

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 Issuance of 17 ESA Section 10(a)(1)(A) Scientific Research Permits in Oregon, Washington, Idaho and California affecting Salmon, Steelhead, Rockfish, Eulachon, and Green Sturgeon in the West Coast Region

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Action Agencies: The National Marine Fisheries Service (NMFS)
The U.S. Fish and Wildlife Service
The Environmental Protection Agency

Affected Species and NMFS’s 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 (<i>O. tshawytscha</i>)	Threatened	Yes	No	No	No
PS steelhead (<i>O. mykiss</i>)	Threatened	Yes	No	No	No
Puget Sound/Georgia Basin (PS/GB) bocaccio (<i>Sebastes paucispinis</i>)	Endangered	Yes	No	No	No
PS/GB yelloweye rockfish (<i>S. ruberrimus</i>)	Threatened	Yes	No	No	No
Hood Canal summer-run (HCS) chum salmon (<i>O. keta</i>)	Threatened	Yes	No	No	No
Upper Columbia River (UCR) spring-run Chinook salmon (<i>O. tshawytscha</i>)	Endangered	Yes	No	No	No
Upper Columbia River (UCR) steelhead (<i>O. mykiss</i>)	Threatened	Yes	No	No	No

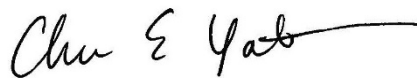
ESA-Listed Species	Status	Is Action Likely To Adversely Affect Species?	Is Action Likely To Jeopardize the Species?	Is Action Likely To Adversely Affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Middle Columbia River (MCR) steelhead (<i>O. mykiss</i>)	Threatened	Yes	No	No	No
Snake River (SnkR) spring/summer-run (spr/sum) Chinook salmon (<i>O. tshawytscha</i>)	Threatened	Yes	No	No	No
Snake River (SnkR) fall-run Chinook salmon (<i>O. tshawytscha</i>)	Threatened	Yes	No	No	No
Snake River (SnkR) steelhead (<i>O. mykiss</i>)	Threatened	Yes	No	No	No
Snake River (SnkR) sockeye salmon (<i>O. nerka</i>)	Endangered	Yes	No	No	No
Lower Columbia River (LCR) Chinook salmon (<i>O. tshawytscha</i>)	Threatened	Yes	No	No	No
Lower Columbia River (LCR) coho salmon (<i>O. kisutch</i>)	Threatened	Yes	No	No	No
Lower Columbia River (LCR) steelhead (<i>O. mykiss</i>)	Threatened	Yes	No	No	No
Columbia River (CR) chum salmon (<i>O. keta</i>)	Threatened	Yes	No	No	No
Upper Willamette River (UWR) Chinook salmon (<i>O. tshawytscha</i>)	Threatened	Yes	No	No	No
Upper Willamette River (UWR) steelhead (<i>O. mykiss</i>)	Threatened	Yes	No	No	No
Oregon Coast (OC) coho salmon (<i>O. kisutch</i>)	Threatened	Yes	No	No	No
Southern Oregon/Northern California Coast (SONCC) coho salmon (<i>O. kisutch</i>)	Threatened	Yes	No	No	No
Northern California (NC) steelhead (<i>O. mykiss</i>)	Threatened	Yes	No	No	No

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?
California Coastal (CC) Chinook salmon (<i>Oncorhynchus tshawytscha</i>)	Threatened	Yes	No	No	No
Sacramento River (SacR) winter-run Chinook salmon (<i>O. tshawytscha</i>)	Endangered	Yes	No	No	No
Central Valley spring-run (CVS) Chinook salmon (<i>O. tshawytscha</i>)	Threatened	Yes	No	No	No
California Central Valley (CCV) steelhead (<i>O. mykiss</i>)	Threatened	Yes	No	No	No
Southern DPS (SDPS) eulachon (<i>Thaleichthys pacificus</i>)	Threatened	Yes	No	No	No
Southern DPS (SDPS) green sturgeon (<i>Acipenser medirostris</i>)	Threatened	Yes	No	No	No
Southern Resident killer whale (SRKW) (<i>Orcinus orca</i>)	Endangered	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 Jennifer Quan
 Regional Administrator

Date:

April 10, 2024

TABLE OF CONTENTS

1. INTRODUCTION8

1.1 BACKGROUND.....8

1.2 CONSULTATION HISTORY8

1.3 PROPOSED FEDERAL ACTION.....12

Common Elements among the Proposed Permit Actions.....20

2. ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT (ITS)23

2.1 ANALYTICAL APPROACH.....23

2.2 RANGEWIDE STATUS OF THE SPECIES AND CRITICAL HABITAT24

Climate Change.....25

 Pacific Northwest.....25

 California26

 Marine Habitats27

 Impacts on Salmon and Steelhead.....27

 2.2.1 *Status of the Species*.....28

 2.2.1.1 Puget Sound Chinook Salmon.....44

 2.2.1.2 Puget Sound Steelhead.....46

 2.2.1.3 Puget Sound/Georgia Basin Rockfish47

 2.2.1.3.1 Puget Sound/Georgia Basin DPS Bocaccio.....48

 2.2.1.3.2 Puget Sound/Georgia Basin DPS Yello weye Rockfish.....49

 2.2.1.4 Hood Canal Summer-run Chum Salmon.....51

 2.2.1.5 Upper Columbia River Spring-run Chinook Salmon.....52

 2.2.1.6 Upper Columbia River Steelhead.....53

 2.2.1.7 Middle Columbia River Steelhead.....54

 2.2.1.8 Snake River Spring/Summer-run Chinook Salmon.....55

 2.2.1.9 Snake River Fall-run Chinook Salmon.....57

 2.2.1.10 Snake River Basin Steelhead.....58

 2.2.1.11 Snake River Sockeye Salmon.....59

 2.2.1.12 Lower Columbia River Chinook Salmon.....60

 2.2.1.13 Lower Columbia River Coho Salmon61

 2.2.1.14 Lower Columbia River Steelhead.....63

 2.2.1.15 Columbia River Chum Salmon64

 2.2.1.16 Upper Willamette River Chinook Salmon.....65

 2.2.1.17 Upper Willamette River Steelhead.....67

 2.2.1.18 Oregon Coast Coho Salmon68

 2.2.1.19 Southern Oregon/Northern California Coast Coho Salmon70

 2.2.1.20 Northern California Steelhead.....72

 2.2.1.21 California Coastal Chinook Salmon.....73

 2.2.1.22 Sacramento River Winter-run Chinook Salmon.....74

 2.2.1.23 Central Valley Spring-run Chinook Salmon.....75

 2.2.1.24 California Central Valley Steelhead.....77

 2.2.1.25 SDPS Eulachon78

 2.2.1.26 SDPS Green Sturgeon.....80

 2.2.2 *Status of the Species' Critical Habitat*.....82

2.3 ACTION AREA.....88

 2.3.1 *Action Areas for the Individual Permits*.....89

2.4 ENVIRONMENTAL BASELINE92

 2.4.1 *Summary for all Listed Species*.....94

2.5 EFFECTS OF THE ACTION.....98

 2.5.1 *Effects on Critical Habitat*.....98

 2.5.2 *Effects on the Species*.....99

 Capturing, Handling, and Anesthesia.....99

 Electrofishing100

 Gastric Lavage.....102

 Hook and Line/Angling.....102

 Observation.....104

Sacrifice (Intentionally Killing).....	105
Screw trapping.....	105
Seines, Small Traps, and Hand/Dip Nets.....	106
Tagging/Marking.....	106
Tissue Sampling.....	108
Trawls.....	109
Weirs.....	109
2.5.3 Species-specific Effects of Each Permit.....	109
Permit 1127-7R.....	112
Permit 1410-14R.....	114
Permit 1484-8R.....	118
Permit 14046-5R.....	119
Permit 15207-5R.....	121
Permit 16344-4R.....	123
Permit 18260-3R.....	124
Permit 18331-3R.....	125
Permit 22003-3R.....	127
Permit 22319-3R.....	128
Permit 22865-2R.....	129
Permit 27337.....	130
Permit 26300.....	132
Permit 27619.....	133
Permit 27869.....	134
Permit 27874.....	135
Permit 28047.....	136
2.6 CUMULATIVE EFFECTS.....	138
2.7 INTEGRATION AND SYNTHESIS.....	141
<i>Salmonid Species</i>	148
<i>Other species</i>	157
<i>Critical Habitat</i>	159
<i>Summary</i>	159
2.8 CONCLUSION.....	161
2.9 INCIDENTAL TAKE STATEMENT.....	161
2.10 REINITIATION OF CONSULTATION.....	161
2.11 "NOT LIKELY TO ADVERSELY AFFECT" DETERMINATION.....	162
<i>Southern Resident Killer Whales Determination</i>	162
3. MAGNUSON-STEVENSON FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT CONSULTATION.....	167
3.1 ESSENTIAL FISH HABITAT AFFECTED BY THE PROJECT.....	167
3.2 ADVERSE EFFECTS ON ESSENTIAL FISH HABITAT.....	167
3.3 ESSENTIAL FISH HABITAT CONSERVATION RECOMMENDATIONS.....	168
3.4 STATUTORY RESPONSE REQUIREMENT.....	168
3.5 SUPPLEMENTAL CONSULTATION.....	168
4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW.....	169
4.1 UTILITY.....	169
4.2 INTEGRITY.....	169
4.3 OBJECTIVITY.....	169
5. REFERENCES.....	171
5.1 FEDERAL REGISTER NOTICES.....	171
5.2 LITERATURE CITED.....	173

List of Acronyms

ARIS – Adaptive Resolution Imaging Sonar
 ARN – Administrative Record Number
 BPA – Bonneville Power Administration
 C/H/R – Capture/Handle/Release
 C/M, T, S/R – Capture/Mark, Tag, Sample Tissue/Release Live Animal
 CC – California Coastal
 CCC – Central California Coast
 CCV – California Central Valley
 CDFW – California Department of Fish and Wildlife
 CFR – Code of Federal Regulation
 CH – Critical Habitat
 CHART – Critical Habitat Analytical Review Teams
 CR – Columbia River
 CRITFC – Columbia River Inter-Tribal Fish Commission
 CVS – Central Valley spring-run
 CWT – Coded Wire Tag
 DC – Direct Current
 DEQ – Oregon Department of Environmental Quality
 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)
 ICTRT – Interior Columbia Technical Recovery Team
 IDFG – Idaho Department of Fish and Game
 IM – Intentional (Directed) Mortality
 ISAB – Independent Scientific Advisory Board
 ISU – Idaho State University
 ITS – Incidental Take Statement
 LCR – Lower Columbia River
 LHAC – Listed Hatchery Adipose Clipped
 LHIA – Listed Hatchery Intact Adipose
 MCR – Middle Columbia River
 MPG – Major Population Group
 MSA – Magnuson-Stevens Fishery Conservation and Management Act
 NC – Northern California
 NFH – National Fish Hatchery
 NMFS – National Marine Fisheries Service
 NOAA – National Oceanic and Atmospheric Administration

NWFSC – Northwest Fisheries Science Center
O/H – Observe/Harass
OC – Oregon Coast
ODFW – Oregon Department of Fish and Wildlife
OL – Ozette Lake
OSU – Oregon State University
PBF – Physical or Biological Features
PCE – Primary Constituent Element
PFMC – Pacific Fishery Management Council
PIT – Passive Integrated Transponder
PRD – Protected Resources Division
PS – Puget Sound
PS/GB – Puget Sound/Georgia Basin
RK – River Kilometer
ROV – Remotely Operated Vehicle
RPM – Reasonable and Prudent Measure
S – Southern
SacR – Sacramento River
SBT – Shoshone-Bannock Tribes
SnkR – Snake River
SCCC – South-Central California Coast
SDPS – Southern Distinct Population Segment
SONCC – Southern Oregon/Northern California Coast
spr/sum – spring/summer run
SR – Southern Resident
SRKW – Southern Resident Killer Whales
SWFSC – Southwest Fisheries Science Center
SVWID – Snoqualmie Valley Watershed Improvement District
TRT – Technical Recovery Team
UCR – Upper Columbia River
USFWS – United States Fish and Wildlife Service
USGS – United States Geological Survey
UW – University of Washington
UWR – Upper Willamette River
VSP – Viable Salmonid Population
WCR – West Coast Region
WDFW – Washington Department of Fish and Wildlife
WDNR – Washington Department of Natural Resources

1. INTRODUCTION

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

1.1 Background

The National Marine Fisheries Service (NMFS) prepared the biological opinion (opinion) and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 USC 1531 et seq.), and implementing regulations at 50 CFR 402, as amended. It constitutes a review of 17 scientific research permits NMFS is proposing to issue under section 10(a)(1)(A) of the ESA and is based on information provided in the associated applications for the proposed permits, published and unpublished scientific information on the biology and ecology of listed salmonids in the action areas, and other sources of information.

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

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

The West Coast Region's (WCR's) Protected Resources Division (PRD) received 17 applications for permits to conduct scientific research (or enhancement) in Washington, Oregon, Idaho and California (see Table 1 and the text following it):

- Eleven applications were to renew existing permits;
- Six applications were for new permits.

Because the permit requests are similar in nature and duration and are expected to affect many of the same listed species, we combined them into a single consultation pursuant to 50 CFR 402.14(c).

The affected species are:

- Chinook salmon
 - Puget Sound (PS)
 - Upper Columbia River (UCR) spring-run
 - Snake River (SnkR) fall-run
 - Snake River (SnkR) spring/summer run
 - Lower Columbia River (LCR)

- Upper Willamette River (UWR)
- Sacramento River winter-run (SacR)
- Central Valley spring-run (CVS)
- California Coastal (CC)
- Coho salmon
 - Lower Columbia River (LCR)
 - Oregon Coast (OC)
 - Southern Oregon/Northern California Coast (SONCC)
- Chum salmon
 - Hood Canal summer-run (HCS)
 - Columbia River (CR)
- Sockeye salmon
 - Snake River (SnkR)
- Steelhead
 - Puget Sound (PS)
 - Upper Columbia River (UCR)
 - Middle Columbia River (MCR)
 - Snake River Basin (SnkR)
 - Lower Columbia River (LCR)
 - UWR
 - Northern California (NC)
 - California Central Valley (CCV)
- Southern DPS (SDPS) Green sturgeon
- SDPS Eulachon
- Puget Sound/Georgia Basin (PS/GB) bocaccio
- PS/GB yelloweye rockfish

The proposed actions also have the potential to affect Southern resident killer whales (SRKW) and their critical habitat by diminishing the whales' prey base. We concluded that the proposed activities are not likely to adversely affect SRKW 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. The Applications Considered in this Biological Opinion and Their Associated Applicants.

Permit Number	Applicant
1127-7R	Shoshone-Bannock Tribes
1410-14R	NMFS Northwest Fisheries Science Center
1484-8R	Washington Department of Natural Resources

Permit Number	Applicant
14046-5R	King County Department of Natural Resources and Parks
15207-5R	Amnis Opes Institute, LLC
16344-4R	Oregon State University
18260-3R	Confederated Tribes of the Warm Springs Reservation
18331-3R	Wild Fish Conservancy
22003-3R	King County Department of Natural Resources and Parks
22319-3R	Herrera Environmental Consultants
22865-2R	U.S. Forest Service
26300	Fishery Foundation of California
27337	Lower Elwha Klallam Tribe
27619	Scott River Water Trust
27869	U.S. Fish and Wildlife Service
27874	California Department of Fish and Wildlife
28047	U.S. Forest Service - PNW Research Station

We received a permit renewal request (1127-7R) from the Shoshone-Bannock Tribes (SBT) on December 28, 2023. Requested edits were sent, addressed, and the application was completed on January 10, 2024.

We received a permit renewal request (1410-14R) from the Northwest Fisheries Science Center (NWFSC) on May 26, 2023. Requested edits were sent, addressed, and the application was completed on January 30, 2024.

We received a permit renewal request (1484-8R) from the Washington Department of Natural Resources (WDNR) on December 13, 2023. Requested edits were sent, addressed, and the application was completed on January 10, 2024.

We received a permit renewal request (14046-5R) from the King County Department of Natural Resources and Parks (KCDNRP) on November 27, 2023. Requested edits were sent, addressed, and the application was completed on January 10, 2024.

We received a permit renewal request (15207-5R) from the Amnis Opes Institute (AOI) on November 15, 2023. Requested edits were sent, addressed, and the application was completed on December 14, 2023.

We received a permit renewal request (16344-4R) from the Oregon State University (OSU) on December 30, 2023. Requested edits were sent, addressed, and the application was completed on February 12, 2024.

We received a permit renewal request (18260-3R) from the Confederated Tribes of Warm Springs (CTWS) on December 18, 2023. Requested edits were sent, addressed, and the application was completed on December 19, 2023.

We received a permit renewal request (18331-3R) from the Wild Fish Conservancy (WFC) on September 13, 2023. Requested edits were sent, addressed, and the application was completed on December 13, 2023.

We received a permit renewal request (22003-3R) from the KCDNRP on November 27, 2023. Requested edits were sent, addressed, and the application was completed on November 28, 2023.

We received a permit renewal request (22319-3R) from the Herrera Environmental Consultants (HEC) on December 28, 2023. Requested edits were sent, addressed, and the application was completed on January 26, 2024.

We received a permit renewal request (22865-2R) from the United States Forest Service (USFS) on December 19, 2023. The application was deemed completed on that date.

We received a new permit request (26300) from the Fishery Foundation of California on December 27, 2023. Requested edits were sent, addressed, and the application was completed on February 1, 2024.

We received a new permit request (27337) from the Lower Elwha Klallam Tribe (LEKT) on July 13, 2023. Requested edits were sent, addressed, and the application was completed on February 15, 2024.

We received a new permit request (27619) from the Scott River Water Trust on September 15, 2023. Requested edits were sent, addressed, and the application was completed on December 31, 2024.

We received a new permit request (27869) from the U.S. Fish and Wildlife Service (USFWS) on December 19, 2023. Requested edits were sent, addressed, and the application was completed on January 17, 2024.

We received a new permit request (27874) from the California Department of Fish and Wildlife (CDFW) on January 4, 2024. Requested edits were sent, addressed, and the application was completed on February 1, 2024.

We received a permit renewal request (28047) from the USFS - PNW Research Station on January 2, 2024. Requested edits were sent, addressed, and the application was completed on February 15, 2024.

Most of the 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 February 27, 2024 asking for public comment on them (89 FR 14438). The public was given 30 days to comment on the permit applications and, once those periods closed on March 28, 2024, the consultation was formally initiated on March 29, 2024. 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.

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

1.3 Proposed Federal Action

Under the ESA, “action” means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR 402.02). Under the MSA, “Federal action” means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a Federal Agency (50 CFR 600.910).]

The proposed actions here are NMFS’ issuance of 17 scientific research permits pursuant to section 10(a)(1)(A) of the ESA. The permits would cover the research activities proposed by the applicants listed in Table 1, above. The permits would variously authorize researchers to take all the species listed on the front page of this document (except southern resident killer whales). “Take” is defined in section 3 of the ESA; it means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect [a listed species] or to attempt to engage in any such conduct.

We considered, under the ESA, whether the proposed action would cause any other activities and determined that it would not.

Permit 1127-7R

The Shoshone-Bannock Tribes are seeking to renew a permit that for nearly three decades has allowed them to annually take listed SR steelhead and spr/sum Chinook salmon while conducting research designed to (1) monitor adult and juvenile fish in key upper Snake River subbasin watersheds, (2) assess the utility of hatchery Chinook salmon in increasing natural populations in the Salmon River, and (3) evaluate the genetic and ecological impacts hatchery Chinook salmon may have on natural populations. The fish would primarily benefit from the research in two ways. First, the research would broadly be used to help guide restoration and recovery efforts throughout the Snake River basin. Second, the research would be used to determine how hatchery supplementation can be used as a tool for salmon recovery. The research would also help the Tribes re-establish traditional fishing opportunities and connect with and protect cultural, ecological, and social values and rights.

The researchers would use screw traps, weirs, electrofishing, and hook-and-line angling gear to capture the listed fish. Once captured, the fish would undergo various sampling, tagging, and handling regimes; they would then be allowed to recover and released. Some tissue samples would be taken from adult fish carcasses, and the researchers would conduct some snorkeling surveys and redd counts. In all cases, trained crews would conduct the operations, no adult salmonids would be electrofished, and all activities would take place in the Salmon River subbasin. The researchers are not proposing to kill any of the fish they capture, but some may die as an unintended result of the research.

Permit 1410-14R

The Northwest Fisheries Science Center (NWFSC) is seeking to renew a research permit that currently allows them to take juvenile and adult CC, CVS, LCR, PS, SacR, SnkR fall-run, SnkR spr/sum, UCR, and UWR Chinook salmon; CR chum salmon; LCR, OC, and SONCC coho salmon; SnkR sockeye salmon; and LCR, MCR, SnkR, UCR, and UWR steelhead while conducting a study of the Columbia River plume and the surrounding ocean environment off the coasts of Oregon and Washington. The NWFSC research may also cause them to take SDPS eulachon, a species for which there are currently no ESA take prohibitions. This renewal would also allow the researchers to lethally sample a subset of adult salmon to allow for tissue and otolith collection. The purposes of the research are to (1) determine the abundance, distribution, growth, and condition of juvenile Columbia River salmonids in the river's plume and characterize its physical and biological features as they relate to salmonid survival; (2) determine the impact that predators and food supply have on survival among juvenile Columbia River Chinook and coho salmon as they migrate through the Columbia River estuary and plume; and (3) synthesize the early ocean ecology of juvenile Columbia River salmonids, test mechanisms that control salmonid growth and survival, and produce ecological indices that forecast salmonid survival.

The research would benefit the affected species by (1) providing data to improve understanding of how the ocean and Columbia River plume conditions affect juvenile salmonids, (2) helping predict how changing ocean conditions would affect salmonid growth and survival, and (3) helping improve salmon management actions in relation to river, plume, and ocean conditions. Information on adults would also help researchers better understand the relationship between older salmon individuals and predators such as Southern Resident Killer Whales (SRKWs). The NWFSC proposes to capture fish using a surface trawl, which can cause lethally crush and descale juvenile salmonids and eulachon. Juvenile salmonids would be identified to species, measured for length, and frozen for further analysis (*i.e.* weight, growth, genetics, diet (stomach contents), parasites, pathogens, and physiological condition). All juvenile salmon are lethally sampled, and a subset of adult salmon will be lethally sampled for tissue analyses including otoliths and stomach contents. The remaining adult salmonids that are not lethally sampled would be held in an aerated livewell, identified to species, measured for length, checked for tags and marks, and released. Eulachon would either be returned to the capture location or retained for further scientific research activities at the NWFSC.

Permit 1484-8R

The Washington Department of Natural Resources (WDNR) is seeking to renew for five years a permit that currently authorizes them to take juvenile CR chum salmon, LCR Chinook salmon, LCR coho salmon, and LCR and MCR steelhead in WDNR-managed forests in Washington State. The purpose of the study is to survey stream reaches above natural barriers to determine if fish are present. This information is needed to determine appropriate widths of riparian buffers to leave intact during timber harvest. This study would benefit listed species by documenting the need for increased riparian buffers, which better protect aquatic and riparian habitat where fish are present. In addition, data on the distribution of fish gained from this study would be used to inform land management decisions and thereby better protect listed species.

The WDNR proposes to capture juvenile fish using single-pass backpack electrofishing. The researchers would turn off the electricity as soon as a fish is seen. Fish would be identified regardless of whether they are netted; if fish are netted they would be held in the water only long enough to identify them and then released at the site of capture. The WDNR does not intend to kill any of the fish being captured, but a small number may die as an unintended consequence of the proposed activities.

Permit 14406-5R

The King County Department of Natural Resources and Parks (KCDNRP) is seeking to renew for five years a research permit that currently allows them to take juvenile PS Chinook salmon and PS steelhead. Sampling sites would be in four Puget Sound (Washington) sub-basins—Snoqualmie, Lake Washington, Duwamish, and Puyallup—and intertidal nearshore areas in the Puget Sound (King County, Washington). The purposes of the study are to (1) evaluate the effectiveness of restoration actions through biological monitoring, (2) understand how juvenile salmonids use specific riverine habitats in order to prioritize restoration projects and guide project design, (3) assess salmonid habitat status and trends in small streams with varying degrees of land use while monitoring current stream conditions, and (4) assess contaminant levels in various freshwater fish.

The research would benefit the affected species by determining how restoration and recovery actions are contributing to listed species recovery, providing information on the extent of juvenile salmonid rearing in off-channel areas, guiding future restoration projects based upon monitoring results, providing information on habitat use by yearling fall-run Chinook salmon, and contributing to our knowledge of Chinook salmon life histories.

The KCDNRP proposes to capture fish using beach seines, fyke nets, gill nets, hook and line angling, minnow traps, and backpack and boat-operated electrofishing. Most of the captured fish would be anaesthetized, identified to species, allowed to recover, and released. A subset of the Chinook salmon would also be tagged (acoustic, passive integrated transponder (PIT), and elastomer), dyed (Bismark Brown), gastric lavaged, and have scales collected. The researchers do not intend to kill any listed fish, but some may die as an inadvertent result of the research.

Permit 15207-5R

The Amnis Opes Institute (AOI) is seeking to renew for five years a research permit that currently allows them to take juvenile and adult LCR, PS, SnkR fall-run, SnkR spr/sum, UCR, and UWR Chinook salmon; CR and HCS chum salmon; LCR, OC, and SONCC coho salmon; SnkR sockeye salmon; and LCR, MCR, PS, SnkR, UCR, and UWR steelhead throughout Idaho, Oregon, and Washington States. The purpose of the study is to develop baseline data of the physical and chemical habitat for rivers and streams throughout the United States. Research transects would be randomly determined and would take place on alternating sides of the sampled rivers and streams for a distance of 40 times the mean wetted channel width. The researchers would stop every five channel widths to process the fish. This research would benefit the affected species by characterizing the biological condition of rivers and thereby provide data that supports Clean Water Act implementation.

The AOI researchers propose to capture fish using raft-mounted and backpack electrofishing equipment; stunned fish would be placed in a livewell with a soft mesh dip-net. Fish would be identified to species, measured to length, searched for abnormalities, and returned to the water when recovered. ESA-listed species would be processed and released first. If adult salmonids are observed, electrofishing activities would immediately cease and the researchers would move to another location before resuming electrofishing activities. The researchers do not intend to kill any listed fish, but some may die as an inadvertent result of the research.

Permit 16344-4R

The Oregon State University is seeking to renew for five years a research permit that currently allows them to take juvenile listed hatchery SONCC coho in the Upper Klamath River. The purposes of this research are to (1) determine the effects of infection by the myxozoan parasite *Ceratonova shasta* on coho salmon, and (2) estimate disease effects for each study year on the wild coho population. The work would benefit fish by providing information on endemic *C. shasta* levels in the Klamath River and thereby help managers monitor and mitigate the parasite's effects on listed species.

Juvenile coho salmon from Iron Gate, Fall Creek and/or Trinity River hatcheries would be transported to selected locations on the Klamath River and monitored for disease after the exposure to *C. shasta*. Following exposure, all fish would be transported to the Oregon State University J. L. Fryer Aquatic Animal Health Laboratory where time to morbidity, overall morbidity and infection prevalence would be ascertained through microscopic and molecular analysis of intestinal tissues. Because all of the fish will be exposed to the parasite *C. shasta*, they cannot be released after the experiments. In addition, infection prevalence data are needed which requires euthanizing all fish surviving the exposures, since surviving fish may still be infected with the parasite.

Permit 18260-3R

The Confederated Tribes of the Warm Springs Reservation (CTWS) is seeking to renew for five years a permit that currently authorizes them to take juvenile and adult LCR Chinook salmon, LCR coho salmon, and LCR and MCR steelhead. The purpose of the study is to describe abundance, habitat associations, spawning, distribution, migration patterns, harvest rates, and limiting factors for Pacific lamprey in Fifteen Mile Creek and Hood River and their tributaries (Oregon). The research would provide important basic ecological information about Pacific lamprey, which is not ESA-listed, but which is an important indicator species for characterizing watershed health. Although researchers are targeting juvenile and adult Pacific lamprey (*Entosphenus tridentatus*) for capture, other species may be taken during sampling activities. The research would benefit listed species by improving understanding of watershed condition and helping managers prioritize habitat restoration projects in the Fifteen Mile Creek and Hood River basins. The work would also help the CTWS people re-connect with, increase, and manage a traditional food source.

The CTWS proposes to collect fish from March through October using backpack electrofishing and hand, dip, fyke, and hoop nets. During electrofishing surveys, the researchers would use “lamprey settings” (i.e., very low voltage). The researchers would set hoop (0.8 m diameter with 1.9 cm mesh) and fyke (2.5 m high by 2.75 m wide with 1.9 cm mesh size) nets facing downstream in low velocity areas. They will modify the fyke net to deter adult steelhead from entering the hoop net by tying twine across the first throat of the net to create an effective mesh size across the opening of 7.5 cm. This modification has effectively deterred steelhead from entering fyke nets set in previous fieldwork. The researchers propose to measure and PIT- or radio-tag adult lamprey before releasing them. The researchers would immediately release any salmonids that are captured or briefly hold them in buckets of water before releasing them if they require time to recover from being captured. If salmonids are observed during electrofishing, the researchers would immediately turn off the electricity and allow fish to swim away. The CTWS does not propose to kill any listed salmonids, but a small number may die as an unintended result of the research activities.

Permit 18331-3R

The Wild Fish Conservancy (WFC) is seeking to renew for five years a research permit that currently allows them to take juvenile PS Chinook salmon and PS steelhead in selected stream channels and floodplain areas throughout the Kitsap and Snoqualmie sub-basins of Washington State. The purpose of the study is to classify existing channels by water type and thereby validate

and update county, city, and Washington Department of Natural Resources stream classifications and hydrological maps. This research would benefit the affected species by filling data gaps regarding fish passage impediments (tidegates, culverts, etc.) and providing fish species composition and distribution—information needed to identify, prioritize, and implement restoration projects.

The WFC proposes to capture fish using backpack electrofishing. Fish would be identified to species, tissue sampled (caudal fin clip—steelhead only), and released. Once fish presence is established, either through visual observation or electrofishing, electrofishing would be discontinued. Surveyors would then proceed upstream until a change in habitat parameters is encountered and electrofishing would recommence. The researchers do not intend to kill any listed fish, but some may die as an inadvertent result of the research.

Permit 22003-2R

The KCDNRP is seeking to renew a five-year research permit that currently allows them to annually take juvenile and adult PS Chinook salmon, PS steelhead, and PS/GB bocaccio and adult SDPS green sturgeon in the marine waters and shorelines of King County (Washington State). The KCDNRP research may also cause them to take juvenile and adult SDPS eulachon and PS/GB yelloweye rockfish—species for which there are currently no ESA take prohibitions. The purpose of the study is to capture English sole, brown rockfish (*Sebastes auriculatus*), copper rockfish (*Sebastes caurinus*), quillback rockfish (*Sebastes maliger*), and various forage fish to monitor tissue levels of toxic chemical contaminants. This research would benefit the affected species by (1) providing information on the types and concentrations of chemicals in fish, (2) helping managers understand the impact chemical exposures have on marine fish health, (3) filling data gaps to help managers make informed management decisions, and (4) informing a long-term program to evaluate changes in chemical body burdens in fish over time as environmental improvements are made (stormwater discharges reduced, contaminated sediments remediated, etc.).

The KCDNRP proposes to capture fish using bottom trawls, beach seines, cast nets, and hook and line (sabiki rigs). Captured ESA-listed fish would be identified to species and released. Listed rockfish would be released via rapid submergence to their capture depth to reduce adverse effects from barotrauma. Targeted species (and incidental mortalities) would be sacrificed, stored on ice, and analyzed for contaminants. The researchers do not intend to kill any listed fish, but some may die as an inadvertent result of the research.

Permit 22319-3R

Herrera Environmental Consultants (HEC) is seeking to renew a five-year research permit that currently allows them to annually take juvenile PS Chinook salmon and PS steelhead while conducting a study in streams near Redmond, Washington. The purpose of the research is to conduct a paired watershed study monitoring stream health by collecting benthic macroinvertebrates in urban and nearby relatively pristine streams. Due to the collection methods, there is a possibility of capturing juvenile salmonids. The research would benefit listed fish by determining the effectiveness

of stormwater management in urban streams which can lead directly to water quality and habitat improvement.

The HEC researchers propose to use a D-frame kick net to capture the fish. Any fish captured would be identified to species and released. The researchers do not intend to kill any of the fish being captured, but a small number may die as an unintended consequence of the proposed activities.

Permit 22865-2R

The United States Forest Service (USFS) is seeking to renew a permit that currently allows them to annually take juvenile UCR Chinook salmon, UCR steelhead, and MCR steelhead during research activities taking place at various points in the Yakima, Methow, Entiat, and Wenatchee River drainages in Washington State. The purpose of the research is to determine fish distribution in those subbasins. The research would benefit the fish by giving land managers information they need to design forest management activities (e.g., timber sales, grazing plans, road building) in a manner that would help them have the smallest possible effect on listed species.

Under the renewed permit, the USFS would use using minnow traps, hook-and-line angling, and electrofishing equipment to capture the fish. The fish would then be identified and immediately released whenever possible. The USFS does not intend to kill any of the listed fish being captured, but a small number may die as an unintended result of the research activities.

Permit 26300

The Fishery Foundation of California is seeking a new permit that would authorize them to take juvenile CVS Chinook salmon, CCV steelhead, and juvenile SDPS green sturgeon. The purpose of this study is to document the presence of native fish species in Snodgrass Slough, the Cosumnes River and Laguna Creek in Sacramento County, CA prior to a large floodplain restoration project. The study would benefit affected species by providing data on species presence, seasonal water conditions and migratory windows that will inform the restoration project.

Juveniles would be collected via beach seine and fyke net. Juvenile fish would be captured, handled, and released. The researchers are not proposing to kill any of the listed fish being captured, but a small number of fish may be killed as an inadvertent result of these activities.

Permit 27337

The Lower Elwha Klallam Tribe (LEKT) is seeking a five-year permit that would allow them to take juvenile HCS chum and PS Chinook and PS steelhead during the course of research designed to determine fish and shellfish presence and use in a 28-acre estuarine lagoon at the base of Ediz Hook in Port Angeles, WA. The study would benefit affected species by providing data on species presence, and that information, along with detailed habitat and water quality data, would be used to

inform future restoration actions in the area. Those restoration actions, in turn, would help the LEKT people once again conduct traditional fishing and shellfishing activities in the lagoon.

The fish would be captured primarily by beach seining, but some may be captured in fukui and minnow traps. Once captured, the fish would be handled and released. The researchers are not proposing to kill any of the listed fish being captured, but a small number of fish may be killed as an inadvertent result of the proposed activities.

Permit 27619

The Scott River Water Trust is seeking a new permit that would authorize them to take juvenile and adult SONCC coho salmon in the Scott River, CA. The purpose of this study is to assess fish passage at Youngs Dam to determine how and when juvenile and adult salmon utilize the fish ladder at Youngs Dam. The project seeks to determine an ideal flow target through the fish ladder in an effort to improve fish passage at the dam. The study would benefit SONCC coho by providing data to identify and inform recommendations to improve volitional fish passage through Youngs Dam.

Juveniles would be collected via beach seines and observed during snorkel surveys. Juvenile coho would be captured, handled, and released. A subsample of captured juveniles would be anesthetized, tissue sampled, and PIT-tagged prior to release. Adult coho would be observed at weirs, fish ladders, dam and during snorkel surveys. The researchers are not proposing to kill any of the listed fish being captured, but a small number of fish may be killed as an inadvertent result of these activities.

Permit 27869

The U.S. Fish and Wildlife Service (USFWS) is seeking a five-year permit that would allow them to take juvenile HCS chum and PS Chinook and PS steelhead during the course of research designed to determine what effect the hatchery barriers have on the distribution of migratory sculpin (with considerations for how these barriers may also be affecting the distributions of strictly fluvial sculpin species). The research would benefit listed species by producing data on how hatchery weirs affect salmonid migrations in the areas being studied. That data could then be used to modify weir operations for the benefit of the migrating fish.

The fish would largely be collected by electrofishing, but seining or dipnetting may also be employed. All listed fish would be immediately released without further handling. Sampling would cease and the activity would be moved if adult Chinook, chum, or steelhead (or their redds) are encountered at any time during a survey. The researchers are not proposing to kill any of the listed fish being captured, but a small number of fish may be killed as an inadvertent result of these activities.

Permit 27874

The California Department of Fish and Wildlife (CDFW) is seeking a new permit that would authorize them to take juvenile and adult SDPS green sturgeon in the Sacramento and San Joaquin Rivers, CA. The purpose of this study is to develop an indices of white sturgeon abundance for use in species management. Though non-listed white sturgeon are the target species, green sturgeon might be encountered.

