0.036
Puget Sound steelhead	Adult	Natural	1,908	39	9.831	0.222
		Listed Hatchery	40	5		
	Juvenile	Natural	43,695	831	1.939	0.037
		Listed Hatchery	7,330	134	2.680	0.049
Hood Canal summer-run chum salmon	Adult	Natural	1,168	18	4.154	0.064
	Juvenile	Natural	572,875	2,370	13.508	0.056
		Listed Hatchery	255	37	0.170	0.025
Southern DPS eulachon	Adult	Natural	27,680	25,455	0.119	0.110
	Subadult	Natural	1,030	1,030		
	Juvenile	Natural	190	106		

Actual take levels associated with these activities are almost certain to be a substantially lower than the permitted levels. There are three reasons for this. First, most researchers do not handle the full number of juveniles or adults they are allowed. That is, for the vast majority of scientific research permits, history has shown that researchers generally take far fewer salmonids than the allotted number of salmonids every year. For example, 20.45% of requested take and 14.74% of requested mortalities were used in ID, OR, and WA Section 10a1A permits from 2008 to 2017. Second, we purposefully inflate our take and mortality estimates for each proposed study to account for the effects of potential accidental deaths. Therefore, it is very likely that far fewer fish—especially juveniles—would be killed under any given research project than the researchers are permitted. Third, for salmonids, many of the fish that may be affected would be in the smolt stage, but others would be yearlings, parr, or even fry. These are all simply be described as "juveniles," and treated as if they were smolts even though a great many of them would be from life stages represented by multiple spawning years and containing more individuals than reach the smolt stage—perhaps as much as an order of magnitude more. Therefore, the estimates of percentages of ESUs/DPSs taken were derived by (a) conservatively estimating the actual number of juveniles, (b) overestimating the number of fish likely to be killed, and (c) treating each dead juvenile fish as part of the same year class. Thus, the actual numbers of juvenile salmonids the research is likely to kill are undoubtedly smaller than the stated figures—probably something on the order of one seventh of the values given in Table 5.

2.5 Effects of the Proposed Action on the Species and Their Designated Critical Habitat

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. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (see 50 CFR 402.17). In our analysis, which describes the effects of the proposed action, we considered 50 CFR 402.17(a) and (b).

2.5.1 Effects on Critical Habitat

In general, the permitted activities would be (1) electrofishing, (2) capturing fish with angling equipment, traps, and nets of various types, (3) collecting biological samples from live fish, and (4) collecting fish for biological sampling. All of these techniques are minimally intrusive in terms of their effect on habitat because they would involve very little, if any, disturbance of streambeds or adjacent riparian zones. Some fish collection activities involve bottom trawls in marine or estuarine environments which may temporarily disturb substrate, displace benthic invertebrate prey, and increase turbidity just above the water surface. However, such trawl actions affect small spatial areas of habitat and are brief in duration, so these effects are expected to be ephemeral and attenuate rapidly. Therefore, none of the activities analyzed in this Opinion will measurably affect any habitat PBF function or value described earlier (see section 2.2.2).

2.5.2 Effects on the Species

As discussed above, the proposed research activities would not measurably affect any of the listed species' habitat. The actions are therefore not likely to measurably affect any of the listed species by reducing that habitat's ability to contribute to their survival and recovery.

The primary effect of the proposed research will be on the listed species in the form of capturing and handling the fish. Harassment caused by capturing, handling, and releasing fish generally leads to stress and other sub-lethal effects that are difficult to assess in terms of their impact on individuals, let alone entire species.

The following subsections describe the types of activities being proposed. Each is described in terms broad enough to apply to all the permits. The activities would be carried out by trained professionals using established protocols. The effects of the activities are well documented and discussed in detail below. No researcher would receive a permit unless the activities (e.g., electrofishing) incorporate NMFS' uniform, pre-established set of mitigation measures. These measures are described in Section 1.3 of this opinion. They are incorporated (where relevant) into every permit as part of the conditions to which a researcher must adhere.

Capture/handling

The primary effect of the proposed research on the listed species would be in the form of capturing and handling fish. We discuss effects from handling fish, and the general effects of capture using seines and traps here. The effects from other capture methods are discussed in more detail in the subsections below.

Capturing, handling, and releasing fish generally leads to stress and other sub-lethal effects that are difficult to assess in terms of their impact on individuals, populations, and species (Sharpe et al. 1998). Handling fish may cause stress, injury, or death, which typically are due to overdoses of anesthetic, differences in water temperatures between the river and holding buckets, depleted dissolved oxygen in holding buckets, holding fish out of the water, and physical trauma. Stress on salmonids increases rapidly from handling if the water temperature exceeds 18ºC or dissolved oxygen is below saturation. Fish transferred to holding buckets can experience trauma if care is not taken in the transfer process, and fish can experience stress and injury from overcrowding in traps, nets, and buckets. Decreased survival of fish can result when stress levels are high because stress can be immediately debilitating and may also increase the potential for vulnerability to subsequent challenges (Sharpe et al. 1998). The permit conditions identified in Section 1.3 contain measures that mitigate factors that commonly lead to stress and trauma from handling, and thus minimize the harmful effects of capturing and handling fish. When these measures are followed, fish typically recover rapidly from handling.

Electrofishing

Electrofishing is a process by which an electrical current is passed through water containing fish in order to stun them, which makes them easy to capture. It can cause a suite of effects ranging from disturbing the fish to killing them. The percentage of fish that are unintentionally killed by electrofishing varies widely depending on the equipment used, the settings on the equipment, and the expertise of the technician (Sharber and Carothers 1988, McMichael 1993, Dalbey et al. 1996; Dwyer and White 1997). Research indicates that using continuous direct current (DC) or low-frequency (30 Hz) pulsed DC waveforms produce lower spinal injury rates, particularly for salmonids (Fredenberg 1992, McMichael 1993, Sharber et al. 1994, Snyder 1995).

Most studies on the effects of electrofishing on fish have been conducted on adult fish greater than 300 mm in length (Dalbey et al. 1996). Electrofishing can have severe effects on adult salmonids. Adult salmonids can be injured or killed due to spinal injuries that can result from forced muscle contractions. Sharber and Carothers (1988) reported that electrofishing killed 50 percent of the adult rainbow trout in their study.

Spinal injury rates are substantially lower for juvenile fish than for adults. Smaller fish are subjected to a lower voltage gradient than larger fish (Sharber and Carothers 1988) and may, therefore, be subject to lower injury rates (e.g., Hollender and Carline 1994, Dalbey et al. 1996, Thompson et al. 1997). McMichael et al. (1998) reported a 5.1% injury rate for juvenile Middle Columbia River steelhead captured by electrofishing in the Yakima River subbasin.

When using appropriate electrofishing protocols and equipment settings, shocked fish normally revive quickly. Studies on the long-term effects of electrofishing indicate that even with spinal injuries, salmonids can survive long-term; however, severely injured fish may have stunted growth (Dalbey et al. 1996, Ainslie et al. 1998).

Permit conditions would require that all researchers follow NMFS' electrofishing guidelines (NMFS 2000). The guidelines require that field crews:

- Use electrofishing only when other survey methods are not feasible.
- Be trained by qualified personnel in equipment handling, settings, maintenance to ensure proper operating condition, and safety.
- Conduct visual searches prior to electrofishing on each date and avoid electrofishing near adults or redds. If an adult or a redd is detected, researchers must stop electrofishing at the research site and conduct careful reconnaissance surveys prior to electrofishing at additional sites.
- Test water conductivity and keep voltage, pulse width, and rate at minimal effective levels. Use only DC waveforms.
- Work in teams of two or more technicians to increase both the number of fish seen at one time and the ability to identify larger fish without having to net them. Working in teams allows netter(s) to remove fish quickly from the electrical field and to net fish farther from the anode, where the risk of injury is lower.
- Observe fish for signs of stress and adjust electrofishing equipment to minimize stress.
- Provide immediate and adequate care to any fish that does not revive immediately upon removal from the electrical current.

The preceding discussion focused on the effects of backpack electrofishing and the ways those effects would be mitigated. In larger streams and rivers, electrofishing units are sometimes mounted on boats or rafts. These units often use more current than backpack electrofishing equipment because they need to cover larger and deeper areas. The environmental conditions in larger, more turbid streams can limit researchers' ability to minimize impacts on fish. As a result, boat electrofishing can have a greater impact on fish.

Gastric Lavage

Knowledge of the food and feeding habits of fish are important in the study of aquatic ecosystems. However, in the past, food habit studies required researchers to kill fish for stomach removal and examination. Consequently, several methods have been developed to remove stomach contents without injuring the fish. Most techniques use a rigid or semi-rigid tube to inject water into the stomach to flush out the contents.

Few assessments have been conducted regarding the mortality rates associated with nonlethal methods of examining fish stomach contents (Kamler and Pope 2001). However, Strange and Kennedy (1981) assessed the survival of salmonids subjected to stomach flushing and found no difference between stomach-flushed fish and control fish that were held for three to five days. In addition, when Light et al. (1983) flushed the stomachs of electrofished and anesthetized brook trout, survival was 100% for the entire observation period. In contrast, Meehan and Miller (1978) determined the survival rate of electrofished, anesthetized, and stomach-flushed wild and hatchery coho salmon over a 30-day period to be 87% and 84% respectively.