Juvenile and adult SDPS green sturgeon would be collected via long line and hook and line sampling and observed via camera and sonar. Juvenile and adult fish would be captured, handled, tagged, and released. The researchers are not proposing to kill any of the listed fish being captured, but a small number of fish may be killed as an inadvertent result of these activities.

Permit 28047

The USFWS is seeking a five-year permit that would allow them to take juvenile LCR, UWR, PS, and CC Chinook; CR and HCS chum; LCR, PS, UWR, and NC steelhead; and LCR, OC, and SONCC coho. The fish would be taken during efforts to determine the uppermost ranges of several species of fish in more than 20 subbasins in western Oregon and Washington and northern California. The research would produce a large amount of presence/absence data on listed fish and thus help managers plan and carry out land management actions across a broad portion of three states.

The researchers would use backpack electrofishing units to capture the fish. Once captured, all listed salmonids would simply be identified and immediately released. In all cases, the researchers would be operating near what is already considered to be the upper limit of salmonid trout distribution, so they are unlikely to encounter many listed fish in any case. Regardless, the researchers are not proposing to kill any of the listed fish being captured, but a small number of fish may be killed as an inadvertent result of these activities.

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 permit holder or any employee, contractor, or agent of the permit holder. Also, NMFS may include conditions specific to the proposed research in the individual permits.

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 issuing 16 scientific research permits and one enhancement permit, individually or in aggregate:

- May adversely affect PS, UCR, SnkR spr/sum, SnkR fall-run, LCR, UWR, SacR winter-run, CVS, CC Chinook salmon; LCR, OC, and SONCC coho salmon; HCS and CR chum salmon; SnkR sockeye salmon; PS, UCR, MCR, SnkR, LCR, NC, and CCV steelhead; SDPS green sturgeon; SDPS eulachon; PS/GB bocaccio; and PS/GB yelloweye rockfish, 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 CFR 402.02). 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).

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.

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 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

Major ecological realignments are already occurring in response to climate change, which 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 West Coast Region (Crozier *et al.* 2019). Long-term trends in warming have continued at global, national, and regional scales (Siegel and Crozier 2020). It is almost certain that annual and seasonal surface temperatures over all of North America will continue to increase at a rate greater than the global average (Gutiérrez *et al.* 2021). As described in the Intergovernmental Panel on Climate Change Sixth Assessment Report (Gutiérrez *et al.* 2021), precipitation is also very likely to continue to increase over most of North America above 45°N, and likely to decrease in the southwestern U.S. (particularly in winter), and there is high certainty snow cover will decline over most regions of North America during the 21st century in terms of water equivalent, extent and annual duration (the only exception being high-latitude regions).

These changes will not be spatially homogeneous across the action area landscape, and are therefore discussed in regionally-specific sections below.

Pacific Northwest

During the last century regional temperatures in the Pacific Northwest have increased substantially—nearly 2°F—and are projected to continue to increase during all seasons under all climate change prediction scenarios (Abatzoglou *et al.* 2014, Vose *et al.* 2017, Rupp *et al.* 2017). Temperatures have risen steadily, while precipitation remains highly variable, thus intensifying the hydrological cycle within the atmosphere and causing more intense storm events (Warner *et al.* 2015). Warming is likely to continue during the next century as average temperatures are projected to increase on average by another 3 to 5°F by the end of the 21st century, with the largest increases predicted to occur in the summer (Rupp *et al.* 2017). Decreases in summer precipitation of 4-10% by the end of the century are also consistently predicted across climate models, although much higher predictions for winter precipitation (8-14% increase) result in a predicted overall increase in annual precipitation (Rupp *et al.* 2017). 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, with the largest increases in winter flood frequency and magnitude predicted for mixed rain-snow watersheds (Dominguez *et al.* 2012, Mote *et al.* 2014). Winter precipitation will also be more likely to fall as rain than snow, resulting in decreased snowpack and earlier snowmelt (Mote *et al.* 2014, Mote *et al.* 2016). Within snow-dominated watersheds, warmer winters and springs reduce snow accumulation and hasten snowmelt. Reduced snowpack causes an earlier and smaller freshet in spring. Reduced snowpack also can lead to lower minimum flows and higher stream temperatures in summer (May 2018). Decreased snowpack will increase risks of drought, lower instream flows, warmer water temperatures, and wildfires (Mote *et al.* 2014, McKenzie and Littell 2017).

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 (Mantua *et al.* 2010, Crozier *et al.* 2019). Temperature increases also shift timing of key life cycle events for salmonids and species forming the base of their aquatic food webs (Crozier *et al.* 2019, Tillmann and Siemann 2011, Winder and Schindler 2004). Higher stream temperatures will 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 also likely to cause physiological stress that could result in decreased disease resistance and lower reproductive success for many salmon species (Beechie *et al.* 2013; Wainwright and Weitkamp 2013; Whitney *et al.* 2016).

Reduced streamflows will also likely reduce available suitable habitat for anadromous fish by making 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, Tonina *et al.* 2022). As more basins become rain-dominated and prone to more severe winter storms, higher winter stream flows may also 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). There is also evidence that changes in weather patterns and reductions in spring freshets have altered migration timing for eulachon, which may lead to earlier spawning and flushing of juveniles out of rivers (Moody 2008, Schweigert *et al.* 2007). Such changes in migration timing could result in a mismatch between juvenile outmigration and favorable marine upwelling conditions in the eastern Pacific (Gustafson *et al.* 2010, Sharma *et al.* 2016).

California

California has experienced continually below average precipitation and record high air temperatures in the last decade, a trend that models predict will continue (Alizedeh 2021). Heat waves are expected to occur more often, and heat wave temperatures are likely to be higher, with 2014-2018 being the five warmest years on record globally (NOAA NCEI 2022). Total precipitation in California may decline; critically dry years may increase (Alizedeh 2021, Sridhar *et al.* 2018). Events of both extreme precipitation and intense aridity are projected for California, increasing climactic volatility throughout the state (Swain *et al.* 2018). Snowpack is a major contributor to stored and distributed water and water temperature in the state (Yan *et al.* 2021), but this important water source is becoming increasingly threatened. The Sierra Nevada snowpack is likely to decrease by as much as 70 to 90 percent by the end of this century under the highest emission scenarios modeled (Luers and Moser 2006). California wildfires are expected to increase in frequency and magnitude, with 77% more area burned by 2099 under a high emission scenario model (Westerling 2018). Vegetative cover may also change, with decreases in evergreen conifer forest and increases in grasslands and mixed evergreen forests. The likely change in amount of rainfall in Northern and Central Coastal California streams under various warming scenarios is less certain, although as noted above, total rainfall across the state is expected to decline.

For the California North Coast, models show increased variability in interannual winter precipitation and increased summer evapotranspiration, showing that low summer flows are likely to become lower, less predictable and highly variable (Sridhar *et al.* 2018). Many of these changes are likely to further degrade salmonid habitat by, for example, reducing stream flows during the summer and raising summer water temperatures (Williams *et al.* 2016). Estuaries may also experience changes detrimental to salmonids and green sturgeon. Estuarine productivity is likely to change based on alterations to freshwater flows, prey availability, and altered run times (Chasco *et al.* 2021, Siegel and Crozier 2020).

Marine Habitats

In marine environments, changes in temperatures as well as chemistry, circulation patterns, and food supply are likely to affect ecosystems and habitats important to subadult and adult green sturgeon and salmonids (Crozier *et al.* 2020, Keefer *et al.* 2018, Barnett *et al.* 2020), which would be expected to negatively affect marine growth and survival of listed fish. The projections described above are for the mid- to late-21st Century. Over shorter periods, climate conditions not caused by the human addition of carbon dioxide to the atmosphere are more likely to predominate (Koontz *et al.* 2018, Yan *et al.* 2021).

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 (Ou *et al.* 2015, Williams *et al.* 2019). Global sea levels are expected to continue rising throughout this century, reaching likely predicted increases of 10-32 inches by 2081-2100 (IPCC WGI 2021). These changes will likely result in increased erosion, more frequent and severe coastal flooding, increased temperature regimes, and shifts in the composition of nearshore habitats (Reeder *et al.* 2013, Crozier *et al.* 2019). 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 (Osterback *et al.* 2018).

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 (Zabel *et al.* 2006; Siegel and Crozier 2020). 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). Pacific eulachon are also expected to be adversely affected by lower upwelling conditions and higher sea surface temperatures, which result in poorer ocean conditions for growth (Sharma *et al.* 2016). 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 (Stachura *et al.* 2014, Siegel and Crozier 2020, Chasco *et al.* 2021).

Impacts on Salmon and Steelhead

The physical impacts of climate change described above are predicted to cause a variety of impacts to Pacific salmon and their ecosystems (Mote *et al.* 2013; Crozier *et al.* 2008; Martins *et al.* 2012; Wainwright and Weitkamp 2013; Mote *et al.* 2019, Dalton and Fleishman 2021). The adaptive

ability of threatened and endangered salmon and steelhead 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). The primary effects of climate change on Pacific Northwest salmon and steelhead are (Crozier 2016, 2021):

- Direct effects of increased water temperatures on fish physiology and increased susceptibility to disease.
- Temperature-induced changes to stream flow patterns can block fish migration, trap fish in dewatered sections, dewater redds, introduce non-native fish, and degrade water quality.
- Alterations to freshwater, estuarine, and marine food webs can alter the availability and timing of food resources.
- Changes in estuarine and ocean productivity can affect the abundance and productivity of fish resources.

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 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, 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.

In addition, it should be noted that for many species in this biological opinion, hatchery populations make up part of the listed unit and may be tied to the four VSP parameters defined above. As a result, this opinion often analyzes effects on hatchery components, and when it does, the terms “artificially propagated” and “hatchery” are used interchangeably, as are the terms “naturally propagated” and “natural.”

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).

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 Status Review	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.	<ul style="list-style-type: none"> • 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 Puget Sound Steelhead DPS have not substantively changed since the listing in 2007, or since the 2011 status review. Furthermore, the Puget Sound Steelhead TRT recently concluded that the DPS was at very low viability, as were all three of its constituent MPGs, and many of its 32 populations. In the near term, the outlook for environmental conditions affecting Puget Sound 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 Puget Sound steelhead survival and production are expected to continue.	<ul style="list-style-type: none"> • 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
Puget Sound/ Georgia Basin DPS of	Endangered 04/28/2010 (75 FR 22276)	NMFS 2017d	NMFS 2016a	Though bocaccio were never a predominant segment of the multi-species rockfish population within the Puget Sound/Georgia	<ul style="list-style-type: none"> • Over harvest • Water pollution • Climate-induced changes to rockfish habitat

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Bocaccio				<p>Basin, their present-day abundance is likely a fraction of their pre-contemporary fishery abundance. Most bocaccio within the DPS may have been historically spatially limited to several basins within the DPS. They were apparently historically most abundant in the Central and South Sound with no documented occurrences in the San Juan Basin until 2008. The apparent reduction of populations of bocaccio in the Main Basin and South Sound represents a further reduction in the historically spatially limited distribution of bocaccio, and adds significant risk to the viability of the DPS.</p>	<ul style="list-style-type: none"> • Small population dynamics
<p>Puget Sound/ Georgia Basin DPS of Yelloweye Rockfish</p>	<p>Threatened 04/28/2010 (75 FR 22276)</p>	<p>NMFS 2017d</p>	<p>NMFS 2016a</p>	<p>Yelloweye rockfish within the Puget Sound/Georgia Basin (in U.S. waters) are very likely the most abundant within the San Juan Basin of the DPS. Yelloweye rockfish spatial structure and connectivity is threatened by the apparent reduction of fish within each of the basins of the DPS. This reduction is probably most acute within the basins of Puget Sound proper. The severe reduction of fish in these basins may eventually result in a contraction of the DPS' range.</p>	<ul style="list-style-type: none"> • Over harvest • Water pollution • Climate-induced changes to rockfish habitat • Small population dynamics
<p>Hood Canal summer-run chum salmon</p>	<p>Threatened 06/28/2005 (70 FR 37160)</p>	<p>HCCC 2005 NMFS 2007</p>	<p>Ford 2022*</p>	<p>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 five years, and have been greater than replacement rates in the past two 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.</p>	<ul style="list-style-type: none"> • Reduced floodplain connectivity and function • Poor riparian condition • Loss of channel complexity Sediment accumulation • Altered flows and water quality

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
				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.	
Upper Columbia River spring-run Chinook salmon	Endangered 06/28/2005 (70 FR 37160)	UCSRB 2007	NMFS 2022b	This ESU comprises four independent populations. Three are at high risk and one is functionally extirpated. Current estimates of natural origin spawner abundance increased relative to the levels observed in the prior review for all three extant populations, and productivities were higher for the Wenatchee and Entiat populations and unchanged for the Methow population. However, abundance and productivity remained well below the viable thresholds called for in the Upper Columbia Recovery Plan for all three populations.	<ul style="list-style-type: none"> • Effects related to hydropower system in the mainstem Columbia River • Degraded freshwater habitat • Degraded estuarine and nearshore marine habitat • Hatchery-related effects • Persistence of non-native (exotic) fish species • Harvest in Columbia River fisheries
Upper Columbia River steelhead	Threatened 01/05/2006 (71 FR 834)	UCSRB 2007	NMFS 2022b	This DPS comprises four independent populations. Three populations are at high risk of extinction while 1 population is at moderate risk. Upper Columbia River steelhead populations have increased relative to the low levels observed in the 1990s, but natural origin abundance and productivity remain well below viability thresholds for three out of the four populations. The status of the Wenatchee River steelhead population continued to improve based on the additional year's information available for the most recent review. The abundance and productivity viability rating for the Wenatchee River exceeds the minimum threshold for 5% extinction risk. However, the overall DPS status remains unchanged from the prior review, remaining at high risk driven by low abundance and productivity relative to viability objectives and diversity concerns.	<ul style="list-style-type: none"> • Adverse effects related to the mainstem Columbia River hydropower system • Impaired tributary fish passage • Degraded floodplain connectivity and function, channel structure and complexity, riparian areas, large woody debris recruitment, stream flow, and water quality • Hatchery-related effects • Predation and competition • Harvest-related effects
Middle Columbia River steelhead	Threatened 01/05/2006 (71 FR 834)	NMFS	NMFS 2022c	This DPS comprises 17 extant populations. The DPS does not currently include steelhead that are designated as part of an experimental	<ul style="list-style-type: none"> • Degraded freshwater habitat • Mainstem Columbia River hydropower-related impacts

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
				<p>population above the Pelton Round Butte Hydroelectric Project. Returns to the Yakima River basin and to the Umatilla and Walla Walla Rivers have been higher over the most recent brood cycle, while natural origin returns to the John Day River have decreased. There have been improvements in the viability ratings for some of the component populations, but the DPS is not currently meeting the viability criteria in the MCR steelhead recovery plan. In general, the majority of population level viability ratings remained unchanged from prior reviews for each major population group within the DPS.</p>	<ul style="list-style-type: none"> • Degraded estuarine and nearshore marine habitat • Hatchery-related effects • Harvest-related effects • Effects of predation, competition, and disease
Snake River spring/summer-run Chinook salmon	Threatened 06/28/2005 (70 FR 37160)	NMFS 2017b	NMFS 2022d	<p>This ESU comprises 28 extant and four extirpated populations. All except one extant population (Chamberlin Creek) are at high risk. Natural origin abundance has increased over the levels reported in the prior review for most populations in this ESU, although the increases were not substantial enough to change viability ratings. Relatively high ocean survivals in recent years were a major factor in recent abundance patterns. While there have been improvements in abundance and productivity in several populations relative to prior reviews, those changes have not been sufficient to warrant a change in ESU status.</p>	<ul style="list-style-type: none"> • Degraded freshwater habitat • Effects related to the hydropower system in the mainstem Columbia River, • Altered flows and degraded water quality • Harvest-related effects • Predation
Snake River fall-run Chinook salmon	Threatened 06/28/2005 (70 FR 37160)	NMFS 2017c	NMFS 2022e	<p>This ESU has one extant population. Historically, large populations of fall Chinook salmon spawned in the Snake River upstream of the Hells Canyon Dam complex. The extant population is at moderate risk for both diversity and spatial structure and abundance and productivity. The overall viability rating for this population is 'viable.' Overall, the status of Snake River fall Chinook salmon has clearly improved compared to the time of listing and compared to prior status reviews. The single extant population in the ESU is currently</p>	<ul style="list-style-type: none"> • Degraded floodplain connectivity and function • Harvest-related effects • Loss of access to historical habitat above Hells Canyon and other Snake River dams • Impacts from mainstem Columbia River and Snake River hydropower systems • Hatchery-related effects • Degraded estuarine and nearshore habitat.

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Snake River basin steelhead	Threatened 01/05/2006 (71 FR 834)	NMFS 2017b	NMFS 2022f	meeting the criteria for a rating of ‘viable’ developed by the ICTRT, but the ESU as a whole is not meeting the recovery goals described in the recovery plan for the species, which require the single population to be “highly viable with high certainty” and/or will require reintroduction of a viable population above the Hells Canyon Dam complex.	<ul style="list-style-type: none"> • Adverse effects related to the mainstem Columbia River hydropower system • Impaired tributary fish passage • Degraded freshwater habitat • Increased water temperature • Harvest-related effects, particularly for B-run steelhead • Predation • Genetic diversity effects from out-of-population hatchery releases
Snake River sockeye salmon	Endangered 06/28/2005 (70 FR 37160)	NMFS 2015	NMFS 2022g	This single population ESU is at very high risk due to small population size. There is high risk across all four basic risk measures. Although the captive brood program has been successful in providing substantial numbers of hatchery produced fish for use in supplementation efforts, substantial increases in survival rates across all life history stages must occur to re-establish sustainable natural production. In terms of natural production, the Snake River Sockeye salmon ESU remains at extremely high risk although there has been substantial progress on the first phase of the proposed recovery approach – developing a hatchery based program to amplify and conserve the stock to facilitate reintroductions.	<ul style="list-style-type: none"> • Effects related to the hydropower system in the mainstem Columbia River • Reduced water quality and elevated temperatures in the Salmon River • Water quantity • Predation

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Lower Columbia River Chinook salmon	Threatened 06/28/2005 (70 FR 37160)	NMFS 2013a	NMFS 2022h	This ESU comprises 32 independent populations. Twenty-seven populations are at very high risk, 2 populations are at high risk, one population is at moderate risk, and 2 populations are at very low risk Overall, there was little change since the last status review in the biological status of this ESU, although there are some positive trends. Increases in abundance were noted in about 70% of the fall-run populations and decreases in hatchery contribution were noted for several populations. Relative to baseline VSP levels identified in the recovery plan, there has been an overall improvement in the status of a number of fall-run populations, although most are still far from the recovery plan goals.	<ul style="list-style-type: none"> • Reduced access to spawning and rearing habitat • Hatchery-related effects • Harvest-related effects on fall Chinook salmon • An altered flow regime and Columbia River plume • Reduced access to off-channel rearing habitat • Reduced productivity resulting from sediment and nutrient-related changes in the estuary • Contaminant
Lower Columbia River coho salmon	Threatened 06/28/2005 (70 FR 37160)	NMFS 2013a	NMFS 2022h	Of the 24 populations that make up this ESU, 21 populations are at very high risk, 1 population is at high risk, and 2 populations are at moderate risk. Recent recovery efforts may have contributed to the observed natural production, but in the absence of longer term data sets it is not possible to parse out these effects. Populations with longer term data sets exhibit stable or slightly positive abundance trends. Some trap and haul programs appear to be operating at or near replacement, although other programs still are far from that threshold and require supplementation with additional hatchery-origin spawners. Initiation of or improvement in the downstream juvenile facilities at Cowlitz Falls, Merwin, and North Fork Dam are likely to further improve the status of the associated upstream populations. While these and other recovery efforts have likely improved the status of a number of coho salmon populations, abundances are still at low levels and the majority of the populations remain at moderate or high risk. For the Lower Columbia River region land development and increasing human population pressures will	<ul style="list-style-type: none"> • Degraded estuarine and near-shore marine habitat • Fish passage barriers • Degraded freshwater habitat: Hatchery-related effects • Harvest-related effects • An altered flow regime and Columbia River plume • Reduced access to off-channel rearing habitat in the lower Columbia River • Reduced productivity resulting from sediment and nutrient-related changes in the estuary • Juvenile fish wake strandings • Contaminants

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Lower Columbia River steelhead	Threatened 01/05/2006 (71 FR 834)	NMFS 2013a	NMFS 2022h	<p>likely continue to degrade habitat, especially in lowland areas. Although populations in this ESU have generally improved, especially in the 2013/14 and 2014/15 return years, recent poor ocean conditions suggest that population declines might occur in the upcoming return years</p> <p>This DPS comprises 23 historical populations, 17 winter-run populations and six summer-run populations. Nine populations are at very high risk, 7 populations are at high risk, 6 populations are at moderate risk, and 1 population is at low risk. The majority of winter-run steelhead populations in this DPS continue to persist at low abundances. Hatchery interactions remain a concern in select basins, but the overall situation is somewhat improved compared to prior reviews. Summer-run steelhead populations were similarly stable, but at low abundance levels. The decline in the Wind River summer-run population is a source of concern, given that this population has been considered one of the healthiest of the summer-runs; however, the most recent abundance estimates suggest that the decline was a single year aberration. Passage programs in the Cowlitz and Lewis basins have the potential to provide considerable improvements in abundance and spatial structure, but have not produced self-sustaining populations to date. Even with modest improvements in the status of several winter-run DIPs, none of the populations appear to be at fully viable status, and similarly none of the MPGs meet the criteria for viability.</p>	<ul style="list-style-type: none"> • Degraded estuarine and nearshore marine habitat • Degraded freshwater habitat • Reduced access to spawning and rearing habitat • Avian and marine mammal predation • Hatchery-related effects • An altered flow regime and Columbia River plume • Reduced access to off-channel rearing habitat in the lower Columbia River • Reduced productivity resulting from sediment and nutrient-related changes in the estuary • Juvenile fish wake strandings • Contaminants
Columbia River chum salmon	Threatened 06/28/2005 (70 FR 37160)	NMFS 2013a	NMFS 2022h	<p>Overall, the status of most chum salmon populations is unchanged from the baseline VSP scores estimated in the recovery plan. A total of 3 of 17 populations are at or near their recovery viability goals, although under the recovery plan</p>	<ul style="list-style-type: none"> • Degraded estuarine and nearshore marine habitat • Degraded freshwater habitat • Degraded stream flow as a result of hydropower and water supply operations

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Upper Willamette River Chinook salmon	Threatened 06/28/2005 (70 FR 37160)	ODFW and NMFS 2011	Ford 2022*	<p>scenario these populations have very low recovery goals of 0. The remaining populations generally require a higher level of viability and most require substantial improvements to reach their viability goals. Even with the improvements observed during the last five years, the majority of populations in this ESU remain at a high or very high risk category and considerable progress remains to be made to achieve the recovery goals.</p> <p>This ESU comprises seven populations. Five populations are at very high risk, one population is at moderate risk (Clackamas River) and one population is at low risk (McKenzie River). Consideration of data collected since the last status review in 2010 indicates the fraction of hatchery origin fish in all populations remains high (even in Clackamas and McKenzie populations). The proportion of natural origin spawners improved in the North and South Santiam basins, but is still well below identified recovery goals. Abundance levels for five of the seven populations remain well below their recovery goals. Of these, the Calapooia River may be functionally extinct and the Molalla River remains critically low. Abundances in the North and South Santiam rivers have risen since the 2010 review, but still range only in the high hundreds of fish. The Clackamas and McKenzie populations have previously been viewed as natural population strongholds, but have both experienced declines in abundance despite having access to much of their historical spawning habitat. Overall, populations appear to be at either moderate or high risk, there has been likely little net change in the VSP score for the ESU since the last review, so the ESU remains at moderate risk.</p>	<ul style="list-style-type: none"> • Reduced water quality • Current or potential predation • An altered flow regime and Columbia River plume • Reduced access to off-channel rearing habitat in the lower Columbia River • Reduced productivity resulting from sediment and nutrient-related changes in the estuary • Juvenile fish wake strandings • Contaminants • Degraded freshwater habitat • Degraded water quality • Increased disease incidence • Altered stream flows • Reduced access to spawning and rearing habitats • Altered food web due to reduced inputs of microdetritus • Predation by native and non-native species, including hatchery fish • Competition related to introduced salmon and steelhead • Altered population traits due to fisheries and bycatch

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Upper Willamette River steelhead	Threatened 01/05/2006 (71 FR 834)	ODFW and NMFS 2011	Ford 2022*	This DPS has four demographically independent populations. Three populations are at low risk and one population is at moderate risk. Declines in abundance noted in the last status review continued through the period from 2010-2015. While rates of decline appear moderate, the DPS continues to demonstrate the overall low abundance pattern that was of concern during the last status review. The causes of these declines are not well understood, although much accessible habitat is degraded and under continued development pressure. The elimination of winter-run hatchery release in the basin reduces hatchery threats, but non-native summer steelhead hatchery releases are still a concern for species diversity and a source of competition for the DPS. While the collective risk to the persistence of the DPS has not changed significantly in recent years, continued declines and potential negative impacts from climate change may cause increased risk in the near future.	<ul style="list-style-type: none"> • Degraded freshwater habitat • Degraded water quality • Increased disease incidence • Altered stream flows • Reduced access to spawning and rearing habitats due to impaired passage at dams • Altered food web due to changes in inputs of microdetritus • Predation by native and non-native species, including hatchery fish and pinnipeds • Competition related to introduced salmon and steelhead • Altered population traits due to interbreeding with hatchery origin fish
Oregon Coast coho salmon	Threatened 06/20/2011 (76 FR 35755)	NMFS 2016b	NMFS 2022i	This ESU comprises 56 populations including 21 independent and 35 dependent populations. The last status review indicated a moderate risk of extinction. Significant improvements in hatchery and harvest practices have been made for this ESU. Most recently, spatial structure conditions have improved in terms of spawner and juvenile distribution in watersheds; none of the geographic area or strata within the ESU appear to have considerably lower abundance or productivity. The ability of the ESU to survive another prolonged period of poor marine survival remains in question.	<ul style="list-style-type: none"> • Reduced amount and complexity of habitat including connected floodplain habitat • Degraded water quality • Blocked/impaired fish passage • Inadequate long-term habitat protection • Changes in ocean conditions
Southern Oregon/Northern California Coast coho salmon	Threatened 06/28/2005 (70 FR 37160)	NMFS 2014a	SWFSC 2023*	This ESU comprises 31 independent, 9 independent, and 5 ephemeral populations all grouped into 7 diversity strata. Of the 31 independent populations, 24 are at high risk of extinction and 6 are at moderate risk of	<ul style="list-style-type: none"> • Lack of floodplain and channel structure • Impaired water quality • Altered hydrologic function • Impaired estuary/mainstem function

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Northern California steelhead	Threatened 6/7/2000 (65 FR 36074)	NMFS 2016c	SWFSC 2023*	<p>extinction. The extinction risk of an ESU depends upon the extinction risk of its constituent independent populations; because the population abundance of most independent populations are below their depensation threshold, the SONCC coho salmon ESU is at high risk of extinction and is not viable</p> <p>This DPS historically comprised 42 independent populations of winter-run steelhead (19 functionally independent and 23 potentially independent), and up to 10 independent populations (all functionally independent) of summer-run steelhead, with more than 65 dependent populations of winter-run steelhead in small coastal watersheds, and Eel river tributaries. Many populations are considered to be extant. Significant gaps in information exist for the Lower Interior and North Mountain Interior diversity strata. All winter-run populations are currently well below viability targets, with most at 5-13% of these goals. Mixed population trends arise depending on time series length; thus, there is no strong evidence to indicate conditions for winter-run populations have worsened appreciably since the last status review. Summer-run populations are of concern. While one run is near the viability target, others are very small or there is a lack of data. Overall, available information for winter- and summer-run populations do not suggest an appreciable increase or decrease in extinction risk since the last status review.</p>	<ul style="list-style-type: none"> • Degraded riparian forest conditions • Altered sediment supply • Increased disease/predation/competition • Barriers to migration • Fishery-related effects • Hatchery-related effects <ul style="list-style-type: none"> • Dams and other barriers to migration • Logging • Agriculture • Ranching • Fishery-related effects • Hatchery-related effects
California Coastal Chinook salmon	Threatened 09/16/1999 (64 FR 50394)	NMFS 2016c	SWFSC 2023*	<p>This ESU historically supported 16 Independent populations of fall-run Chinook salmon (11 Functionally Independent and five potentially Independent), six populations of spring-run Chinook salmon, and an unknown number of dependent populations. Based on the data available, eight of the 16 populations were</p>	<ul style="list-style-type: none"> • Logging and road construction altering substrate composition, increasing sediment load, and reducing riparian cover • Estuarine alteration resulting in lost complexity and habitat from draining and diking

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
				classified as data deficient, one population was classified as being at a Moderate/High risk of extirpation, and six populations were classified as being at a High risk of extirpation. There has been a mix in population trends, with some population escapement numbers increasing and others decreasing. Overall, there is a lack of compelling evidence to suggest that the status of these populations has improved or deteriorated appreciably since the previous status review.	<ul style="list-style-type: none"> • Dams and barriers diminishing downstream habitats through altered flow regimes and gravel recruitment • Climate change • Urbanization and agriculture degrading water quality from urban pollution and agricultural runoff • Gravel mining creating barriers to migration, stranding of adults, and promoting spawning in poor locations • Alien species (i.e. Sacramento Pikeminnow) • Small hatchery production without monitoring the effects of hatchery releases on wild spawners
Sacramento River winter-run Chinook salmon	Endangered 09/16/1999 (64 FR 50394)	NMFS 2014b	SWFSC 2023*	This ESU historically supported 18 or 19 Independent populations, with some smaller dependent populations, and four diversity groups. Only three populations are extant (Mill, Deer, and Butte creeks on the upper Sacramento River) which only represent one diversity group (Northern Sierra Nevada). Spatial diversity is increasing with presence (at low numbers in some cases) in all diversity groups. Recolonization of the Battle Creek population with increasing abundance of the Clear Creek population is benefiting ESU viability. The reappearance of phenotypic spring-run to the San Joaquin River tributaries may be the beginning of natural recolonization processes in once extirpated rivers. Active reintroduction efforts on the Yuba and San Joaquin rivers show promise. The ESU is trending positively towards achieving at least two populations in each of the four historical diversity groups necessary for recovery.	<ul style="list-style-type: none"> • Dams block access to 90 percent of historic spawning and summer holding areas along with altering river flow regimes and temperatures. • Diversions • Urbanization and rural development • Logging • Grazing • Agriculture • Mining – historic hydraulic mining from the California Gold Rush era. • Estuarine modified and degraded, thus reducing developmental opportunities for juvenile salmon • Fisheries • Hatcheries • ‘Natural’ factors (e.g. ocean conditions)
Central Valley spring-run Chinook salmon	Threatened 09/16/1999 (64 FR 50394)	NMFS 2014b	SWFSC 2023*	This ESU historically supported 18 or 19 Independent populations, with some smaller dependent populations, and four diversity groups. Only three populations are extant (Mill,	<ul style="list-style-type: none"> • Dams block access to 90 percent of historic spawning and summer holding areas along with altering river flow regimes and temperatures.

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
				<p>Deer, and Butte creeks on the upper Sacramento River) which only represent one diversity group (Northern Sierra Nevada). Spatial diversity is increasing with presence (at low numbers in some cases) in all diversity groups. Recolonization of the Battle Creek population with increasing abundance of the Clear Creek population is benefiting ESU viability. The reappearance of phenotypic spring-run to the San Joaquin River tributaries may be the beginning of natural recolonization processes in once extirpated rivers. Active reintroduction efforts on the Yuba and San Joaquin rivers show promise. The ESU is trending positively towards achieving at least two populations in each of the four historical diversity groups necessary for recovery.</p>	<ul style="list-style-type: none"> • Diversions • Urbanization and rural development • Logging • Grazing • Agriculture • Mining – historic hydraulic mining from the California Gold Rush era. • Estuarine modified and degraded, thus reducing developmental opportunities for juvenile salmon • Fisheries • Hatcheries • ‘Natural’ factors (e.g. ocean conditions)
California Central Valley steelhead	Threatened 3/19/1998 (63 FR 13347)	NMFS 2014a	SWFSC 2023	<p>Steelhead are present throughout most of the watersheds in the Central Valley, but often in low numbers, especially in the San Joaquin River tributaries. The status of this DPS appears to have changed little since the 2011 status review stating the DPS was in danger of extinction. There is still a paucity of data on the status of wild populations. There are some encouraging signs of increased returns over the last few years. However, the catch of unmarked (wild) steelhead at Chipps Island is still less than 5 percent of the total smolt catch, which indicates natural production of steelhead throughout the Central Valley remains at very low levels. Despite a positive trend on Clear Creek and encouraging signs from Mill Creek, all other concerns raised in the previous status review remain.</p>	<ul style="list-style-type: none"> • Major dams • Water diversions • Barriers • Levees and bank protection • Dredging and sediment disposal • Mining • Contaminants • Alien species • Fishery-related effects • Hatchery-related effects
Southern DPS of green sturgeon	Threatened 04/07/2006 (71 FR 17757)	NMFS 2018	NMFS 2021a	<p>The Sacramento River contains the only known green sturgeon spawning population in this DPS. The current estimate of spawning adult abundance is between 824-1,872 individuals.</p>	<ul style="list-style-type: none"> • Reduction of its spawning area to a single known population • Lack of water quantity • Poor water quality

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Southern DPS of eulachon	Threatened 03/18/2010 (75 FR 13012)	NMFS 2017d	NMFS 2022j	<p>Telemetry data and genetic analyses suggest that SDPS green sturgeon generally occur from Graves Harbor, Alaska to Monterey Bay, California and, within this range, most frequently occur in coastal waters of Washington, Oregon, and Vancouver Island and near San Francisco and Monterey bays. Within the nearshore marine environment, tagging and fisheries data indicate that Northern and SDPS green sturgeon prefer marine waters of less than a depth of 110 meters.</p>	<ul style="list-style-type: none"> • Poaching
Southern resident killer whale	Endangered 11/18/2005 (70 FR 69903)	NMFS 2008a	NMFS 2021b	<p>The Southern DPS 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</p>	<ul style="list-style-type: none"> • 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
Southern resident killer whale	Endangered 11/18/2005 (70 FR 69903)	NMFS 2008a	NMFS 2021b	<p>The Southern Resident killer whale DPS is composed of a single population that ranges as far south as central California and as far north as southeast Alaska. The estimated effective size of the population (based on the number of breeding individuals under ideal genetic conditions) is very small — <30 whales, or about 1/3 of the current population size. The small effective population size, the absence of gene</p>	<ul style="list-style-type: none"> • Quantity and quality of prey • Exposure to toxic chemicals • Disturbance from sound and vessels • Risk from oil spills

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
				flow from other populations, and documented breeding within pods may elevate the risk from inbreeding and other issues associated with genetic deterioration. As of July 1, 2013, there were 26 whales in J pod, 19 whales in K pod and 37 whales in L pod, for a total of 82 whales. Estimates for the historical abundance of Southern Resident killer whales range from 140 whales (based on public display removals to 400 whales, as used in population viability analysis scenarios.	

* Updated viability data are available from Ford 2022 and SWFSC 2023, although updated 5-year reviews have not been completed for these species.

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.).

2.2.1.1 Puget Sound Chinook Salmon

Abundance and Productivity

The current abundance for PS Chinook salmon populations is displayed in Table 3, below. 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.

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 failures, human error, disease, 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 juvenile Chinook salmon annually.

Table 3. Recent Five-Year Geometric Means for Estimated PS Chinook Juvenile Outmigrations and Adult Returns (Ford 2022) (LHIA=Listed hatchery, intact adipose (fin); LHAC= listed hatchery, adipose-clipped).

Life Stage	Origin	Outmigration/Return
Adult	Natural	23,371
Adult	Hatchery	23,232
Juvenile	Natural	3,728,240
Juvenile	LHIA	8,680,000
Juvenile	LHAC	25,624,500

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 less than 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-1980s. In recent years, only five populations have had productivities above zero. These are Lower Skagit, Upper Skagit, Lower Sauk, Upper Sauk, and Suiattle, all Skagit River populations are in the Whidbey Basin MPG. The overall pattern continues the decline reported in the Northwest Fishery Science Center's 2015 viability assessment (Ford 2022).

None of the 22 Puget Sound populations meets 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 five 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-tag 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.

Juvenile listed hatchery PS steelhead abundance estimates come from the annual hatchery production goals (WDFW 2022). The combined hatchery production goal for listed PS steelhead is roughly 279 thousand juveniles annually (Table 4).

Table 4. Recent Five-Year Geometric Means for Estimated PS Steelhead Juvenile Outmigrations and Adult Returns (Ford 2022).