Hook and Line/Angling

Fish caught with hook and line and released alive may still die due to injuries and stress they experience during capture and handling. Angling-related mortality rates vary depending on the type of hook (barbed vs barbless), the type of bait (natural vs artificial), water temperature, anatomical hooking location, species, and the care with which fish are handled and released (level of air exposure and length of time for hook removal).

The available information assessing hook and release mortality of adult steelhead suggests that hook and release mortality with barbless hooks and artificial bait is low. Nelson et al. (2005) reported an average mortality of 3.6% for adult steelhead that were captured using barbless hooks and radio tagged in the Chilliwack River, BC. The authors also note that there was likely some tag loss and the actual mortality might be lower. Hooton (1987) found catch and release mortality of adult winter steelhead to average 3.4% (127 mortalities of 3,715 steelhead caught) when using barbed and barbless hooks, bait, and artificial lures. Among 336 steelhead captured on various combinations of popular terminal gear in the Keogh River, the mortality of the combined sample was 5.1%. Natural bait had slightly higher mortality (5.6%) than did artificial lures (3.8%), and barbed hooks (7.3%) had higher mortality than barbless hooks (2.9%). Hooton (1987) concluded that catching and releasing adult steelhead was an effective mechanism for maintaining angling opportunity without negatively affecting stock recruitment. Reingold (1975) showed that adult steelhead hooked, played to exhaustion, and then released returned to their target spawning stream at the same rate as steelhead not hooked and played to exhaustion. Pettit (1977) found that egg viability of hatchery steelhead was not negatively affected by catch-and-release of pre-spawning adult female steelhead. Bruesewitz (1995) found, on average, fewer than 13% of harvested summer and winter steelhead in Washington streams were hooked in critical areas (tongue, esophagus, gills, eye). The highest percentage (17.8%) of critical area hookings occurred when using bait and treble hooks in winter steelhead fisheries.

The referenced studies were conducted when water temperatures were relatively cool, and primarily involve winter-run steelhead. Catch and release mortality of steelhead is likely to be higher if the activity occurs during warm water conditions. In a study conducted on the catch and release mortality of steelhead in a California river, Taylor and Barnhart (1999) reported over 80% of the observed mortalities occurred at stream temperatures greater than 21 degrees C. Catch and release mortality during periods of elevated water temperature are likely to result in post-release mortality rates greater than reported by Nelson et al. (2005) or Hooton (1987) because of warmer water and that fact that summer fish have an extended freshwater residence that makes them more likely to be caught. As a result, NOAA Fisheries expects steelhead hook and release mortality to be in the lower range discussed above.

Juvenile steelhead occupy many waters that are also occupied by resident trout species and it is not possible to visually separate juvenile steelhead from similarly-sized, stream-resident, rainbow trout. Because juvenile steelhead and stream-resident rainbow trout are the same species, are similar in size, and have the same food habits and habitat preferences, it is reasonable to assume that catch-and-release mortality studies on stream-resident trout are similar for juvenile steelhead. Where angling for trout is permitted, catch-and-release fishing with prohibition of use of bait reduces juvenile steelhead mortality more than any other angling regulatory change. Artificial lures or flies tend to superficially hook fish, allowing expedited hook removal with minimal opportunity for damage to vital organs or tissue (Muoneke and Childress, 1994). Many studies have shown trout mortality to be higher when using bait than when angling with artificial lures and/or flies (Wydoski 1977; Mongillo 1984; Taylor and White 1992; Muoneke and Childress 1994; Schill and Scarpella 1995; Schisler and Bergersen 1996). Wydoski (1977) showed the average mortality of trout, when using bait, to be more than four times greater than the mortality associated with using artificial lures and flies. Taylor and White (1992) showed average mortality of trout to be 31.4% when using bait versus 4.9 and 3.8% for lures and flies, respectively. Schisler and Bergersen (1996) reported average mortality of trout caught on passively fished bait to be higher (32%) than mortality from actively fished bait (21%). Mortality of fish caught on artificial flies was only 3.9%. In the compendium of studies reviewed by Mongillo (1984), mortality of trout caught and released using artificial lures and single barbless hooks was often reported at less than 2%.

Most studies have found a notable difference in the mortality of fish associated with using barbed versus barbless hooks (Wydoski 1977; Mongillo 1984; Taylor and White 1992; Bartholomew and Bohnsack 2005; Huhn and Arlinghaus 2011). Researchers have generally concluded that barbless hooks result in less tissue damage, they are easier to remove, and because they are easier to remove the handling time is shorter. In summary, catch-and-release mortality of steelhead is generally lowest when researchers are restricted to use of artificial flies and lures. As a result, all steelhead sampling via angling must be carried out using barbless artificial flies and lures.

Only a few reports are available that provide empirical evidence showing what the catch and release mortality is for Chinook salmon in freshwater. The ODFW has conducted studies of hooking mortality incidental to the recreational fishery for Chinook salmon in the Willamette River. A study of the recreational fishery estimates a per-capture hook-and-release mortality for wild spring Chinook salmon in Willamette River fisheries of 8.6% (Schroeder et al. 2000), which is similar to a mortality of 7.6% reported by Bendock and Alexandersdottir (1993) in the Kenai River, Alaska.

A second study on hooking mortality in the Willamette River, Oregon, involved a carefully controlled experimental fishery, and mortality was estimated at 12.2% (Lindsay et al. 2004). In hooking mortality studies, hooking location, gear type, and unhook time is important in determining the mortality of released fish. Fish hooked in the jaw or tongue suffered lower mortality (2.3 and 17.8% in Lindsay et al. (2004)) compared to fish hooked in the gills or esophagus (81.6 and 67.3%). Numerous studies have reported that deep hooking is more likely to result from using bait (e.g. eggs, prawns, or ghost shrimp) than lures (Lindsay et al. 2004). One theory is that bait tends to be passively fished and the fish is more likely to swallow bait than a lure. Passive angling techniques (e.g. drift fishing) are often associated with higher hooking mortality rates for salmon while active angling techniques (e.g. trolling) are often associated with lower hooking mortality rates (Cox-Rogers et al. 1999).

Catch and release fishing does not seem to have an effect on migration. Lindsay et al. (2004) noted that "hooked fish were recaptured at various sites at about the same frequency as control fish". Bendock and Alexandersdottir (1993) found that most of their tagged fish later turned up on the spawning grounds. Cowen et al. (2007) found little evidence of an adverse effect on spawning success for Chinook salmon.

Not all of the fish that are hooked are subsequently landed. We were unable to find any studies that measured the effect of hooking and losing a fish. However, it is reasonable to assume that non-landed morality would be negligible, as fish lost off the hook are unlikely to be deeply hooked and would have little or no wound and bleeding (Cowen et al. 2007).

Based on the available data, the *U.S. v. Oregon* Technical Advisory Committee has adopted a 10% rate in order to make conservative estimates of incidental mortality in fisheries (TAC 2008). Nonetheless, given the fact that no ESA section 10 permit or 4(d) authorization may "operate to the disadvantage of the species," we allow no more than a three percent mortality rate for any listed species collected via angling, and all such activities must employ barbless artificial lures and flies.

Observation

For some parts of the proposed studies, listed fish would be observed but not captured (e.g., by snorkel surveys or from the banks). Observation without handling is the least disruptive method for determining a species' presence/absence and estimating their relative numbers. Its effects are also generally the shortest-lived and least harmful of the research activities discussed in this section because a cautious observer can effectively obtain data while only slightly disrupting the fishes' behavior. Fry and juveniles frightened by the turbulence and sound created by observers are likely to seek temporary refuge in deeper water or behind or under rocks or vegetation. In extreme cases, some individuals may leave a particular pool or habitat type and then return when observers leave the area. At times, the research involves observing adult fish—which are more sensitive to disturbance. During some of the research activities discussed below, redds may be visually inspected, but per NMFS' pre-established mitigation measures (included in state fisheries agency submittals), would not be walked on. Harassment is the primary form of take associated with these observation activities, and few if any injuries (and no deaths) are expected to occur—particularly in cases where the researchers observe from the stream banks rather than in the water. Because these effects are so small, there is little a researcher can do to mitigate them except to avoid disturbing sediments, gravels, and, to the extent possible, the fish themselves, and allow any disturbed fish the time they need to reach cover.

Sacrifice (Intentionally Killing)

In some instances, it is necessary to kill a captured fish in order to gather whatever data a study is designed to produce. In such cases, determining effect is a very straightforward process: the sacrificed fish, if they are juveniles, are forever removed from the gene pool and the effect of their deaths is weighed in the context that the effect on their listed unit and, where possible, their local population. If the fish are adults, the effect depends upon whether they are killed before or after they have a chance to spawn. If they are killed after they spawn, there is very little overall effect. Essentially, it amounts to removing the nutrients their bodies would have provided to the spawning grounds. If they are killed before they spawn, not only are they removed from the population, but so are all their potential progeny. Thus, killing pre-spawned adults has the greatest potential to affect the listed species. Because of this, NMFS only very rarely allows pre-spawned adults to be sacrificed. And, in almost every instance where it is allowed, the adults are stripped of sperm and eggs so their progeny can be raised in a controlled environment such as a hatchery—thereby greatly decreasing the potential harm posed by sacrificing the adults. As a general rule, adults are not sacrificed for scientific purposes and no such activity is considered in this opinion.