Life Stage	Origin	Outmigration/Return
Adult	Natural	18,196
Adult	Hatchery	1,618
Juvenile	Natural	2,253,842
Juvenile	LHIA	53,000
Juvenile	LHAC	226,000

No Abundance information is available 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. While increases in spawner abundance were observed in a number of populations over the last five 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 major population group 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 five 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 Puget Sound/Georgia Basin Rockfish

The VSP criteria described by McElhaney et al. (2000) identified spatial structure, diversity, abundance, and productivity as criteria to assess the viability of salmonid species because these

criteria encompass a species' "reproduction, numbers, or distribution" as described in 50 CFR 402.02. These viability criteria reflect concepts that are well founded in conservation biology and are generally applicable to a wide variety of species because they describe demographic factors that individually and collectively provide strong indicators of extinction risk for a given species (Drake et al. 2010), and are therefore applied here for PS/GB bocaccio.

Life history traits of yelloweye rockfish and PS/GB bocaccio suggest generally low levels of inherent productivity because they are long-lived, mature slowly, and have sporadic episodes of successful reproduction (Musick 1999; Tolimieri and Levin 2005). Using several available, but spatiotemporally patchy, data series on rockfish occurrence and abundance in Puget Sound Tolimieri et al. (2017) determined that total rockfish declined at a rate of 3.1 to 3.8 percent per year from 1977 to 2014, or a 69 to 76 percent total decline over that period. The two listed DPSs declined over-proportional compared to the total rockfish assemblage. Therefore, long-term population growth rate for the listed species was likely even lower (more negative) than that for total rockfish. While there is little to no evidence of recent recovery of total groundfish abundance in response to protective measures enacted over the last 25 years (Essington et al. 2021), increases in the prevalence of several life stages of the more common rockfish species have been observed (Pacunski et al. 2020; LeClair et al. 2018). Given the slow maturation rate, episodic recruitment success, and rarity of yelloweye and bocaccio, combined with targeted fisheries being closed for over a decade, insufficient data exist to assess the recent recovery trajectory of these species.

Factors currently limiting recovery for PS/GB DPS yelloweye and bocaccio include (NMFS 2017d):

- Fishery mortality (commercial and recreational bycatch)
- Derelict fishing gear in nearshore and deep-water environments
- Degraded water quality (chemical contamination, hypoxia, nutrients)
- Climate change (ocean warming and acidification)
- Habitat degradation (rocky habitat loss of eelgrass and kelp, nearshore development disrupting juvenile rearing and food production)

2.2.1.3.1 Puget Sound/Georgia Basin DPS Bocaccio

The PS/GB bocaccio DPS was listed as endangered on April 28, 2010 (75 FR 22276). In April 2016, we completed a 5-year status review that recommended the DPS retain its endangered classification (Tonnes et al. 2016), and we released a recovery plan in October 2017 (NMFS 2017a).

Abundance and Productivity

In 2013, the Washington Department of Fish and Wildlife (WDFW) published abundance estimates from a remotely operated vehicle (ROV) survey conducted in 2008 in the San Juan Island area (Pacunski et al. 2013). This survey was conducted exclusively within rocky habitats and represents the best available abundance estimates to date for one basin of the DPS. The survey produced an estimate of 4,606 (100 percent variance) PS/GB bocaccio in the San Juan area (Tonnes et al. 2016). We currently lack the necessary information to make an informed estimate of the abundance of other

age classes. Though the WDFW has produced other ROV-based estimates of rockfish biomass in Washington waters of the DPSs, none have both covered the entirety of the DPSs and had sufficient sample size to accurately estimate population size for rare species such as bocaccio.

Table 5. Estimated Adult Bocaccio Abundance (Pacunski et al. 2013).

Life Stage	Origin	Abundance
Adult	Natural	4,606

The PS/GB bocaccio DPS exists at very low abundance and observations are relatively rare. No reliable range-wide historical or contemporary population estimates are available for the PS/GB bocaccio DPS. It is believed that prior to contemporary fishery removals, each of the major PS/GB basins likely hosted relatively large, though unevenly distributed, populations of PS/GB bocaccio. They were likely most common within the South Sound and Main Basin, but were never a predominant segment of the total rockfish abundance within the region (Drake et al. 2010). The best available information indicates that between 1965 and 2007, total rockfish populations have declined by about 70 percent in the Puget Sound region, and that PS/GB bocaccio have declined by an even greater extent (Drake et al. 2010; Tonnes et al. 2016; NMFS 2017a).

Structure and Diversity

The PS/GB bocaccio DPS includes all bocaccio from inland marine waters east of the central Strait of Juan de Fuca and south of the northern Strait of Georgia, collectively known as the Salish Sea. The waters of Puget Sound and Straits of Georgia can be divided into five interconnected basins that are largely hydrologically isolated from each other by relatively shallow sills. The basins within US waters are: (1) San Juan, (2) Main, (3) South Sound, and (4) Hood Canal. The fifth basin consists of Canadian waters east and north of the San Juan Basin into the Straits of Georgia. Although most individuals of the PS/GB bocaccio DPS are believed to remain within the basin of their origin, including larvae and pelagic juveniles, some movement between basins occurs, and the DPS is currently considered a single population (Tonnes et al. 2016). Research intended to assess this assumption using genetic techniques was unable to collect sufficient samples for analysis (Andrews et al. 2018), but is ongoing.

2.2.1.3.2 Puget Sound/Georgia Basin DPS Yelloweye Rockfish

The PS/GB yelloweye DPS was listed as threatened on April 28, 2010 (75 FR 22276). In April 2016, we completed a 5-year status review that recommended the DPS retain its threatened classification (Tonnes et al. 2016), and we released a recovery plan in October 2017 (NMFS 2017a).

Abundance and Productivity

In 2013, WDFW published abundance estimates from a remotely operated vehicle (ROV) survey conducted in 2008 in the San Juan Island area (Pacunski et al. 2013). This survey was conducted exclusively within rocky habitats and represents the best available abundance estimates to date for

one basin of the DPS. The survey produced an estimate of 47,407 (25 percent variance) adult yelloweye rockfish (Tonnes et al. 2016). We currently lack the necessary information to make an informed estimate of the abundance of other age classes. Though the WDFW has produced other ROV-based estimates of rockfish biomass in Washington waters of the DPSs, none have both covered the entirety of the DPSs and had sufficient sample size to accurately estimate population size for rare species such as yelloweye.

Table 6. Estimated Adult Yelloweye Rockfish Abundance (Pacunski et al. 2020).

Life Stage	Origin	Abundance
Adult	Natural	114,494

Yelloweye rockfish within U.S. waters of the PS/GB are very likely the most abundant within the San Juan and Hood Canal Basins. In Puget Sound, catches of PS/GB yelloweye rockfish have declined as a proportion of the overall rockfish catch in the decades preceding listing (Drake et al. 2010). Adult PS/GB yelloweye rockfish also typically occupy relatively small ranges (Love et al. 2002), and the extent to which they may move to find suitable mates is unknown. Yelloweye rockfish productivity is therefore potentially vulnerable to an Allee effect, where at small population sizes the decreased probability of adults encountering potential mates leads to continual decline of productivity and population density, and ultimately extinction. However, there is insufficient information to determine that this is currently occurring for yelloweye rockfish, and this question warrants further research (Hutchings and Reynolds 2004).

Structure and Diversity

The PS/GB bocaccio DPS includes all yelloweye rockfish found in waters of Puget Sound, the Strait of Juan de Fuca east of Victoria Sill, the Strait of Georgia, and Johnstone Strait. Recent collection and analysis of PS/GB yelloweye rockfish tissue samples revealed significant genetic differentiation between the inland (DPS) and coastal yelloweye samples (Andrews et al. 2018). These new data are consistent with and further support the existence of a population of PS/GB yelloweye rockfish that is discrete from coastal populations, an assumption that was made at the time of listing based on proxy species including quillback and copper rockfish (Ford 2015; Tonnes et al. 2016).

In addition, yelloweye rockfish from Hood Canal were genetically differentiated from other PS/GB yelloweye, indicating a previously unknown degree of population differentiation within the DPS (Ford 2015; Tonnes et al. 2016; Andrews et al. 2018). Other genetic analysis has found that yelloweye rockfish in the Georgia Basin had the lowest molecular genetic diversity of a collection of samples along the coast (Siegle et al. 2013). Although the adaptive significance of such microsatellite diversity is unclear, it may suggest low effective population size, increased drift, and thus lower genetic diversity in the PS/GB yelloweye DPS. Yelloweye rockfish spatial structure and connectivity is threatened by the apparent reduction of fish within each of the basins of the DPS, as they were once prized fishery targets. This reduction is probably most acute within the basins of Puget Sound proper. The severe reduction of fish in these basins may eventually result in a contraction of the DPS' range.

2.2.1.4 Hood Canal Summer-run Chum Salmon

Abundance and Productivity

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). Fifteen-year trends in log natural-origin spawner abundance over two time periods (1990 – 2005 and 2004 – 2019) show strongly positive trends in the two populations in the first time period, but abundance trends for both populations 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 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). Abundance estimates for the ESU components are listed below.

Table 7. Recent 5-Year Geometric Means for Estimated HCS Chum Juvenile Outmigrations and Adult Returns (Ford 2022).

Life Stage	Origin	Outmigration/Return
Adult	Natural	28,117
Adult	Hatchery	881
Juvenile	Natural	4,240,958

Productivity for this ESU had increased at the time of the last review (NWFSC 2015) but has been down for the last 3 years for the Hood Canal population, and for the last four years for the Strait of Juan de Fuca population (Ford 2022). Productivity rates have varied above and below replacement rates over 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. Four artificial propagation programs were initially listed as part of the ESU (79 FR 20802). 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.

Hatchery contribution varies greatly among the spawning aggregations within each population. It is generally 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 generally decreased over the last several years as supplementation programs were terminated as planned (Ford 2022). All were ended by 2011 in the Strait of Juan de Fuca population, and by 2017 in the Hood Canal population.

Recent analyses suggested the Hood Canal population would be considered to be at negligible risk of extinction considering current biological performance, provided that the exploitation rate remains very low (Ford 2022). The Strait of Juan de Fuca population had a much higher risk of extinction, even with a zero exploitation rate. As noted above, since 2017, both populations have experienced much lower returns, and a 2020 analysis showed considerably reduced population performance under a changing ocean climate (Ford 2022).

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 review (NWFSC 2015) but has been down for the last 3 years for the Hood Canal population, and for the last four years for the Strait of Juan de Fuca population. Productivity of individual spawning aggregates shows only two of eight aggregates have viable performance. Spatial structure and diversity viability parameters, as originally determined by the TRT have improved and nearly meet the viability criteria for both populations. 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, however. Overall, the Hood Canal summer chum salmon ESU therefore remains at moderate risk of extinction, with viability largely unchanged from the 2015 status review.

2.2.1.5 Upper Columbia River Spring-run Chinook Salmon

Abundance and Productivity

To estimate abundance of juvenile natural and hatchery UCR spring-run Chinook salmon, we calculate the geometric means for outmigrating smolts over the past five years by using annual abundance estimates provided by the NWFSC (Zabel 2017, 2018, 2020, 2021, 2022). To estimate the abundance figures for adult returns, we used the geometric means of the last five years of adult returns as reported by the NWFSC (Ford 2022). The figures for adults are broken down by natural and hatchery fish, but not into individual hatchery components (i.e., LHAC and LHIA). Abundance estimates for the ESU components are listed below.

Table 8. Recent 5-Year Geometric Means for Estimated UCR Chinook Juvenile Outmigrations and Adult Returns (Ford 2022; Zabel 2017, 2018, 2020, 2021, 2022).

Life Stage	Origin	Outmigration/Return
Adult	Natural	813
Adult	Hatchery	1,140
Juvenile	Natural	488,401
Juvenile	LHIA	470,744
Juvenile	LHAC	682,958

These adult return numbers represent substantial reductions from levels seen in the last status review (NWSFC 2015). Since that time, all three populations have seen approximately 50% reductions in natural spawners. All populations in the ESU have low (< 1.0) R/S (recruit/spawner) values, indicating that the natural replacement rate is not keeping up with all sources of mortality across the animals' life cycle. In addition, the 15-year (2004-2019) linear regressions for natural spawner

abundances are negative for all three populations in the ESU (Ford 2022). Thus, both abundance and productivity have been decreasing for all UCR Chinook populations for the last several years and the populations all remain well below the Interior Columbia Basin Technical Recovery Team’s (ICTRT’s) minimum viability thresholds for natural abundance (ICTRT 2007). All three populations are considered to be at high risk of extinction stemming from factors related to abundance and productivity.

Structure and Diversity

Excluding one extirpated population, the UCR Chinook ESU is made up of three extant populations (Methow, Wenatchee, and Entiat), all of which have some hatchery spawner component, though the Entiat population is not currently being directly supplemented. The natural spawner components for all three populations had been increasing since approximately 2009, but the trend has been downward for the last two years in all cases. Currently, the natural component of the Methow population is 37% (an increase since the last status review), the Wenatchee population natural component is 43% (also an increase), and the Entiat is 70% natural spawners (a decrease since the last review) (Ford 2022). The spatial structure risk ratings for the populations range from low to moderate, but due to the high levels of hatchery fish on the populations’ spawning grounds, the diversity risk is still rated as high for all three populations.

Because the risks ratings for abundance and productivity also remain high, the integrated overall risk ratings covering all VSP parameters remain high for all three populations and overall viability has not markedly changed since the last status review.

2.2.1.6 Upper Columbia River Steelhead

Abundance and Productivity

To estimate abundance of juvenile natural and hatchery UCR steelhead, we calculate the geometric means for outmigrating smolts over the past five years by using annual abundance estimates provided by the NWFSC (Zabel 2017, 2018, 2020, 2021, 2022). To calculate the abundance figures for adult returns, we took the geometric means of the last five years of adult returns—as estimated by expanded redd surveys, carcass counts, dam counts, and run-at-large PIT tag detections (Ford 2022). The figures for adults are broken down by natural and hatchery fish, but not into individual hatchery components (i.e., LHAC and LHIA) (Table 8).

Table 9. Recent Five-Year Geometric Means for Estimated UCR Steelhead Juvenile Outmigrations and Adult Returns (Ford 2022; Zabel 2017 2018, 2020, 2021, 2022).

Life Stage	Origin	Outmigration/Return
Adult	Natural	1,465
Adult	Hatchery	2,893
Juvenile	Natural	150,459
Juvenile	LHIA	139,810
Juvenile	LHAC	765,850

These adult return numbers represent substantial reductions from levels seen in the last status review (NWSFC 2015). Since that time, all four populations have seen reductions in natural spawners—these reductions range from 28% (Methow R.) to 63% (Wenatchee R.). All populations in the DPS have low (< 1.0) R/S (recruit/spawner) values, indicating that the natural replacement rate is not keeping up with all sources of mortality across the animals’ life cycle. In addition, the 15-year (2004-2019) linear regressions for natural spawner abundances are negative for all four populations in the DPS (Ford 2022). Thus, both abundance and productivity have been decreasing for all four UCR steelhead populations for the last several years and they all remain well below the ICTRT’s minimum viability criteria (ICTRT 2007). The Methow, Entiat, and Okanogan populations are considered to be at high risk of extinction stemming from factors related to abundance and productivity; the Wenatchee population is considered to be at moderate risk relative to these factors.

Structure and Diversity

The UCR steelhead DPS is made up of four populations (Methow, Wenatchee, Entiat, and Okanogan) all of which have some hatchery spawner component, though the Entiat population is not currently being directly supplemented. The natural spawner components for all four populations have been increasing since approximately 2000, but the trend has been downward for the Wenatchee R. population in recent years. Currently, the natural components of the populations range from 24% (Okanogan) to 50% (Wenatchee) (Ford 2022).

The integrated spatial structure and diversity risk ratings for the populations are high for all four populations. Because the risks ratings for abundance and productivity are also high for all but the Wenatchee population, the integrated overall risk ratings covering all VSP parameters remain high for all populations in the DPS and viability concerns remain acute.

2.2.1.7 Middle Columbia River Steelhead

Abundance and Productivity

To estimate abundance of juvenile natural and hatchery MCR steelhead, we calculate the geometric means for outmigrating smolts over the past five years by using annual abundance estimates provided by the NWFSC (Zabel 2017, 2018, 2020, 2021, 2022). To estimate the abundance figures for adult returns, we used the geometric means of the last five years of adult returns as reported by the NWFSC (Ford 2022). The figures for adults are broken down by natural and hatchery fish, but not into individual hatchery components (i.e., LHAC and LHIA). Abundance estimates for the DPS components are listed below (Table 9).

Table 10. Recent 5-Year Geometric Means for Estimated MCR Steelhead Juvenile Outmigrations and Adult Returns (Ford 2022; Zabel 2017, 2018, 2020, 2021, 2022).

Life Stage	Origin	Outmigration/Return
Adult	Natural	13,598
Adult	Hatchery	713
Juvenile	Natural	351,481

Life Stage	Origin	Outmigration/Return
Juvenile	LHIA	113,302
Juvenile	LHAC	372,581

In all but one population (Klickitat R.), these adult return numbers represent substantial reductions from levels seen in the last status review (NWSFC 2015). Since that time, 16 out of the DPS's 17 extant populations have seen reductions in natural spawners that range from 15% (upper Yakima R.) to 70% (eastside Deschutes R.). In addition, only four populations show productivity increases over the last 14 years, and all populations in the DPS have demonstrated decreases in productivity during the most recent 3-five years for which we have data (Ford 2022). Thus, both abundance and productivity have been decreasing for essentially all MCR steelhead populations for the last several years; however, five populations remain above the ICTRT's minimum viability thresholds for natural abundance (ICTRT 2007) and several more are near their thresholds. In addition, freshwater productivity indices (FWPIs) are above 1.0 for all populations except the Umatilla—indicating that poor marine survival could be driving most of the downturns. The result is that most of the populations are considered to be at moderate extinction risk with regard to abundance and productivity criteria, but three (Deschutes R. westside, Rock Cr., and Touchet R.) are considered to be at high risk (Ford 2022).

Structure and Diversity

The MCR steelhead DPS comprises two extirpated and 17 extant populations from four major population groups. Thirteen of the populations are made up of 96% (or more) natural spawners. Of the remaining four, only the Touchet R. (at 76%) comprises less than 85% natural fish (Ford 2022). This DPS also includes steelhead from the four artificial propagation programs (FR 85 81822), but does not currently include steelhead that are designated as part of an experimental population. The integrated extinction risks associated with spatial structure and diversity are rated as moderate for 14 populations, low for two populations, and high for only one—the upper Yakima R., due to its high diversity-related risk. These ratings represent little change from the last status review.

General viability ratings for all the populations range from “high risk” to “highly viable,” with most populations falling in the “maintained” category. As a result, overall, the MCR steelhead DPS remains at moderate risk of extinction, with viability essentially unchanged from the last review.

2.2.1.8 Snake River Spring/Summer-run Chinook Salmon

Abundance and Productivity

To estimate abundance of juvenile natural and hatchery SnkR spr/sum Chinook, we calculate the geometric means for outmigrating smolts over the past five years by using annual abundance estimates provided by the NWFSC (Zabel 2017, 2018, 2020, 2021, 2022). To estimate the abundance figures for adult returns, we used the geometric means of the last five years of adult returns as reported by the NWFSC (Ford 2022). The figures for adults are broken down by natural

and hatchery fish, but not into individual hatchery components (i.e., LHAC and LHIA). Abundance estimates for the ESU components are listed below.

Table 11. Recent 5-Year Geometric Means for Estimated SnkR spr/sum Chinook Juvenile Outmigrations and Adult Returns (Ford 2022; Zabel 2017, 2018, 2020, 2021, 2022).

Life Stage	Origin	Outmigration/Return
Adult	Natural	4,419
Adult	Hatchery	2,822
Juvenile	Natural	682,600
Juvenile	LHIA	695,385
Juvenile	LHAC	4,743,977

The most recent 5-year geometric mean abundance estimates for 26 out of the ESU's 27 populations show a consistent and marked pattern of declining population size (one showed a slight increase from previously very low levels), with natural spawner abundance levels for the 27 populations declining by an average of 55% (Ford 2022). In five cases, the natural spawner reductions are greater than 70% and, for total spawners, the reductions are 80% or more in four populations. Similarly, all 27 populations have shown declines in productivity over the last three to five years for which we have information; however, FWPIs remain above 1.0 for 17 out of the 22 populations for which we have data—indicating that marine survival may largely be driving the productivity declines. As a result of all these negative trends, the integrated abundance and productivity extinction risks for this ESU are rated as high for all but three populations rated as moderate and two for which there is insufficient data to assign a risk rating. None of the 27 populations meets or exceeds its ICTRT minimum viability abundance threshold (ICTRT 2007).

Structure and Diversity

The SnkR spr/sum Chinook salmon ESU comprises 27 extant populations from among five MPGs. The fraction of natural fish on the spawning grounds ranges from 24% (Grand Ronde R. upper mainstem) to 100% (14 populations); as a result, the hatchery fraction for each population is somewhat variable, but well over half of the populations are made up of more than 90% natural fish. Further, since the mid-1990s, there has been a concerted effort to decrease out-of-basin hatchery supplementation for this ESU and increase the use of local broodstock—so in many cases the hatchery fraction is derived from local stock. Nonetheless, The ESU also includes spring/summer-run Chinook salmon from thirteen artificial propagation programs (85 FR 81822). Because the populations commonly remain well distributed, the integrated structure/diversity risk ratings for this ESU are generally low to moderate, but four populations are rated as being at high risk for these factors.

Overall viability ratings for this ESU's populations are given as high risk for all but three populations that are considered maintained. As a result, the ESU as a whole is considered to be at moderate to high risk, with viability largely unchanged from the last review.

2.2.1.9 Snake River Fall-run Chinook Salmon

Abundance and Productivity

To estimate abundance of juvenile natural and hatchery SnkR fall-run Chinook, we calculate the geometric means for outmigrating smolts over the past five years by using annual abundance estimates provided by the NWFSC (Zabel 2017, 2018, 2020, 2021, 2022). To calculate the abundance figures for adult returns, we took the geometric means of the last five years of adult returns—as estimated by dam counts, PIT-stag studies, parental-based-tagging, redd counts, and other methods (Ford 2022). The figures for adults are broken down by natural and hatchery fish, but not into individual hatchery components (i.e., LHAC and LHIA).

Table 12. Recent Five-Year Geometric Means for Estimated SnkR Fall Chinook Juvenile Outmigrations and Adult Returns (Ford 2022; Zabel 2017, 2018, 2020, 2021, 2022).

Life Stage	Origin	Outmigration/Return
Adult	Natural	7,262
Adult	Hatchery	14,879
Juvenile	Natural	799,765
Juvenile	LHIA	2,966,190
Juvenile	LHAC	2,608,733

The geometric mean natural adult abundance for the most recent 10 years (2010-2019) is 8,920. This is higher than the 10-year geomean reported in the most recent status review (NWFSC 2015), but it includes a 34% reduction in natural spawners over the last five years. Nonetheless, while the population has not been able to maintain the higher returns it achieved in some years between 2010 and 2015, it has continued to remain above the ICTRT defined minimum abundance threshold of 3,000 natural adults (ICTRT 2007). Productivity has remained below replacement since 2010 (Ford 2022), but because the ESU has remained above the ICTRT abundance threshold, it is considered to be at low risk of extinction with regard to abundance and productivity factors.

Structure and Diversity

The SnkR fall-run Chinook salmon ESU is made up of one extant population spread out over five spatially complex spawning areas in the Snake River and lower mainstems of the Clearwater, Imnaha, Grande Ronde, Salmon and Tucannon rivers (ICTRT 2007). The ESU also includes fall-run Chinook salmon from four artificial propagation programs (85 FR 81822). The single population consists of 33% natural spawners—a 2% increase since the last status review (NMFS 2015). Because the ESU contains only one population that is made up largely of hatchery spawners, the integrated extinction risk for factors relating to structure and diversity is considered to be moderate. And while the one population is currently considered viable, the ESU is not meeting the recovery goals described in the recovery plan for the species—that would require the single population to be “highly viable with high certainty” and/or reintroduction of a viable population above the Hells Canyon Dam complex (NMFS 2017b).

The SnkR fall-run Chinook salmon ESU is therefore considered to be at moderate-to-low risk of extinction, with viability largely unchanged from the last review.

2.2.1.10 Snake River Basin Steelhead

Abundance and Productivity

To estimate abundance of juvenile natural and hatchery SnkR steelhead, we calculate the geometric means for outmigrating smolts over the past five years by using annual abundance estimates provided by the NWFSC (Zabel 2017, 2018, 2020, 2021, 2022). To calculate the abundance figures for adult returns, we took the geometric means of the last five years of adult returns—as estimated by dam counts, PIT-stag studies, genetics sampling, redd counts, and other methods (Ford 2022). The figures for adults are broken down by natural and hatchery fish, but not into individual hatchery components (i.e., LHAC and LHIA).

Table 13. Recent Five-Year Geometric Means for Estimated SnkR Steelhead Juvenile Outmigrations and Adult Returns (Ford 2022; Zabel 2017, 2018, 2020, 2021, 2022).

Life Stage	Origin	Outmigration/Return
Adult	Natural	9,965
Adult	Hatchery	3,285
Juvenile	Natural	573,245
Juvenile	LHIA	528,903
Juvenile	LHAC	3,058,720

The five-year geometric mean abundance estimates for all the populations in this DPS show significant declines in the recent past (Ford 2022). The population decreases ranged from 15% (Lochsa/Selway) to over 70% (Little Salmon/Rapid R.), with most declines somewhere in the 50% range.

These declines, following years of general increase, resulted in nearly zero population change over the past five years for the three populations with sufficiently long data time series to measure. Overall productivity among every population in the DPS has also declined over the last five years for which we have data. However, the freshwater component of productivity, as measured by FWPIs, has remained above 1.0 for every MPG in the DPS (Ford 2022)—which may indicate low marine survival rates are driving much of the recent declines. Given the abundance and productivity downturns in recent years, the DPS is now generally rated as being at moderate extinction risk for factors relating to abundance and productivity, though three populations are at very low risk and three are at high risk.

Structure and Diversity

The SnkR steelhead DPS comprises 23 extant populations from among five MPGs. The fraction of natural fish on the spawning grounds ranges from 14% (Little Salmon/Rapid R.) to 100% (Asotin

Cr.), so the hatchery fraction is somewhat variable, but 11 of the populations are made up of more than 95% natural fish. The DPS also includes steelhead from six artificial propagation programs (85 FR 81822). In the most recent status review, spatial structure risk ratings for all but one of the Snake Basin steelhead populations were considered to be low or very low because natural production is well distributed within those populations. (The single exception was Panther Creek, which was given a high risk rating.) The diversity risk ratings ranged from low (10 populations) to moderate (16 populations). As a result, all populations except Panther Cr. are considered to be at low to moderate extinction risk from factors relating to structure and diversity.

General viability ratings for all the populations range from “high risk” to “highly viable,” with most populations falling in the “maintained” category. As a result, overall, the SnkR steelhead DPS remains at moderate risk of extinction, with viability essentially unchanged from the last review.

2.2.1.11 Snake River Sockeye Salmon

Abundance and Productivity

To estimate abundance of juvenile natural and hatchery SnkR sockeye, we calculate the geometric means for outmigrating smolts over the past five years (2016-2020) by using annual abundance estimates provided by the NWFSC (Zabel 2017a, 2017b, 2018, 2020, 2021). To estimate the abundance figures for adult returns, we used the geometric means of the last five years of adult returns as reported by the NWFSC (Ford 2022). The figures for adults are broken down by natural and hatchery fish, but not into individual hatchery components (i.e., LHAC and LHIA). In addition, there are no LHIA juvenile fish in this ESU because all hatchery fish have their adipose fins clipped. Abundance estimates for the ESU components are listed below.

Table 14. Recent 5-Year Geometric Means for Estimated SnkR Sockeye Juvenile Outmigrations and Adult Returns (Ford 2022; Zabel 2017, 2018, 2020, 2021, 2022).

Life Stage	Origin	Outmigration/Return
Adult	Natural	16
Adult	Hatchery	97
Juvenile	Natural	18,000
Juvenile	LHAC*	298,464

*All listed hatchery fish in this ESU have had their adipose fins clipped.

After a number of years of small but steady increases, adult sockeye salmon returns to the Sawtooth Basin crashed in 2015 and natural returns have remained low since then (Ford 2022). The low returns of fish collected at the Redfish Lake and Sawtooth weirs have limited anadromous releases into Redfish Lake to a high of 311 hatchery fish in 2016, and no natural anadromous fish have been released since 2014 because they are required to be spawned in the captive broodstock program. Captive adult releases continue to support spawning in Redfish Lake, but productivity for this ESU is almost entirely due to the captive spawning efforts. Given the low returns in recent years, the production occurring almost entirely in hatchery environments, and the persistence of poor climatic conditions during times when the adult sockeye are migrating, the species’ extinction risk remains high for factors relating to abundance and productivity.

Structure and Diversity

The SnkR sockeye salmon ESU is made up of one extant population that persists only in portions of the upper Salmon River in the Stanley basin. It is dominated by hatchery production in the form of captive broodstock supplementation efforts. Given the ESU’s limited spatial structure and largely hatchery-driven constituency, the species remains at high extinction risk with regard to both the structure and diversity factors.

Thus, the Snake River Sockeye ESU remains at extremely high overall risk. Though there has been substantial progress in developing a hatchery-based program to amplify and conserve the stock to facilitate reintroductions, these measures have yet to take full effect. In addition, current climate change modeling supports the extremely high-risk rating and highlights the potential for extirpation in the near future (Ford 2022). The viability of the SnkR sockeye ESU therefore has likely declined since the time of the last review, and the extinction risk remains very high.

2.2.1.12 Lower Columbia River Chinook Salmon

Abundance and Productivity

To estimate abundance of juvenile natural and hatchery LCR Chinook, we calculate the geometric means for outmigrating smolts over the past five years by using annual abundance estimates provided by the NWFSC (Zabel 2017, 2018, 2020, 2021, 2022). To calculate the abundance figures for adult returns, we took the geometric means of the last five years of adult returns—as estimated by index reach redd counts, tributary weir counts, mark/recapture surveys, and hatchery trap, dam trap, and dam ladder counts (Ford 2022). The figures for adults are broken down by natural and hatchery fish, but not into individual hatchery components (i.e., LHAC and LHIA).

Table 15. Recent Five-Year Geometric Means for Estimated LCR Chinook Juvenile Outmigrations and Adult Returns (Ford 2022; Zabel 2017, 2018, 2020, 2021, 2022).

Life Stage	Origin	Outmigration/Return
Adult	Natural	29,298
Adult	Hatchery	18,814
Juvenile	Natural	11,135,315
Juvenile	LHIA	942,328
Juvenile	LHAC	30,923,844

The most recent five-year geometric mean abundance estimates for the ESU’s 32 demographically independent populations (DIPs) are highly variable. We only have recent natural and hatchery fish abundance data for 23 of the DIPs, and about half of them have seen decreases in natural spawners and about half have seen increases. However, all but two DIPs (Sandy R. spring-run and Lower Gorge tributaries fall-run) have shown decreases in productivity for the most recent years for which we have data. Of the 32 DIPs, only seven are at or near their recovery viability goals (Dornbusch

2013)—and six of those seven are from the same stratum (Cascade). All of the Coastal and Gorge MPG fall-run populations (except the Lower Gorge DIP) likely fell within the high to very-high risk categories for abundance and productivity. Similarly, with the exception of the Sandy River spring-run DIP, all of the spring-run DIPs in the Cascade and Gorge MPGs are at high to very high risk, with a number of populations at or near zero and others largely persisting through hatchery supplementation (Ford 2022).

Structure and Diversity

The LCR Chinook salmon ESU comprises 32 historic DIPs from among six MPGs (though we do not have VSP data for all of them). The ESU also includes Chinook salmon from eighteen artificial propagation programs (85 FR 81822). The fraction of natural fish on the spawning grounds ranges from 0.04% (Big Creek fall-run) to 100% in two DIPs (Lewis R. late-fall-run, Kalama R. spring-run). As a result, the hatchery fraction for each population is somewhat variable, but approximately 2/3 of the DIPs for which have data are made up of more than 50% natural fish. Further, while overall hatchery production for the ESU has been reduced slightly in recent years, hatchery fish still represent the majority of fish returning to the ESU (Ford 2022). In terms of structure, there have been a number of large-scale efforts to improve accessibility in this ESU (one of the primary metrics for spatial structure): Cowlitz R., Toutle R., Hood R. White Salmon R., etc. These efforts are showing some positive results and many are likely to support sustainable populations in previously inaccessible habitat sometime in the near future (5-10 years). As a result, the structure VSP criterion is improving for a number of LCR Chinook populations.

Overall, there has been modest change since the last status review in the biological status of Chinook salmon populations in the Lower Columbia River ESU (NWFSC 2015), although some populations do exhibit marked improvements. Increases in abundance were noted in about half of the fall-run populations and 75% of the spring-run population for which data were available. Decreases in hatchery contribution were also noted for several populations. Relative to baseline VSP levels identified in the Recovery Plan (NMFS 2013a), there has been an overall improvement in the status of a number of fall-run populations, although most are still far from the recovery plan goals. In summation, LCR Chinook viability has increased somewhat since the last status review, but the ESU remains at moderate risk of extinction.

2.2.1.13 Lower Columbia River Coho Salmon

Abundance and Productivity

To estimate current abundance of juvenile natural and hatchery LCR coho salmon, we calculate the geometric means for outmigrating smolts over the past five years by using annual abundance estimates provided by the NWFSC (Zabel 2017, 2018, 2020, 2021, 2022). 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-tag studies, redd counts, and other methods (Ford 2022).

Table 16. Recent Five-Year Geometric Means for Estimated LCR Coho Juvenile Outmigrations and Adult Returns (Ford 2022; Zabel 2017, 2018, 2020, 2021, 2022).

Life Stage	Origin	Outmigration/Return
Adult	Natural	18,714
Adult	Hatchery	15,949
Juvenile	Natural	827,007
Juvenile	LHIA	324,130
Juvenile	LHAC	7,941,886

The 2015 status review update (NWFSC 2015) occurred at a time of near-record returns for several LCR coho populations, but conditions have worsened substantially since then, so the ESU abundance has declined markedly during the last five years. Natural spawner and total abundances have decreased in almost all populations, and Coastal and Gorge Strata populations are all at low levels with significant numbers of hatchery-origin coho salmon on the spawning grounds. Only six of the 23 populations for which we have data appear to be above their recovery goals (Ford 2022). This includes the Youngs Bay DIP and Big Creek DIP, which have very low recovery goals, and the Salmon Creek DIP and Tilton River DIP, which were not assigned goals but have relatively high abundances. Of the remaining DIPs in the ESU, 3 DIPs are at 50-99% of their recovery goals, seven DIPs are at 10-50% of their recovery goals, and seven populations are at less than 10% of their recovery goals (this includes the Lower Gorge DIP for which there are no data, but it is assumed that the abundance is low).

Spatial Structure and Diversity

The LCR coho salmon ESU is composed of all naturally spawned populations of coho salmon in the Columbia River and its tributaries in Washington and Oregon, from the mouth of the Columbia River up to and including the Big White Salmon and Hood Rivers, and including the Willamette River to Willamette Falls, Oregon. The ESU also includes twenty-one artificial propagation programs are part of the ESU (85 FR 81822). Before they were listed under the ESA, the coho salmon in the Columbia River were managed primarily as a hatchery stock. Coho were present in all lower Columbia River tributaries, but the run now consists of very few wild fish. It is possible that some native coho populations are now extinct, but the presence of naturally spawning hatchery fish makes it difficult to ascertain. The strongest remaining populations occur in Oregon and include the Clackamas River and Scappoose Creek.

There have been a number of large-scale efforts to improve accessibility, one of the primary metrics for spatial structure, in this ESU. Dams were removed over ten years ago on the Hood and White Salmon rivers. Fish passage operations (trap and haul) are ongoing on the Lewis and Cowlitz, and Toutle rivers. Hatchery production has been relatively stable and the proportion of hatchery-origin fish on the spawning grounds has increased for some populations and decreased for others. The transition from segregated hatchery programs to integrated local broodstock programs should reduce the risks from domestication and non-native introgression.

There have likely been incremental improvements in spatial structure during the last five years, but poor ocean and freshwater conditions have masked any benefits from these changes. Similarly, improvements in fish passage at culverts has improved, with 132 km (79 miles) of stream habitat being opened up in Washington State alone since 2015 (LCFRB 2020), but there are a large number of small-scale fish barriers that remain to be upgraded or removed.

Overall abundance trends for the ESU are generally negative. In light of the poor ocean and freshwater conditions that occurred during much of this recent review period, it should be noted that some of the populations exhibited resilience and only experienced relatively small declines in abundance (Ford 2022). Some populations were exhibiting positive productivity trends during the last year of review, representing the return of the progeny from the 2016 adult return (Ford 2022). Improvements in diversity and spatial structure have been slight and overshadowed by declines in abundances and productivity. For individual populations, the risk of extinction spans the full range from low to very high. Overall, the LCR coho ESU remains at moderate risk, and viability is largely unchanged from the last status review.