Screw trapping

Smolt, rotary screw (and other out-migration) traps, are generally used to obtain information on natural population abundance and productivity. On average, they achieve a sample efficiency of four to 20% of the emigrating population from a river or stream--depending on river size. Although, under some conditions traps may achieve a higher efficiency for a relatively short period of time. Based on years of sampling at hundreds of locations under hundreds of scientific research authorizations, we would expect the mortality rates for fish captured at rotary screw type traps to be one percent or less.

The trapping, capturing, or collecting and handling of juvenile fish using traps is likely to cause some stress on listed fish. However, fish typically recover rapidly from handling procedures. The primary factors that contribute to stress and mortality from handling are excessive doses of anesthetic, differences in water temperature, dissolved oxygen conditions, the amount of time that fish are held out of water, and physical trauma. Stress on salmonids increases rapidly from handling if the water temperature exceeds 64.4 degrees F (18 degrees C) or if dissolved oxygen is below saturation. Additionally, stress can occur if there are more than a few degrees difference in water temperature between the stream/river and the holding tank.

The potential for unexpected injuries or mortalities among listed fish is reduced in a number of ways. In general, screw traps are checked at least daily and usually fish are handled in the morning. This ensures that the water temperature is at its daily minimum when fish are handled. Also, fish may not be handled if the water temperature exceeds 69.8 degrees Fahrenheit (21 degrees C). Great care must be taken when transferring fish from the trap to holding areas and the most benign methods available are used—often this means using sanctuary nets when transferring fish to holding containers to avoid potential injuries. The investigators' hands must be wet before and during fish handling. Appropriate anesthetics must be used to calm fish subjected to collection of biological data. Captured fish must be allowed to fully recover before being released back into the stream and will be released only in slow water areas. And often, additional criteria are applied on a case-by case basis: safety protocols vary by river velocity and trap placement, the number of times the traps are checked varies by water and air temperatures, the number of people working at a given site varies by the number of outmigrants expected, etc. All of these protocols are used to make sure the mortality rates stay at one percent or lower.

Tangle Netting

Tangle nets are similar to gillnets, having a top net with floats and a bottom net with weights, but tangle nets have smaller mesh sizes than gill nets. Tangle nets are designed to capture fish by the snout or jaw, rather than the gills. Researchers must select the mesh size carefully depending on their target species, since a tangle net may act as a gill net for fish that are smaller than the target size.

Tangle nets can efficiently capture salmonids in large rivers and estuaries, and have been used successfully for the lower Columbia River spring Chinook salmon commercial fishery (Vander Haegen et al. 2004). However, fish may be injured or die if they become physiologically exhausted in the net or if they sustain injuries such as abrasion or fin damage. Entanglement in nets can damage the protective slime layer, making fish more susceptible to infections. These injuries can result in immediate or delayed mortality. Vander Haegen et al. (2005) reported that spring Chinook salmon had lower delayed mortality rates when captured in tangle nets (92% survival) versus gill nets (50% survival), relative to a control group. Vander Haegen et al. (2005) emphasized that, to minimize both immediate and delayed mortality, researchers must employ best practices including using short nets with short soak times, and removing fish from the net carefully and promptly after capture. As with other types of capture, fish stress increases rapidly if the water temperature exceeds 18 ºC or dissolved oxygen is below saturation.

Tagging/Marking

Techniques such as Passive Integrated Transponder (PIT) tagging, coded wire tagging, fin-clipping, and the use of radio transmitters are common to many scientific research efforts using listed species. All sampling, handling, and tagging procedures have an inherent potential to stress, injure, or even kill the marked fish. This section discusses each of the marking processes and its associated risks.

A PIT tag is an electronic device that relays signals to a radio receiver; it allows salmonids to be identified whenever they pass a location containing such a receiver (e.g., any of several dams) without researchers having to handle the fish again. The tag is inserted into the body cavity of the fish just in front of the pelvic girdle. The tagging procedure requires that the fish be captured and extensively handled; therefore, any researchers engaged in such activities will follow the conditions listed previously in this Opinion (as well as any permit-specific conditions) to ensure that the operations take place in the safest possible manner. In general, the tagging operations will take place where there is cold water of high quality, a carefully controlled environment for administering anesthesia, sanitary conditions, quality control checking, and a carefully regulated holding environment where the fish can be allowed to recover from the operation.

PIT tags have very little effect on growth, mortality, or behavior. The few reported studies of PIT tags have shown no effect on growth or survival (Prentice et al. 1987; Jenkins and Smith 1990; Prentice et al. 1990). For example, in a study between the tailraces of Lower Granite and McNary Dams (225 km), Hockersmith et al. (2000) concluded that the performance of yearling Chinook salmon was not adversely affected by gastrically- or surgically-implanted sham radio tags or PIT-tags. Additional studies have shown that growth rates among PIT-tagged Snake River juvenile fall Chinook salmon in 1992 (Rondorf and Miller 1994) were similar to growth rates for salmon that were not tagged (Conner et al. 2001). Prentice and Park (1984) also found that PIT-tagging did not substantially affect survival in juvenile salmonids.

Coded wire tags (CWTs) are made of magnetized, stainless-steel wire. They bear distinctive notches that can be coded for such data as species, brood year, hatchery of origin, and so forth (Nielsen 1992). The tags are intended to remain within the animal indefinitely, consequently making them ideal for long-term, population-level assessments of Pacific Northwest salmon. The tag is injected into the nasal cartilage of a salmon and therefore causes little direct tissue damage (Bergman et al. 1968; Bordner et al. 1990). The conditions under which CWTs may be inserted are similar to those required for applying PIT-tags.

A major advantage to using CWTs is the fact that they have a negligible effect on the biological condition or response of tagged salmon; however, if the tag is placed too deeply in the snout of a fish, it may kill the fish, reduce its growth, or damage olfactory tissue (Fletcher et al. 1987; Peltz and Miller 1990). This latter effect can create problems for species like salmon because they use olfactory clues to guide their spawning migrations (Morrison and Zajac 1987).

In order for researchers to be able to determine later (after the initial tagging) which fish possess CWTs, it is necessary to mark the fish externally—usually by clipping the adipose fin—when the CWT is implanted (see text below for information on fin clipping). One major disadvantage to recovering data from CWTs is that the fish must be killed in order for the tag to be removed. However, this is not a significant problem because researchers generally recover CWTs from salmon that have been taken during the course of commercial and recreational harvest (and are therefore already dead).

The other primary method for tagging fish is to implant them with acoustic tags, radio tags, or archival loggers. There are two main ways to accomplish this and they differ in both their characteristics and consequences. First, a tag can be inserted into a fish's stomach by pushing it past the esophagus with a plunger. Stomach insertion does not cause a wound and does not interfere with swimming. This technique is benign when salmon are in the portion of their spawning migrations during which they do not feed (Nielsen 1992). In addition, for short-term studies, stomach tags allow faster post-tagging recovery and interfere less with normal behavior than do tags attached in other ways.

The second method for implanting tags is to place them within the body cavities of (usually juvenile) salmonids. These tags do not interfere with feeding or movement. However, the tagging procedure is difficult, requiring considerable experience and care (Nielsen 1992). Because the tag is placed within the body cavity, it is possible to injure a fish's internal organs. Infections of the sutured incision and the body cavity itself are also possible, especially if the tag and incision are not treated with antibiotics (Chisholm and Hubert 1985; Mellas and Haynes 1985).

Fish with internal tags often die at higher rates than fish tagged by other means because tagging is a complicated and stressful process. Mortality is both acute (occurring during or soon after tagging) and delayed (occurring long after the fish have been released into the environment). Acute mortality is caused by trauma induced during capture, tagging, and release. It can be reduced by handling fish as gently as possible. Delayed mortality occurs if the tag or the tagging procedure harms the animal in direct or subtle ways. Tags may cause wounds that do not heal properly, may make swimming more difficult, or may make tagged animals more vulnerable to predation (Howe and Hoyt 1982; Matthews and Reavis 1990; Moring 1990). Tagging may also reduce fish growth by increasing the energetic costs of swimming and maintaining balance. As with the other forms of tagging and marking, researchers will keep the harm caused by tagging to a minimum by following the conditions in the permits as well as any other permit-specific requirements.

Tissue Sampling

Tissue sampling techniques such as fin-clipping are common to many scientific research efforts using listed species. All sampling, handling, and clipping procedures have an inherent potential to stress, injure, or even kill the fish. This section discusses tissue sampling processes and its associated risks.

Fin clipping is the process of removing part or all of one or more fins to obtain non-lethal tissue samples and alter a fish's appearance (and thus make it identifiable). When entire fins are removed, it is expected that they will never grow back. Alternatively, a permanent mark can be made when only a part of the fin is removed or the end of a fin or a few fin rays are clipped. Although researchers have used all fins for marking at one time or another, the current preference is to clip the adipose, pelvic, or pectoral fins. Marks can also be made by punching holes or cutting notches in fins, severing individual fin rays (Welch and Mills 1981), or removing single prominent fin rays (Kohlhorst 1979). Many studies have examined the effects of fin clips on fish growth, survival, and behavior. The results of these studies are somewhat varied; however, it can be said that fin clips do not generally alter fish growth. Studies comparing the growth of clipped and unclipped fish generally have shown no differences between them (e.g., Brynildson and Brynildson 1967). Moreover, wounds caused by fin clipping usually heal quickly—especially those caused by partial clips.