2.2.1.14 Lower Columbia River Steelhead

Abundance and Productivity

To estimate abundance of juvenile natural and hatchery LCR steelhead, we calculate the geometric means for outmigrating smolts over the past five years by using annual abundance estimates provided by the NWFSC (Zabel 2017, 2018, 2020, 2021, 2022). To calculate the abundance figures for adult returns, we took the geometric means of the last five years of adult returns—as estimated by expanded redd surveys, index and census surveys, dam and weir counts, and adult mark-resight studies during prespawm holding (Ford 2022).

Table 17. Recent Five-Year Geometric Means for Estimated LCR Steelhead Juvenile Outmigrations and Adult Returns (Ford 2022; Zabel 2017 2018, 2020, 2021, 2022).

Life Stage	Origin	Outmigration/Return
Adult	Natural	8,152
Adult	Hatchery	6,382
Juvenile	Natural	375,208
Juvenile	LHIA	14,801
Juvenile	LHAC	1,183,963

Total spawner counts are available for 17 (of 21) DIPs, but the wild spawner fraction is known for only six of those populations. Total spawners have increased in nine of the DIPs since the most recent review (NWFSC 2015), and of the six DIPs with known wild spawner fractions, three have increased, two have decreased, and one remains essentially unchanged. However, productivity has decreased for all six of those DIPs. We do not have any productivity data for the rest of the LCR steelhead DIPs because we do not know how many wild fish are returning to them. For most winter-run populations, the trend in the 2015 to 2019 period is strongly negative as expressed in annual productivity estimates. There is some concern that this downward trend may be indicative of

something more systemic than short-term freshwater or oceanic conditions. For most summer-run DIPS, the changes in 5-year abundances have been not substantial, however recent negative trends are of concern here as well (Ford 2022).

Structure and Diversity

The LCR steelhead DPS comprises 23 DIPs that come from four MPGs—two winter-run and two summer-run. This DPS also includes steelhead from eight artificial propagation programs (FR 85 81822), so all of the DIPs experience some hatchery influence, though hatchery production has decreased from 3 million smolts to 2.75 million since the last review (Ford 2022). Among the DIPs for which we know the numbers of wild spawners, the range is from 49% natural fish (upper Cowlitz R. winter-run) to 94% natural fish (Sandy R. winter-run). In terms of structure, there have been a number of large-scale efforts to improve accessibility for this DPS—e.g., upper Cowlitz, Cispus, and Tilton Rivers. However, structure remains a concern, especially for those populations that rely on adult trap-and-haul programs and juvenile downstream passage structures for sustainability (Ford 2022).

Of the 23 DIPs in the LCR steelhead DPS, 10 are putatively at or above the goals set in the recovery plan (Dornbusch 2013); however, many of these abundance estimates do not distinguish between natural and hatchery-origin spawners. Although a number of DIPs exhibited increases in their 5-year geometric mean, others remain depressed, and neither the winter- nor summer-run MPGs are near viability in the Columbia River Gorge. Overall, the LCR steelhead are therefore considered to be at moderate risk, and their viability is largely unchanged from the most recent review (Ford 2022).

2.2.1.15 Columbia River Chum Salmon

Abundance and Productivity

To estimate current abundance of juvenile natural and hatchery CR chum salmon, we calculate the geometric means for outmigrating smolts over the past five years by using annual abundance estimates provided by the NWFSC (Zabel 2017, 2018, 2020, 2021, 2022). To estimate the abundance of adult spawners, we took the geometric means of the last five years of adult returns—as estimated by dam and weir counts, tributary surveys, mark-recaptures studies, radio-tag studies, PIT-tag studies, redd counts, and other methods (Ford 2022).

Table 18. Recent Five-Year Geometric Means for Estimated CR Chum Juvenile Outmigrations and Adult Returns (Ford 2022; Zabel 2017, 2018, 2020, 2021, 2022).

Life Stage	Origin	Outmigration/Return
Adult	Natural	17,305
Adult	Hatchery	1,145
Juvenile	Natural	7,777,554
Juvenile	LHIA *	554,973

*There are no listed adipose-fin-clipped fish in this ESU.

Of the 17 historical populations identified, only three currently exceed the abundance targets in the recovery plan (NMFS 2013). The remaining populations have unknown abundances, although it is reasonable to assume that the abundances are very low and unlikely to be more than 10% of the established recovery goals. Even with the improvements observed in three populations over the last five years, the majority of populations in this ESU remain at a very high risk for abundance and productivity factors.

Spatial Structure and Diversity

The Willamette/Lower Columbia River Technical Recovery Team (WLC-TRT) identified 17 historical populations divided into three major population groups. Three artificial propagation programs are also considered to be part of the ESU (85 FR 81822). Currently, spawning populations of CR chum salmon are limited to tributaries below Bonneville Dam, with most spawning occurring in the Grays River, near the mouth of the Columbia River, and Hardy and Hamilton Creeks, approximately three miles below Bonneville Dam. In contrast to other species, mainstem dams have less of an effect on chum salmon distribution. Rather, it is smaller, stream-scale blockages that limit chum access to spawning habitat. Upland development can also affect the quality of spawning habitat by disrupting the groundwater upwelling that chum prefer. In addition, juvenile habitat has been curtailed through dikes and revetments that block access to riparian areas that are normally inundated in the spring. Loss of lower river and estuary habitat probably limits the species' ability to expand and recolonize historical habitat. Presently, detectable numbers of chum salmon persist in only four of the 17 demographically independent populations—a fraction of their historical range.

It is notable that during this most recent review period, the three populations (Grays River, Washougal, and Lower Gorge) improved markedly in abundance. In contrast, the other populations in this ESU have not exhibited any detectable improvement in status. Abundances for these populations are assumed to be at or near zero, and straying from nearby healthy populations do not seem sufficient to reestablish self-sustaining populations. The viability of this ESU is relatively unchanged since the last review, and the improvements in some populations do not warrant a change in risk category, especially given the uncertainty regarding climatic effects in the near future (Ford 2022). The CR chum salmon ESU therefore remains at moderate risk of extinction, and its viability is largely unchanged from the most recent review.

2.2.1.16 Upper Willamette River Chinook Salmon

Abundance and Productivity

To estimate current abundance of juvenile natural and hatchery UWR Chinook salmon, we calculate the geometric means for outmigrating smolts over the past five years by using annual abundance estimates provided by the NWFSC (Zabel 2017, 2018, 2020, 2021, 2022). To estimate the abundance of adult spawners, we used the geometric means of the last five years of adult returns as reported by the NWFSC (Ford 2022). Abundance estimates for the ESU components are listed below.

Table 19. Recent 5-Year Geometric Means for Estimated UWR Chinook Salmon Juvenile Outmigrations and Adult Returns (Ford 2022; Zabel 2017, 2018, 2020, 2021, 2022).

Life Stage	Origin	Outmigration/Return
Adult	Natural	10,531
Adult	Hatchery	25,380
Juvenile	Natural	1,159,334
Juvenile	LHIA	0
Juvenile	LHAC*	4,361,832

*All hatchery fish in this ESU have had their adipose fins clipped.

Abundance levels for all but one of this ESU’s seven populations remain well below their recovery goals. The Clackamas River currently exceeds its abundance recovery goal. In addition, the Calapooia River population may be functionally extinct and the Molalla River remains critically low (there is considerable uncertainty regarding the level of natural production in the Molalla River). Abundances in the North and South Santiam rivers have declined since the 2015 status review update (NWFSC 2015), with natural-origin abundances in the low hundreds of fish.

The Middle Fork Willamette River is at a very low abundance, even with the inclusion of natural origin spring-run Chinook salmon spawning in Fall Creek. While returns to Fall Creek Dam number in the low hundreds, prespawn mortality rates are very high in the basin; however, the Fall Creek program does provide valuable information on juvenile fish passage through operational drawdown. With the exception of the Clackamas River, the proportion of natural origin spawners in the remainder of the ESU are well below those identified in the recovery goals (ODFW and NMFS 2011). While the Clackamas River appears to be able to sustain above recovery goal abundances, even during relatively poor ocean and freshwater conditions, the remainder of the ESU is well short of its recovery goals.

Spatial Structure and Diversity

The Upper Willamette River Conservation and Recovery Plan for Chinook Salmon and Steelhead (ODFW and NMFS 2011) identifies seven demographically independent populations of spring Chinook salmon: Clackamas, Molalla, North Santiam, South Santiam, Calapooia, McKenzie, and the Middle Fork Willamette. The ESU also contains spring-run Chinook salmon from six artificial propagation programs (85 FR 81822). The recovery plan identifies the Clackamas, North Santiam, McKenzie and Middle Fork Willamette populations as “core populations” and the McKenzie as a “genetic legacy population.” Core populations are those that were historically the most productive populations. The McKenzie population is also important for meeting genetic diversity goals. Spatial structure—particularly access to historical spawning habitat—continues to be a concern.

In the absence of effective passage programs, spawners in the North Santiam, Middle Fork Willamette, and to a lesser extent South Santiam and McKenzie rivers will continue to be confined to more lowland reaches where land development, water temperatures, and water quality may be limiting. A second spatial structure concern is the availability of juvenile rearing habitat in side channel or off-channel habitat. River channelization and shoreline development have constrained habitat in the lower tributary reaches and Willamette river mainstem and this, in turn, has limited the potential for fry and subyearling “movers” emigrating to the estuary (Schroeder *et al.* 2016).

Overall, there has likely been a declining trend in the viability of the Upper Willamette Chinook salmon ESU since the 2015 status review. The magnitude of this change is not sufficient to suggest a change in risk category, however, so the Upper Willamette Chinook salmon ESU remains at moderate risk of extinction.

2.2.1.17 Upper Willamette River Steelhead

Abundance and Productivity

To estimate current abundance of juvenile natural and hatchery UWR Chinook salmon, we calculate the geometric means for outmigrating smolts over the past five years by using annual abundance estimates provided by the NWFSC (Zabel 2017, 2018, 2020, 2021, 2022). To estimate the abundance of adult spawners, we took the geometric means of the last five years of adult returns—as estimated by Willamette Falls adult bypass counts, PIT-stag studies, redd counts, and other methods (Ford 2022).

Table 20. Recent Five-Year Geometric Means for Estimated UWR Steelhead Juvenile Outmigrations and Adult Returns (Ford 2022; Zabel 2017, 2018, 2020, 2021, 2022).

Life Stage	Origin	Outmigration/Return
Adult	Natural	2,628
Adult	Hatchery	*
Juvenile	Natural	135,303

*This DPS contains no hatchery fish.

Populations in this DPS have experienced long-term declines in spawner abundance. The underlying causes of these declines are not well understood. Returning adult winter steelhead do not experience the same deleterious water temperatures as the spring-run Chinook salmon and prespawn mortalities are not likely to be significant. Although the recent magnitude of these declines is relatively moderate, the continued declines are a cause for concern (Ford 2022).

Spatial Structure and Diversity

The recovery plan for this DPS (ODFW and NMFS 2011) identifies four demographically independent populations of steelhead: Molalla, North Santiam, South Santiam, and Calapooia. No artificially propagated steelhead stocks are considered part of the listed species. The hatchery summer-run steelhead in the basin are an out-of-basin stock and not considered part of the DPS. Winter steelhead have been reported spawning in the west-side tributaries to the Willamette River, but these tributaries were not considered to have constituted an independent population historically. The west-side tributaries may serve as a population sink for the DPS (Myers et al. 2006).

Improvements to fish passage and operational temperature control at the dams on the North and South Santiam rivers continue to be a concern. It is unclear if sufficient high-quality habitat is available below Detroit Dam to support the population reaching its VSP recovery goal, or if some form of access to the upper watershed is necessary to sustain a “recovered” population. Similarly,

the South Santiam Basin may not be able to achieve its recovery goal status without access to historical spawning and rearing habitat above Green Peter Dam (Quartzville Creek and Middle Santiam River) and/or improved juvenile downstream passage at Foster Dam.

While the diversity goals are partially achieved through the closure of winter-run steelhead hatchery programs in the Upper Willamette River, there is some concern that the summer-run steelhead releases in the North and South Santiam rivers may be influencing the viability of native steelhead.

Overall, the UWR steelhead DPS continued to decline in abundance since the previous status review in 2015. While the viability of the ESU appears to be declining, the recent uptick in abundance may provide a short-term demographic buffer. Although the most recent counts at Willamette Falls and the Bennett dams in 2019 and 2020 suggest a rebound from the record 2017 lows, it should be noted that current “highs” are equivalent to past lows. Introgression by non-native summer-run steelhead continues to be a concern. Genetic analysis suggests that there is introgression among native late-winter steelhead and summer-run steelhead (Van Doornik et al. 2015, Johnson et al. 2018, Johnson et al. 2021). Accessibility to historical spawning habitat is still limited, especially in the North Santiam River. Efforts to provide juvenile downstream passage at Detroit are well behind the prescribed timetable (NMFS 2008b), and passage at Green Peter Dam has not yet entered the planning stage. Much of the accessible habitat in the Molalla, Calapooia, and lower reaches of North and South Santiam rivers is degraded and under continued development pressure. Although habitat restoration efforts are underway, the time scale for restoring functional habitat is considerable. Overall, the Upper Willamette steelhead DPS therefore is at moderate-to-high risk, with a declining viability trend (Ford 2022).

2.2.1.18 Oregon Coast Coho Salmon

Abundance and Productivity

To estimate the abundance of adult spawners, we used the geometric means of the last five years of adult returns as reported by the NWFSC (Ford 2022). While we currently lack data on how many natural juvenile coho salmon this ESU produces, it is possible to make rough estimates of juvenile abundance from adult return data. By applying a very conservative value of 2,000 eggs per female to an estimated 30,631 females returning (half of 61,262) to this ESU, one may expect approximately 61.3 million eggs to be produced annually. Nickelson (1998) found survival of coho from egg to parr in Oregon coastal streams to be around 7%. Thus, we can estimate that roughly 4.3 million natural-origin juvenile coho salmon are produced annually by the Oregon Coast ESU. In addition, the Cow Creek OC coho salmon artificial propagation program has an annual release target of 60,000 juveniles in the Umpqua River (ODFW 2017). Abundance estimates for the ESU components are listed below,

Table 21. Recent 5-Year Geometric Means for Estimated OC Coho Juvenile Outmigrations and Adult Returns (Ford 2022).

Life Stage	Origin	Outmigration/Return
Adult	Natural	60,624
Adult	Hatchery	638
Juvenile	Natural	4,288,340
Juvenile	LHAC	60,000

The spawner abundance of coho salmon in the Oregon Coast ESU varies by time and population. The large populations (abundances > 6,000 spawners since 2015) include the Coos, Coquille, Nehalem, Tillamook, Asea, Siuslaw, and Lower Umpqua Rivers (Ford 2022). The total abundance of spawners in the ESU generally increased between 1999 and 2014, before dropping in 2015 and remaining low. The 2014 OC coho return (355,600 wild and hatchery spawners) was the highest since at least the 1950s (2011 was the second highest with 352,200), while the 2015 return (56,000 fish) was the lowest since the late 1990s. Most independent and dependent populations show synchronously high abundances in 2002-2003, 2009-2011 and 2014, and low abundances in 2007, 2012-2013, and now 2015-2019—this indicates the overriding importance of marine survival to returns of OC coho (Ford 2022).

Spatial Structure and Diversity

The geographic area occupied by the OC coho salmon ESU is physically diverse, and includes numerous rocky headlands and an extensive area with sand dunes. Most rivers the ESU's range drain the west slope of the Coast Range, with the exception the Umpqua River, which extends through the Coast Range to drain the Cascade Mountains (Weitkamp *et al.* 1995). While most coho salmon populations in the ESU use stream and riverine habitats, there is extensive winter lake rearing by juvenile coho salmon in several large lake systems. The Oregon and Northern California Coasts Technical Recovery Team identified 56 populations, including 21 independent and 36 dependent populations in five biogeographic strata (Lawson *et al.* 2007). The ESU also includes the Cow Creek hatchery coho stock, produced at the Rock Creek Hatchery. Independent populations are populations that historically would have had a high likelihood of persisting in isolation from neighboring populations for 100 years. Dependent populations tend to be smaller and may not have been able to maintain themselves continuously for periods as long as hundreds of years without strays from adjacent populations.

The spatial structure of coho salmon populations within the ESU can also be inferred from population-specific spawner abundances and productivity (Ford 2022). In particular, there is no geographic area or stratum within the ESU that appears to have considerably lower abundances or be less productive than other areas or strata and therefore might serve as a “population sink.” Furthermore, if the factors driving abundances in independent populations apply equally to dependent populations, then it is unlikely that small populations are being lost at unusually high rates, which is a concern for spatial structure (McElhany *et al.* 2000). Abundance and productivity trends for dependent populations in the North and Mid Coast strata show the same patterns and trends as independent populations, consistent with this premise.

The biological status of the ESU has likely degraded slightly since the 2015 status review (NWFSC 2015), which covered a period of favorable ocean conditions and high marine survival rates. However, the ESU's status has improved relative to the 2012 assessment (NMFS 2012). This improvement occurred despite similar or better abundances and marine survival rates during the earlier period, suggesting that management decisions to reduce both harvest and hatchery releases continue to benefit the species. A recent assessment of the vulnerability of ESA-listed salmonid “species” to climate change indicated that OC coho had high overall vulnerability, had high biological sensitivity and climate exposure, but only moderate adaptive capacity (Crozier *et al.*

2019). Overall, the OC coho ESU is therefore at moderate-to-low risk of extinction, with viability largely unchanged from the most recent review.

2.2.1.19 Southern Oregon/Northern California Coast Coho 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 (SWFSC 2023). While we currently lack data on how many natural juvenile coho salmon this ESU produces, it is possible to make rough estimates of juvenile abundance from adult return data. Sandercock (1991) published fecundity estimates for several coho salmon stocks; average fecundity ranged from 1,983 to 5,000 eggs per female. By applying a very conservative value of 2,000 eggs per female to an estimated 1,154 females returning (50 percent of the run) to this ESU, one may expect approximately 12.6 million eggs to be produced annually. Nickelson (1998) found survival of coho salmon from egg to parr in Oregon coastal streams to be around 7 percent. Thus, we can estimate that roughly the Southern Oregon/Northern California Coast ESU produces 884,870 natural-origin juvenile coho salmon annually. Combined hatchery releases for the Cole Rivers, Trinity River, and Iron Gate hatchery programs result in an estimate of 650 thousand hatchery-origin outmigrants per year (A. Cranford pers comm., ODFW 2020)

Table 22. Recent Five-Year Geometric Means for Estimated SONCC coho Juvenile Outmigrations and Adult Returns (SWFSC 2023^a).

Life Stage	Origin	Outmigration/Return
Adult	Natural and Hatchery	12,641
Juvenile	Natural	884,870
Juvenile	LHIA	75,000
Juvenile	LHAC	575,000

^a Data are provisional and subject to change

We only have population-level estimates of abundance for seven of the 26 independent populations in this ESU. The available data indicate that the six independent populations remain below recovery targets and, in two cases (Shasta River and Mattole River), are below the high-risk thresholds established by the TRT and adopted in the recovery plan (NMFS 2014). Although they are well below recovery thresholds, positive abundance trends were observed in the Elk and Scott rivers populations. The remaining five populations had negative abundance trends. All independent populations that are included in this assessment and were included in the previous assessment from five years ago had a lower average annual abundance in this most recent assessment, including the Scott River.

Spatial Structure and Diversity

Williams et al. (2006) identified 36 independent and nine dependent populations of coho salmon in the SONCC coho salmon ESU. The ESU also includes coho salmon from three hatchery programs in Oregon and California (85 FR 81822). Independent populations are populations that historically would have had a high likelihood of persisting in isolation from neighboring populations for 100 years and are rated as functionally independent or potentially independent. Dependent populations historically would not have had a high likelihood of persisting in isolation for 100 years. These populations were further grouped into seven diversity strata based on the geographical arrangement of the populations and basin-scale genetic, environmental, and ecological characteristics.

The primary factors affecting the genetic and life history diversity of SONCC coho salmon appear to be low population abundance and the influence of hatcheries and out-of-basin introductions. Although the operation of a hatchery tends to increase the abundance of returning adults, the reproductive success of hatchery-born salmonids spawning in the wild can be less than that of naturally produced fish (Araki et al. 2007). As a result, the higher the proportion of hatchery-born spawners, the lower the overall productivity of the population, as demonstrated by Chilcote (2003). Because the main stocks in the SONCC coho salmon ESU (i.e., Rogue River, Klamath River, and Trinity River) remain heavily influenced by hatcheries and have little natural production in mainstem rivers (Weitkamp et al. 1995; Good et al. 2005), some of these populations are at high risk of extinction with respect to the genetic diversity parameter.

In addition, some populations are extirpated or nearly extirpated (i.e., Middle Fork Eel, Bear River, Upper Mainstem Eel) and some brood years have low abundance or may even be absent in some areas (e.g., Shasta River, Scott River, Mattole River, Mainstem Eel River), which further affects the spatial structure and diversity of the ESU. The ESU's current genetic variability and variation in life history likely contribute significantly to long-term risk of extinction. Given the recent trends in abundance across the ESU, the genetic and life history diversity of populations are probably very low and inadequately contributing to a viable ESU.

In summary, data availability for this ESU remains generally poor, new information available since Williams et al. (2016) suggests there has been little improvement over the five years since the last viability assessment (SWFSC 2023). For the seven independent populations with appropriate data to assess population viability, all are at or above a moderate risk based on population viability criteria (Williams et al. 2008). Five of the seven populations have negative trends in abundance including two (Shasta and Mattole rivers) that are at high-risk based on viability criteria (Williams et al. 2008). Of the two populations with positive abundance trends (Elk and Scott rivers), only one has a significant positive abundance trend (Elk River). The Scott River's 12-year average of 670 fish is well below the recovery target of 6,500 (NMFS 2014); both the Elk River and Scott River are at moderate-risk of extinction based on the spawner density criterion (Williams et al. 2008). Based on the available data, the extinction risk of the SONCC Coho Salmon ESU has increased since the last assessment.

2.2.1.20 Northern California Steelhead

Abundance and Productivity

Adult abundance and redd surveys are frequently conducted throughout many of the populations in this DPS. However, the record is inconsistent with either no fish observed or no surveys conducted in some years. Due to the inconsistency of the record we have used a 5-year average as an estimate for abundance (2014-2015 to 2018-2019 sampling seasons) for population data were available (CDFW 2020). While we currently lack data on naturally produced juvenile NC steelhead, it is possible to make rough estimates of juvenile abundance from the available adult return data. Juvenile NC steelhead abundance estimates come from the escapement data displayed in the table below (Table 23). 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 (half of the escapement of spawners –4,178 females), 14.6 million eggs are expected to be produced annually. With an estimated survival rate of 6.5 percent (Ward and Slaney 1993), the DPS should produce roughly 950,495 natural-origin outmigrants annually. No hatchery NC steelhead are listed as part of this DPS.

Table 23. Recent Five-Year Means for Estimated NC Steelhead Adult Returns and Estimated Juvenile Outmigrations (CDFW 2020, Pauley et al. 1986, Ward and Slaney 1993).

Life Stage	Origin	Outmigration/Return
Adult	Natural	8,356
Juvenile	Natural	950,495

The SWFSC (2022) reported that winter-run populations remain well below recovery targets. Trends in abundance for larger populations have been mixed, with the majority showing slight (non-significant) increases. Moreover, there appears to be a downward (but non-significant) trend in abundance for smaller populations.

Summer-run populations remain a significant concern. The Middle Fork Eel River population has remained remarkably stable for nearly five decades and is closer to its recovery target (~80%) than any other population in the DPS. However, the other summer-run populations in the DPS are either well below recovery targets or there is not enough information to evaluate abundance and productivity.

Spatial Structure and Diversity

The NC steelhead DPS comprises both winter- and summer-run steelhead populations and does not include any hatchery stocks. Extant summer-run populations are found in Redwood Creek, Mad River, Eel River (Middle Fork), and the Mattole River. Two artificial propagation programs were originally listed as part of the DPS, but both programs were terminated in the mid-2000s (NMFS 2007). Bjorkstedt et al. (2005) concluded that the NC steelhead DPS historically comprised 42 populations of winter-run steelhead and as many as 10 populations of summer-run steelhead. Winter-

run steelhead were also likely found in numerous smaller coastal watersheds that were dependent on immigration from the larger independent populations.

NC steelhead remain broadly distributed throughout their range, with the exception of habitat upstream of dams on both the Mad River and Eel River that have reduced the extent of available habitat. The distribution and abundance of summer-run steelhead continues to be a significant concern for the diversity of the DPS (Williams et al. 2021). Summer-run steelhead persist in the Middle Fork Eel, Mad, Mattole, and Van Duzen rivers, as well as Redwood Creek. However, the numbers of summer-run steelhead in most of these systems is believed to be well below viability targets. Hatchery practices expose natural populations to genetic introgression and the potential for deleterious interactions between native stock and introduced steelhead. At the time of listing, the artificial propagation programs identified as potential threats to diversity were Yager Creek/Van Duzen, Van Arsdale Fish Station, Mad River, Noyo River and the North Fork Gualala hatcheries. The Yager Creek/Van Duzen, Van Arsdale Fish Station, Noyo and the North Fork Gualala hatchery programs have since been terminated. Although the steelhead produced at the Mad River Hatchery are not considered part of the DPS, CDFW continues to operate the hatchery.

Although most populations for which there are population estimates available remain well below viability targets, trends have been relatively flat, suggesting that this DPS is not at immediate risk of extinction.

2.2.1.21 California Coastal Chinook Salmon

Abundance and Productivity

Adult Chinook salmon abundance estimates come from (1) sonar-based estimates on Redwood Creek and the Mad and Eel rivers, (2) weir counts at Freshwater Creek (one tributary of the Humboldt Bay population), (3) trap counts at Van Arsdale Station (representing a small portion of the upper Eel River population), (4) adult abundance estimates based on spawner surveys for six populations on the Mendocino Coast, and (5) video counts of adult Chinook salmon at Mirabel on the Russian River (SWFSC 2023). Previous status reviews have included maximum live/dead counts in three index reaches in the Eel River (Sproul and Tomki creeks) and Mad River (Cannon Creek); however, these efforts have been discontinued and replaced with the more rigorous efforts to monitor populations in the Eel and Mad rivers using sonar methods. Nonetheless, and despite the recent improvements, population-level abundance data are still limited. Abundance estimates for the ESU components are listed below.

Table 24. Recent 5-Year Means for Estimated CC Chinook Adult Returns and Estimated Juvenile Outmigrations (SWFSC 2023).

Life Stage	Origin	Outmigration/Return
Adult	Natural	13,169
Juvenile	Natural	2,392,807

While we currently lack data on naturally produced juvenile CC Chinook salmon production, it is possible to make rough estimates of juvenile abundance from adult return data. Juvenile CC Chinook salmon population abundance estimates come from applying estimate of the percentage of females in

the population, fecundity, and survival rates to escapement data. We have no precise specific data on average fecundity for female CC Chinook salmon, however, Healey and Heard (1984) indicates that average fecundity for Chinook salmon in the nearby Klamath River is 3,634 eggs for female. By applying that rate to the estimated 6,584 females returning (half of the average total number of spawners), and applying an estimated survival rate from egg to smolt of 10 percent, the ESU could produce roughly 2.4 million natural outmigrants annually.

Structure and Diversity

Relatively new sonar-based monitoring programs in the Mad and Eel Rivers, which have replaced index-reach surveys in a limited number of tributaries, indicate that populations in these watersheds are doing better than believed in previous assessments, with the Mad River population currently at levels above recovery targets. Likewise, sonar-based estimates for Redwood Creek suggest that the Redwood Creek population, while somewhat variable, is approaching its recovery target in favorable years. Trends in the longer time series are mixed, with the Freshwater Creek population showing a significant decline and the Van Arsdale population showing no significant trend over the in either the long (23-year) or short (12-year) time series.

Data from populations in the more southerly diversity strata indicate that most populations (all except the Russian River) have exhibited mixed trends but remain far from recovery targets. In all Mendocino Coast populations (Ten Mile, Noyo, Big, Navarro, and Garcia rivers), surveys have failed to detect Chinook salmon in 3–10 of the 11 or 12 years of monitoring, suggesting only sporadic occurrence in these watersheds. Thus, concerns remain not only about the small population sizes, but the maintenance of connectivity across the ESU. Only the Russian River population has consistently numbered in the low thousands of fish in most years, making it the largest population south of the Eel River. The ESU therefore continues to be at risk of reduced spatial structure and diversity throughout its range (SWFSC 2023).

2.2.1.22 Sacramento River Winter-run Chinook Salmon

Abundance and Productivity

To estimate the abundance of adult spawners in this ESU we took the means of the last three years of adult returns—as estimated by mark-recaptures studies, redd counts, and carcass surveys (SWFSC 2023). The average of the estimated run size of in-river spawners from the most recent three years (2017-2019) was 3,702 adults. Over the most recent three years 68% of in-river spawners on average were hatchery-origin (SWFSC 2023), and therefore we estimate there would be 1,185 natural-origin and 2,517 hatchery-origin in-river spawners in a given year. When added to the average of 180 adults spawned per year at the Livingston Stone National Fish Hatchery (LSNFH) over the most recent three years, the total abundance of hatchery-origin adults is estimated to be 2,697 annually.

To estimate the abundance of juvenile SacR Chinook we utilize estimates developed pursuant to the biological opinion for the long-term operations of the Central Valley Project and State Water Project. Each year, a technical team from the Interagency Ecological Program uses adult escapement estimates from carcass surveys in the prior year, genetic data, the estimated number of fry-equivalents passing Red Bluff Diversion Dam, and survival rates of fry and smolts as they migrate

downstream, to estimate the number of juvenile winter-run Chinook salmon to enter the Sacramento-San Joaquin Delta. We use these projections as our estimates of the number of hatchery-origin and naturally produced juveniles expected to be present in the system, as summarized in the table below.

Table 25. Recent 5-Year Means for Estimated SacR Chinook Adult Returns and Estimated Juvenile Outmigrations (SWFSC 2023).

Life Stage	Origin	Outmigration/Return
Adult	Natural	1,185
Adult	Hatchery	2,697
Juvenile	Natural	125,038
Juvenile	LHAC	158,855

As with many Central Valley Chinook salmon populations, the abundance of Sacramento River winter-run Chinook salmon has declined during recent periods of unfavorable ocean conditions and droughts (SWFSC 2023). These conditions likely contributed to the low numbers of natural-origin adults observed in 2017 and 2018. However, recent improvements in adult returns in 2018 and 2019 have resulted in current population sizes that satisfy the low-risk criterion for abundance of this population. Still, the 10-year trend in run size, is not significantly different from zero (SWFSC 2023), and therefore does not indicate long-term improvements.

Structure and Diversity

The SacR Chinook population continues to be considered at high extinction risk because of the lack of population redundancy within the ESU, which has long consisted of a single spawning population spawning in the mainstem Sacramento River (SWFSC 2023). Reintroduction efforts in Battle Creek initiated in 2017 have begun the process of establishing a second winter-run Chinook salmon population, though it is not sufficient to mitigate the risk to the primary population in this ESU (SWFSC 2023).

In addition to limited spatial structure, this ESU is also highly dependent on the hatchery-origin fish produced by the LSNFH (SWFSC 2023). The primary role of this conservation hatchery is to prevent extinction of this ESU, so in response to drought conditions from 2013-2015 the number of hatchery adults spawned and juveniles released was greatly increased. This resulted in a significant increase in the proportion of hatchery-origin adult spawners in 2017 and 2018 (>80%), continuing a worsening trend of increasing hatchery influence that has reached levels placing this ESU at a high risk of extinction (SWFSC 2023).

2.2.1.23 Central Valley Spring-run Chinook Salmon

Abundance and Productivity

To estimate annual abundance of natural adult spawners (natural- and hatchery-origin), we calculate the average of the most recent three years of adult spawner counts (2017 through 2019) from surveys conducted by CDFW (SWFSC 2023). The Feather River Hatchery (FRH) is the only hatchery that produces CVS Chinook (with the exception of the San Joaquin Salmon Conservation and Research

Facility). The majority of spring-run Chinook salmon adults returning to spawn in the Feather River are therefore of hatchery origin; coded-wire tag data collected by CDFW from 2015-2019 spawning surveys indicates that on average 96% of adults spawning in the Feather River over the past five years have been of hatchery origin (Palmer-Zwahlen *et al.* 2019 and 2020, Letvin *et al.* 2020, 2021a, and 2021b). We therefore multiplied this fraction by the total population of spawners reported for the Feather River to estimate 2,083 hatchery-origin adults in this ESU, and the remainder of the Feather River adults in addition to all other populations estimated for this ESU resulted in the estimate of 6,756 natural-origin adults annually, based on the three-year averages (SWFSC 2023, Table 26).

While we currently lack data on naturally produced juvenile CVS Chinook salmon production, it is possible to make rough estimates of juvenile abundance from adult return data. The abundance of natural-origin CVS Chinook salmon juveniles was generated by applying estimates of the percentage of females in the population, fecundity, and survival rates to escapement data. Assuming half of the returning adults are females (4,420 females), and applying an average fecundity of 4,161 eggs per female and a 10% survival rate from egg to juvenile outmigrant (CDFG 1998), over 1.8 million natural-origin juvenile CVS Chinook salmon could be produced annually. The annual release target for hatchery juvenile spring-run Chinook salmon from the Feather River Hatchery is 2 million. Abundance estimates for the ESU components are listed below.

Table 26. Recent Three-Year Means for Estimated CVS Chinook Adult Returns and Estimated Juvenile Outmigrations (SWFSC 2023).

Life Stage	Origin	Outmigration/Return
Adult	Natural	6,756
Adult	Hatchery	2,083
Juvenile	Natural	1,838,954
Juvenile	LHAC	2,000,000

All populations of CVS Chinook salmon continue to decline in abundance, with the exception of two dependent populations (SWFSC 2023). The total abundance (hatchery- and natural-origin spawners) of CVS Chinook in the Sacramento River basin in 2019 was approximately half of the population size in 2014 and close to the decadal lows that occurred as recently as the last two years (Azat 2020). The Butte Creek spring-run population has become the backbone of this ESU, in part due to extensive habitat restoration and the accessibility of floodplain habitat in the Butte Sink and the Sutter Bypass for juvenile rearing in the majority of years. Butte Creek remains at low risk, yet all viability metrics for the ESU have been trending in a negative direction in recent years (SWFSC 2023). Most dependent spring-run populations have been experiencing continued and, in some cases, drastic declines (SWFSC 2023).

Structure and Diversity

The Central Valley Technical Review Team estimated that historically there were 18 independent populations of CVS Chinook salmon, along with a number of dependent populations, in four distinct or diversity groups (Lindley *et al.* 2004). Of these 18 populations, only three remain (Mill, Deer, and Butte creeks, which are tributary to the upper Sacramento River) and they represent only the northern Sierra Nevada diversity group (SWFSC 2023). However, spatial diversity in the ESU is

increasing and spring-run Chinook salmon are present (albeit at low numbers in some cases) in all diversity groups. The reestablishment of a population in Battle Creek and increasing abundance in Clear Creek observed in some years appears to be increasing the species’ viability (SWFSC 2023). Similarly, the reappearance of early migrating Chinook salmon to the San Joaquin River tributaries may be the beginning of natural dispersal processes into rivers where they were once extirpated. Active reintroduction efforts on the Yuba River, above Shasta and Don Pedro dams, and below Friant Dam, if successful, would further improve the viability of this ESU.

Current introgression between fall- and spring-run Chinook salmon in the FRH breeding program and straying of FRH spring-run Chinook salmon to other spring-run populations where genetic introgression would be possible is having an adverse effect on the diversity of this ESU (SWFSC 2023). Off-site releases of FRH spring-run Chinook salmon have caused hatchery fish to increasingly stray into other spring-run populations and, if continued, could result in a moderate risk of extinction to other spring-run Chinook salmon populations. However, in 2014, the FRH started releasing spring-run production into the Feather River rather than the San Francisco Bay and it is hypothesized that this will reduce straying (Palmer-Zwahlen *et al.* 2019; Sturrock *et al.* 2019).

2.2.1.24 California Central Valley Steelhead

Abundance and Productivity

To estimate annual abundance for adult spawners (natural- and hatchery-origin) we use the average of the estimated run sizes for the most recent three years (2017-2019) from populations with available survey data (SWFSC 2023). It is important to note that these estimates do not include data from a number of watersheds where steelhead are known to be present, and therefore likely represent an underestimate of adult abundance for the DPS. In addition, while we know that the large average numbers of adults returning to the Mokelumne River, Feather River, and Coleman hatcheries (9,325 of the 11,494 returning adults) are predominantly of hatchery origin, we do not have sufficient population-level data to estimate the proportion of hatchery-origin spawners across the DPS. Abundance estimates for the DPS components are listed below.