Mortality among fin-clipped fish is also variable. Some immediate mortality may occur during the marking process, especially if fish have been handled extensively for other purposes (e.g., stomach sampling). Delayed mortality depends, at least in part, on fish size; small fishes have often been found to be susceptible to it and Coble (1967) suggested that fish shorter than 90 mm are at particular risk. The degree of mortality among individual fishes also depends on which fin is clipped. Studies show that adipose- and pelvic-fin-clipped coho salmon fingerlings have a 100% recovery rate (Stolte 1973). Recovery rates are generally recognized as being higher for adipose- and pelvic-fin-clipped fish in comparison to those that are clipped on the pectoral, dorsal, and anal fins (Nicola and Cordone 1973). Clipping the adipose and pelvic fins probably kills fewer fish because these fins are not as important as other fins for movement or balance (McNeil and Crossman 1979). Mortality is generally higher when the major median and pectoral fins are clipped. Mears and Hatch (1976) showed that clipping more than one fin may increase delayed mortality, but other studies have been less conclusive.

Trawls

Trawls are cone-shaped, mesh nets that are towed, often, along benthic habitat (Hayes 1983, Hayes et al. 1996). Rectangular doors, attached to the towing cables, keep the mouth of the trawl open. Most trawls are towed behind a boat, but small trawls can be operated by hand. As fish enter the trawl, they tire and fall to the cod-end of the trawl. Mortality and injury rates associated with trawls can be high, particularly for small or fragile fish. Fish can be crushed by debris or other fish caught in the net. However, all of the trawling considered in this opinion is midwater trawling which may be less likely to capture heavy debris loads than benthic or demersal trawl sampling. Depending on mesh size, some small fish are able to escape the trawl through the netting. However, not all fish that escape the trawl are uninjured, as fish may be damaged while passing through the netting. Short duration trawl hauls (5 to 10 minutes maximum) may reduce injuries (Hayes 1983, Hayes et al. 1996).

Weirs

Capture of adult salmonids by weirs is common practice in order to collect information; (1) enumerate adult salmon and steelhead entering the watershed; (2) determine the run timing of adult salmon and steelhead entering the watershed; (3) estimate the age, sex, and length composition of the salmon escapement into the watershed; and (4) used to determine the genetic composition of fish passing through the weir (i.e., hatchery versus natural). Information pertaining to the run size, timing, age, sex, and genetic composition of salmon and steelhead returning to the respective watershed will provide managers valuable information to refine existing management strategies.

Some weirs have a trap to capture fish, while other weirs have a video or DIDSON sonar to record fish migrating through the weir. Weirs with or without a trap, have the potential to delay migration. All weir projects will adhere to the draft NMFS West Coast Region Weir Guidelines and include detailed descriptions of the weirs. The Weir Guidelines require the following: (1) traps must be checked and emptied daily, (2) all weirs including video and DIDSON sonar weirs must be inspected and cleaned of any debris daily, (3) the development and implementation of monitoring plans to assess passage delay, and (4) a development and implementation of a weir operating plan. These guidelines are intended to help improve fish weir design and operation in ways which will limit fish passage delays and increase weir efficiency.

2.5.3 Effects on the Species' Biological Requirements

To assess the Tribal Plan's impact on the listed species' biological requirements, we compare the total annual proposed take (Table 6) to the estimated annual abundance of adult and juvenile listed salmonids and eulachon (Table 3 and section 2.2.1), and assume the estimated take remains constant over the 5-year Tribal Plan period. The analysis process relies on multiple sources of data. In Section 2.2.1 (Status of the Species), we estimated the average annual abundance for the species considered in this document. For most of the listed species, we estimated abundance for adult returning fish and outmigrating smolts. These data come from estimates compiled by our Science Centers for the species status reviews, which are updated every five years. Additional data sources include state agencies (e.g., WDFW), county and local agencies, and educational and non-profit institutions. These sources are vetted for scientific accuracy before their use. For hatchery propagated juvenile salmonids, we use hatchery production goals. Table 3 displays the estimated annual abundance of hatchery-propagated and naturally produced listed fish.

Since there are no measurable habitat effects, the analysis will consist primarily of examining directly measurable impacts on abundance. Abundance effects are themselves relevant to extinction risk, are directly related to productivity effects, and are somewhat but less directly to structure and diversity effects. The effect of the action is measured in terms of its impact on the relevant species' total abundance by origin (Natural) and production (hatchery-propagated).

Table 6. Summary of total annual proposed take for all research projects included in the Tribal Plan

Species	Life Stage	Origin	Take Action	Requested Handling Take	Requested Lethal Take
Puget Sound Chinook salmon	Adult	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	194	6
		Listed Hatchery	Capture/Handle/Release Animal	20	1
		Listed Hatchery	Capture/Mark, Tag, Sample Tissue/Release Live Animal	276	15
	Juvenile	Natural	Capture/Handle/Release Animal	45,700	259
		Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	102,125	1,089
		Natural	Intentional (Directed) Mortality	1,560	1,560
		Listed Hatchery	Capture/Handle/Release Animal	73,925	688
		Listed Hatchery	Capture/Mark, Tag, Sample Tissue/Release Live Animal	83,985	974
		Listed Hatchery	Intentional (Directed) Mortality	2,365	2,365
Puget Sound steelhead	Adult	Natural	Capture/Handle/Release Animal	4	0
		Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	290	4
	Juvenile	Natural	Capture/Handle/Release Animal	6,307	104
		Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	34,480	446
		Natural	Intentional (Directed) Mortality	50	50

		Listed Hatchery	Capture/Handle/Release Animal	85	3
		Listed Hatchery	Capture/Mark, Tag, Sample Tissue/Release Live Animal	1,000	10
Hood Canal summer-run chum salmon	Adult	Natural	Capture/Handle/Release Animal	10	1
	Juvenile	Natural	Capture/Handle/Release Animal	1,850	23
		Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	100	1
Southern DPS eulachon	Adult	Natural	Capture/Handle/Release Animal	275	12

As previously discussed in Section 1.3 (Scope and Structure of analysis) although the Tribal Plan describes the 37 projects that are planned for 2022, all of these projects are multiple year projects that were active during 2021 and they are mostly expected to extend well beyond 2026. In addition, the proposed action also includes a 10% buffer added to the take and mortality requests for the 37 projects for all species, life stages, and production (Table 7).

Table 7. Total annual requested take and mortalities, plus the 10% buffer, compared to the estimated abundance

Species	Life Stage	Origin	Requested Take plus 10%	Requested Mortality plus 10%	Percent of ESU/DPS handled	Percent of ESU/DPS killed
Puget Sound Chinook salmon	Adult	Natural	213	7	0.913	0.028
		Listed Hatchery	326	18	1.402	0.076
	Juvenile	Natural	164,324	3,199	4.408	0.086
		Listed Hatchery	176,302	4,430	0.511	0.013
Puget Sound steelhead	Adult	Natural	323	4	1.632	0.022
	Juvenile	Natural	44,921	660	1.993	0.029
		Listed Hatchery	1,194	14	0.436	0.005
Hood Canal summer-run chum salmon	Adult	Natural	11	1	0.039	0.004
	Juvenile	Natural	2,145	26	0.051	<0.001
Southern DPS eulachon	Adult	Natural	302	13	0.001	<0.001

Abundance estimates for adult hatchery salmonids include marked and unmarked fish

2.5.3.1 Puget Sound Chinook Salmon

The specific projects and related take estimates are described in detail in the Tribal Plan (NWIFC 2022) and the 37 associated projects submitted on the NOAA APPS website. Those records are incorporated in full herein. Most of the captured juvenile fish would be variously marked, tagged, or tissue sampled and released, whereas most of the adult fish would be briefly handled and released. However, any fish handling carries an inherent potential for causing or promoting stress, disease, injury, or death of the specimen. We have summarized the total proposed take in Table 6.

Researchers, when submitting their applications, estimated the number of juvenile and adult PS Chinook salmon that may be handled and killed during the year. Additionally, as discussed in Section 1.3, to account for the dynamic and potentially increasing scope of research that may annually affect listed PS Chinook salmon, we increased the requested fish handling and lethal take numbers in this evaluation by 10%. Although it is difficult to anticipate how much more research may be requested, we believe this 10% buffer would be sufficient to include any changes or additions. Table 7 compares the total requested take, plus the 10% buffer, to the species' estimated abundance.

A few projects have requested to intentionally kill juvenile natural-origin PS Chinook salmon. The purposes of the lethal take are to analyze otoliths, pathogen presence, and tissue toxicology. Otolith analysis allows researchers to measure residence time in freshwater, migration in and out of the tidally-influenced estuary, and entry and residence in nearshore marine waters. This detailed life history provides essential information about survival rates of juvenile fish that utilize different habitat types and the carrying capacity of those habitats. Further, analyzing the chemical content of the otolith growth increments may provide even more information about the origin and life history of salmon. For pathogen and toxicology analysis, examination of the internal tissues of sacrificed salmon may help provide important information about the impact and presence of pathogens and toxins in the environment and their effect upon listed salmonids. The researchers will concentrate their lethal take on fish that appear to be stressed, likely to die, or are already dead at the time of capture. There is no request to intentionally kill adult PS Chinook salmon though some fish may die as an inadvertent result of these activities.

Because the majority of the fish that would be captured are expected to recover with no ill effects, the true effects of the proposed action are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, Table 7 compares the numbers of fish that may be killed to the total abundance numbers expected for the ESU. At the ESU level, the permitted activities may kill at most 0.068% of the natural-origin PS Chinook juveniles, 0.01% of the hatchery-origin juveniles, 0.019% of the natural-origin adults, and 0.057% hatchery-origin adults from this ESU. Therefore, the research would be a very small impact on the species' abundance, a likely similar impact on their productivity and, because the research would be spread out across all the ESU's populations, there would likely be no measurable effect on the species' spatial structure or diversity.

2.5.2.2 Puget Sound Steelhead

As with the effects on PS chinook described above, most of the captured juvenile steelhead would be variously marked, tagged, or tissue sampled and released, whereas most of the adult fish would be briefly handled and released. However, any fish handling carries an inherent potential for causing or promoting stress, disease, injury, or death of the specimen. We have summarized the total proposed take in Table 6. To account for the dynamic and potentially increasing scope of research that may annually affect listed PS steelhead, we increased the requested fish handling and lethal take numbers in this evaluation by 10% (Table 7).

One project has requested to intentionally kill juvenile natural-origin PS steelhead to analyze their otoliths and internal tissues. Otolith analysis allows researchers to measure residence time in freshwater, migration in and out of the tidally-influenced estuary, and entry and residence in nearshore marine waters. This detailed life history provides essential information about survival rates of juvenile fish that utilize different habitat types and the carrying capacity of those habitats. Further, analyzing the chemical content of the otolith growth increments may provide even more information about the origin and life history of salmon. There is no request to intentionally kill adult PS steelhead though some fish may die as an inadvertent result of these activities.

Because the majority of the fish that would be captured are expected to recover with no ill effects, the true effects of the proposed action are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, Table 7 compares the numbers of fish that may be killed to the total abundance numbers expected for the DPS. At the DPS level, the permitted activities may kill at most 0.029% of the natural-origin PS steelhead juveniles, 0.005% hatchery-origin juveniles and 0.022% adults from this DPS. Therefore, the research would be a very small impact on the species' abundance, a likely similar impact on their productivity and, because the research would be spread out across all the DPS's populations, there would likely be no measurable effect on the species' spatial structure or diversity.

2.5.3.3 Hood Canal Summer-Run Chum Salmon

The NWIFC would conduct, oversee, or coordinate four projects that could take listed HCS chum salmon. Most of the captured juvenile fish would be variously marked, tagged, or tissue sampled and released, whereas the adult fish would be briefly handled and released. However, any fish handling carries an inherent potential for causing or promoting stress, disease, injury, or death of the specimen. We have summarized the total proposed take in Table 6. Additionally, we increased the requested fish handling and lethal take numbers in this evaluation by 10% (Table 7). None of the projects have requested to intentionally kill juvenile or adult natural-origin HCS chum salmon though some fish may die as an inadvertent result of these activities.

Because the majority of the fish that would be captured are expected to recover with no ill effects, the true effects of the proposed action are best seen in the context of the fish that are likely to be killed (Table 7). At the ESU level, the permitted activities may kill < 0.001% of natural-origin HCS chum juveniles and 0.004% of natural-origin adults from this ESU. Therefore, the research would be a very small impact on the species' abundance, a likely similar impact on their productivity and, because the research would be spread out across all the ESU's populations, there would likely be no measurable effect on the species' spatial structure or diversity.

2.5.2.4 Southern Distinct Population Segment of Eulachon

The NWIFC would conduct, oversee, or coordinate three projects that could take adult listed Southern eulachon. Most of the fish would be briefly handled and released. However, any fish handling carries an inherent potential for causing or promoting stress, disease, injury, or death of the specimen. We have summarized the total proposed take in Table 6. Additionally, we increased the requested fish handling and lethal take numbers in this evaluation by 10% (Table 7).

None of the projects have requested to intentionally kill juvenile or adult natural-origin SDPS eulachon.

Because the majority of the fish that would be captured are expected to recover with no ill effects, the true effects of the proposed action are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, Table 7 compares the numbers of fish that may be killed to the total abundance numbers expected for the DPS. At the DPS level, the permitted activities may kill at most < 0.001% of adult Southern eulachon. Therefore, the research would be a very small impact on the species' abundance, a likely similar impact on their productivity and, because the research would be spread out across all the ESU's populations, there would likely be no measurable effect on the species' spatial structure or diversity.

2.6 Cumulative Effects

"Cumulative effects" are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02 and 402.17(a)). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Because the action area falls entirely within designated critical habitat or navigable marine waters, the vast majority of future actions in the region will undergo section 7 consultation with one or more of the Federal entities with regulatory jurisdiction over water quality, habitat management, flood management, navigation, or hydroelectric generation. In almost all instances, proponents of future actions will need government funding or authorization to carry out a project that may affect salmonids or Southern eulachon or their habitat, and therefore the effects such a project may have on listed species will be analyzed when the need arises.

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 species status/environmental baseline vs. cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the status section (Section 2.2).

In developing this biological opinion, we considered several efforts being made at the local, tribal, state, and national levels to conserve listed species—primarily final recovery plans and efforts laid out in the Status review updates for Pacific salmon and steelhead listed under the Endangered Species Act. The recovery plans, status summaries, and limiting factors that are part of the analysis of this Opinion are discussed in detail in Table 2 (Section 2.2.1).

The result of that review was that salmon take—particularly take associated with monitoring and habitat restoration—is likely to continue to increase in the region for the foreseeable future. However, as noted above, all actions falling in those categories would also have to undergo consultation (like that in this opinion) before they are allowed to proceed.

Future state, tribal, and local government actions will likely be in the form of legislation, administrative rules, or policy initiatives. Government and private actions may include changes in land and water uses, including ownership and intensity, any of which could impact listed species or their habitat. Government actions are subject to political, legislative, and fiscal uncertainties. These realities, added to the geographic scope of the action area, which encompasses numerous government entities exercising various authorities, make any analysis of cumulative effects difficult and speculative. For more information on the various efforts being made at the local, tribal, state, and national levels to conserve listed salmonids, see any of the recent viability assessments, listing Federal Register notices, and recovery planning documents (Table 2).

Thus, non-Federal activities are likely to continue affecting listed species and habitat within the action area. These cumulative effects in the action area are difficult to analyze because of this opinion's large geographic scope, the different resource authorities in the action area, the uncertainties associated with government and private actions, and the changing economies of the region. Whether these effects will increase or decrease is a matter of speculation; however, it seems likely that they will continue to increase as a general pattern over time. The primary cumulative effects will arise from those water quality and quantity impacts that occur as human population growth and development shift patterns of water and land use, thereby creating more intense pressure on streams and rivers within this geography in terms of volume, velocities, pollutants, baseflows, and peak flows. But the specifics of these effects, too, are impossible to predict at this time. In addition, there are the aforementioned effects of climate change—many of those will arise from or be exacerbated by actions taking place in the Pacific Northwest and elsewhere that will not undergo ESA consultation. Although many state, tribal, and local governments have developed plans and initiatives to benefit listed fish, they must be applied and sustained in a comprehensive way before NMFS can consider them "reasonably foreseeable" in its analysis of cumulative effects.

We can, however, make some generalizations based on population trends.

Puget Sound/Western Washington

Non-Federal actions are likely to continue affecting listed species. The cumulative effects in this portion of the action area are difficult to analyze because of this opinion's geographic scope, however, based on the trends identified in the baseline, the adverse cumulative effects are likely to increase. From 1960 through 2016, the population in Puget Sound has increased from 1.77 to 4.86 million people (Source: WA state Office of Financial Management homepage). During this population boom, urban land development has eliminated hydrologically mature forest and undisturbed soils resulting in significant change to stream channels (altered stream flow patterns, channel erosion) which eventually results in habitat simplification (Booth et al. 2002). Combining this population growth with over a century of resource extraction (logging, mining, etc.), Puget Sound's hydrology has been greatly changed and has created a different environment than what Puget Sound salmonids evolved in (Cuo et al. 2009). Scholz et al. (2011) has documented adult coho salmon mortality rates of 60-100% for the past decade in urban central Puget Sound streams that are high in metals and petroleum hydrocarbons especially after stormwater runoff. In addition, marine water quality factors (e.g. climate change, pollution) are likely to continue to be degraded by various human activities that will not undergo consultation. Although state, tribal, and local governments have developed plans and initiatives to benefit listed fish, they must be applied and sustained in a comprehensive way before NMFS can consider them "reasonably foreseeable" in its analysis of cumulative effects. Thus, the most likely cumulative effect is that the habitat in the action area is likely to continue to be degraded with respect to its ability to support the listed salmonids.