Table 26. Recent Three-Year Means for Estimated CCV Steelhead Adult Returns and Estimated Juvenile Outmigrations (SWFSC 2023).

Life Stage	Origin	Outmigration/Return
Adult	Natural and Hatchery	11,494
Juvenile	Natural	1,307,443
Juvenile	LHAC	1,050,000

While we currently lack data on naturally produced juvenile CCV steelhead, it is possible to make rough estimates of juvenile abundance from the available adult return data. Fecundity estimates for steelhead 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 (half of the adult total, or 5,747 females), over 20 million eggs are expected to be produced annually. With an estimated survival rate of 6.5 percent (Ward and Slaney 1993), the DPS should produce roughly 1.3 million natural-origin outmigrants annually. The sum of expected

annual releases from all of the hatchery programs is used to estimate the abundance of outmigrating hatchery-origin juvenile CCV steelhead (CDFW 2020, unpublished).

Steelhead are present throughout most of the watersheds in the Central Valley, but often in low numbers, especially in the San Joaquin River tributaries, and population abundance data remain extremely limited for this DPS. While the total hatchery populations have continued to increase in abundance in recent years, the state of natural-origin fish remains poor and largely unknown (SWFSC 2023). Recent expansions in monitoring, such as in the Yuba, Stanislaus, and Tuolumne rivers and the San Joaquin River tributaries, have recently allowed several populations to be evaluated using viability criteria for the first time, and many show recent declines. Data collected through 2019 from the Chipps Island midwater trawl, which provides information on the trends in abundance for the DPS as a whole, indicate that the production of natural-origin steelhead remains very low relative to the abundance of hatchery-origin steelhead (SFWSC 2022).

Structure and Diversity

Recent modest improvements in the abundance of this DPS is driven by the increase in adult returns to hatcheries from previous lows, but improvements to the sizes of the largely hatchery populations does not warrant a downgrading of the DPS extinction risk. As described above, the lack of improved natural production as estimated by exit at Chipps Island, and low abundances coupled with large hatchery influence in the Southern Sierra Nevada diversity group, are cause for concern (SWFSC 2023). In addition to the major populations being reliant on hatchery supplementation, the influence of hatchery-origin steelhead that are not part of the DPS also threaten the genetic diversity of this species. Nimbus Hatchery steelhead were founded from coastal steelhead populations, and continued introgression of strays from this program with natural-origin American River steelhead poses a risk to the CV steelhead DPS (SWFSC 2023).

2.2.1.25 SDPS 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 2017b). 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 2017b).

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 five 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 2018 through 2022 have ranged from a low of an estimated 248,496 fish in 2022 to a high of 15,352,621 fish in 2020 (DFO 2023, estimate based on report weight assuming 11.16 fish per pound and 2,204.62 pounds per metric tonne). Abundance estimates for the DPS components are listed below.

Table 27. SDPS eulachon spawning stock biomass survey estimates (NMFS 2022f, DFO 2023).

Year	Columbia River Spawning Stock Estimate (mean)	Fraser River Spawning Stock Estimate (mean)
2017	18,307,100	
2018	4,100,000	10,038,252
2019	46,684,765	2,657,184
2020 ^a	21,280,000	15,352,621
2021	96,395,712	3,469,102
2022		248,496
5-Year geomean^b	23,513,733	3,232,658

^a Abbreviated estimate; sampling stopped mid-March of 2020

^b 5-year geometric mean of most recent years of mean eulachon biomass estimates

Structure and Diversity

The southern DPS 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 DPS 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 2017b). 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 (Beacham *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 *et al.* 2016, NMFS 2017b). A 2015 genetic study of single nucleotide polymorphism (SNP) markers in eulachon from several geographic regions concluded there might 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 2017b).

Threats and Limiting Factors

The greatest threat identified to the persistence of SDPS eulachon was climate change impacts on ocean conditions (Gustafson *et al.* 2016, NMFS 2017b). Poor conditions in the Northeast Pacific Ocean in 2013-2015 are likely linked to the sharp declines in eulachon abundance in monitored rivers in 2016 and 2017 (NMFS 2017b). The likelihood that these poor ocean conditions will persist into the near future suggest that subpopulation declines may again be widespread in the upcoming return years (NMFS 2017b), although returns in 2021 do not appear to have been as dramatically impacted by the 2019 Northeast Pacific marine heatwave as prior years were by the 2013-2015 event. Climate change impacts on freshwater habitat were also identified as a moderate threat to all subpopulations due to increasing water temperatures and changes in flow quantity and timing (Gustafson *et al.* 2016, NMFS 2017b).

Eulachon bycatch in offshore shrimp fisheries was also ranked in the top four threats in all subpopulations of the DPS. Dams and water diversions in the Klamath and Columbia rivers and predation in the Fraser and British Columbia coastal rivers filled out the last of the top four threats for this DPS (Gustafson *et al.* 2010; as cited in NMFS 2017b). Predation by pinnipeds and degraded water quality (due to increased temperatures and toxic contaminants) were identified as moderate threats to all or most subpopulations. All other threats were ranked as either low or very low severity to some or all subpopulations in the DPS (NMFS 2017b). The risk these threats pose to the persistence of eulachon remained largely unchanged compared to the time of listing, as of the most recent status review (Gustafson *et al.* 2016). No limiting factors were identified for SDPS eulachon (NMFS 2017b).

2.2.1.26 SDPS Green Sturgeon

Green sturgeon comprise two DPSs with two geographically distinct spawning locations. The northern DPS spawn in rivers north of and including the Eel River in Northern California, with

known spawning occurring in the Eel, Klamath, and Trinity rivers in California and the Rogue and Umpqua rivers in Oregon. The southern DPS adults spawn in rivers south of the Eel River, which is currently restricted to the Sacramento River.

Abundance and Productivity

Since 2010, Dual Frequency Identification Sonar (DIDSON) surveys of aggregating sites in the upper Sacramento River for S green sturgeon have been conducted. Previous reports based on data from 2010 to 2015 estimated the total population size to be 17,548 individuals, and abundance estimates were derived for each age class by applying a conceptual demographic structure from prior modeling (Mora et al. 2018). The Southwest Fisheries Science Center (SWFSC) continued Mora et al. (2018)’s work and conducted DIDSON surveys at aggregation sites in the upper Sacramento River from 2016-2020. The total population estimate has recently been updated to 17,723 individuals based on data from 2016 to 2018 (Dudley 2021, as cited in Ford 2022). Applying the same demographic proportions as prior previous estimates (Beamesderfer et al. 2007 as cited in Mora et al. 2018) to this total, we calculated abundance estimates of adults, juveniles, and sub-adults that would be expected as portions of this updated total (Table 31).

Table 28. SDPS green sturgeon estimated total population size based on data from 2016 to 2018 (Dudley 2021), and life stage-specific abundance estimates derived from the total (Beamesderfer et al. 2007 as cited in Mora et al. 2018).

Life stage	Abundance Estimate	Range	
		25 th Percentile	75 th Percentile
Total DPS	17,723 ^a	6,761	37,891
Juvenile	4,431		
Sub-adult	11,165		
Adult	2,127		

^aMedian value for 2018 was selected as the revised population estimate in Dudley 2021.

The DIDSON surveys and associated modeling will eventually provide population trend data, but we currently do not have enough data to provide information on long-term trends, and demographic features or trends needed to evaluate the recovery of SDPS green sturgeon. Annual spawner count estimates in the upper Sacramento River from 2010 to 2019 found that the DPS only met the spawner demographic recovery criterion (i.e., spawning population size of at least 500 individuals in any given year) in one of those years (Dudley 2020, as cited in Ford 2022). There are currently no studies that address juvenile and subadult abundance of S green sturgeon to evaluate whether the recovery criterion for increasing trends of these life stages is being met (NMFS 2021a).

Structure and Diversity

Telemetry data and genetic analyses suggest that SDPS green sturgeon generally occur from Graves Harbor, Alaska to Monterey Bay, California and, within this range, most frequently occur in coastal waters of Washington, Oregon, and Vancouver Island and near San Francisco and Monterey bays (NMFS 2021a). Adult and subadult SDPS green sturgeon have been observed in large concentrations in the summer and fall within coastal bays and estuaries along the west coast of the United States,

and telemetry studies performed by the WDFW and NMFS-Northwest Fisheries Science Center (NWFSC) have shown a great amount of seasonal movement between the coastal bays and estuaries and the nearshore marine environment (NMFS 2021a). Green sturgeon also move extensively within an individual estuary and between different estuaries during the same season (WDFW and ODFW 2014, as cited in NMFS 2021a). In California, Miller et al. (2020) recorded adult and subadult SDPS green sturgeon presence year-round in the Sacramento-San Joaquin Delta, Suisun Bay, San Pablo Bay, and Central San Francisco Bay, although spawning Southern DPS adults often use the area as a migration corridor, passing through within a few days of entering. These adults migrate into the Sacramento River to spawn, although small numbers of adults have also been observed in the Yuba and Feather Rivers and San Joaquin River Basin (NMFS 2021a).

Sustained spawning of S green sturgeon adults is currently restricted to the Sacramento River, and the spawning population congregates in a limited area of the river compared to potentially available habitat. The reason for this is unknown, and it is concerning given that a catastrophic or targeted poaching event impacting just a few holding areas could affect a significant portion of the adult population (NMFS 2021a). Removal of the Red Bluff Diversion Dam (RBDD) barrier did allow SDPS green sturgeon to freely access a larger area of the river, so the Southern DPS likely now holds in a larger area of the river compared to when RBDD was operating in 2011 (NMFS 2021a). New research documents spawning by S green sturgeon in the Feather and Yuba rivers multiple years, although it is periodic, and not continuous as required to meet the recovery criterion for continuous spawning for populations in these rivers (NMFS 2021a). Given the limited number of occurrences and lack of consistent successful spawning events in additional spawning locations, the limited spatial distribution of spawning continues to make this DPS vulnerable.

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 29, below.

Table 29. 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 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.
Puget Sound/Georgia Basin DPS of bocaccio	11/13/2014 79 FR 68042	Critical habitat for bocaccio includes 590.4 square miles of nearshore habitat and 414.1 square miles of deepwater habitat. Critical habitat is not designated in areas outside of United States jurisdiction; therefore, although waters in Canada are part of the DPSs' ranges for all three species, critical habitat was not designated in that area. Based on the natural history of bocaccio and their habitat needs, NMFS identified two physical or biological features, essential for their conservation: 1) Deepwater sites (>30 meters) that support growth, survival, reproduction, and feeding opportunities; 2) Nearshore juvenile rearing sites with sand, rock and/or cobbles to support forage and refuge. Habitat threats include degradation of rocky habitat, loss of eelgrass and kelp, introduction of non-native species that modify habitat, and degradation of water quality as specific threats to rockfish habitat in the Georgia Basin.
Puget Sound/Georgia Basin DPS of yelloweye rockfish	11/13/2014 79 FR 68042	Critical habitat for yelloweye rockfish includes 414.1 square miles of deepwater marine habitat in Puget Sound, all of which overlaps with areas designated for canary rockfish and bocaccio. No nearshore component was included in the CH listing for juvenile yelloweye rockfish as they, different from bocaccio and canary rockfish, typically are not found in intertidal waters (Love et al. 1991). Yelloweye rockfish are most frequently observed in waters deeper than 30 meters (98 ft) near the upper depth range of adults (Yamanaka et al. 2006). Habitat threats include degradation of rocky habitat, loss of eelgrass and kelp, introduction of non-native species that modify habitat, and degradation of water quality as specific threats to rockfish habitat in the Georgia Basin.
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.

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
Upper Columbia River spring-run Chinook salmon	09/02/2005 70 FR 52630	Critical habitat encompasses four subbasins in Washington containing 15 occupied watersheds, as well as the Columbia River rearing/migration corridor. Most HUC5 watersheds with PBFs for salmon are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some, or high, potential for improvement. We rated conservation value of HUC5 watersheds as high for 10 watersheds, and medium for five watersheds. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Upper Columbia River steelhead	09/02/2005 70 FR 52630	Critical habitat encompasses 10 subbasins in Washington containing 31 occupied watersheds, as well as the Columbia River rearing/migration corridor. Most HUC5 watersheds with PBFs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 20 watersheds, medium for eight watersheds, and low for three watersheds.
Middle Columbia River steelhead	09/02/2005 70 FR 52630	Critical habitat encompasses 15 subbasins in Oregon and Washington containing 111 occupied watersheds, as well as the Columbia River rearing/migration corridor. Most HUC5 watersheds with PBFs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of occupied HUC5 watersheds as high for 80 watersheds, medium for 24 watersheds, and low for 9 watersheds.
Snake River spring/summer-run Chinook salmon	10/25/1999 64 FR 57399	Critical habitat consists of river reaches of the Columbia, Snake, and Salmon rivers, and all tributaries of the Snake and Salmon rivers (except the Clearwater River) presently or historically accessible to this ESU (except reaches above impassable natural falls and Hells Canyon Dam). Habitat quality in tributary streams varies from excellent in wilderness and roadless areas, to poor in areas subject to heavy agricultural and urban development (Wissmar et al. 1994). Reduced summer stream flows, impaired water quality, and reduced habitat complexity are common problems. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Snake River fall-run Chinook salmon	10/25/1999 64 FR 57399	Critical habitat consists of river reaches of the Columbia, Snake, and Salmon rivers, and all tributaries of the Snake and Salmon rivers presently or historically accessible to this ESU (except reaches above impassable natural falls, and Dworshak and Hells Canyon dams). Habitat quality in tributary streams varies from excellent in wilderness and roadless areas, to poor in areas subject to heavy agricultural and urban development (Wissmar et al. 1994). Reduced summer stream flows, impaired water quality, and reduced habitat complexity are common problems. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Snake River basin steelhead	09/02/2005 70 FR 52630	Critical habitat encompasses 25 subbasins in Oregon, Washington, and Idaho. Habitat quality in tributary streams varies from excellent in wilderness and roadless areas, to poor in areas subject to heavy agricultural and urban development (Wissmar et al. 1994). Reduced summer stream flows, impaired water quality, and reduced habitat complexity are common problems. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Snake River sockeye salmon	10/25/1999 64 FR 57399	Critical habitat consists of river reaches of the Columbia, Snake, and Salmon rivers; Alturas Lake Creek; Valley Creek; and Stanley, Redfish, Yellow Belly, Pettit and Alturas lakes (including their inlet and outlet creeks). Water quality in all five lakes generally is adequate for juvenile sockeye salmon, although zooplankton numbers vary considerably. Some reaches of the Salmon River and tributaries exhibit

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
Lower Columbia River Chinook salmon	09/02/2005 70 FR 52630	temporary elevated water temperatures and sediment loads that could restrict sockeye salmon production and survival (NMFS 2015). Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System. Critical habitat encompasses 10 subbasins in Oregon and Washington containing 47 occupied watersheds, as well as the lower Columbia River rearing/migration corridor. Most HUC5 watersheds with PBFs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some, or high potential for improvement. We rated conservation value of HUC5 watersheds as high for 30 watersheds, medium for 13 watersheds, and low for four watersheds.
Lower Columbia River coho salmon	02/24/2016 81 FR 9252	Critical habitat encompasses 10 subbasins in Oregon and Washington containing 55 occupied watersheds, as well as the lower Columbia River and estuary rearing/migration corridor. Most HUC5 watersheds with PBFs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 34 watersheds, medium for 18 watersheds, and low for three watersheds.
Lower Columbia River steelhead	09/02/2005 70 FR 52630	Critical habitat encompasses nine subbasins in Oregon and Washington containing 41 occupied watersheds, as well as the lower Columbia River rearing/migration corridor. Most HUC5 watersheds with PBFs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 28 watersheds, medium for 11 watersheds, and low for two watersheds.
Columbia River chum salmon	09/02/2005 70 FR 52630	Critical habitat encompasses six subbasins in Oregon and Washington containing 19 occupied watersheds, as well as the lower Columbia River rearing/migration corridor. Most HUC5 watersheds with PBFs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 16 watersheds, and medium for three watersheds.
Upper Willamette River Chinook salmon	09/02/2005 70 FR 52630	Critical habitat encompasses 10 subbasins in Oregon containing 56 occupied watersheds, as well as the lower Willamette/Columbia River rearing/migration corridor. Most HUC5 watersheds with PBFs for salmon are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some, or high, potential for improvement. Watersheds are in good to excellent condition with no potential for improvement only in the upper McKenzie River and its tributaries (NMFS 2005). We rated conservation value of HUC5 watersheds as high for 22 watersheds, medium for 16 watersheds, and low for 18 watersheds.
Upper Willamette River steelhead	09/02/2005 70 FR 52630	Critical habitat encompasses seven subbasins in Oregon containing 34 occupied watersheds, as well as the lower Willamette/Columbia River rearing/migration corridor. Most HUC5 watersheds with PBFs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. Watersheds are in good to excellent condition with no potential for improvement only in the upper McKenzie River and its tributaries (NMFS 2005). We rated conservation value of HUC5 watersheds as high for 25 watersheds, medium for 6 watersheds, and low for 3 watersheds.
Oregon Coast coho salmon	02/11/2008 73 FR 7816	Critical habitat encompasses 13 subbasins in Oregon. The long-term decline in Oregon Coast coho salmon productivity reflects deteriorating conditions in freshwater habitat as well as extensive loss of access to habitats in estuaries and tidal freshwater. Many of the habitat changes resulting from land use practices over the last 150 years that contributed to the ESA-listing of Oregon Coast coho salmon continue to hinder recovery of the populations; changes in the watersheds due to land use practices have weakened natural watershed processes and

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
Southern Oregon/Northern California Coast coho salmon	05/05/1999 64 FR 24049	<p>functions, including loss of connectivity to historical floodplains, wetlands and side channels; reduced riparian area functions (stream temperature regulation, wood recruitment, sediment and nutrient retention); and altered flow and sediment regimes (NMFS 2016b). Several historical and ongoing land uses have reduced stream capacity and complexity in Oregon coastal streams and lakes through disturbance, road building, splash damming, stream cleaning, and other activities. Beaver removal, combined with loss of large wood in streams, has also led to degraded stream habitat conditions for coho salmon (Stout et al. 2012)</p> <p>Critical habitat includes all areas accessible to any life-stage up to long-standing, natural barriers and adjacent riparian zones. SONCC coho salmon critical habitat within this geographic area has been degraded from historical conditions by ongoing land management activities. Habitat impairments recognized as factors leading to decline of the species that were included in the original listing notice for SONCC coho salmon include: 1) Channel morphology changes; 2) substrate changes; 3) loss of in-stream roughness; 4) loss of estuarine habitat; 5) loss of wetlands; 6) loss/degradation of riparian areas; 7) declines in water quality; 8) altered stream flows; 9) fish passage impediments; and 10) elimination of habitat</p>
Northern California steelhead	9/2/2005 70 FR 52488	<p>There are approximately 3,028 miles of stream habitats and 25 square miles of estuary habitats designated as critical habitat for NC steelhead. NMFS determined that marine areas did not warrant consideration as critical habitat for this DPS. NC steelhead PBFs are sites and habitat components which support one or more life stages. There are 50 watersheds within the range of this DPS. Nine watersheds received a low rating, 14 received a medium rating, and 27 received a high rating of conservation value to the DPS. Two estuarine habitats, Humboldt Bay and the Eel River estuary, have high conservation value ratings. Since designation, critical habitat for this species has continued to be degraded somewhat by the factors listed above in the status section. Nonetheless, a number of restoration efforts have been undertaken by local, state, and Federal entities resulting in slightly improved conditions in some areas and a slowing of the negative trend.</p>
California Coastal Chinook salmon	09/02/2005 70 FR 52488	<p>Critical habitat includes approximately 1,475 miles of stream habitats and 25 square miles of estuary habitats. There are 45 watersheds within the range of this ESU. Eight watersheds received a low rating, 10 received a medium rating, and 27 received a high rating of conservation value to the ESU. Two estuarine habitat areas used for rearing and migration (Humboldt Bay and the Eel River Estuary) also received a high conservation value rating. PBFs include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, and nearshore marine areas. Since designation, critical habitat for this species has continued to be. Nonetheless, a number of restoration efforts have been undertaken by local, state, and Federal entities resulting in slightly improved conditions in some areas and a slowing of the negative trend.</p>
Sacramento River winter-run Chinook salmon	06/16/1993 58 FR 33212 Modified 03/23/1999 64 FR 14067	<p>Critical habitat includes the following waterways, bottom and water of the waterways and adjacent riparian zones: The Sacramento River from Keswick Dam, Shasta County (RK 486) to Chipps Island (RK 0) at the westward margin of the Sacramento-San Joaquin Delta, all waters from Chipps Island westward to Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and Carquinez Strait, all waters of San Pablo Bay westward of the Carquinez Bridge, and all waters of San Francisco Bay (north of the San Francisco/Oakland Bay Bridge) from San Pablo Bay to the Golden Gate Bridge. The critical habitat for this species was designated before the CHART team process, thus watersheds have not yet been evaluated for conservation value. Since designation, critical habitat for this species has continued to be degraded. Nonetheless, a number of restoration efforts have been undertaken by local, state, and Federal entities resulting in slightly improved conditions in some areas and a slowing of the negative trend.</p>

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
Central Valley spring-run Chinook salmon	09/02/2005 70 FR 52488	Critical habitat includes approximately 1,373 miles of stream habitats and 427 square miles of estuary habitats in 37 watersheds. The CHART rated seven watersheds as having low, three as having medium, and 27 as having high conservation value to the ESU. Four of these watersheds comprise portions of the San Francisco-San Pablo-Suisun Bay estuarine complex, which provides rearing and migratory habitat for the ESU. PBFs include freshwaters spawning sites, freshwater rearing sites, and freshwater migration corridors. Since designation, critical habitat for this species has continued to be degraded somewhat by the factors listed above in the status section. Nonetheless, a number of restoration efforts have been undertaken by local, state, and Federal entities resulting in slightly improved conditions in some areas and a slowing of the negative trend.
California Central Valley steelhead	9/2/2005 70 FR 52488	There are approximately 2,308 miles of stream habitats and 254 square miles of estuary habitats designated as critical habitat for CCV steelhead. NMFS determined that marine areas did not warrant consideration as critical habitat for this DPS. CCV steelhead PBFs are those sites and habitat components which support one or more life stages. There are 67 watersheds within the range of this DPS. Twelve watersheds received a low rating, 18 received a medium rating, and 37 received a high rating of conservation value to the DPS. Since designation, critical habitat for this species has continued to be degraded somewhat by the factors listed above in the status section. Nonetheless, a number of restoration efforts have been undertaken by local, state, and Federal entities resulting in slightly improved conditions in some areas and a slowing of the negative trend.
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 DPS 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 DPS of green sturgeon	10/09/2009 74 FR 52300	Critical habitat has been designated in coastal U.S. marine waters within 60 fathoms depth from Monterey Bay, California (including Monterey Bay), north to Cape Flattery, Washington, including the Strait of Juan de Fuca, Washington, to its United States boundary; the Sacramento River, lower Feather River, and lower Yuba River in California; the Sacramento-San Joaquin Delta and Suisun, San Pablo, and San Francisco bays in California; tidally influenced areas of the Columbia River estuary from the mouth upstream to river mile 46; and certain coastal bays and estuaries in California (Humboldt Bay), Oregon (Coos Bay, Winchester Bay, Yaquina Bay, and Nehalem Bay), and Washington (Willapa Bay and Grays Harbor), including but not limited to, areas upstream to the head of tide in various streams that drain into the bays, as listed in Table 1 in USDC (2009). The CHART identified several activities that threaten the PBFs in coastal bays and estuaries and necessitate the need for special management considerations or protection. The application of pesticides is likely to adversely affect prey resources and water quality within the

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
Southern resident killer whale	11/29/2006 71 FR 69054 08/02/2021 86 FR 41688	<p>bays and estuaries, as well as the growth and reproductive health of SDPS green sturgeon through bioaccumulation. Other activities of concern include those that disturb bottom substrates, adversely affect prey resources, or degrade water quality through re-suspension of contaminated sediments. Of particular concern are activities that affect prey resources. Prey resources are affected by: commercial shipping and activities generating point source pollution and non-point source pollution that discharge contaminants and result in bioaccumulation of contaminants in green sturgeon; disposal of dredged materials that bury prey resources; and bottom trawl fisheries that disturb the bottom (but result in beneficial or adverse effects on prey resources for green sturgeon).</p> <p>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 (mi²) (40,472.7 square kilometers (km²)) 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. 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.</p>

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, chum salmon, coho salmon, sockeye salmon, steelhead, SDPS eulachon, and SDPS green sturgeon in all sub-basins of the Pacific Northwest (Washington, Oregon, Idaho) and California. Additionally, the action area includes all marine waters off the West Coast of the contiguous United States (including nearshore waters) from Northern Oregon to the Canadian border and Puget Sound that are accessible to listed

Chinook salmon, chum salmon, coho salmon, sockeye salmon, steelhead, rockfish, eulachon, and green sturgeon.

The reason the action area for this opinion is so large is that many of the permits would cover activities taking place over wide portions of the listed species' ranges. For example, the activities conducted under Permit 15207-5R could take place in very nearly any of the salmon-bearing waters in Oregon, Idaho, and Washington, while activities under Permit 28047 could be conducted over large portions of western Oregon and Washington and northern California. Other permits would allow activities to cover several counties (1484-8R) or take place in mainstem and marine environments (1410-14R) where researchers could intercept individual animals from anywhere in their respective ranges.

Nonetheless, where it is possible to narrow the range of the research effects, the analysis would take that limited geographic scope into account when determining the proposed actions' impacts on the species and their critical habitat (see permit summaries below for the instances in which this would be applicable). Still, the action area is generally spread out over much of Idaho, Oregon, Washington and California and it is also discontinuous. That is, there are large areas in between the various actions' locations where listed salmonids, sturgeon, eulachon, etc., do exist, but where they would not be affected to any degree by any of the proposed activities. Also, and as noted earlier, the proposed actions could affect the killer whales' prey base (Chinook salmon) in places far from where the whales themselves are found, and those effects are described in the Not Likely to Adversely Affect section (2.11).

Despite the action being widely distributed across the landscape, in most cases, the proposed research activities would take place in individually very small sites. That is, individual researchers might visit dozens of sites, but at each site they would only electrofish a few hundred feet of river, deploy a beach seine covering only a few hundred square feet of a stream, or operate a screw trap in a few tens of square feet of habitat. Nonetheless, most of the proposed research activities would take place in designated critical habitat, therefore 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 29).

2.3.1. Action Areas for the Individual Permits

Permit 1127-7R – The proposed activities would take place in several locations through the upper Salmon River subbasin (Idaho): (1) Screw traps would be located in East Fork and Valley Creek somewhat near their confluences with the Salmon River; (2) electrofishing would take place in Herd Creek, Valley Creek, and the Yankee Fork of the Salmon River; and (3) a screw trap in lower Yankee Fork of the Salmon River, an adult weir in the lower Yankee Fork of the Salmon River, and another adult weir in the upper Yankee Fork of the Salmon River. The minimally intrusive nature of the proposed activities is such that they are not expected to have any measurable downstream effects.

Permit 1410-14R – The proposed activities would take place in the Pacific Ocean off Oregon and Washington from nearshore out to 50 miles from Cape Flattery, WA to Newport, OR. Six to eleven

transects using a Nordic rope trawl would take place in waters ranging from 15 feet in depth to 3000 feet in depth. The Washington transects would be located off Cape Flattery, La Push, Queets River, Grays Harbor, and Willapa Bay. The Oregon transects would be located off the Columbia River, Cape Meares, Cascade Head, and Newport.

Permit 1484-8R – The proposed activities would take place in the tributaries north of the lower Columbia River from Klickitat County to the Pacific Ocean on lands managed by the WDNR (Washington state). The surveys would be presence/absence electrofishing surveys that are expected to be minimally intrusive and not expected to have any measurable downstream effects.

Permit 14046-5R – The proposed activities would take place throughout King County, Washington. Four distinct projects are part of this permit with each examining different habitats and locations by using multiple capture and handling methods. Two of the projects would be studying effectiveness and need for salmon habitat restoration through fish surveys in streams, rivers, and intertidal zones throughout the county. The third project would be studying fish status and trends in streams and rivers throughout the county. The fourth project would be researching chemical contamination in non-listed fish in lakes (including Lake Washington and Lake Sammamish), streams, and rivers throughout the county. The minimally intrusive nature of the proposed activities is such that they are not expected to have any measurable downstream effects.

Permit 15207-5R – The proposed activities would take place in randomly selected sites covering much of the salmon-bearing waters of Oregon, Washington, and Idaho. The electrofishing site locations would change annually, and it is therefore impossible to characterize the action area more narrowly for this project. However, the activities' nature are such that all effects are expected to be restricted to the actual sites where the research takes place; and there would be no measurable downstream effects at all.

Permit 16344-4R – The proposed activities would take place at long-established index sites in the upper and lower Klamath River. In any given year, the lower-river sites could be located at Beaver Creek (Rkm 258) or Seiad Valley (Rkm 207) and the upper-river sites at Keno Eddy (Rkm 369) or Williamson River (Rkm 441). Some fish would also be transferred from Fall Creek and/or Trinity River Hatchery to the John L Fryer Aquatic Animal Health Laboratory. The minimally intrusive nature of the proposed activities is such that they are not expected to have any measurable downstream effects.

Permit 18260-3R – The proposed activities would take place throughout the Fifteen Mile Creek and Hood River watersheds in Oregon. The minimally intrusive nature of the proposed activities is such that they are not expected to have any measurable downstream effects.

Permit 18331-3R – The proposed activities would take place throughout the Snoqualmie River, Snohomish River, and Skykomish River watersheds along with various rivers and streams on the Kitsap peninsula and tributaries to Hood Canal in Washington state. The water typing surveys would include single-pass presence/absence electrofishing and, as such, are not expected to have any measurable downstream effects.

Permit 22003-3R – The proposed research would take place in both the marine waters of Puget Sound (Elliot Bay, Shilshole Bay, and Quartermaster Harbor) and the intertidal zones throughout

King County, Washington. The marine zones will be sampled using an otter trawl at depths from five to 60 fathoms deep, for five to 20 minutes, and up to five times at each sampling location until 120 English sole are captured. Beach seines, cast nets, and Sabiki rigs will be used in the intertidal zones for sampling forage fish. For the intertidal activities, the activities would be minimally intrusive; and since all the activities take place in marine waters, no effects are expected beyond the immediate sites where the research would be conducted.

Permit 22319-3R – The proposed activities would take place in seven watersheds containing tributaries to lake Washington in Washington State: Evans Creek, Monticello Creek, Tosh Creek, Colin Creek, Seidel Creek, Country Creek, Tyler's Creek. A 150-meter reach of each creek would be sampled. The minimally intrusive nature of the proposed activities is such that they are not expected to have any measurable downstream effects.

Permit 22865-2R – The proposed activities would take place in randomly selected sites covering much of the salmon-bearing waters on the Wenatchee-Okanogan National Forest. The activities could take place in any fish-bearing waters of the Naches, Yakima, Wenatchee, Entiat, and Methow subbasins. The minimally intrusive nature of the proposed activities is such that they are not expected to have any measurable downstream effects.

Permit 26300 – The proposed activities would take place in Snodgrass Slough and the lower Cosumnes River—both in the Lower Cosumnes-Lower Mokelumne watershed in northern California. The activities would be of limited geographic scope, and their minimally intrusive nature is such that they are not expected to have any measurable downstream effects.

Permit 27337 – The proposed activities would take place at Ediz Hook lagoon, which is located at the base of Ediz Hook on the west end of Port Angeles, Washington. The activities would take place in the marine environment and are minimally intrusive, so we do not anticipate any downstream effects.

Permit 27619 – The proposed activities would take place in the mainstem Scott River between Horn Lane Bridge and Fay Lane Bridge in Siskiyou County, California. The minimally intrusive nature of the proposed activities is such that they are not expected to have any measurable downstream effects.

Permit 27869 – The proposed activities would take place in small areas of the Duckabush, Dosewallops, and Big and Little Quilcene Rivers in northwestern Washington State. The minimally intrusive nature of the proposed activities is such that they are not expected to have any measurable downstream effects.

Permit 27874 – The proposed activities would take place throughout much of the Sacramento River and several miles of the San Joaquin River, as well as in San Pablo and Suisun Bays. Most of the work would involve observation, and the rest would be nearly as unintrusive. As a result, we do not expect the work to have any measurable downstream effects.

Permit 28407 – The proposed activities would take place in several dozen watersheds scattered across western Oregon and Washington and northern California. The majority of the work would take place in headwater streams well above anadromy, and all of it would be minimally intrusive. As a result, we do not expect there to be any measurable downstream effects.

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 a great many activities (summarized below and in Tables 2 and 29) have had on the various listed species’ survival and recovery, and in many cases these actions have taken place well upstream from where the currently proposed individual research actions would occur. Because the action area under consideration covers individual animals from the majority of the various listed species’ entire ranges (see Section 1.3), the effects of these past activities on the species themselves (effects on abundance, productivity, etc.) are displayed in more detail in the species status sections that precede this section (see Section 2.2). That is, for much of the work being contemplated here, the physical results of activities in the action area *are indistinguishable from those effects described in the previous section on the species’ rangewide status.*

In general, though, and with respect to the species’ habitat, the environmental baseline is the culmination of these effects on the PBFs that are essential to the conservation of the species. The PBFs for listed species in the action area are best expressed in terms of the sites essential to supporting one or more of the species’ life stages. These sites, in turn, contain physical and biological features essential to conserving the species (70 FR 52630). The specific PBFs/PCEs include (for most species):

1. Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development.
2. Freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
3. Freshwater migration corridors free of obstruction with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.

4. Estuarine areas free of obstruction with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.

5. Nearshore marine areas free of obstruction with water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.

6. Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.

The best scientific information presently available demonstrates that a multitude of factors, past and present, have contributed to the decline of west coast salmonids, eulachon, and green sturgeon by adversely affecting these essential habitat features. These factors are well known and documented in hundreds of scientific papers, policy documents, news articles, books, and other media. It is therefore unnecessary to exhaustively detail in this opinion the many ways in which human activities and natural factors have affected the species' PBFs.

Some factors in the action area (e.g., hydropower and agricultural development) have had adverse effects on every single one of the freshwater habitat-related biological requirements listed above, while other factors have only affected some of those essential habitat features. For example, road building has had a sizeable effect on stream substrates and water quality (through siltation), and road culverts have blocked fish passage, but such activities have not had much of an effect on water velocity. In another instance, timber harvest and grazing activities have affected—to greater or lesser degrees—nearly all the factors except space throughout the four states. And urban development has affected them all as well, but generally to a small degree in the largely rural portions of the species' ranges. In short, nearly every widespread human activity in the West has adversely affected some or all of the habitat features listed above. And by disrupting those habitat features, these activities—coupled with hatchery and fishery effects and occasional natural disturbances such as drought and fire—have had detrimental impacts on all the species' health, physiology, numbers, and distribution in nearly every subpopulation and at every life stage. More detailed information on how the various human activities have affected the species' critical habitat is found in each of the species' status discussions (Section 2.2). And even more information can be found in any of NMFS' several Status of the Species Evaluations—all of which are available on our website: <https://www.fisheries.noaa.gov/about/west-coast-region>.

Thus, and again, for much of the work being contemplated here, the impacts that previous Federal, state, and private activities in the action area have had on the species cannot be segregated from those effects summarized in the sections 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. However, as noted previously, some of the proposed work has a more limited geographic scope or targets individual fish in areas above mainstem habitat. If the work would not take place in

marine or mainstem areas or would not be widely distributed across the majority of a given species' range, then the action area can be narrowed for a more specific analysis—and in those instances, the relevant local status information will be taken into account for both species and critical habitat.

Analysis at the ESU/DPS level will be performed for all permits listed in Table 1. The permits for which population-level analysis will be performed are:

- 1127-7R
- 18260-3R
- 27619
- 27869

2.4.1 Summary for all Listed Species

Factors Limiting Recovery

As noted above, the best scientific information presently available demonstrates that a multitude of factors, past and present, have contributed to the decline of west coast salmonids, sturgeon, eulachon, and rockfish. 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' decisions 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. Once again, see Tables 2 and 29 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.

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 2024, 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 30 displays the total take for the ongoing research authorized under ESA sections 4(d) and 10(a)(1)(A).

Table 30. Total Allowed Take of Listed Species for Scientific Research Approved at the end of 2023 Not Including the Take from Permits Being Renewed as Part of This Action.

Species	Life Stage	Origin ^a	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Puget Sound Chinook salmon	Adult	Natural	1,457	51	6.234	0.218
		LHIA	753	23	11.674 ^b	0.654 ^b
		LHAC	1,959	129		
	Juvenile	Natural	730,180	12,847	19.585	0.345
		LHIA	224,717	5,118	2.589	0.059
		LHAC	178,656	8,252	0.697	0.032
Puget Sound steelhead	Adult	Natural	5,066	91	27.841	0.500
		LHIA	427	12	28.307 ^b	1.112 ^b
		LHAC	31	6		
	Juvenile	Natural	102,460	1,929	4.546	0.086
		LHIA	2,973	46	5.609	0.087
		LHAC	10,949	183	4.845	0.081
Puget Sound/Georgia Basin DPS bocaccio	Adult	Natural	22	13	1.563 ^c	0.847 ^c
	Juvenile	Natural	50	26		
Puget Sound/Georgia Basin DPS yelloweye rockfish	Adult	Natural	28	18	0.069 ^c	0.043 ^c
	Juvenile	Natural	51	31		
Hood Canal summer-run chum salmon	Adult	Natural	2,132	37	7.583	0.132
		LHAC	1	0	0.114	0.000
	Juvenile	Natural	1,083,080	4,711	25.539	0.111
		LHAC	95	19	-	-
Upper Columbia River spring-run Chinook salmon	Adult	Natural	192	6	23.616	0.738
		LHIA	156	4	29.123 ^b	1.053 ^b
		LHAC	176	8		
	Juvenile	Natural	12,796	267	2.620	0.055
		LHIA	1,764	53	0.375	0.011
		LHAC	1,294	41	0.189	0.006
Upper Columbia River steelhead	Adult	Natural	198	4	13.515	0.273
		LHIA	90	2	10.266 ^b	0.277 ^b
		LHAC	207	6		
	Juvenile	Natural	11,070	52	7.357	0.035
		LHIA	2,004	40	1.433	0.029
		LHAC	9,196	188	1.201	0.025
Middle Columbia River steelhead	Adult	Natural	2,210	34	16.252	0.250
		LHIA	200	7	260.870 ^b	3.787 ^b
		LHAC	1,660	20		
	Juvenile	Natural	181,037	4,061	51.507	1.155
		LHIA	8,743	120	7.717	0.106
		LHAC	491	19	0.132	0.005
	Adult	Natural	754	20	17.063	0.453

Species	Life Stage	Origin ^a	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Snake River spring/summer-run Chinook salmon		LHIA	623	7	28.349 ^b	0.602 ^b
		LHAC	177	10		
	Juvenile	Natural	559,599	7,006	81.981	1.026
		LHIA	68,557	490	9.859	0.070
		LHAC	85,798	777	1.809	0.016
Snake River fall-run Chinook salmon	Adult	Natural	81	9	1.115	0.124
		LHIA	36	1	0.759 ^b	0.101 ^b
		LHAC	77	14		
	Juvenile	Natural	4,711	226	0.589	0.028
		LHIA	2,010	142	0.068	0.005
		LHAC	2,391	166	0.092	0.006
Snake River Basin steelhead	Adult	Natural	10,309	123	103.452	1.234
		LHIA	2,540	38	178.417 ^b	2.709 ^b
		LHAC	3,321	51		
	Juvenile	Natural	398,667	5,321	69.546	0.928
		LHIA	51,798	521	9.793	0.099
		LHAC	54,124	595	1.769	0.019
Snake River sockeye salmon	Adult	Natural	112	6	700.000	37.500
		LHIA	1	0	2.062 ^b	0.000 ^b
		LHAC	1	0		
	Juvenile	Natural	8,295	296	46.083	1.644
		LHAC	200	56	0.067	0.019
Lower Columbia River Chinook salmon	Adult	Natural	434	24	1.481	0.082
		LHIA	1	0	2.163 ^b	0.112 ^b
		LHAC	406	21		
	Juvenile	Natural	414,153	5,719	3.719	0.051
		LHIA	379	20	0.040	0.002
		LHAC	2,400	465	0.008	
Lower Columbia River coho salmon	Adult	Natural	1,082	20	5.782	0.107
		LHIA	1	0	2.558 ^b	0.245 ^b
		LHAC	407	39		
	Juvenile	Natural	242,606	2,901	29.335	0.351
		LHIA	770	11	0.238	0.003
		LHAC	16,116	174	0.203	0.002
Lower Columbia River steelhead	Adult	Natural	3,111	33	38.162	0.405
		LHAC	66	4	1.034	0.063
	Juvenile	Natural	51,648	887	13.765	0.236
		LHIA	3	0	0.020	0.000
		LHAC	3,257	56	0.275	0.005
Columbia River chum salmon	Adult	Natural	90	11	0.520	0.064
		LHIA	3	1	0.524 ^b	0.175 ^b
		LHAC	3	1		
	Juvenile	Natural	68,618	818	0.882	0.011
		LHIA	550	6	0.099	0.001
		LHAC	16	1	-	-
Upper Willamette River Chinook salmon	Adult	Natural	265	8	2.516	0.076
		LHIA	1	0	0.623 ^b	0.055 ^b
		LHAC	157	14		

Species	Life Stage	Origin ^a	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
	Juvenile	Natural	82,945	2,972	7.155	0.256
		LHIA	873	10	-	-
		LHAC	14,820	261	0.340	0.006
Upper Willamette River steelhead	Adult	Natural	377	6	14.346	0.228
	Juvenile	Natural	27,553	624	20.364	0.461
Oregon Coast coho salmon	Adult	Natural	15,203	177	25.078	0.292
		LHAC	16	4	2.508	0.627
	Juvenile	Natural	687,540	15,636	16.033	0.365
		LHAC	205	7	0.342	0.012
Southern Oregon/Northern California Coast coho salmon	Adult	Natural	4,493	43	71.031 ^d	0.712 ^d
		LHIA	3,422	29		
		LHAC	1,064	18		
	Juvenile	Natural	276,828	4,853	31.285	0.548
		LHIA	17,778	704	23.704	0.939
		LHAC	20,471	555	3.560	0.097
California Coastal Chinook salmon	Adult	Natural	519	22	3.941	0.167
	Juvenile	Natural	109,294	1,924	4.568	0.080
Sacramento River winter-run Chinook salmon	Adult	Natural	1,424	17	120.169	1.435
		LHAC	1,422	49	52.725	1.817
	Juvenile	Natural	425,679	11,403	340.440	9.120
		LHAC	203,330	7,233	127.997	4.553
Central Valley spring-run Chinook salmon	Adult	Natural	1,806	29	26.732	0.429
		LHAC	894	81	42.919	3.889
	Juvenile	Natural	1,005,332	20,413	54.669	1.110
		LHIA	2,600	6	-	-
		LHAC	60,657	4,633	3.033	0.232
California Central Valley steelhead	Adult	Natural	4,376	138	55.925 ^d	2.697 ^d
		LHIA	100	2		
		LHAC	1,952	170		
	Juvenile	Natural	87,676	2,233	6.706	0.171
		LHIA	50	1	-	-
		LHAC	29,283	1,578	2.789	0.150
Southern DPS eulachon	Adult	Natural	38,864	30,877	0.151	0.120
	Subadult	Natural	180	6		
	Juvenile	Natural	1,425	1,268		
Southern DPS green sturgeon	Adult	Natural	509	13	23.930	0.611
	Subadult	Natural	378	21	3.386	0.188
	Juvenile	Natural	6,646	193	149.989	4.356
	Larvae	Natural	11,348	1,124	-	-
	Egg	Natural	3,870	3,870		

^a LHAC=Listed Hatchery Adipose Clipped, LHIA = Listed Hatchery Intact Adipose.

^b Abundances for adult hatchery salmonids are LHAC and LHIA combined.

^c Abundance for adult and juvenile components combined

^d Abundances for all adult components are combined.

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 than the allotted number of fish every year. Over the past five years, researchers in the Section 10(a)(1)(A) program have reported taking approximately 24% and killing approximately 11% of the juveniles that were authorized, and only taking roughly 15% and killing roughly 8% of the adults that were authorized across all species. (More recent figures on less-than-allotted take for individual permits being renewed are discussed in the individual analyses in Section 2.5.) 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 the tables.

2.5 Effects of the Action

Under the ESA, “effects of the action” are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. 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

Full descriptions of effects of the proposed research activities are given in the following sections. In general, the permitted activities would be (1) electrofishing, (2) capturing fish with angling equipment, traps, temporary weirs, 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 that are not designated as “critical” 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.

Capturing, Handling, and Anesthesia

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 and anesthetizing fish, and the general effects of capture using seines and traps here. We discuss effects from other capture methods in more detail in the subsections below.

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, populations, and species (Sharpe et al. 1998). Handling of 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. Excessive air exposure causes gill lamellae to collapse, ceasing aerobic respiration and causing hypoxia. High water temperature can contribute to high mortality following air exposure (Patterson et al. 2017). Loss of protective mucus is a common injury during capture and handling which increases susceptibility to disease (Cook et al. 2018). Mucus contains antibacterial proteins, and its loss makes fish vulnerable to pathogens that may cause infections and latent mortality. Fish held at higher water temperature have a higher risk of infection post-sampling (Patterson et al. 2017). Stress on salmonids increases rapidly from handling if the water temperature exceeds 18°C or dissolved oxygen is below saturation. Exhaustion from excess physical activity can result in death through acidosis or latent mortality due to the inability to recover from exhaustion. Fish that survive physiological imbalances caused during handling can lose equilibrium and have impaired swimming abilities, increasing their susceptibility to predation (Cook et al. 2018). 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. Capture and handling stressors can combine to cause cumulative effects that greatly increase the likelihood of fish mortality. 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.

Anesthetics are crucial for minimizing stress and immobilizing fish during handling, transport, blood sampling, PIT tagging, and tissue sampling. Commonly used fish anesthetics include Tricaine Methanesulfonate (MS-222), Clove oil, Benzocaine, and 2-Phyenoxyethanol. These are typically administered through immersion, where fish absorb the anesthetic through their gills. Anesthetics depress the central and peripheral nervous system, resulting in a state of sedation during which the fish is rendered unconscious, minimizing changes to biochemical stress indicators including plasma cortisol, glucose, and lactate (Martins et al. 2018). Stress responses in fish need to be minimized since they have negative physiological effects that can compromise growth, reproduction, and immunity (Souza et al. 2019). Immersion anesthetics typically have higher efficacy in warmer water temperatures and lower efficacy in water with low pH value (Neiffer & Stamper 2009, Priborsky & Velisek 2018). Higher doses are associated with quicker induction and longer recovery. Fish anesthetics can alter fish plasma biochemical indices, hematological profile, oxidative stress biomarkers, and antioxidant enzymes (Priborsky & Velisek 2018). When chemical anesthetics are first administered, fish can experience a phase of intense excitement and agitation as their inhibitory neurons become depressed before full anesthesia is achieved (Young et al. 2019, Souza et al. 2019). Exposure to high levels of anesthetics can thus induce stress (Young et al. 2019), and anesthetic overdoses can be fatal.

Tricaine Methanesulfonate (MS-222) is a widely used anesthetic in fish research, and the only fish anesthetic approved by the FDA for use in fish that people may consume —this includes ESA-listed fish that may be harvested. MS-222 requires personal protective equipment during handling and must be mixed with a buffering agent since it reduces water pH (Neiffer & Stamper 2009, Martins et al. 2018). During surgery an anesthetic maintenance dose is required to maintain stage 4 anesthesia (Carter et al. 2010). MS-222 can cause several side effects, including compromising a fish's antioxidant defenses, increasing cortisol (which reduces oxygen uptake), and reducing blood flow through the gills (Teles et al. 2019). Long-term effects of MS-222 exposure are not adequately known, and ease of accidental overdose from MS-222 is a concern (Carter et al. 2010).

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. High voltage current is passed between an anode and a cathode, which induces muscular convulsions (galvanotaxis) in fish when they encounter a high enough voltage gradient between the electrodes. Electrofishing can have several short-term effects, including stress, fatigue, reduced feeding, and susceptibility to predation (NMFS 2000). Electrofishing can also cause physical injuries such as internal hemorrhaging and spinal injuries, which are caused by galvanotaxis. Mortality from electrofishing is typically due to respiratory failure or asphyxiation (Snyder 2003). The extent to which sampled fish are affected depends on the electrofishing waveform, pulse frequency, fish age and size, number of exposures, and operator skill (Panek & Densmore 2011, Simpson et al. 2016, Chiaramonte 2020, Pottier &

Marchand 2020). Research indicates that using continuous direct current (DC) or low-frequency (30 Hz) pulsed DC waveforms produce lower spinal injury rates, particularly for salmonids (Holliman et al. 2010, Pottier & Marchand 2020, Clancy et al. 2021). Higher frequencies generally result in better catch efficiency albeit with higher rates of injury (Chiaromonte et al. 2020).

Adult salmonids are particularly susceptible to spinal injuries, as longer fish (> 300mm) are subjected to strong voltage gradients by the electrofishing anode (Pottier & Marchand 2020). Adult salmonids can be injured or killed due to spinal injuries that can result from forced muscle contractions. Spinal injuries to salmonids become increasingly detectable over time and are often not immediately apparent (Holliman et al. 2010). To avoid causing such injuries, we do not allow electrofishing to be used as a method for capturing adult salmonids. Though electrofishing crews do sometimes inadvertently encounter adults during their work, they must immediately turn off their equipment and allow the fish to swim away. Smaller, juvenile fish are subjected to lesser voltage gradients, but there is conflicting evidence about whether this results in lower rates of injury (Snyder 2003). Spawning female salmonids are also vulnerable, since electrofishing can reduce survival rates for eggs spawned from previously electroshocked females (Cho et al. 2002, Huysman et al. 2018). Salmon in early developmental stages, including embryos and alevin, are another vulnerable group for whom electrofishing should be avoided (Simpson et al. 2016). Electrofishing can also inflict harm on non-target species, particularly during multiple pass depletion surveys, during which non-target fish can be exposed to multiple electroshocks (Panek & Densmore 2011). Incidence of injuries for target fish and non-target bycatch alike increases with multiple exposures (Panek & Densmore 2013).

When using appropriate electrofishing protocols and equipment settings, shocked fish normally revive quickly. When done carefully, electrofishing of individual fish has been shown to not affect wild salmonid abundance (Clancy et al. 2021), and individual long-term survival is not usually compromised (Snyder 2003). However, individual growth may be stunted by electroshock exposure, resulting in abnormally low weight and small size (Thompson et al. 1997, Dwyer et al. 2001). The latent, sublethal, and population level impacts of electrofishing are areas that are not well understood, and in which further research is recommended.

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 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. Researchers conducting boat electrofishing must follow NMFS' electrofishing guidelines.

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 percent 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 percent and 84 percent 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 (Taylor and White 1992; Schill and Scarpella 1995; Muoneke and Childress 1994; Mongillo 1984; Wydoski 1977; 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 (Huhn and Arlinghaus 2011; Bartholomew and Bohnsack 2005; Taylor and White 1992; Mongillo 1984; Wydoski 1977). 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 nonlanded mortality 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. Only in the rarest cases would any take be associated with these observation activities, and that would be in the form of harassment (see section 2.9). No injuries and no deaths would be 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. These can be found in the individual study protocols and in the permit conditions stated earlier. 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, several other stringent 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 and more are used to make sure the mortality rates stay at one percent or lower.

Seines, Small Traps, and Hand/Dip Nets

Seines, traps, and hand or dip net methods are generally used to obtain information on fish distribution and abundance, habitat use, life history, and outmigration timing, and are often used to capture fish for further data collection procedures such as tagging, sampling, or gastric lavage. Beach seines and small traps (such as minnow traps, or similar) are used to collect juvenile fish in shallow-water habitats. Boat seines (such as purse seines) and large traps (such as fyke traps, or similar) are used to collect or observe adults. Nets can injure fish by removing protective mucus and tearing gills (Patterson et al. 2017). Wearing gloves during handling and using soft rubber or knotless nets minimizes damage to fish gills, scales, and mucus. In general, handling should be conducted with soft, smooth, and pre-wetted gear. Based on years of sampling at hundreds of locations under hundreds of scientific research authorizations, we would expect the mortality rates for fish captured by seines, traps, or hand/dip nets to be three percent or less.

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 codend 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, Stickney 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 have included 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 Species-specific Effects of Each Permit

In previous sections, we estimated the annual abundance of adult and juvenile listed salmonids, eulachon, green sturgeon, eulachon, and rockfish. Because none of the proposed actions would have any measurable negative habitat effects, the analysis will consist primarily of examining directly

measurable impacts of proposed activities 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. Examining the magnitude of these effects at the individual and, where possible, population levels is the best way to determine effects at the species level. Table 31 displays the estimated annual abundance of the listed species.

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 (i.e. CDFW, IDFW, ODFW, 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. The following table displays the estimated abundance for the listed species analyzed in this opinion.

Table 31. Estimated annual abundance of ESA listed fish (Ford 2022, SWFSC 2023, CDFW 2020, Zabel 2017, 2018, 2020, 2021, 2022) (LHAC= Listed Hatchery, Adipose-clipped, LHIA= Listed Hatchery, Intact Adipose).

Species	Life Stage	Origin ^a	Abundance
PS Chinook salmon	Adult	Natural	23,371
		Listed Hatchery ^b	23,232
	Juvenile	Natural	3,728,240
		LHIA	8,680,000
		LHAC	25,624,500
PS steelhead	Adult	Natural	18,196
		Listed Hatchery ^b	1,618
	Juvenile	Natural	2,253,842
		LHIA	53,000
		LHAC	226,000
HCS chum salmon	Adult	Natural	28,117
		Listed Hatchery ^b	881
	Juvenile	Natural	4,240,958
Puget Sound/Georgia Basin DPS bocaccio	Adult	Natural	4,606
Puget Sound/Georgia Basin DPS yelloweye rockfish	Adult	Natural	114,494
Hood Canal summer-run chum salmon	Adult	Natural	28,117
		Listed Hatchery ^b	881
	Juvenile	Natural	4,240,958
UCR Chinook salmon	Adult	Natural	813
		Listed Hatchery ^b	1,140
	Juvenile	Natural	488,401
		LHIA	470,744
		LHAC	682,958
UCR steelhead	Adult	Natural	1,465
		Listed Hatchery ^b	2,893
	Juvenile	Natural	150,459
		LHIA	139,810

Species	Life Stage	Origin ^a	Abundance
		LHAC	765,850
MCR steelhead	Adult	Natural	13,598
		Listed Hatchery ^b	713
	Juvenile	Natural	351,481
		LHIA	113,302
		LHAC	372,581
SnkR spr/sum Chinook salmon	Adult	Natural	4,419
		Listed Hatchery ^b	2,822
	Juvenile	Natural	682,600
		LHIA	695,385
		LHAC	4,743,977
SnkR fall-run Chinook salmon	Adult	Natural	7,262
		Listed Hatchery ^b	14,879
	Juvenile	Natural	799,765
		LHIA	2,966,190
		LHAC	2,608,733
SnkR steelhead	Adult	Natural	9,965
		Listed Hatchery ^b	3,285
	Juvenile	Natural	573,245
		LHIA	528,903
		LHAC	3,058,720
SnkR sockeye salmon	Adult	Natural	16
		Listed Hatchery ^b	97
	Juvenile	Natural	18,000
LHAC		298,464	
LCR Chinook salmon	Adult	Natural	29,298
		Listed Hatchery ^b	18,814
	Juvenile	Natural	11,135,315
		LHIA	942,328
		LHAC	30,923,844
LCR coho salmon	Adult	Natural	18,714
		Listed Hatchery ^b	15,949
	Juvenile	Natural	827,007
		LHIA	324,130
		LHAC	7,941,886
LCR steelhead	Adult	Natural	8,152
		Listed Hatchery ^b	6,382
	Juvenile	Natural	375,208
		LHIA	14,801
		LHAC	1,183,963
CR chum salmon	Adult	Natural	17,305
		Listed Hatchery ^b	1,145
	Juvenile	Natural	7,777,554
LHIA		554,973	
UWR Chinook salmon	Adult	Natural	10,531
		Listed Hatchery ^b	25,380
	Juvenile	Natural	1,159,334
		LHIA	0
		LHAC	4,361,832
UWR steelhead	Adult	Natural	2,628
	Juvenile	Natural	135,303
OC coho salmon	Adult	Natural	60,624

Species	Life Stage	Origin ^a	Abundance
		Listed Hatchery ^b	638
	Juvenile	Natural	4,288,340
		LHAC	60,000
SONCC coho salmon	Adult	LHAC, LHIA & NOR ^c	12,641
	Juvenile	Natural	884,870
		LHAC	575,000
NC steelhead	Adult	LHAC, LHIA & NOR ^c	8,356
	Juvenile	Natural	950,493
CC Chinook salmon	Adult	Natural	13,169
	Juvenile	Natural	2,392,807
SacR winter-run Chinook salmon	Adult	Natural	1,185
		Listed Hatchery ^b	2,697
	Juvenile	Natural	125,038
CVS Chinook salmon	Adult	Natural	6,756
		Listed Hatchery ^b	2,083
	Juvenile	Natural	1,838,954
CCV steelhead	Adult	LHAC, LHIA & NOR ^c	11,494
		Natural	1,307,443
	Juvenile	LHAC	1,050,000
SDPS eulachon	Adult	Natural	26,746,391
SDPS green sturgeon	Adult	Natural	2,127
	Subadult	Natural	11,165
	Juvenile	Natural	4,431

^a LHAC=Listed Hatchery Adipose Clipped, LHIA = Listed Hatchery Intact Adipose.

^b Abundances for adult hatchery salmonids are LHAC and LHIA combined.

^c Abundances for all adult components are combined.

Permit 1127-7R

The Shoshone-Bannock Tribes are seeking to renew a permit that for more than two decades has allowed them to annually take listed SnkR spr/sum Chinook salmon and steelhead while conducting research designed to (1) monitor adult and juvenile fish in key upper Snake River subbasin watersheds, (2) assess the utility of hatchery Chinook salmon in increasing natural populations in the Salmon River, and (3) evaluate the genetic and ecological impacts hatchery Chinook salmon may have on natural populations.

Under these three projects, a large number of SnkR spr/sum Chinook salmon and steelhead would be observed from river banks and by snorkelers. Some of the observed fish—and a number of others—would be captured using rotary screw traps, electrofishing, seine nets, hook and line angling, picket weirs, and an adult weir in the East Fork Salmon River in Idaho. Many of the fish would then simply be released; but a number of them would be measured, PIT-tagged, and tissue sampled. The tagged fish would generally be allowed to recover and then released. A subsample of the tagged fish would be kept for 24 hours to monitor for delayed mortality or other side effects. Some adult fish may be transported a maximum of 45 minutes away from their capture site in keeping with the

recommendations of the Interior Columbia Basin Technical Recovery Team. Data would also be collected from dead adult Chinook salmon carcasses and extensive visual spawning ground surveys would be conducted. As stated previously, the SBT does not propose to kill any of the fish they capture, but a small number may die as an unintended result of the activities. The amounts of take the SBT is requesting are found in the table just below.

Please note that henceforth “LHIA” (listed hatchery, intact adipose) indicates animals of hatchery origin that have intact adipose fins, and “LHAC” (listed hatchery, adipose clipped) indicates hatchery fish that have had their adipose fins clipped.

Table 32. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 1127-7R

Species	Life Stage	Origin*	Take Action*	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Snake River spring/summer-run Chinook salmon	Adult	Natural	C/M, T, ST/R	500	1	11.315	0.023
		LHIA	C/M, T, ST/R	100	1	3.721	0.071
		LHAC	C/M, T, ST/R	5	1		
	Juvenile	Natural	C/H/R	2,650	65	0.560	0.012
		Natural	C/M, T, ST/R	5,000	98		
		LHIA	C/H/R	550	20	0.435	0.009
		LHIA	C/M, T, ST/R	5,500	101		
Snake River Basin steelhead	Juvenile	Natural	C/H/R	2,400	44	0.659	0.013
		Natural	C/M, T, ST/R	5,150	106		
		LHIA	C/M, T, ST/R	50	1	0.009	<0.001
		LHAC	C/H/R	700	8	0.023	

*C=Capture, H=handle, R=release, T=Tag, M=Mark, ST=Sample tissue

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species—these figures are presented in the last column of the table above.

As the table above demonstrates, the overall effect on the two species’ abundance would in all cases be very small. However, the fish that may be killed would not be coming out of each species as a whole, but only the parts that reside in the upper Salmon River subbasin. Because of the nature of the research, it is not possible to determine—beyond saying that the fish are from the upper Salmon

River basin—exactly where in the listed units either the juveniles or adults would originate. The area’s annual contributions to the two species’ abundance varies, but a query of the Salmon Population Summary (SPS) database² demonstrates that the area contributes something on the order of one-tenth of the natural spawners found in the SnkR spr/sum Chinook salmon species ESU. It is unknown how many of the steelhead come from the area, but the proportion is probably of a similar magnitude. Thus the overall effect on *local* abundance could entail values on the order of ten times as high as those displayed, thus the effect could be mortality rates of as much as 0.1% of the natural juvenile steelhead and 0.1% of the natural spr/sum-run Chinook salmon coming out of that system. That is, as many as one in a thousand juvenile steelhead and juvenile spr/sum-run Chinook salmon could be killed during the course of the research. The calculation is the same for the adults: around two natural adult Chinook salmon out of a thousand might be killed by the activities—but even that low rate is unlikely given that the researchers have killed no adult Chinook salmon at all in the last several years of sampling.

Thus, these numbers represent very small impacts on the local abundance (and therefore productivity) and, as such, they are unlikely to have any long-term negative affect on the local populations’ survival—particularly given that there is not likely to be any measurable effect on the populations’ structure or diversity. This is even more the case at the species level. Also, the effect of these losses would to some extent be offset by the information generated from the research, which would be used to improve survival of the species in the future. A great deal of the information we have on steelhead and Chinook salmon status in the upper Salmon River comes directly from previous iterations of this research over the last 20+ years. It is also likely that the impacts will be smaller than those laid out above. Over the most recent five years, the researchers have only taken 1.86% of their requested take, and killed 0.34% of their requested mortalities, so it is most likely that the actual effect will be less than that displayed in the table above by a similar magnitude.

Further, the SBT would take a number of steps to make sure their research has the smallest possible effect on the fish they are taking. In the past, this has meant mortality rates of 1% or less in the smolt monitoring and PIT-tagging activities and 1% mortality in the electrofishing. This means that the actual mortalities associated with this research are likely to be half—or less—of the levels stated. Given this history, the researchers’ record of not killing adults at all, the already stated Permit Conditions (Section 1.3), and the crucial nature of the research in terms of its utility in helping recover the species and their habitat, the small losses to be incurred are likely to have a minimal adverse effect on the species’ abundance and productivity and no measurable impact on their structure or diversity.

Permit 1410-14R

Under permit 1410-14R the NMFS Northwest Fisheries Science Center is seeking to renew a permit that would authorize them to take adult Puget Sound Chinook salmon, Upper Columbia River spring-run Chinook salmon, Upper Columbia River steelhead, Middle Columbia River steelhead, Snake River spring/summer-run Chinook salmon, Snake River fall-run Chinook salmon, Snake River Basin steelhead, Snake River sockeye salmon, Lower Columbia River Chinook salmon, Lower

² The Northwest Fisheries Science Center’s [Salmon Population Database \(SPS\)](#) is designed to provide access to demographic data compiled for ESA-listed salmonid populations as part of the NWFSC’s technical recovery planning efforts.

Columbia River coho salmon, Lower Columbia River steelhead, Columbia River chum salmon, Upper Willamette River Chinook salmon, Upper Willamette River steelhead, Oregon Coast coho salmon, Southern Oregon/Northern California Coast coho salmon, California Coastal Chinook salmon, Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Southern DPS eulachon in order to (1) determine the ocean distribution and behaviors of smolt and sub-adult salmonids including Chinook and coho salmon and steelhead; (2) understand the degree to which fish from different origins use near-shore habitats; (3) synthesize the early ocean ecology of juvenile Columbia River salmon, test mechanisms that control salmonid growth and survival, and produce ecological indices that forecast juvenile salmonid survival; and (4) use simulation models, statistical analyses of climate, ocean and biological time series data, and indices to produce improved river and salmon management.

At each sampling event, juvenile salmonids of each species and size class (i.e., subyearling and yearling Chinook salmon based on size) will be measured and individually frozen at -20°C; some of the juvenile salmon in excess of this number may be frozen together. Once on shore, juvenile salmon will be stored at -80°C. All juvenile salmon would be thawed, weighed, and dissected to remove tissues for growth, genetics, diet (stomach contents), parasites, pathogens and physiological condition; excised tissues are either immediately refrozen or, in the case of stomachs, preserved in prefer solution. Adult salmonids would be returned immediately to the ocean. Captured eulachon would be either released or retained for further scientific research activities at NWFSC. Other captured species (species that are not ESA-listed) would be enumerated, measured, and either retained for further analysis or returned to the water.

The researchers are proposing to kill a small number of listed fish, and a small number of fish may be killed as an inadvertent result of these activities. The amounts of take the NMFS Northwest Fisheries Science Center are requesting is found in the table below.

Table 33. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 1410-14R

Species	Life Stage	Origin	Take Action*	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Puget Sound Chinook salmon	Adult	Natural	IM	15	15	0.064	0.064
		LHIA	IM	3	3	0.121	0.121
		LHAC	IM	25	25		
	Juvenile	Natural	IM	25	25	<0.001	<0.001
		LHIA	IM	6	6		
		LHAC	IM	110	110		
Upper Columbia River spring-run Chinook salmon	Adult	Natural	IM	1	1	0.123	0.123
		LHIA	IM	1	1	0.175	0.175
		LHAC	IM	1	1		
	Juvenile	Natural	IM	80	80	0.016	0.016
		LHIA	IM	20	20	0.004	0.004
		LHAC	IM	190	190	0.028	0.028
	Juvenile	Natural	IM	7	7	0.005	0.005

Species	Life Stage	Origin	Take Action*	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Upper Columbia River steelhead		LHIA	IM	7	7	0.003	0.003
		LHAC	IM	21	21		
Middle Columbia River steelhead	Juvenile	Natural	IM	25	25	0.007	0.007
		LHAC	IM	11	11	0.003	0.003
Snake River spring/summer-run Chinook salmon	Adult	Natural	IM	1	1	0.023	0.023
		LHIA	IM	1	1		
		LHAC	IM	1	1		
	Juvenile	Natural	IM	122	122	0.018	0.018
		LHIA	IM	32	32	0.005	0.005
		LHAC	IM	290	290	0.006	0.006
Snake River fall-run Chinook salmon	Adult	Natural	IM	2	2	0.028	0.028
		LHIA	IM	1	1		
		LHAC	IM	3	3		
	Juvenile	Natural	IM	60	60	0.008	0.008
		LHIA	IM	17	17	<0.001	<0.001
		LHAC	IM	145	145	0.006	0.006
Snake River Basin steelhead	Adult	LHAC	IM	1	1	0.030	0.030
	Juvenile	Natural	IM	14	14	0.002	0.002
		LHIA	IM	6	6	0.001	0.001
		LHAC	IM	30	30	0.0010	0.0010
Snake River sockeye salmon	Juvenile	LHAC	IM	6	6	0.002	0.002
Lower Columbia River Chinook salmon	Adult	Natural	IM	25	25	0.085	0.085
		LHIA	IM	3	3		
		LHAC	IM	40	40		
	Juvenile	Natural	IM	190	190	0.002	0.002
		LHIA	IM	50	50	0.005	0.005
		LHAC	IM	740	740	0.002	0.002
Lower Columbia River coho salmon	Adult	Natural	IM	5	5	0.027	0.027
		LHIA	IM	2	2		
		LHAC	IM	10	13		
	Juvenile	Natural	IM	175	175	0.021	0.021
		LHIA	IM	195	195	0.060	0.060
		LHAC	IM	970	970	0.012	0.012
Lower Columbia River steelhead	Juvenile	Natural	IM	24	24	0.006	0.006
		LHAC	IM	24	24	0.002	0.002
Columbia River chum salmon	Juvenile	Natural	IM	36	36	<0.001	<0.001
		LHIA	IM	12	12	0.002	0.002
Upper Willamette River Chinook salmon	Adult	Natural	IM	4	4	0.038	0.038
		LHIA	IM	1	1		
		LHAC	IM	2	2		
	Juvenile	Natural	IM	72	72	0.006	0.006
		LHIA	IM	18	18	<0.001	<0.001
		LHAC	IM	170	170	0.004	0.004

Species	Life Stage	Origin	Take Action*	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Upper Willamette River steelhead	Juvenile	Natural	IM	4	4	0.003	0.003
Oregon Coast coho salmon	Adult	Natural	IM	8	8	0.013	0.013
		LHAC	IM	15	15	2.351	2.351
	Juvenile	Natural	IM	100	100	0.002	0.002
		LHAC	IM	250	250	0.417	0.417
Southern Oregon/Northern California Coast coho salmon	Adult	Natural	IM	1	1	0.016	0.016
		LHAC	IM	1	1		
	Juvenile	Natural	IM	10	10	0.001	0.001
		LHAC	IM	10	10	0.002	0.002
California Coastal Chinook salmon	Adult	Natural	IM	1	1	0.008	0.008
	Juvenile	Natural	IM	1	1	<0.001	<0.001
		LHAC	IM	1	1		
Sacramento River winter-run Chinook salmon	Adult	Natural	IM	1	1	0.084	0.084
		LHAC	IM	1	1	0.037	0.037
	Juvenile	Natural	IM	1	1	<0.001	<0.001
		LHAC	IM	1	1		
Central Valley spring-run Chinook salmon	Adult	Natural	IM	1	1	0.015	0.015
		LHAC	IM	1	1	0.048	0.048
	Juvenile	Natural	IM	2	2	<0.001	<0.001
		LHAC	IM	8	8		
Southern DPS eulachon	Adult	Natural	C/H/R	100	100	0.004	0.004
	Subadult	Natural	C/H/R	1,000	1,000		

*C/H/R= Capture/Handle/Release, IM=Intentional (Directed) Mortality

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species—these figures are presented in the last column of the table above.

For this project, the fish mortality rate is expected to be high due to the capture method, a Nordic surface trawl. This capture method causes lethal crushing and descaling injuries to all captured juvenile salmonids and eulachon. Further, one of the goals of this project is to conduct full body analysis of juvenile salmonids, so the majority (if not all) of the captured juvenile salmonids would serve the purpose of the research as they are collected, frozen, and sent to the NWFSC lab for analysis. Because of the location and capture methods of the research, it is not possible to determine or target unlisted or listed salmonid ESUs/DPSs in advance. Therefore, it is reasonable to expect that the salmonid take will be roughly evenly distributed over the entire ESUs and DPSs; and thus, the take levels must be placed in the contexts of each species as a whole.

At the ESU/DPS levels for natural-origin salmonids and eulachon, the permitted activities may kill at most about 0.002% of any juvenile natural component (Table 33). All adult salmonids that are

captured would be either immediately returned to the ocean or held for a very short time in live-wells with aerated and continually refreshed in situ water so that they may be identified, checked for marks or tags and tissue sampled prior to release. The largest percentage of natural adults that may be killed during the research come from the UCR Chinook ESU—0.12% (roughly one in a thousand). Take at this level is unlikely to have a meaningfully resolvable effect on abundance and productivity and essentially none on structure or diversity.

It is also likely that the impacts will be smaller than those laid out above. Over the most recent five years, the researchers have only taken 13.73% of their requested take, and killed 14.6% of their requested mortalities, so it is most likely that the actual effect will be less than that displayed in the table above by a similar magnitude.

An effect of the research that cannot be quantified is the conservation benefit to the species resulting from the research. The purposes and benefits of the research are laid out above, but there is another aspect to it: Another goal of this project is to provide complementary data to Section 10(a)(1)(A) permit 22369 by using different capture equipment which allows them to reach different marine habitats (i.e. deeper waters, further from shore) and research a different subset of salmonids. The knowledge learned from these two projects combined should provide a more complete picture of marine salmonid life than provided by either one of these projects individually.

Permit 1484-8R

As noted previously, issuing permit 1484-8R would authorize the WDNR to take juvenile CR chum salmon, LCR Chinook salmon, LCR coho salmon, and LCR and MCR steelhead in WDNR-managed forests in Washington State for the purpose of surveying stream reaches above natural barriers to determine if fish are present. This information is needed to determine appropriate widths of riparian buffers to leave intact during timber harvest. The researchers would use single-pass backpack electrofishing to capture the fish, then identify and release them. Up to five listed, natural-origin juvenile salmonids (one of each ESU/DPS/species authorized) may die as a result of the research annually. The requested take is laid out in the table below.

Table 34. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 1484-8R

Species	Life Stage	Origin	Take Action*	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Middle Columbia River steelhead	Juvenile	Natural	C/H/R	10	1	0.003	<.001
Lower Columbia River Chinook salmon		Natural	C/H/R	10	1	<0.001	
Lower Columbia River coho salmon		Natural	C/H/R	10	1	0.001	
Lower Columbia River steelhead		Natural	C/H/R	10	1	0.003	
Columbia River chum salmon		Natural	C/H/R	10	1	<0.001	

*C/H/R= Capture/Handle/Release

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species—these figures are presented in the last column of the table above.