Therefore, the most likely cumulative effect is that the habitat in the action area is likely to continue to be degraded with respect to its ability to support the listed salmonids.

One final thing to consider when considering cumulative effects is the time period over which the activity would operate. The approval considered here would be good for a maximum of five years and the effects on listed species abundance they generate could continue for up to four years after that, though they would decrease in each succeeding year. We are unaware of any major non-Federal activity that could affect listed salmonids and is certain to occur in the action area during that timeframe.

2.7 Integration and Synthesis

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

Aside from the considerations listed above, these assessments are also made in consideration of the other research that has been authorized and that may affect the various listed species. The reasons we integrate the proposed take in the permits considered here with the take from previous (but ongoing) research authorizations are that they are similar in nature and we have good information on what the effects are, and thus it is possible to determine the overall effect of all research in the region on the species considered here. The following table therefore (a) combines the proposed take for the Tribal Plan considered in this opinion for all components of each species, (b) adds that take to the take that has already been authorized in the region and (c) compares those totals to the estimated annual abundance of each species under consideration (Table 8).

Table 8. Total expected take of the ESA listed species for scientific research and monitoring already approved for 2022 plus the research covered in this Biological Opinion.

Species	Life Stage	Origin	Requested Take plus the baseline	Requested Mortality plus the baseline	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Puget Sound Chinook salmon	Adult	Natural	677	27	2.898	0.117
		Listed Hatchery	1,086	46	4.673	0.199
	Juvenile	Natural	510,598	9,984	13.695	0.268
		Listed Hatchery	442,546	15,701	1.283	0.045
Puget Sound steelhead	Adult	Natural	2,231	43	11.464	0.244
		Listed Hatchery	40	5		
	Juvenile	Natural	88,506	1,489	3.927	0.066

Species	Life Stage	Origin	Requested Take plus the baseline	Requested Mortality plus the baseline	Percent of ESU/DPS taken	Percent of ESU/DPS killed
		Listed Hatchery	8,524	148	3.116	0.054
Hood Canal summer-run chum salmon	Adult	Natural	1,179	19	4.193	0.068
	Juvenile	Natural	575,020	2,396	13.559	0.057
		Listed Hatchery	255	37	0.17	0.024
Southern DPS eulachon	Adult	Natural	27,982	25,468	0.120	0.110
	Subadult	Natural	1,030	1,030		
	Juvenile	Natural	190	106		

As the table above illustrates, in all cases the dead fish from all of the permits in this opinion and all the previously authorized research would amount to a less than half a percent of each species' total abundance. In these instances, the total mortalities are so small and so spread out across each listed unit that they are unlikely to have any lasting detrimental effect on the species' numbers, reproduction, or distribution.

Salmonid Species

As Table 8 illustrate, the research—even in total—would have only very small effects on any species' abundance (and therefore productivity) and no discernible effect on structure or diversity because the effects would be attenuated across each entire species.

A few considerations apply generally to our analyses of the total take and mortalities that would be permitted for juveniles and adults of each of these species. First, the true numbers of fish that would actually be taken would most likely be smaller than the amounts authorized. As noted in the research effects section, the researchers generally request more take than they estimate will actually occur. It is therefore very likely that researchers will take fewer fish than estimated, and that the actual effect is likely to be lower than the numbers stated in the tables above. For example, of all the Section 10(a)(1)(A) and 4(d) research permits issued by the West Coast Region between 2017 and 2021, only 25.14% of requested take and 16.3% of requested mortalities actually occurred.

Second, effects on natural-origin components of each listed unit may be smaller than the values in the tables above because of how we ask researchers to report taken fish of unknown origin. In those instances where a non-clipped hatchery fish cannot be differentiated from a natural-origin fish, we ask that researchers err to the side of caution and treat all fish with intact adipose fins as if they were natural-origin fish. Therefore, in most cases, the natural-origin component would in actuality be affected to a lesser degree than the percentages displayed above. It is not possible to know *how* *much* smaller the take figures would be, but that they are smaller is not in doubt. The overall percentages for the listed unit would, however, remain at the same low levels shown.

In addition, the mortality rate for steelhead is undoubtedly less than that displayed due to the overlap between PS steelhead and resident trout species. The reason for this is that it is effectively certain that at least some of the fish that could be taken and counted as juvenile natural-origin steelhead would in fact be native, resident redband trout or other O. mykiss subspecies. Because it is extremely difficult to tell the difference between the juvenile steelhead and resident redband and other rainbow trout in the field, we ask that any captured fish that could come from a listed unit be counted as such. Thus, the actual lethal take rate would be less than described in Table 8.

Lastly, the research being conducted in the region adds critical knowledge about the species' status—knowledge that we are required to have every five years to perform status reviews for all listed species. So, in evaluating the impacts of the research program, any effects on abundance and productivity are weighed in light of the potential value of the information collected as a result of the research. Regardless of its relative magnitude, the negative effects associated with the research program on these species would to some extent be offset by gaining information that would be used to help the species survive and recover.

Eulachon

For listed eulachon, all the mortalities, even taken together, represent very a small fraction of the various species' abundance. Since no directed mortality is requested for the Tribal Plan (2022-2026) within this Opinion, it is important to remember that lethal take estimates exist only to account for potential accidental deaths.

For the listed Southern eulachon, the total amount of estimated lethal take for the proposed research would be three adult eulachon. This is the maximum amount of lethal take contemplated in this biological opinion; if the Tribal Plan (2022-2026) is authorized and exercised, a lesser amount of take is expected to actually occur. Overall, these numbers represent very small fractions of the abundances for eulachon (<0.0001%) (Table 7). For the vast majority of scientific research permits, history has shown that researchers generally take fewer eulachon than the allotted number of eulachon every year (1.66% of requested take and 1.7% of requested mortalities were used in the West Coast Region Section 10a1A and 4d research permits from 2017 to 2021).

Thus, we expect the research activities' detrimental effects on the species' abundance and productivity to be small—even in combination with all the rest of the research authorized in the basin. But even if in the worst case scenario all the fish authorized as mortalities were to be killed in actuality, this would represent only a small reduction in overall abundance and productivity, and because that slight impact would be distributed throughout the species' range, it would be so attenuated as to have no appreciable effect on spatial structure or diversity. And finally, regardless of its relative magnitude, all the negative effect associated with the research program on this species would to some extent be offset by gaining information that would be used to help the species survive and recover.

Critical Habitat

As previously discussed, we do not expect the individual actions to have any appreciable effect on any listed species' critical habitat. This is true for all the proposed permit actions in combination as well: the actions' short durations, minimal intrusion, and overall lack of measurable effect signify that even when taken together they would have no discernible impact on critical habitat.

Summary

As noted earlier, no listed species currently has all its biological requirements being met. Their status is such that there must be a substantial improvement in the environmental conditions of their habitat and other factors affecting their survival if they are to begin to approach recovery. In addition, while the future impacts of cumulative effects are uncertain at this time, they are likely to continue to be negative. Nonetheless, in no case would the proposed actions exacerbate any of the negative cumulative effects discussed (habitat alterations, etc.) and in all cases the research may eventually help to limit adverse effects by increasing our knowledge about the species' requirements, habitat use, and abundance. The effects of climate change are also likely to continue to be negative. However, given the proposed actions' short time frames and limited areas, those negative effects, while somewhat unpredictable, are too small to be effectively gauged as an additional increment of harm over the time span considered in this analysis. Moreover, the actions would in no way contribute to climate change (even locally) and, in any case, many of the proposed actions would actually help monitor the effects of climate change by noting stream temperatures, flows, etc. So while we can expect both cumulative effects and climate change to continue their negative trends, it is unlikely that the proposed actions would have any additive impact to the pathways by which those effects are realized (e.g., a slight reduction in salmonid abundance would have no effect on increasing stream temperatures or continuing land development).

To this picture, it is necessary to add the increment of effect represented by the proposed actions. Our analysis shows that the proposed research activities would have slight negative effects on each species' abundance and productivity, but those reductions are so small as to have no more than a very minor effect on the species' survival and recovery. In all cases, even the worst possible effect on abundance is expected to be minor compared to overall population abundance, the activity has never been identified as a threat, and the research is designed to benefit the species' survival in the long term.

For over two decades, research and monitoring activities conducted on listed fish in the Pacific Northwest have provided resource managers with a wealth of important and useful information regarding anadromous fish populations. For example, juvenile fish trapping efforts have enabled managers to produce population inventories, PIT-tagging efforts have increased our knowledge of anadromous fish abundance, migration timing, and survival, and fish passage studies have enhanced our understanding of how fish behave and survive when moving past dams and through reservoirs. By issuing research authorizations—including many of those being contemplated again in this opinion—NMFS has allowed information to be acquired that has enhanced resource managers' abilities to make more effective and responsible decisions with respect to sustaining anadromous salmonid populations, mitigating adverse impacts on endangered and threatened salmon and steelhead, and implementing recovery efforts. The resulting information continues to improve our knowledge of the respective species' life histories, specific biological requirements, genetic make-up, migration timing, responses to human activities (positive and negative), and survival in the rivers and ocean. And that information, as a whole, is critical to the species' survival.