At the ESU/DPS level, the permitted activities would never kill even 0.001% of the natural juveniles from any of the listed units. At the local level, the effect of losing a single individual would be somewhat magnified, but it is difficult to gauge how much. Because the work would take place throughout SW Washington and would move from year to year, it is very difficult to show an effect at the local population level—and regardless, any population that might be affected during one field season would be unlikely to see an effect during the next because the researchers would shift from watershed to watershed throughout the life of the permit. It is, therefore, unlikely that the work would have any but the most minor impact on the listed species' abundance and productivity at either the local or the species level (and it would have no measurable effect on structure or diversity). This is especially given that over the most recent five years, the researchers have neither taken nor liked any listed fish. As a result, in most years, the work is not likely to have any effect at all on listed species.

An effect of the research that cannot be quantified is the conservation benefit to the species resulting from the research. This study would benefit listed species by documenting the need for increased riparian buffers, which better protect aquatic and riparian habitat where fish are present. In addition, data on the distribution of fish gained from this study would be used to inform land management decisions and better protect listed species.

Permit 14046-5R

As noted previously, issuing permit 14046-4R would authorize the KCDNRP to renew an existing permit that currently authorizes them to take juvenile PS Chinook salmon and PS steelhead in four Puget Sound (Washington) sub-basins—Snoqualmie, Lake Washington, Duwamish, and Puyallup—and intertidal nearshore areas in the Puget Sound (King County, Washington). The researchers would use beach seines, fyke nets, gill nets, hook and line, minnow traps, and backpack and boat-operated electrofishing to capture the fish. They would then anaesthetized, identified to species, allowed to recover, and released. A subset of the Chinook salmon would also be tagged (acoustic, PIT, and elastomer), dyed (Bismark Brown), gastric lavaged, and have scales collected.

The researchers are not proposing to kill any of the listed fish being captured, but a small number of fish may be killed as an inadvertent result of these activities. The amounts of take being requesting are found in the table below.

Table 35. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 14046-5R

Species	Life Stage	Origin	Take Action*	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Puget Sound Chinook salmon	Juvenile	Natural	C/H/R	4,075	82	0.118	0.002
		Natural	C/M, T, ST/R	4,750	95		
		LHAC	C/H/R	4,625	129	0.016	<0.001
		LHAC	C/M, T, ST/R	3,725	112		
Puget Sound steelhead	Juvenile	Natural	C/H/R	580	16	0.026	0.002
		LHIA	C/H/R	50	1	0.094	
		LHAC	C/H/R	155	5	0.069	

*C=Capture, H=handle, R=release, T,=Tag, M=Mark, ST=Sample tissue

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species—these figures are presented in the last column of the table above.

At the ESU/DPS levels, the permitted activities may kill at most 0.002% of the natural-origin juvenile PS Chinook salmon and hatchery-origin PS steelhead. Because the research would take place over such a broad area, and in the marine environment, the potential losses cannot be ascribed to any population for any species and must therefore be viewed in the context of the listed units as individual wholes. As a result, though the research may in some instances have a very small impact on species abundance and productivity, it would in no measurable way impact structure or diversity for any species. Moreover, it is likely that the impacts will be smaller than those laid out above. Over the most recent five years, the researchers have only taken 7.57% of their requested take, and killed 7.32% of their requested mortalities, so it is most likely that the actual effect will be less than one-tenth of that displayed in the table above.

An effect of the research that cannot be quantified is the conservation benefit to the species resulting from the research. The purposes of the study are to (1) evaluate the effectiveness of restoration actions through biological monitoring, (2) understand how juvenile salmonids use specific riverine habitats in order to prioritize restoration projects and guide project design, (3) assess salmonid habitat status and trends in small streams with varying degrees of land use while monitoring current stream conditions, and (4) assess contaminant levels in various freshwater fish. The research would benefit the affected species by determining how restoration and recovery actions are contributing to listed species recovery, providing information on the extent of juvenile salmonid rearing in off-channel areas, guiding future restoration projects based upon monitoring results, providing information on habitat use by yearling fall-run Chinook salmon, and contributing to our knowledge of Chinook salmon life histories.

Permit 15207-5R

As noted previously, issuing permit 15207-5R would authorize the AOI to renew an existing permit that currently authorizes them to take juveniles and adults from 18 listed salmonid ESUs/DPSs throughout Idaho, Oregon, and Washington states. Using raft-mounted and backpack electrofishing equipment, fish would be captured, identified to species, measured to length, searched for abnormalities, and returned to the water when recovered. In general, the researchers would avoid adult salmonids: some may be encountered as an unintentional result of the sampling, but none would be killed. The following table lays out the amounts of take being requested.

Table 36. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 15207-5R

Species	Life Stage	Origin	Take Action*	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Puget Sound Chinook salmon	Adult	Natural	C/H/R	4	0	0.017	0.000
		LHAC	C/H/R	4	0		
	Juvenile	Natural	C/H/R	350	10	0.009	<0.001
		LHAC	C/H/R	350	10	0.001	
Puget Sound steelhead	Adult	Natural	C/H/R	4	0	0.022	0.000
		LHAC	C/H/R	4	0	0.247	
	Juvenile	Natural	C/H/R	350	10	0.016	<0.001
		LHAC	C/H/R	350	10	0.155	0.004
Hood Canal summer-run chum salmon	Adult	Natural	C/H/R	4	0	0.014	0.000
	Juvenile	Natural	C/H/R	100	3	0.002	<0.001
Upper Columbia River spring-run Chinook salmon	Adult	Natural	C/H/R	1	0	0.123	0.000
		LHAC	C/H/R	1	0	0.088	
	Juvenile	Natural	C/H/R	50	2	0.010	<0.001
		LHAC	C/H/R	50	2	0.007	
Upper Columbia River steelhead	Adult	Natural	C/H/R	1	0	0.068	0.000
		LHAC	C/H/R	1	0	0.035	
	Juvenile	Natural	C/H/R	50	2	0.033	0.001
		LHAC	C/H/R	50	2	0.007	<0.001
Middle Columbia River steelhead	Adult	Natural	C/H/R	4	0	0.029	0.000
		LHAC	C/H/R	4	0	0.561	
	Juvenile	Natural	C/H/R	350	10	0.100	0.003
		LHAC	C/H/R	350	10	0.094	
Snake River spring/summer-run Chinook salmon	Adult	Natural	C/H/R	4	0	0.091	0.000
	Juvenile	Natural	C/H/R	300	9	0.044	0.001
		LHAC	C/H/R	300	9	0.006	<0.001
Snake River fall-run Chinook salmon	Adult	Natural	C/H/R	2	0	0.028	0.000
	Juvenile	Natural	C/H/R	300	9	0.038	0.001
Snake River Basin steelhead	Adult	Natural	C/H/R	5	0	0.050	0.000
		LHAC	C/H/R	4	0	0.122	
	Juvenile	Natural	C/H/R	350	11	0.061	0.002
		LHAC	C/H/R	300	9	0.010	<0.001

Species	Life Stage	Origin	Take Action*	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Snake River sockeye salmon	Adult	Natural	C/H/R	1	0	6.250	0.000
	Juvenile	Natural	C/H/R	30	1	0.167	0.006
Lower Columbia River Chinook salmon	Adult	Natural	C/H/R	4	0	0.014	0.000
		LHAC	C/H/R	4	0	0.021	
	Juvenile	Natural	C/H/R	200	6	0.002	<0.001
		LHAC	C/H/R	200	6	<0.001	
Lower Columbia River coho salmon	Adult	Natural	C/H/R	4	0	0.021	0.000
		LHAC	C/H/R	4	0	0.025	
	Juvenile	Natural	C/H/R	200	6	0.024	<0.001
		LHAC	C/H/R	200	6	0.003	
Lower Columbia River steelhead	Adult	Natural	C/H/R	4	0	0.049	0.000
		LHAC	C/H/R	4	0	0.063	
	Juvenile	Natural	C/H/R	200	6	0.053	0.002
		LHAC	C/H/R	200	6	0.017	
Columbia River chum salmon	Adult	Natural	C/H/R	1	0	0.006	0.000
	Juvenile	Natural	C/H/R	30	1	<0.001	<0.001
Upper Willamette River Chinook salmon	Adult	Natural	C/H/R	4	0	0.038	0.000
		LHAC	C/H/R	4	0	0.016	
	Juvenile	Natural	C/H/R	150	5	0.013	<0.001
		LHAC	C/H/R	150	5	0.003	
Upper Willamette River steelhead	Adult	Natural	C/H/R	4	0	0.152	0.000
	Juvenile	Natural	C/H/R	150	5	0.111	0.004
Oregon Coast coho salmon	Adult	Natural	C/H/R	4	0	0.007	0.000
		LHAC	C/H/R	4	0	0.627	
	Juvenile	Natural	C/H/R	150	6	0.003	<0.001
		LHAC	C/H/R	50	2	0.083	
Southern Oregon/Northern California Coast coho salmon	Adult	Natural	C/H/R	2	0	0.016	0.000
	Juvenile	Natural	C/H/R	75	2	0.008	<0.001

*C=Capture, H=handle, R=release

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species—these figures are presented in the last column of the table above.

At the ESU/DPS levels for natural-origin salmonids, the largest effect the permitted activities may have is to kill, at most, 0.006% of the juvenile SnkR sockeye salmon. All other listed natural-origin ESUs/DPSs would see smaller effects, and the impacts would be spread out over a great many tributary and mainstem habitats in Oregon, Washington, and Idaho—many of the major fish-producing river systems would be sampled—thus no single population is likely to experience a

disproportionate degree of negative impact. This effect is, therefore, very small at the population level and nearly negligible at the ESU/DPS level, and it would only be seen in terms of its impact on abundance (and therefore productivity) because there would be no appreciable impact at all on structure or diversity. It is also likely that the impacts will be smaller than those laid out above. Over the most recent four years, the researchers have neither taken nor killed any listed fish, so it is most likely that the actual effect will be effectively zero in most years.

An effect of the research that cannot be quantified is the conservation benefit to the species resulting from the research. The purpose of the study is to develop baseline data of the physical and chemical habitat for rivers and streams throughout the United States. This research would benefit the affected species by characterizing the biological condition of rivers and, thereby, provide data that supports Clean Water Act implementation.

Permit 16344-4R

Under permit 16344-4R the Oregon State University is seeking to renew a permit that would authorize them to take juvenile SONCC coho salmon in order to (1) determine the effects of infection by the myxozoan parasite *Ceratonova shasta* on coho salmon, and (2) estimate disease effects for each study year on the wild coho population. Juvenile coho salmon from Iron Gate, Fall Creek and/or Trinity River hatcheries would be transported to selected locations on the Klamath River and monitored for disease after the exposure to *C. shasta*. Following exposure, all fish would be transported to the Oregon State University J. L. Fryer Aquatic Animal Health Laboratory where time to morbidity, overall morbidity and infection prevalence would be ascertained through microscopic and molecular analysis of intestinal tissues. Because all of the fish will be exposed to the parasite *C. shasta*, they cannot be released after the experiments. In addition, infection prevalence data are needed which requires euthanizing all fish surviving the exposures, since surviving fish may still be infected with the parasite. The OSU researchers are requesting the amounts of take found in the table below.

Table 37. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 16344-4R

Species	Life Stage	Origin	Take Action*	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Southern Oregon/Northern California Coast coho salmon	Juvenile	LHIA	C/ST/R	540	0	0.560	0.200
		LHIA	Intentional (Directed) Mortality	300	300		

*C=Capture, ST=Sample Tissue, R=Release

It should be noted that the values in the table above are, to some extent, redundant because the same juveniles collected and transported are those that will be later euthanized for analysis. Because all of the treatment fish will be exposed to the parasite *C. shasta*, they cannot be released after the experiments. In addition, infection prevalence data are needed which requires euthanizing all fish surviving the exposures, since surviving fish may still be infected with the parasite. Control fish will also be euthanized at the termination of the study. However, all of these fish will be obtained directly

from hatcheries and are not expected to decrease the hatchery releases for this ESU, so these mortalities are not expected to impact the ESU.

To determine the effects of potential research losses, we compare the numbers of fish that will be killed to the total abundance numbers expected for the population and species. These figures are presented in the far-right column of the above table. As discussed above, the juveniles taken for this study will be collected directly from hatchery brood and not yet released into a particular population area. Therefore, we have analyzed the effects at the ESU/DPS scale. As the figures above demonstrate, the research under this permit would kill at most 0.2% of the hatchery-origin juvenile component of the SONCC coho salmon ESU. However, because these fish are expected to be in excess of what hatcheries will produce to meet their juvenile release objectives, we do not expect juvenile releases to be decreased or the abundance of the ESU to be affected by this research.

Research associated with Permit 16344-4R would therefore have little to no impact on abundance, productivity, spatial structure or diversity for these listed species. Results from this study would benefit listed species by supporting an ongoing research to determine the effects of infection by the myxozoan parasite *Ceratonova shasta* on coho salmon, and estimate disease effects for each study year on the wild coho population for this ESU. It is also likely that the impacts will be smaller than those laid out above. Over the most recent five years, the researchers have only taken 45.67% of their requested take, and killed 45.67% of their requested mortalities, so it is most likely that the actual effect will be less than that displayed in the table above by a similar magnitude.

Permit 18260-3R

As noted previously, issuing permit 18260-2R would authorize the CTWS to take juvenile and adult LCR Chinook salmon, LCR coho salmon, and LCR and MCR steelhead in Fifteen Mile Creek and Hood River and their tributaries in Oregon. Juveniles would be collected via backpack electrofishing, fyke net. Juvenile fish would be captured, handled, and released. Adults would be collected via Net, Hoop, fyke net. Adults would be captured, handled (anesthetized, weighed, measured, and checked for marks or tags), and released. Up to four listed, natural-origin juvenile salmonids (one LCR Chinook salmon, one LCR coho salmon, one MCR steelhead and one LCR steelhead) may die as a result of the research annually. The requested take is laid out in the table below.

Table 38. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 18260-3R

Species	Life Stage	Origin	Take Action*	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Middle Columbia River steelhead	Adult	Natural	C/H/R	5	0	0.037	0.000
	Juvenile	Natural	C/H/R	10	0	0.003	
Lower Columbia River Chinook salmon	Adult	Natural	C/H/R	5	0	0.017	0.000
	Juvenile	Natural	C/H/R	60	1	<0.001	<0.001
Lower Columbia River coho salmon	Adult	Natural	C/H/R	5	0	0.027	0.000
	Juvenile	Natural	C/H/R	60	1	0.007	<0.001
	Adult	Natural	C/H/R	5	0	0.061	0.000

Species	Life Stage	Origin	Take Action*	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Lower Columbia River steelhead		LHAC	C/H/R	5	0	0.078	
	Juvenile	Natural	C/H/R	60	1	0.016	<0.001
		LHAC	C/H/R	60	1	0.005	

*C=Capture, H=Handle, R=Release

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species—these figures are presented in the last column of the table above.

At the ESU/DPS level, the permitted activities would never kill even 0.001% of the natural juveniles from any of the listed units. In total, the overall effect would be as close to zero as possible at the ESU and DPS levels. At the local level, the effect of losing a single individual would be somewhat magnified, but it is difficult to gauge how much because we have little information on the contributions that Fifteenmile Creek and the Hood River make to the listed species' abundance. Nonetheless, even if each effect were magnified by a factor of 100, that would still mean the research might kill, at most, the approximate equivalent of one juvenile fish out of ten thousand. It is therefore unlikely that the work would have any but the most minor impact on the listed species' abundance and productivity at either the local or the species level and it would have no measurable effect on structure or diversity for any of the species considered. This is especially given that over the most recent five years, the researchers have neither taken nor killed any listed fish. As a result, in most years, the work is not likely to have any effect at all on listed species.

An effect of the research that cannot be quantified is the conservation benefit to the species resulting from the research. The purpose of the study is to describe abundance, habitat associations, spawning, distribution, migration patterns, harvest rates, and limiting factors for Pacific lamprey in Fifteen Mile Creek and Hood River and their tributaries. The research would provide important basic ecological information about Pacific lamprey, which is not ESA-listed, but which is an important indicator species for characterizing watershed health. Although researchers are targeting juvenile and adult Pacific lamprey (*Entosphenus tridentatus*) for capture, other species may be taken during sampling activities. The research would benefit listed species by improving understanding of watershed condition and helping managers prioritize habitat restoration projects in the Fifteen Mile Creek and Hood River subbasins.

Permit 18331-3R

Under permit 18331-3R the Wild Fish Conservancy is seeking to renew a permit that would authorize them to continue taking juvenile PS Chinook, juvenile PS steelhead, and juvenile HCS

chum in an effort to determine the upper extent of fish presence (and therefore habitat) in many of the major river systems flowing into the Puget Sound and Hood canal in Washington State.

The researchers would use backpack electrofishing equipment to capture the juvenile fish. They would then largely be captured, handled, and released. A subsample of captured juvenile steelhead would be anesthetized, tissue sampled, and PIT-tagged before being released.

The researchers are not proposing to kill any of the listed fish being captured, but a small number of fish may be killed as an inadvertent result of these activities. The Wild Fish Conservancy is requesting the amounts of take found in the table below.

Table 39. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 18331-3R

Species	Life Stage	Origin	Take Action*	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Puget Sound Chinook salmon	Juvenile	Natural	C/H/R	12	1	<0.001	<0.001
		LHIA	C/H/R	2	0		0.000
		LHAC	C/H/R	10	1		<0.001
Puget Sound steelhead		Natural	C/M, T, ST/R	230	7	0.010	
Hood Canal summer chum		Natural	C/H/R	15	1	<0.001	

*C=Capture, H=Handle, M=Mark, T=Tag, ST=Sample Tissue, R=Release

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species—these figures are presented in the last column of the table above.

As the table illustrates, in no case would the researchers take more than one one-hundredth of a percent of any species' abundance and kill less than one one-thousandth of one percent. And because the research would take place over such a broad area, even these small potential losses cannot be ascribed to any population for any species and must therefore be viewed in the context of the listed units as individual wholes. As a result, though the research may in some instances have a very minor

impact on the listed species’ abundance and productivity, it would be nearly zero in most cases and would in no measurable way impact structure or diversity for any species.

It is also likely that the impacts will be smaller than those laid out above. Over the most recent 4 years, the researchers have taken only 8.96% of their requested take and killed no fish at all. So it is most likely that the actual effect will actually be zero in most years. But even if the entirety of the take were to occur, it would be offset to some extent by the knowledge to be gained—presence/absence information that would be used to needed to identify, prioritize, and implement restoration projects for salmon habitat.

Permit 22003-3R

As noted previously, issuing permit 22003-3R would authorize the KCDNRP to continue taking adult S green sturgeon and juvenile and adult PS Chinook salmon, PS steelhead, S eulachon, PS/GB yelloweye rockfish, and PS/GB bocaccio in the marine waters and shorelines of King County (Washington state). The researchers would use bottom trawls, beach seines, cast nets, and hook and line (sabiki rigs), to capture the which would then be identified to species. All viable listed fish will be released as swiftly as possible. Listed adult rockfish would be released via rapid submergence to their capture depth to reduce the adverse effects from barotrauma. The requested take is laid out in the table below.

Table 40. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 22003-3R

Species	Life Stage	Origin	Take Action*	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Puget Sound Chinook salmon	Adult	Natural	C/H/R	4	2	0.017	0.009
		LHAC	C/H/R	5	2	0.022	
	Juvenile	Natural	C/H/R	1,310	24	0.035	<0.001
		LHAC	C/H/R	700	32	0.003	
Puget Sound steelhead	Adult	Natural	C/H/R	2	2	0.011	0.011
		LHAC	C/H/R	2	2	0.124	0.124
	Juvenile	Natural	C/H/R	11	1	<0.001	<0.001
		LHAC	C/H/R	11	1	0.005	
Puget Sound/Georgia Basin DPS bocaccio	Adult	Natural	C/H/R	4	2	0.282	0.109
	Subadult	Natural	C/H/R	2	1		
	Juvenile	Natural	C/H/R	7	2		
Puget Sound/Georgia Basin DPS yelloweye rockfish	Adult	Natural	C/H/R	4	2	0.011	0.004
	Subadult	Natural	C/H/R	2	1		
	Juvenile	Natural	C/H/R	7	2		
Southern DPS eulachon	Adult	Natural	C/H/R	60	60	<0.001	<0.001
	Subadult	Natural	C/H/R	30	30		
	Juvenile	Natural	C/H/R	100	100		
Southern DPS green sturgeon	Adult	Natural	C/H/R	1	0	0.047	0.000
	Subadult	Natural	C/H/R	1	1	0.009	0.009

***C=Capture, H=Handle, R=Release**

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species—these figures are presented in the last column of the table above.

As the table illustrates, at the ESU/DPS levels—and for natural components—the permitted activities may kill at most 0.109% of the listed PS/GB bocaccio (juvenile and adults combined). Because we do not have any estimates for juvenile PS/GB bocaccio, the impact to the DPS is inflated by using only adult abundance (and the unknown juvenile abundance is expected to be at least two orders of magnitude greater than). Further, requested listed rockfish take is unlikely to happen at all because the fish are extremely rare in Puget Sound—nonetheless, the proposed capture methods and locations may result in their incidental take so we include them here. All other natural listed components for this permit would see a maximum 0.01% mortality rate—and most would be less than that. Therefore, the research would be a very small impact on the species' abundance, a likely similar impact on their productivity, and no measurable effect on their spatial structure or diversity at the ESU or DPS level. And because the work would take place in the marine environment, we cannot resolve any effect at the population level. Moreover, during the most the most recent five years the researchers have been conducting this work, they have neither taken nor killed any listed fish. As a result, in most years, the work is not likely to have any effect at all on listed species.

An effect of the research that cannot be quantified is the conservation benefit to the species resulting from the research. The purpose of the study is to capture English sole (*Parophrys vetulus*), brown rockfish, copper rockfish, quillback rockfish, and various forage fish to monitor tissue levels of toxic chemical contaminants. This research would benefit the affected species by (1) understanding the types and concentrations of chemicals in fish, (2) understanding the impact chemical exposures have on marine fish health, (3) filling data gaps to help managers make informed management decisions, and (4) developing a long-term program to evaluate changes in chemical body burdens in fish over time as environmental improvements are made (stormwater discharges reduced, contaminated sediments remediated, etc.).

Permit 22319-3R

As noted previously, issuing permit 22319-3R would authorize the HEC to take juvenile PS Chinook salmon and PS steelhead in streams near Redmond, Washington. The researchers would use a D-frame kick net to capture the fish, which would then be identified to species, and released. Up to two listed juvenile salmonids (one PS Chinook salmon and one PS steelhead) may die as a result of the research.

The researchers are not proposing to kill any of the listed fish being captured, but a small number of fish may be killed as an inadvertent result of these activities. The amounts of take the Herrera Environmental Consultants is requesting are found in the table below.

Table 41. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 22319-3R

Species	Life Stage	Origin	Take Action*	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Puget Sound Chinook salmon	Juvenile	Natural	C/H/R	20	1	<0.001	<0.001
Puget Sound steelhead		Natural	C/H/R	20	1		

*C=Capture, H=Handle, R=Release

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species—these figures are presented in the last column of the table above.

As the table illustrates, the potential effect of the proposed research is as close to zero as possible. At the population level, the permitted activities may kill at most about 0.0012% of natural-origin juvenile PS Chinook salmon. For PS steelhead, the resident population (North Lake Washington/Lake Sammamish) is considered extirpated. At the ESU/DPS levels, the permitted activities may kill at most less than 0.001% of both listed salmonids. Therefore, the research would be a very small impact on the species’ abundance, a likely similar impact on their productivity, and no measurable effect on their spatial structure or diversity. This is especially given that over the most recent five years, the researchers have neither taken nor killed any listed fish. As a result, in most years, the work is not likely to have any negative effect at all on listed species.

An effect of the research that cannot be quantified is the conservation benefit to the species resulting from the research. The purpose of the research is to conduct a paired watershed study monitoring stream health by collecting benthic macroinvertebrates in urban and nearby relatively pristine streams. The research would thus benefit listed fish by determining the effectiveness of stormwater management in urban streams—which can lead directly to beneficial changes in water quality and habitat improvement management.

Permit 22865-2R

As noted previously, issuing permit 22865-2R would authorize the USFS to continue taking juvenile UCR spring-run Chinook salmon, UCR steelhead, and MCR steelhead at various locations in the Yakima, Methow, Entiat, and Wenatchee River drainages in Washington State. The researchers would use minnow traps, hook-and-line angling, and electrofishing equipment to capture the fish, which would then be identified to species, and released. The requested take is laid out in the table below.

Table 42. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 22865-2R

Species	Life Stage	Origin	Take Action*	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed	
Upper Columbia River spring-run Chinook salmon	Juvenile	Natural	C/H/R	30	1	0.006	<0.001	
		LHIA	C/H/R	20	1	0.004		
		LHAC	C/H/R	10	1	0.001		
Upper Columbia River steelhead		Natural	C/H/R	250	5	0.166	0.003	
		LHIA	C/H/R	200	4	0.143		
		LHAC	C/H/R	750	15	0.098		
Middle Columbia River steelhead			Natural	C/H/R	400	8	0.114	0.002

*C=Capture, H=Handle, R=Release

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species—these figures are presented in the last column of the table above.

As the table illustrates, the permitted activities may kill at most 0.003% of juvenile natural-origin UCR steelhead; all other listed components would be affected to lesser degrees. Due to the fact that the research activities could take place almost anywhere in the species’ ranges from year to year, the impacts cannot be examined at the population level. As a result, and overall, the research would be a very small impact on the species’ abundance, a likely similar impact on their productivity, and no measurable effect on their spatial structure or diversity. It is also likely that the impacts would be even smaller than those laid out above. Over the most recent four years, the researchers have only taken 0.03% of their requested take, and killed no fish at all, the actual effect of the work is likely to be zero in any given year.

An effect of the research that cannot be quantified is the conservation benefit to the species resulting from the research. The purpose of the research is to determine fish distribution in the Yakima, Methow, Entiat, and Wenatchee River drainages. The research would benefit the fish by giving land managers information they need in order to design forest management activities (e.g., timber sales, grazing plans, road building) so that they have the least possible effect on listed species.

Permit 27337

As noted previously, issuing Permit 27337 to the Lower Elwha Klallam Tribe would authorize them to take juvenile PS Chinook salmon, PS steelhead, and HCS chum salmon during the course of intensive habitat surveys conducted in Ediz Hook, near Port Angeles, WA. The juvenile fish would be collected via beach seine and then handled and released.

The researchers are not proposing to kill any of the listed fish being captured, but a small number of fish may be killed as an inadvertent result of these activities. The amounts of take the Lower Elwha Klallam Tribe is requesting are found in the table below.

Table 43. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 27337

Species	Life Stage	Origin	Take Action*	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Puget Sound Chinook salmon	Juvenile	Natural	C/H/R	500	5	0.013	<0.001
		LHIA	C/H/R	500	5	0.006	
		LHAC	C/H/R	500	5	0.002	
Puget Sound steelhead		Natural	C/H/R	50	1	0.022	
		LHAC	C/H/R	50	1	0.022	
Hood Canal summer-run chum salmon		Natural	C/H/R	500	5	0.012	

*C=Capture, H=Handle, R=Release

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species—these figures are presented in the last column of the table above.

At the ESU/DPS level, the permitted activities would never kill even 0.001% of the natural juveniles from any of the listed units. At the local level, the effect of losing a single individual would be somewhat magnified, but because the activities would take place in the marine environment, there is no local population to which the effects may be ascribed—and regardless, any population that might be affected during one field season would be unlikely to see an effect during the next because the populations present in the action area would shift throughout the life of the permit. It is, therefore, unlikely that the work would have any but the most minor impact on the listed species’ abundance and productivity at either the local or the species level (and it would have no measurable effect on structure or diversity). This is especially given that over the most recent five years, other researchers in the Section 10(a)(1)(A) program have reported taking approximately 24% and killing approximately 10% of the juveniles that were authorized, and only taking roughly 17% and killing roughly 10% of the adults that were authorized across all species, so it is most likely that the actual effect will be less than that displayed in the table above by a similar magnitude.

An effect of the research that cannot be quantified is the conservation benefit to the species resulting from the research. This study would benefit listed species by providing data on species presence, and that information, along with detailed habitat and water quality data, would be used to inform future restoration actions in the area.

Permit 26300

Under permit 26300 the Fishery Foundation of California is seeking a new permit that would authorize them to take juvenile CVS Chinook salmon, CCV steelhead, SDPS green sturgeon in order to document the presence of native fish species prior to a large floodplain restoration project. Juveniles would be collected via beach seine and fyke net. Juvenile fish would be captured, handled, and released.

The researchers are not proposing to kill any of the listed fish being captured, but a small number of fish may be killed as an inadvertent result of these activities. The amounts of take the Fishery Foundation of California is requesting are found in the table below.

Table 44. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 26300

Species	Life Stage	Origin*	Take Action**	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Central Valley spring-run Chinook salmon	Juvenile	Natural	C/H/R	40	2	0.002	<0.001
California Central Valley steelhead		Natural	C/H/R	20	2		
		LHIA	C/H/R	40	2	-	-
		LHAC	C/H/R	40	2	0.004	<0.001
Southern DPS green sturgeon		Natural	C/H/R	2	0	0.045	0.000
Central Valley spring-run Chinook salmon	Natural	C/H/R	40	2	0.002	<0.001	

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species—these figures are presented in the last column of the table above.

As the table illustrates, for most species the researchers would take a very small percent of any listed unit—and kill an even smaller percent of those units. At the ESU/DPS level, the permitted activities would never kill even 0.001% of the natural juveniles from any of the listed units. At the local level, the effect of losing one or two individuals would be somewhat magnified, but it is difficult to gauge how much because the sampling would take in the Sacramento River where individuals from multiple populations within an ESU or DPS are mixed. It is unlikely that the work would have any but the most minor impact on the listed species’ abundance and productivity at either the local or the species level and it would have no measurable effect on structure or diversity.

It is also likely that the impacts will be smaller than those laid out above. Over the past five years other researchers in the Section 10(a)(1)(A) program have reported taking approximately 24% and

killing approximately 10% of the juveniles that were authorized, and only taking roughly 17% and killing roughly 10% of the adults that were authorized across all species, so it is most likely that the actual effect will be less than that displayed in the table above by a similar magnitude.

An effect of the research that cannot be quantified is the conservation benefit to the species resulting from the research. This study would benefit listed species by providing data on species presence, seasonal water conditions and migratory windows would be used to inform future restoration actions in the area.

Permit 27619

Under permit 27619 the Scott River Water Trust is seeking a new permit that would authorize them to take juvenile and adult SONCC coho salmon in order to assess fish passage at Youngs Dam on the Scott River to determine how and when juvenile and adult salmon utilize the fish ladder at Youngs Dam.

Juveniles would be collected via beach seines and observed during snorkel surveys. Juvenile coho would be captured, handled, and released. A subsample of captured juveniles would be anesthetized, tissue sampled and PIT-tagged prior to release. Adult coho would be observed at weirs, fish ladders, dam and during snorkel surveys. Tissues may be collected from any carcasses encountered during spawning surveys.

The researchers are not proposing to kill any of the listed fish being captured, but a small number of juvenile fish may be killed as an inadvertent result of these activities. The amounts of take the Scott River Water Trust is requesting are found in the table below.

Table 45. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 27619

Species	Life Stage	Origin*	Take Action**	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Southern Oregon/Northern California Coast coho salmon	Adult	Natural	O/ST	25	0	0.198	0.000
	Juvenile	Natural	C/M, T, ST/R	500	15	0.141	<0.001
		Natural	O/H	2,000	0		

*C=Capture, H=handle, R=release, T=Tag, M=Mark, ST=Sample tissue, O/H=Observe/Harass

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species—these figures are presented in the last column of the table above.

As the table illustrates, the potential effect of the proposed research is as close to zero as possible. At the population level, the permitted activities may kill at most about 0.05% of juvenile SONCC coho salmon in the Scott River. At the ESU level, the permitted activities may kill at most less than 0.001%. Therefore, the research would be a very small impact on the species' abundance, a likely similar impact on their productivity, and no measurable effect on their spatial structure or diversity.

It is also likely that the impacts will be smaller than those laid out above. Over the past five years other researchers in the Section 10(a)(1)(A) program have reported taking approximately 24% and killing approximately 10% of the juveniles that were authorized, and only taking roughly 17% and killing roughly 10% of the adults that were authorized across all species, so it is most likely that the actual effect will be less than that displayed in the table above by a similar magnitude.

Permit 27869

As noted previously, issuing Permit 27869 to the USFWS would allow them to annually take juvenile Puget Sound Chinook salmon, Puget Sound steelhead, Hood Canal summer-run chum salmon while studying migration barriers—primarily for sculpin—in NW Washington State. The researchers would use backpack electrofishing units to capture the fish, but all listed fish would be handled and released as swiftly as possible.

The researchers are not proposing to kill any of the listed fish being captured, but a small number of fish may be killed as an inadvertent result of these activities. The amount of take the U.S. Fish and Wildlife Service is requesting is found in the table below.

Table 46. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 27869

Species	Life Stage	Origin*	Take Action**	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Puget Sound Chinook salmon	Juvenile	Natural	C/H/R	100	7	0.003	<0.001
Puget Sound steelhead		Natural	C/H/R	75	6		
		LHIA	C/H/R	25	2	0.047	0.004
Hood Canal summer-run chum salmon		Natural	C/H/R	7	0	<0.001	0.000

*C=Capture, H=handle, R=release

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species—these figures are presented in the last column of the table above.

As the table illustrates, the researchers would kill very few fish (or none at all) from any of the listed species that would be subject to the permit. At the ESU/DPS level, the permitted activities would never kill even 0.001% of the natural juveniles from any of the listed units (and no adults). In total,

the overall effect would be nearly zero at the ESU and DPS levels. At the local level, the effect of losing a very few individuals would be somewhat magnified, but it is difficult to gauge how much because we have little information on the contributions that the Duckabush, Dosewallops, and Big and Little Quilcene rivers make to the listed species' abundance. Nonetheless, even if each effect were magnified by a factor of 100 (and those systems definitely contribute more than 1/100th of the fish in these listed units), that would still mean the research might kill, at most, the approximate equivalent of one juvenile natural fish out of ten thousand. It is therefore unlikely that the work would have any but the most minor impact on the listed species' abundance and productivity at either the local or the species level and it would have no measurable effect on structure or diversity for any of the species considered.

It is also likely that the impacts will be smaller than those laid out above. Over the past five years other researchers in the Section 10(a)(1)(A) program have reported taking approximately 24% and killing approximately 10% of the juveniles that were authorized, and only taking roughly 17% and killing roughly 10% of the adults that were authorized across all species, so it is most likely that the actual effect will be less than that displayed in the table above by a similar magnitude.

Permit 27874

Under permit 27874, the CDFW is seeking a new permit that would authorize them to take juvenile and adult green sturgeon in order to develop an indices of white sturgeon abundance for use in species management. Though non-listed white sturgeon are the target species, green sturgeon might be encountered. Juvenile and adult green sturgeon would be collected via long line and hook and line sampling and observed via camera and sonar. Juvenile and adult fish would be captured, handled, tagged, and released.

The researchers are not proposing to kill any of the listed fish being captured, but a small number of fish may be killed as an inadvertent result of these activities. The amounts of take the CDFW is requesting are found in the table below.

Table 47. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 27874

Species	Life Stage	Origin*	Take Action**	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Southern DPS green sturgeon	Adult	Natural	C/H/R	100	2	3.526	0.047
		Natural	C/M, T, ST/R	50	1		
		Natural	O/H	75	0		
	Subadult	Natural	C/H/R	150	3	1.008	0.013
		Natural	O/H	75	0		

*C=Capture, H=handle, R=release, T=Tag, M=Mark, ST=Sample tissue, O/H=Observe/Harass

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of

these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species—these figures are presented in the last column of the table above.

As the table illustrates, the researchers would take a small percent of green sturgeon—and kill an even smaller percent (0.047%). In fact, our take tracking system indicates that during prior years of a similar study (17551-4R) conducted by CDFW targeting green sturgeon, there have been only two mortalities of SDPS green sturgeon over the last 10 years. Therefore, it is likely less than one adult will be killed per year for the duration of this permit. As a result, though the research may in some instances have a very small impact on species abundance and productivity, it would in no measurable way impact structure or diversity for any species.

It is also likely that the impacts will be smaller than those laid out above. For SDPS green sturgeon, our research tracking system reveals that researchers ended up lethally taking far fewer individuals of all age classes than they were authorized over the last five years—zero adults and only 0.87% of the juveniles, so it is most likely that the actual effect will be less than that displayed in the table above by a similar magnitude.