Additionally, the information being generated is, to some extent, legally mandated. Though no law calls for the work being done in any particular permit or authorization, the ESA (section 4(c)(2)) requires that we examine the status of each listed species every five years and report on our findings. At that point, we must determine whether each listed species should (a) be removed from the list (b) have its status changed from threatened to endangered, or (c) have its status changed from endangered to threatened. As a result, it is legally incumbent upon us to monitor the status of every species considered here, and the research program, as a whole, is one of the primary means we have of doing that.

Thus, we expect the detrimental effects on the species to be minimal and those impacts would only be seen in terms of slight reductions in adult abundance and productivity. And because these reductions are so slight, the actions—even in combination—would have no appreciable effect on the species' diversity or structure. Moreover, we expect the actions to provide lasting benefits for the listed fish and that all habitat effects would be negligible. And finally, we expect the program as a whole and the permit actions considered here to generate information we need to fulfill our mandate under the ESA.

2.8 Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, the effects of other activities caused by the proposed action, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of Puget Sound Chinook salmon, Puget Sound steelhead, Hood Canal summer-run chum salmon, and Southern eulachon or destroy or adversely modify any of their designated critical habitat.

2.9 Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

In this instance, and for the actions considered in this opinion, there is no incidental take at all. The reason for this is that all the take contemplated in this document would be carried out under permits that allow the permit holders to directly take the animals in question. Because the action would not cause any incidental take, we are not specifying an amount or extent of incidental take that would serve as a reinitiation trigger. Nonetheless, the amounts of direct take have been specified and analyzed in the effects section above (2.5). Those amounts—displayed in the various permits' effects analyses—constitute hard limits on both the amount and extent of take the permit holders would be allowed in a given year. Those amounts are also noted in the reinitiation clause just below because exceeding them would likely trigger the need to reinitiate consultation.

2.10 Reinitiation of Consultation

This concludes formal consultation for "Evaluation and Recommended Determination of a Tribal Resource Management Plan Submitted for Consideration Under the Endangered Species Act's Tribal Plan Limit [50 CFR 223.204] for the Period January 1, 2022 – December 31, 2026."

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

In the context of this opinion, there is no incidental take anticipated and the reinitiation trigger set out in (1) is not applicable. If any of the direct take amounts specified in this opinion's effects analysis section (2.5) are exceeded, reinitiation of formal consultation will be required because the regulatory reinitiation triggers set out in (2) and/or (3) will have been met.

2.11 "Not Likely to Adversely Affect" Determination

NMFS's determination that an action "is not likely to adversely affect" listed species or critical habitat is based on our finding that the effects are expected to be discountable, insignificant, or completely beneficial (USFWS and NMFS 1998). Insignificant effects relate to the size of the impact and should never reach the scale where take occurs; discountable effects are those that are extremely unlikely to occur; and beneficial effects are contemporaneous positive effects without any adverse effects on the species or their critical habitat.

Southern Resident Killer Whales Determination

The Southern Resident killer whale (SRKW) DPS was listed as endangered under the ESA in 2005 (70 FR 69903) and a recovery plan was completed in 2008 (NMFS 2008). A 5-year review under the ESA completed in 2021 concluded that SRKWs should remain listed as endangered and includes recent information on the population, threats, and new research results and publications (NMFS 2021b). Because NMFS determined the action is not likely to adversely affect SRKWs, this document does not provide detailed discussion of environmental baseline or cumulative effects for the SRKW portion of the action area.

In 2021, NMFS published a final rule (86 FR 41668, August 2, 2021) to revise SRKW critical habitat to designate six additional coastal critical habitat areas (approximately 15,910 sq. miles), in addition to the 2,560 square miles previously designated in 2006 in inland waters of Washington (71 FR 69054; November 29, 2006). Each coastal area contains all three physical or biological essential features identified in the 2006 designation: (1) water quality to support growth and development; (2) prey species of sufficient quantity, quality and availability to support individual growth, reproduction and development, as well as overall population growth; and (3) passage conditions to allow for migration, resting, and foraging.

Several factors identified in the final recovery plan for SRKWs may be limiting their recovery including quantity and quality of prey, toxic chemicals that accumulate in top predators, and disturbance from sound and vessels. It is likely that multiple threats are acting together to impact the whales. Although it is not clear which threat or threats are most significant to the survival and recovery of SRKWs, all of the threats identified are potential limiting factors in their population dynamics (NMFS 2008).

SRKWs consist of three pods (J, K, and L) and inhabit coastal waters off Washington, Oregon, and Vancouver Island and are known to travel as far south as central California and as far north as Southeast Alaska (NMFS 2008; Hanson et al. 2013; Carretta et al. 2021). During the spring, summer, and fall months, SRKWs spend a substantial amount of time in the inland waterways of the Strait of Georgia, Strait of Juan de Fuca, and Puget Sound (Bigg 1982; Ford 2000; Krahn et al. 2002; Hauser et al. 2007; Hanson and Emmons 2010). By late fall, all three pods are seen less frequently in inland waters. Although seasonal movements are somewhat predictable, there can be large inter-annual variability in arrival time and days present in inland waters from spring through fall, with late arrivals and fewer days present in recent years (Hanson and Emmons 2010; Whale Museum unpublished data). In recent years, several sightings and acoustic detections of SRKWs have been obtained off the Washington, Oregon, and California coasts in the winter and spring (Hanson et al. 2010; Hanson et al. 2013, Hanson et al. 2017, Emmons et al. 2021, NWFSC unpubl. data). Satellite-linked tag deployments have also provided more data on SRKW movements in the winter indicating that K and L pods use the coastal waters along Washington, Oregon, and California during non-summer months (Hanson et al. 2017), while J pod occurred frequently near the western entrance of the Strait of Juan de Fuca but spent relatively little time in other outer coastal areas. In 2021, NMFS published a rule to revise SRKW critical habitat and designate six additional coastal critical habitat areas (86 Fed. Reg. 41668, August 2, 2021). A full description of the geographic area occupied by SRKW can be found in the biological report that accompanies the final critical habitat rule (NMFS 2021c).

SRKWs consume a variety of fish species (22 species) and one species of squid (Ford et al. 1998; Ford 2000; Ford and Ellis 2006; Hanson et al. 2010; Ford et al. 2016), but salmon are identified as their primary prey. The diet of SRKWs is the subject of ongoing research, including direct observation of feeding, scale and tissue sampling of prey remains, and fecal sampling. The diet data suggest that SRKWs are consuming mostly larger (i.e., generally age 3 and up) Chinook salmon (Ford and Ellis 2006). Scale and tissue sampling from May to September in inland waters of Washington and British Columbia, Canada, indicate that their diet consists of a high percentage of

Chinook salmon (monthly proportions as high as >90%) (Hanson et al. 2010; Ford et al. 2016). Ford et al. (2016) confirmed the importance of Chinook salmon to SRKWs in the summer months using DNA sequencing from whale feces. Salmon and steelhead made up to 98% of the inferred diet, of which almost 80% were Chinook salmon. Coho salmon and steelhead are also found in the diet in inland waters in spring and fall months when Chinook salmon are less abundant (Ford et al. 1998; Ford and Ellis 2006; Hanson et al. 2010; Ford et al. 2016). Prey remains and fecal samples collected in inland waters during October through December indicate Chinook salmon and chum salmon are primary contributors of the whale's diet (Hanson et al. 2021).

Observations of whales overlapping with salmon runs (Wiles 2004; Zamon et al. 2007; Krahn et al. 2007) and collection of prey and fecal samples have also occurred in the winter months. Analysis of prey remains and fecal samples sampled during the winter and spring in coastal waters indicated the majority of prey samples were Chinook salmon (approximately 80% of prey remains and 67% of fecal samples were Chinook salmon), with a smaller number of steelhead, chum salmon, and halibut detected in prey remain samples and foraging on coho, chum, steelhead, big skate, and lingcod detected in fecal samples (Hanson et al. 2021). The occurrence of K and L pods off the Columbia River in March suggests the importance of Columbia River spring runs of Chinook salmon in their diet (Hanson et al. 2013). Chinook salmon genetic stock identification from samples collected in winter and spring in coastal waters included 12 U.S. west coast stocks, and over half the Chinook salmon consumed originated in the Columbia River (Hanson et al. 2021).

At the time of the 2021 population census, there were 74 SRKWs counted in the population, which includes three calves born between the 2020 and 2021 censuses, and all three surviving at the time of this report (CWR 2021). Since the latest census, one additional whale is presumed dead: K21, an adult male. The NWFSC continues to evaluate changes in fecundity and mortality rates, and has updated the work on population viability analyses for Southern Resident killer whales and a science panel review of the effects of salmon fisheries (Krahn et al. 2004; Hilborn et al. 2012; Ward et al. 2013). Following that work, population estimates, including data from the last five years (2017-2021), project a downward trend over the next 2five years. The population projection is most pessimistic if future fecundity rates are assumed to be similar to the last five years, and higher but still declining if average fecundity and survival rates over all years (1985-2021) are used for the projections. Only 2five years were selected for projections because as the model projects out over a longer time frame (e.g., 50 years), there is increased uncertainty around the estimates (also see Hilborn et al. 2012). Recently, Lacy et al. (2017) developed a population viability assessment (PVA) model that attempts to quantify and compare the three primary threats affecting the whales (e.g., prey availability, vessel noise and disturbance, and high levels of contaminants). This model relies on previously published correlations of SRKW demographic rates with Chinook salmon abundance using a prey index for 1979 – 2008, and models SRKW demographic trajectories assuming that the relationship is constant over time. They found that over the range of scenarios tested, the effects of prey abundance on fecundity and survival had the largest impact on the population growth rate (Lacy et al. 2017).

The proposed actions may affect SRKWs indirectly by reducing availability of their preferred prey, Chinook salmon. This analysis focuses on Chinook salmon availability in the ocean because the best available information indicates that salmon are the preferred prey of SRKWs year round, including in coastal waters, and that Chinook salmon are the preferred salmon prey species. Focusing on Chinook salmon provides a conservative estimate of potential effects of the action on SRKWs because the total abundance of all salmon and other potential prey species is orders of magnitude larger than the total abundance of Chinook. To assess the indirect effects of the proposed action on the Southern Resident killer whale DPS, we considered the geographic area of overlap in the marine distribution of Chinook salmon affected by the action, and the range of SRKWs. We also considered the importance of the affected Chinook salmon ESUs compared to other Chinook salmon runs in the SRKW diet composition, and the influence of hatchery mitigation programs. As described in the effects analysis for salmonids, an absolute maximum of 7,629 juvenile and 25 adult Chinook salmon may be killed during the course of the research. As the previous effects analysis illustrated, these losses—even in total—are expected to have only very small effects on salmonid abundance and productivity and no appreciable effect on diversity or distribution for any Chinook salmon ESUs.

The fact that the research would kill Chinook salmon could affect prey availability to the whales in future years throughout their range. For the adult take, approximately 2/3 the 25 fish (natural and hatchery) that could, at maximum, be killed from these ESUs would only be taken by research after they return to shallower bays, estuaries, and their natal rivers, and are therefore very unlikely to be available as prey to the whales that typically feed in coastal offshore areas. This would signify that the research could (conservatively) remove something on the order of 16 adult Chinook (again, natural and hatchery) from the SRKW's prey base.

Because SRKWs prey on adult salmon, to determine effect the juvenile losses might have on SRKWs, we must convert those fish to adult equivalents: the most recent ten-year average smolt-to-adult ratio (SAR) from PIT-tagged Chinook salmon returns is from the Snake River, and indicates that SARs are less than 1% (BPA 2018). If one percent of the 7,629 juvenile Chinook salmon that may be killed by the proposed research activities were otherwise to survive to adulthood, this would translate to the effective loss of about 76 adult Chinook salmon.

Taken together, this would mean that the research, in total, could remove something on the order of 92 adult Chinook from the SRKW prey base in any given year. Given that the number of adult Chinook (listed and unlisted) in the ocean at any given time is orders of magnitude greater than that figure, it is unlikely that SRKW would intercept and feed on many (if any) of these salmon.

If SRKWs consume only large adult Chinook salmon (16,386 kcal/fish), adult female killer whales would consume up to approximately 13 Chinook salmon per day and adult male killer whales would consume up to approximately 16 Chinook salmon per day (Noren 2011, NMFS 2021b). Noren (2011) estimated the daily consumption rate of a population with 82 individuals over the age of 1 that consumes solely Chinook salmon would consume 289,131–347,000 fish/year by assuming the caloric density of Chinook was 16,386 kcal/fish (i.e., the average value for adults from Fraser River). Williams et al. (2011) modeled annual SRKW prey requirements and found that the whole population requires approximately 211,000 to 364,100 Chinook salmon per year. Based on dietary/energy needs and 2015 SRKW abundances, Chasco et al. (2017) also modeled SRKW prey requirements and found that in Salish Sea and U.S. West Coast coastal waters (not including British Columbia), the population requires approximately 393,109, adult (age 1+) Chinook salmon annually on average across model simulations.

Using methods described in NMFS 2021d (and originally used in NMFS 2019), we combined the sex and age specific maximum daily prey energy requirement information with the population census data to estimate daily energetic requirements for all members of the SRKW population, based on the population size as of summer 2020 (72 whales) and using ages for the year 2021. Assuming again a Chinook caloric density of 16,386, a SRKW population of 72 whales, ≥1 year of age, need 755-906 fish/day. Using an energy density of 13,868 kcal/fish (O'Neill et al. 2014, Columbia river fall run energy content), 72 whales would need 892-1071 fish/day. These numbers depend a lot on the ages of the killer whales, as well as the run, size, and calorie content of the salmon prey. But, using these values, this means that the research contemplated in this opinion could kill, in its entirety and at a conservative maximum, about 10% of one day's worth of the fish that the SRKWs need to survive (92 fish out of 892). Moreover, that figure would only hold if the SRKWs could somehow intercept all the fish that might otherwise reach maturity without the permitted take. So even the maximum effect of a loss of 10% of one day's worth of SRKW food could only occur under circumstances so unlikely as to effectively be impossible. However, because there is no available information on the whales' foraging efficiency, it is unknown how much more fish need to be available in order for the whales to capture and consume enough prey to meet their needs.

In addition, as described in Sections 2.4 and 2.5, the estimated Chinook salmon mortality is likely to be much smaller than stated. First, the mortality rate estimates for most of the proposed studies are purposefully inflated to account for potential accidental deaths and it is therefore very likely that fewer salmonids will be killed by the research than stated. In fact, as described in Section 2.4 according to our take tracking in the past, researchers have killed between 4% and 15% of the fish they have been permitted. Thus, the actual reduction in prey that could possibly become available to the whales is probably closer to 3 than 13 fish.

Given these circumstances, and the fact that we anticipate no direct interaction between any of the researchers and SRKWs, NMFS finds that potential adverse effects of the proposed research on SRKWs are insignificant and determines that the proposed action may affect, but is not likely to adversely affect, SRKWs or their critical habitat.

3. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT CONSULTATION

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

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

3.1 Essential Fish Habitat Affected by the Project

In the estuarine and marine areas, salmon EFH extends from the nearshore and tidal submerged environments within state territorial waters out to the full extent of the exclusive economic zone (370.4 km) offshore of Washington, Oregon, and California north of Point Conception. The EFH identified within the action areas are identified in the Pacific coast salmon fishery management plan (PFMC 2014). Freshwater EFH for Pacific salmon includes all those streams, lakes, ponds, wetlands, and other water bodies currently, or historically accessible to salmon in Washington, Oregon, Idaho, and California, except areas upstream of certain impassable man-made barriers (as identified by the PFMC), and longstanding, naturally-impassable barriers (i.e., natural waterfalls in existence for several hundred years).

3.2 Adverse Effects on Essential Fish Habitat

As the Biological Opinion above describes, the proposed research actions are not likely, singly or in combination, to adversely affect the habitat upon which Pacific salmon, groundfish, and coastal pelagic species, depend; the research is therefore not likely to affect EFH. All the actions are of limited duration, minimally intrusive, and are entirely discountable in terms of their effects, short-or long-term, on any habitat parameter important to the fish.

3.3 Essential Fish Habitat Conservation Recommendations

No adverse effects upon EFH are expected; therefore, no EFH conservation recommendations are necessary.

3.4 Statutory Response Requirement

Because no EFH recommendations are being made, there is no statutory response requirement.

3.5 Supplemental Consultation

The Action Agency must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH Conservation Recommendations [50 CFR 600.920(l)].

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

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

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are the agencies listed on the first page of the preceding biological opinion. Other interested users could include all the permittees and other local and tribal interests. The document will be available within two weeks at the NOAA Library Institutional Repository. The format and naming adheres to conventional standards for style.

This ESA section 7 consultation on the approval of the Tribal Plan (2022-2026) concluded that the actions will not jeopardize the continued existence of any species. Therefore, the funding/action agencies may carry out the research actions and NMFS may permit them. Pursuant to the MSA, NMFS determined that no conservation recommendations were needed to conserve EFH.

4.2 Integrity

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

4.3 Objectivity

Information Product Category: Natural Resource Plan

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

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this opinion 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 reviewed in accordance with West Coast Region ESA quality control and assurance processes.

5. REFERENCES

5.1 Federal Register Notices

June 28, 2005 (70 FR 37160). Endangered and Threatened Species: Final Listing Determinations for 16 ESUs of West Coast Salmon, and Final 4(d) Protective Regulations for Threatened Salmonid ESUs.

September 2, 2005 (70 FR 52630). Final Rule: Endangered and Threatened Species: Designated Critical Habitat: Designation of Critical Habitat for 12 Evolutionarily Significant Units of West Coast Salmon and Steelhead in Washington, Oregon, and Idaho.

November 18, 2005 (70 FR 69903). Final Rule: Endangered and Threatened Wildlife and Plants: Endangered Status for Southern Resident Killer Whales.

January 5, 2006 (71 FR 834). Final Rule: Endangered and Threatened Species: Final Listing Determinations for 10 Distinct Population Segments of West Coast Steelhead.

November 29, 2006 (71 FR 69054). Final Rule: Endangered and Threatened Species; Designation of Critical Habitat for Southern Resident Killer Whale.

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