An effect of the research that cannot be quantified is the conservation benefit to the species resulting from the research. This study would benefit listed species by providing data on green sturgeon presence and distribution in the study area.

Permit 28047

Under permit 28047, the USFS is seeking a new permit that would authorize them to take juvenile PS Chinook and steelhead; HCS and CR chum salmon; LCR Chinook, coho and steelhead, UWR Chinook and steelhead, OC and CONCC coho, NC steelhead, and CC Chinook salmon in order to determine the upper reaches of fish presence in streams across the region. The researchers would use backpack electrofishing equipment to capture the fish, which would then be swiftly identified and released without undergoing any other procedure (e.g., tagging, marking, etc.).

The researchers are not proposing to kill any of the listed fish being captured, but a small number of fish may be killed as an inadvertent result of these activities. The amounts of take the USFS is requesting are found in the table below.

Table 48. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 28047

Species	Life Stage	Origin	Take Action*	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Puget Sound Chinook salmon	Juvenile	Natural	C/H/R	750	7	0.020	<0.001
Puget Sound steelhead		Natural	C/H/R	3,000	30	0.133	0.001
Hood Canal summer-run chum salmon		Natural	C/H/R	100	1	0.002	<0.001
Lower Columbia River Chinook salmon		Natural	C/H/R	1,600	16	0.014	

Species	Life Stage	Origin	Take Action*	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Lower Columbia River coho salmon		Natural	C/H/R	4,100	41	0.496	0.005
Lower Columbia River steelhead		Natural	C/H/R	3,500	35	0.933	0.009
Columbia River chum salmon		Natural	C/H/R	340	9	0.004	<0.001
Upper Willamette River Chinook salmon		Natural	C/H/R	3,000	30	0.259	0.003
Upper Willamette River steelhead		Natural	C/H/R	5,600	56	4.139	0.041
Oregon Coast coho salmon		Natural	C/H/R	10,750	107	0.251	0.002
Southern Oregon/Northern California Coast coho salmon		Natural	C/H/R	4,150	41	0.469	0.005
Northern California steelhead		Natural	O/H	1,000	10	0.105	0.001
California Coastal Chinook salmon		Natural	O/H	300	3	0.013	<0.001

**C=Capture, H=Handle, R=release

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species—these figures are presented in the last column of the table above.

As the table illustrates, for most species the researchers would take a small percent of any listed unit—and kill an even smaller percent of those units. Because the research would take place over such a broad area, the potential losses cannot be ascribed to any population for any species and must therefore be viewed in the context of the listed units as individual wholes. As a result, though the research may in some instances have a very small impact on species abundance and productivity, it would in no measurable way impact structure or diversity for any species. This is especially true given the fact that all captured fish would be swiftly released without undergoing any other procedure such as tagging. In other studies using these same methods, the mortality rate is frequently well under 1%, and that is likely to be the case here as well.

Another reason to believe it likely that the impacts would be smaller than those laid out above is the fact that over the past five years, other researchers in the Section 10(a)(1)(A) program have reported taking approximately 24% and killing approximately 10% of the juveniles that were authorized, and only taking roughly 17% and killing roughly 10% of the adults that were authorized across all species, so it is most likely that the actual effect will be less than that displayed in the table above by a similar magnitude.

An effect of the research that cannot be quantified is the conservation benefit to the species resulting from the research. This study would benefit listed species by providing data on fish presence in streams across the region and thereby allow managers to design and conduct activities with listed species preservation and recovery in mind.

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 and 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, sturgeon, rockfish, 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 Tables 2 and 29 and in the species status and environmental baseline sections.

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 PS Chinook salmon and other listed salmonids, see any of the recent

status reviews, listing Federal Register notices, and recovery planning documents, as well as recent consultations on issuance of section 10(a)(1)(A) research permits.

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 and that rate is expected to continue (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.

Idaho and Eastern Oregon and Washington

According to the U.S. Census bureau, the State of Idaho's population has been increasing at about 1% per year over the last several years, but that increase has largely been confined to the State's urban areas. The rural population—the areas where the proposed actions would take place--saw a 14% decrease in population between 1990 and 2012.³ This signifies that in the action areas, if this trend continues, there is likely to be a reduction in competing demands for resources such as water. Also, it is likely that streamside development will decrease. However, given the overall increase in population, recreation demand for resources such as the fish themselves may go up—albeit slowly. The situation is similar for Eastern Oregon and Washington. Both states have seen population increases between 0.5% and 1.5% per year for Oregon between 2000 and 2010,⁴ an overall 12% for Washington between 2000 and 2010, and a 2.7% increase for rural, eastern Oregon for the past five years (2013-2018).⁵ And, though Eastern Washington has also seen some population increase, it has largely been restricted to the population centers rather than the rural areas.⁶ This signifies that, as with Idaho, there is little likelihood that there will be increasing competing demands for primary resources like water, but recreational demand for the species themselves will probably increase along with the human population.

Western Oregon

The situation in Western Oregon is likely to be similar to that of the Puget Sound region: cumulative effects are likely to continue increasing both in the Willamette valley and along the coast, with nearly all counties showing year-by-year population increases of about 0.5% to 1.5% over the last several years.⁶ The result of this growth is that there will be more development and therefore more habitat impacts such as simplification, hydrologic effects, greater levels of pollution (in the Willamette Valley), other water quality impacts, soil disturbance, etc. These effects would be somewhat lessened in the coastal communities, but resource extraction (particularly timber harvest) would probably continue to increase slightly. Though once again, most such activities, whether associated with development or extraction, would undergo formal consultation if they were shown to take place in (or affect) critical habitat or affect listed species. So, it is difficult to characterize the effects that would not be consulted upon beyond saying they are likely to increase both in severity and geographic scope.

California

According to the U.S. Census Bureau, the State of California's population increased 6.1% from 2010 to 2019 (source: [Census Bureau California Quick Facts](#)). If this trend in population growth continues, there will be an increase in competing demands for water resources. Water withdrawals, diversions, and other hydrological modifications to regulate water bodies are likely to continue. Urbanization and rural development are limiting factors for many of the listed salmonids within the State of California and these factors are likely to increase with continued population growth. 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.

³ [Idaho State Journal June 2, 2013 "Idaho's rural population continues to shrink"](#)

⁴ [Portland State University "Annual Oregon Population Report"](#)

⁵ [State of Oregon Employment Department Dec 20, 2018 "A Quick Look at Population Trends in Eastern Oregon"](#)

⁶ [Cashmere Valley Record March 9, 2011 "Population growth slowed during last decade, but state is more diversified"](#)

One final thing to take into account when considering cumulative effects is the time period over which the activity would operate. The permits 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.

One final thing to take into account when considering cumulative effects is the time period over which the activity would operate. The permits 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 two tables therefore (a) combine the proposed take for all the permits considered in this opinion for all components of each species (Table 49), (b) add that take to the take that has already been authorized in the region and (c) compare those totals to the estimated annual abundance of each species under consideration (Table 50).

Table 49. Total requested take for the permits and percentages of the ESA listed species for permits covered in this Biological Opinion.

Species	Life Stage	Origin*	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Puget Sound Chinook salmon	Adult	Natural	23	17	0.098	0.073
		LHIA	3	3	0.159	0.129
		LHAC	34	27		

Species	Life Stage	Origin*	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
	Juvenile	Natural	11,892	257	0.319	0.007
		LHIA	508	11	0.006	<0.001
		LHAC	10,020	399	0.039	0.002
Puget Sound steelhead	Adult	Natural	6	2	0.033	0.011
		LHAC	6	2	0.371	0.124
	Juvenile	Natural	4,316	72	0.191	0.003
		LHIA	75	3	0.142	0.006
		LHAC	566	17	0.250	0.008
Puget Sound/Georgia Basin DPS bocaccio	Adult	Natural	4	2	0.282	0.109
	Subadult	Natural	2	1		
	Juvenile	Natural	7	2		
Puget Sound/Georgia Basin DPS yelloweye rockfish	Adult	Natural	4	2	0.011	0.004
	Subadult	Natural	2	1		
	Juvenile	Natural	7	2		
Hood Canal summer-run chum salmon	Adult	Natural	4	0	0.014	0.000
	Juvenile	Natural	707	9	0.017	<0.001
Upper Columbia River spring-run Chinook salmon	Adult	Natural	2	1	0.246	0.175
		LHIA	1	1	0.263	
		LHAC	2	1		
	Juvenile	Natural	160	83	0.033	0.017
		LHIA	40	21	0.008	0.004
		LHAC	250	193	0.037	0.028
Upper Columbia River steelhead	Adult	Natural	1	0	0.068	0.000
		LHAC	1	0	0.035	
	Juvenile	Natural	307	14	0.204	0.009
		LHIA	207	11	0.148	0.008
		LHAC	821	38	0.107	0.005
Middle Columbia River steelhead	Adult	Natural	9	0	0.066	0.000
		LHAC	4	0	0.561	
	Juvenile	Natural	795	44	0.226	0.013
		LHAC	361	21	0.097	0.006
Snake River spring/summer-run Chinook salmon	Adult	Natural	505	2	11.428	0.142
		LHIA	101	2	3.792	
		LHAC	6	2		
	Juvenile	Natural	8,072	294	1.183	0.043
		LHIA	6,082	153	0.875	0.022
		LHAC	590	299	0.012	0.006
Snake River fall-run Chinook salmon	Adult	Natural	4	2	0.055	0.028
		LHIA	1	1	0.027	0.027
		LHAC	3	3		
	Juvenile	Natural	360	69	0.045	0.009
		LHIA	17	17	<0.001	<0.001
		LHAC	145	145	0.006	0.006

Species	Life Stage	Origin*	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Snake River Basin steelhead	Adult	Natural	5	0	0.050	0.000
		LHAC	5	1	0.152	0.030
	Juvenile	Natural	7,914	175	1.381	0.031
		LHIA	56	7	0.011	0.001
		LHAC	1,030	47	0.034	0.002
Snake River sockeye salmon	Adult	Natural	1	0	6.250	0.000
	Juvenile	Natural	30	1	0.167	0.006
		LHAC	6	6	0.002	0.002
Lower Columbia River Chinook salmon	Adult	Natural	34	25	0.116	0.250
		LHIA	3	3	0.250	
		LHAC	44	40		
	Juvenile	Natural	2,060	214	0.018	0.002
		LHIA	50	50	0.005	0.005
		LHAC	940	746	0.003	0.002
Lower Columbia River coho salmon	Adult	Natural	14	5	0.075	0.100
		LHIA	2	2		
		LHAC	14	13		
	Juvenile	Natural	4,545	224	0.550	0.027
		LHIA	195	195	0.060	0.060
		LHAC	1,170	976	0.015	0.012
Lower Columbia River steelhead	Adult	Natural	9	0	0.110	0.000
		LHAC	9	0	0.141	
	Juvenile	Natural	3,794	67	1.011	0.018
		LHAC	284	31	0.024	0.003
Columbia River chum salmon	Adult	Natural	1	0	0.006	0.000
	Juvenile	Natural	416	47	0.005	<0.001
		LHIA	12	12	0.002	0.002
Upper Willamette River Chinook salmon	Adult	Natural	8	4	0.076	0.028
		LHIA	1	1		
		LHAC	6	2		
	Juvenile	Natural	3,222	107	0.278	0.009
		LHIA	18	18	-	-
LHAC		320	175	0.007	0.004	
Upper Willamette River steelhead	Adult	Natural	4	0	0.152	0.000
	Juvenile	Natural	5,754	65	4.253	0.048
Oregon Coast coho salmon	Adult	Natural	12	8	0.020	0.013
		LHAC	19	15	2.978	2.351
	Juvenile	Natural	11,000	213	0.257	0.005
		LHAC	300	252	0.500	0.420
Southern Oregon/Northern California Coast coho salmon	Adult	Natural	3	1	0.032	0.016
		LHAC	1	1		
	Juvenile	Natural	4,735	68	0.535	0.008
		LHIA	840	300	1.120	0.400

Species	Life Stage	Origin*	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
		LHAC	10	10	0.002	0.002
California Coastal Chinook salmon	Adult	Natural	1	1	0.008	0.008
		Juvenile	1	1	<0.001	<0.001
		LHAC	1	1	-	-
Sacramento River winter-run Chinook salmon	Adult	Natural	1	1	0.084	0.084
		LHAC	1	1	0.037	0.037
	Juvenile	Natural	1	1	<0.001	<0.001
		LHAC	1	1		
Central Valley spring-run Chinook salmon	Adult	Natural	1	1	0.015	0.015
		LHAC	1	1	0.048	0.048
	Juvenile	Natural	42	4	0.002	<0.001
		LHAC	8	8	<0.001	
California Central Valley steelhead	Juvenile	Natural	20	2	0.002	<0.001
		LHIA	40	2	-	-
		LHAC	40	2	0.004	<0.001
Southern DPS eulachon	Adult	Natural	160	160	0.005	0.005
	Subadult	Natural	1,030	1,030		
	Juvenile	Natural	100	100		
Southern DPS green sturgeon	Adult	Natural	151	3	7.099	0.141
	Subadult	Natural	151	4	1.352	0.036
	Juvenile	Natural	2	0	0.045	0.000

^a Abundances for adult hatchery salmonids are LHAC and LHIA combined.

^b Abundances for all adult components are combined.

Thus, the activities contemplated in this opinion may kill—in combination and at most—as much as 2.35% of the fish from any component of any listed species. That component is adult OC coho that have had their adipose fins clipped. However, *all* of those fish are considered surplus to recovery needs and therefore their loss is unlikely to have any measurable adverse effect on the species’ viability. In all other instances found in the table above, the effect is far smaller than that figure and, in most cases, the effect is orders of magnitude smaller. And these figures are probably much lower in actuality, but before engaging in that discussion, it is necessary to add all the take considered in this opinion to the rest of the research take that has been authorized on the West Coast.

Table 50. Total expected take of the ESA listed species for scientific research and monitoring already approved for 2024 plus the permits covered in this Biological Opinion.

Species	Life Stage	Origin*	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Puget Sound Chinook salmon	Adult	Natural	1,480	68	6.333	0.291
		LHIA	756	26	11.833	0.783
		LHAC	1,993	156		

Species	Life Stage	Origin*	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
	Juvenile	Natural	742,072	13,104	19.904	0.351
		LHIA	225,225	5,129	2.595	0.059
		LHAC	188,676	8,651	0.736	0.034
Puget Sound steelhead	Adult	Natural	5,072	93	27.874	0.511
		LHIA	427	12	28.677	1.236
		LHAC	37	8		
	Juvenile	Natural	106,776	2,001	4.738	0.089
		LHIA	3,048	49	5.751	0.092
		LHAC	11,515	200	5.095	0.088
Puget Sound/Georgia Basin DPS bocaccio	Adult	Natural	26	15	1.802	0.934
	Juvenile	Natural	57	28		
Puget Sound/Georgia Basin DPS yelloweye rockfish	Adult	Natural	32	20	0.079	0.046
	Juvenile	Natural	58	33		
Hood Canal summer-run chum salmon	Adult	Natural	2,136	37	7.597	0.132
		LHAC	1	0	0.114	0.000
	Juvenile	Natural	1,083,787	4,720	25.555	0.111
		LHIA	1,445	45	-	-
		LHAC	95	19		
Upper Columbia River spring-run Chinook salmon	Adult	Natural	194	7	23.862	0.861
		LHIA	157	5	29.386	1.228
		LHAC	178	9		
	Juvenile	Natural	12,956	350	2.653	0.072
		LHIA	1,804	74	0.383	0.016
		LHAC	1,544	234	0.226	0.034
Upper Columbia River steelhead	Adult	Natural	199	4	13.584	0.273
		LHIA	90	2	10.301	0.277
		LHAC	208	6		
	Juvenile	Natural	11,377	66	7.562	0.044
		LHIA	2,211	51	1.581	0.036
		LHAC	10,017	226	1.308	0.030
Middle Columbia River steelhead	Adult	Natural	2,219	34	16.319	0.250
		LHIA	200	7	261.431	3.787
		LHAC	1,664	20		
	Juvenile	Natural	181,832	4,105	51.733	1.168
		LHIA	8,743	120	7.717	0.106
		LHAC	852	40	0.229	0.011
Snake River spring/summer-run Chinook salmon	Adult	Natural	1,259	22	28.491	0.498
		LHIA	724	9	32.140	0.744
		LHAC	183	12		
	Juvenile	Natural	567,671	7,300	83.163	1.069
		LHIA	74,639	643	10.733	0.092
		LHAC	86,388	1,076	1.821	0.023
	Adult	Natural	85	11	1.170	0.151

Species	Life Stage	Origin*	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Snake River fall-run Chinook salmon		LHIA	37	2	0.786	0.128
		LHAC	80	17		
	Juvenile	Natural	5,071	295	0.634	0.037
		LHIA	2,027	159	0.068	0.005
		LHAC	2,536	311	0.097	0.012
Snake River Basin steelhead	Adult	Natural	10,314	123	103.502	1.234
		LHIA	2,540	38	178.569	2.740
		LHAC	3,326	52		
	Juvenile	Natural	406,581	5,496	70.926	0.959
		LHIA	51,854	528	9.804	0.100
		LHAC	55,154	642	1.803	0.021
Snake River sockeye salmon	Adult	Natural	113	6	706.250	37.500
		LHIA	1	0	2.062	0.000
		LHAC	1	0		
	Juvenile	Natural	8,325	297	46.250	1.650
		LHAC	206	62	0.069	0.021
Lower Columbia River Chinook salmon	Adult	Natural	468	49	1.597	0.167
		LHIA	4	3	2.413	0.340
		LHAC	450	61		
	Juvenile	Natural	416,213	5,933	3.738	0.053
		LHIA	429	70	0.046	0.007
		LHAC	3,340	1,211	0.011	0.004
Lower Columbia River coho salmon	Adult	Natural	1,096	25	5.857	0.134
		LHIA	3	2	2.658	0.339
		LHAC	421	52		
	Juvenile	Natural	247,151	3,125	29.885	0.378
		LHIA	965	206	0.298	0.064
Lower Columbia River steelhead	Adult	Natural	3,120	33	38.273	0.405
		LHAC	75	4	1.175	0.063
	Juvenile	Natural	55,442	954	14.776	0.254
		LHIA	3	0	0.020	0.000
		LHAC	3,541	87	0.299	0.007
Columbia River chum salmon	Adult	Natural	91	11	0.526	0.064
		LHIA	3	1	0.524	0.175
		LHAC	3	1		
	Juvenile	Natural	69,034	865	0.888	0.011
		LHIA	562	18	0.101	0.003
		LHAC	16	1	-	-
Upper Willamette River Chinook salmon	Adult	Natural	273	12	2.592	0.114
		LHIA	2	1	0.650	0.067
		LHAC	163	16		
	Juvenile	Natural	86,167	3,079	7.432	0.266

Species	Life Stage	Origin*	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
		LHIA	891	28	-	-
		LHAC	15,140	436	0.347	0.010
Upper Willamette River steelhead	Adult	Natural	381	6	14.498	0.228
	Juvenile	Natural	33,307	689	24.617	0.509
Oregon Coast coho salmon	Adult	Natural	15,215	185	25.097	0.305
		LHAC	35	19	5.486	2.978
	Juvenile	Natural	698,540	15,849	16.289	0.370
		LHAC	505	259	0.842	0.432
Southern Oregon/Northern California Coast coho salmon	Adult	Natural	4,496	44	71.062	0.728
		LHIA	3,422	29		
		LHAC	1,065	19		
	Juvenile	Natural	281,563	4,921	31.820	0.556
		LHIA	18,618	1,004	24.824	1.339
		LHAC	20,481	565	3.562	0.098
Northern California steelhead	Adult	Natural	1,720	26	20.584	0.311
	Juvenile	Natural	144,077	2,649	15.158	0.279
California Coastal Chinook salmon	Adult	Natural	520	23	3.949	0.175
	Juvenile	Natural	109,295	1,925	4.568	0.080
Sacramento River winter-run Chinook salmon	Adult	Natural	1,425	18	120.253	1.519
		LHAC	1,423	50	52.762	1.854
	Juvenile	Natural	425,680	11,404	340.441	9.120
		LHAC	203,331	7,234	127.998	4.554
Central Valley spring-run Chinook salmon	Adult	Natural	1,807	30	26.747	0.444
		LHAC	895	82	42.967	3.937
	Juvenile	Natural	1,005,374	20,417	54.671	1.110
		LHAC	60,665	4,641	3.033	0.232
California Central Valley steelhead	Adult	Natural	4,376	138	55.925	2.697
		LHIA	100	2		
		LHAC	1,952	170		
	Juvenile	Natural	87,696	2,235	6.707	0.171
		LHIA	90	3	-	-
		LHAC	29,323	1,580	2.793	0.150
Southern DPS eulachon	Adult	Natural	39,024	31,037	0.156	0.125
	Subadult	Natural	1,210	1,036		
	Juvenile	Natural	1,525	1,368		
Southern DPS green sturgeon	Adult	Natural	660	16	31.030	0.752
	Subadult	Natural	529	25	4.738	0.224
	Juvenile	Natural	6,648	193	150.034	4.356
	Larvae	Natural	11,348	1,124	-	
	Egg	Natural	3,870	3,870		

^a Abundances for adult hatchery salmonids are LHAC and LHIA combined.

^b Abundances for all adult components are combined.

As the table above illustrates, in most 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 component's 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.

However, in 16 components involving 12 species, the total potential mortality could amount to a more substantial percentage of an ESU component (i.e., life stage and origin). As a result, we will review the potential mortality in these instances in more detail.

Salmonid Species

As Tables 49 and 50 illustrate, in most instances, 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.

Nonetheless, there are some instances where closer scrutiny of the effects on a particular component is warranted. The newly proposed research, when considered in combination with research already authorized would potentially kill more than one half of one percent of the estimated abundance of an adult or juvenile (natural) component of the following listed species: PS steelhead, PS/GB bocaccio, UCR Chinook, MCR steelhead, SnkR spr/sum Chinook, SnkR sockeye, SnkR steelhead, SONCC coho, SacR winter-run Chinook salmon, CVS Chinook salmon, CCV steelhead, and SDPS green sturgeon. Detailed descriptions of these effects for juveniles and adults follow in the paragraphs below.

A few considerations apply generally to our analyses of the total mortalities that would be permitted for juveniles and adults of each of these species (Table 50). First, we do not expect the potential mortality of adipose-fin-clipped, hatchery-origin fish contemplated in this opinion to have any genuine effect on the species' survival and recovery in the wild because, while they are listed, they are considered surplus to recovery needs. We therefore focus primarily on the naturally produced ESU or DPS components.

Second, the true numbers of fish that would actually be taken would most likely be smaller than the amounts authorized. We develop conservative estimates of abundance, as described in Section 2.2. As noted repeatedly in the 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. The degree to which these values are likely overestimates, based on actual reported data from recent years of the research program, is discussed for each species and age class in the following subsections and in the effects section.

Another reason effects on natural-origin components of each listed unit may be smaller than the values in the tables above stems from 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. So for instance, given that for the MCR steelhead, unclipped hatchery

fish make up approximately 39% of the animals with intact adipose fins, it is undoubtedly the case that some unclipped fish would be taken and counted as 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.

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.

As described in further detail below, because we found for each ESU and DPS that . . .

1. The research activities' expected detrimental effects on the species' abundance and productivity would be small, even in combination with all the rest of the research authorized in the basin; and
2. That slight impact would be distributed throughout the species' entire range and would therefore be so attenuated as to have no appreciable effect on spatial structure or diversity.

. . . we determined that the impact of the research program—even in its entirety—would be restricted to a small effect on abundance and productivity and that the activities analyzed here would add only a small increment to that impact. Also, and again, those small effects the research program has on abundance and productivity are offset to some degree by the beneficial effects the program as a whole generates in fulfilling a critical role in promoting the species' health by producing information managers need to help listed species recovery.

Juveniles

MCR Steelhead

Under the research program as a whole, 1.17% of the natural-origin juvenile MCR steelhead may be killed in a given year. The actions considered in this opinion would add 44 fish to the total being allotted. Thus, the 1.17% actually represents only a small increase in the number of fish that has previously and repeatedly been analyzed and so the effects of losses of this magnitude are well understood—particularly in light of the fact that those losses arise from efforts to preserve, protect, and better manage the species. No new evidence has come to light since those previous analyses to indicate that this take level would have more than a minor effect on the species' viability given the context of the purposes to which the research is devoted.

In addition, the mortality rate for this species is undoubtedly less than that displayed due to the overlap of MCR steelhead with 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 MCR

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 MCR 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 1.17%.

Moreover, for some ongoing permits, we analyzed the effect of removing juveniles from an experimental population in the Deschutes River as if they were part of the listed unit, but in fact it will be another year until they are actually considered to be part of the MCR steelhead DPS. As a result, several hundred of the juveniles that may be killed come from a population that actually has no take prohibitions and is currently considered excess to the species' survival needs. Still, if all the fish that are permitted to be taken were to be taken in fact, it would likely result in small but measurable abundance and productivity losses for the DPS.

However, it should also be noted that over the last five years, the amount of natural MCR steelhead juveniles taken was only 16.44% of what was permitted and the mortality rate was only 7.1% of that permitted. As a result, the effects of the program as a whole are very likely to be much smaller than those displayed above—probably a good deal less than a tenth of the figure displayed. And in any case, the losses would be spread out across the species' entire range, so there would be no measurable effect on structure or diversity, and no single population would bear the brunt of the effect. The impact of the program, even in its entirety, is thus a very small effect on abundance and productivity, the activities analyzed here would add little increment to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

SnkR spr/sum Chinook Salmon

Under the research program as a whole, 1.07% of the natural-origin juvenile SnkR spr/sum Chinook salmon may be killed in a given year. The actions considered in this opinion would add 294 fish (out of ~8,000) to the total being allotted, so the 1.07% actually represents only a small increase in the absolute number of fish that has previously been analyzed and thus the effects of such losses are well understood—particularly in light of the fact that those losses arise from efforts to preserve, protect, and better manage the species. In addition, no new evidence has come to light since those previous analyses to indicate that this take level would have more than a minor effect on the species' viability given the context of the purposes to which the research is devoted.

Moreover, it should be noted that over the last five years, the amount of natural SnkR spr/sum Chinook salmon juvenile taken was only 12.42% of what was permitted and the mortality rate was only 5.05% of what had been approved. As a result, the effects of the program as a whole are very likely to be much smaller than those displayed above—probably around a twentieth of the figure displayed. Also, the losses would be spread out across the species' entire range, so there would be no measurable effect on structure or diversity, and no single population would be disproportionately affected. The impact of the program, even in its entirety, is thus a very small effect on abundance and productivity, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

SnkR Steelhead

Under the research program as a whole, 0.96% of the natural-origin juvenile SnkR steelhead may be killed in a given year. Just as with SnkR spr/sum Chinook, the actions considered in this opinion would add only a small number of fish—175 out of ~8,000—to the total being allotted, so the 0.96% actually represents only a small increase in the absolute number of fish that has previously been analyzed and thus the effects of such losses are well understood. This is particularly true given that most of that take comes from permits that are being renewed, so a great deal of this exact take has been reviewed before. Also, it is important to remember the fact that those losses arise from efforts to preserve, protect, and better manage the species, so the purpose of those losses plays a role in our analyses. No new evidence has come to light since those previous analyses to indicate that this take level would have more than a minor effect on the species' viability given the context of the purposes to which the research is devoted.

In addition, the mortality rate for this species is undoubtedly lower than that displayed due to the overlap of SnkR steelhead with 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 SnkR 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 SnkR 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 0.96%.

Moreover, it should be noted that over the last five years, the amount of natural SnkR steelhead juveniles taken was only 13.34% of what was permitted and the mortality rate was only 3.56% of what has been permitted. As a result, the effects of the program as a whole are very likely to be much smaller than those displayed above—probably less than one twentieth of the figure displayed. And, in any case, the losses would be spread out across the species' entire range, so there would be no measurable effect on structure or diversity, and no single population would bear the brunt of the effect. The impact of the program, even in its entirety, is thus a very small effect on abundance and productivity, the activities analyzed here would add little increment to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

SnkR Sockeye Salmon

When combined with scientific research and monitoring permits already approved, 1.65% of the juvenile natural-origin SnkR sockeye salmon may be killed by permitted research activities in a given year. While this figure should be viewed with caution, it is important to note that the actions proposed in this opinion would add no fish at all to the mortalities associated with the research program as a whole. This means that mortality rates very nearly the same as the 1.65% have previously been analyzed a number of times and, as such, the effects are well understood—particularly in light of the fact that those losses are the result of efforts to preserve, protect, and better manage the species. In addition, no new evidence has come to light since those previous analyses to indicate that this take level would have more than a minor effect on the species' viability given the context of the purposes to which the research is devoted. Still, the research program as a whole could have a small effect on the species' abundance and productivity—but not on structure or

diversity given that there is only one population and it is largely upheld by hatchery supplementation.

In addition, these truly are worst-case numbers. Over the last five years, the amount of natural SnkR sockeye juveniles taken was only 16.8% of what was permitted and the mortality rate was only 4.03% of what has been permitted. As a result, the effects of the program as a whole are very likely to be much smaller than those displayed above—probably less than one twentieth of the figure displayed.

Lastly, the entire purpose of the two permits with the most juvenile SnkR sockeye salmon take (Permits 1124 and 1341) is to help the sockeye salmon survive and recover. Under Permit 1124 (held by IDFG) the researchers support the use of captive broodstock and other methods and technology to capture, preserve, and study the few remaining sockeye salmon. Under Permit 1341 (held by the Shoshone-Bannock Tribes) researchers seek to help SnkR sockeye salmon recover and expand their range. Though these permits could have some minor negative effect on SnkR sockeye salmon abundance, it is possible that without the research conducted under them this ESU might already have gone extinct; and even if that is not the entirely the case, it is inarguable that the research has been critical to whatever recovery the sockeye salmon have experienced.

SONCC coho salmon

Under the research program as a whole, 0.556% of the natural-origin juvenile SONCC coho salmon may be killed in a given year. The actions considered in this opinion would add 68 fish (out of ~5,000) to the total being allotted, so the 0.556% actually represents only a small increase in the absolute number of fish that has previously been analyzed and thus the effects of such losses are well understood. This is particularly true given that most of that take comes from permits that are being renewed, so a great deal of this exact take has been reviewed before. Also, it is important to remember the fact that those losses arise from efforts to preserve, protect, and better manage the species, so the purpose of those losses plays a role in our analyses. No new evidence has come to light since those previous analyses to indicate that this take level would have more than a minor effect on the species' viability given the context of the purposes to which the research is devoted.

Moreover, it should be noted that over the last five years, the amount of natural SONCC coho salmon juvenile taken was only 22.73% of what was permitted and the mortality rate was only 3.57% of what had been approved. As a result, the effects of the program as a whole are very likely to be much smaller than those displayed above—probably around one thirtieth of the figure displayed. Also, the losses would be spread out across the species' entire range, so there would be no measurable effect on structure or diversity, and no single population would be disproportionately affected. The impact of the program, even in its entirety, is thus a very small effect on abundance and productivity, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

SacR winter-run Chinook salmon

When combined with scientific research and monitoring permits already approved, the potential mortality for juvenile SacR winter-run Chinook salmon would be 9.12% for naturally produced fish. This represents a notable portion of the species' total abundance, and this figure should be viewed with some caution. However, it is important to note that the activities contemplated in this opinion would add only one juvenile fish to the total previously allotted. Thus mortality rates similar to (and even higher than) the 9.12% have previously been analyzed and, as a result, the possible effects of such potential losses are well understood—particularly in light of the fact that those losses arise from efforts to preserve, protect, and better manage the species. In addition, no new evidence has come to light since those previous analyses to indicate that this take level would have more than a minor effect on the species' viability given the context of the purposes to which the research is devoted.

Moreover, it is very likely that researchers will take fewer fish than estimated, and that the actual effects would be lower than the numbers stated in the tables above. Our research tracking system reveals that over the past five years, researchers took 12.51% of the naturally produced SacR winter-run Chinook salmon juveniles they were authorized, and the actual lethal take rate of natural-origin juveniles was only 8.23% of the mortalities authorized. This would mean that the actual effect is likely to be less than one tenth of what is displayed in the table above (or about 0.9%). 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 region. And because that slight impact would be distributed throughout the species' entire range, it would be so attenuated as to have no appreciable effect on spatial structure or diversity. So once again, the impact of the program—even in its entirety—is a small effect on abundance and productivity, the activities analyzed here would add almost no increment to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

CVS Chinook

When combined with scientific research and monitoring permits already approved, the potential mortality for juvenile CVS Chinook salmon from the entire research program would be 1.1% for naturally produced fish. It is important to note that the activities contemplated in this opinion would add only four fish to the total previously allotted. Thus, mortality rates similar to (and even considerably higher than) the 0.995% have previously been analyzed and, as a result, the possible effects of such potential losses are well understood. But even if all four juvenile fish contained in this opinion were killed, the effect on species viability would still be a very small one—particularly in light of the fact that those losses arise from efforts to preserve, protect, and better manage the species. In addition, no new evidence has come to light since those previous analyses to indicate that this take level would have more than a minor effect on the species' viability given the context of the purposes to which the research is devoted..

It is also very likely that researchers will take fewer fish than estimated, and that the actual effects would be lower than the numbers stated above. For naturally produced CVS Chinook salmon, our research tracking system reveals that for the past five years researchers ended up taking in total only 17.74% of the juveniles they were authorized, and the actual mortality rates also averaged only 11.14% of what was requested for juveniles. This would mean that the actual effect is likely to be on

the order of one-tenth of the impact displayed in the table above. 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 region. And because that slight impact would be distributed throughout the species' entire range, it would be so attenuated as to have no appreciable effect on spatial structure or diversity. We therefore find that the impact of the program—even in its entirety—is a small effect on abundance and productivity, the activities analyzed here would add only a small increment to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

Adults

UCR Chinook Salmon

The research program as a whole would permit up to seven natural adult the UCR Chinook to be killed in any given year; this would constitute 0.86% of that component of the ESU. It is important to note that the activities contemplated in this opinion would add only one fish to the total previously allotted. Thus, the 0.86% actually represents only the smallest possible increase in the number of fish that has previously and repeatedly been analyzed, and so the effects of losses of this magnitude are well understood—particularly in light of the fact that those losses arise from efforts to preserve, protect, and better manage the species. In addition, no new evidence has come to light since those previous analyses to indicate that this take level would have more than a minor effect on the species' viability given the context of the purposes to which the research is devoted.

Nonetheless, it is 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 table above. Our research tracking system reveals that over the past five years, researchers ended up taking 1.52% of the adult naturally produced UCR Chinook they were authorized, and the actual mortality rate was zero—signifying that the true effect arising from the research program is likely to be very close to “none” in any given year. Thus, we expect the research activities' detrimental effects on the species' abundance and productivity to be very small, even in combination with all the rest of the research authorized in the basin. And because that slight impact would be distributed throughout the species' entire range, it would be so attenuated as to have no appreciable effect on spatial structure or diversity. We therefore find the impact of the program is a small effect on abundance and productivity, the activities proposed here would probably add no increment to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

SnkR Steelhead

Under the research program as a whole, 1.23% of the natural-origin adult SnkR steelhead may be killed in a given year. The actions considered in this opinion would add no fish to the total being allotted, signifying that take levels nearly identical to the 1.23% rate have previously been repeatedly analyzed and so the possible potential effects of the program are already well understood—particularly in light of the fact that those losses arise from efforts to preserve, protect, and better manage the species. In addition, no new evidence has come to light since those previous analyses to indicate that this take level would have more than a minor effect on the species' viability given the

context of the purposes to which the research is devoted. In any case, the proposed action represents no increase in the absolute numbers of natural fish that could be killed and, in fact, actually represents a decrease in the overall mortality rate from a previous high of 1.3%.

In addition, it is 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 table above. Our research tracking system reveals that over the past five years, researchers ended up taking 11.08% of the adult naturally produced SnkR steelhead they were authorized, and the actual mortality rate was only 2.15% of the mortalities authorized. This would mean that the actual effect of the mortalities is likely to be around one fiftieth of the effect displayed in the table above. 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. And because that slight impact would be distributed throughout the species' entire range, it would be so attenuated as to have no appreciable effect on spatial structure or diversity. We therefore find the impact of the program—even in its entirety—would be a small effect on abundance and productivity, the activities analyzed here would add no increment to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

SnkR Sockeye Salmon

Under the research program as a whole, researchers could possibly kill as many as 6 adult natural fish—this translates to a yearly mortality rate of 37.5% for the natural-origin adult SnkR sockeye salmon. The actions considered in this opinion would add no fish to the total being allotted, so the six possible mortalities have been part of several previous analyses and found not to jeopardize the species. Nonetheless, the 37.5% mortality rate is very high and could genuinely operate to the species disadvantage should it ever actually occur; as such, it requires careful consideration.

To that end, there are a number of caveats associated with that figure. First, the six fish are listed as “natural” but most, if not all, would probably be hatchery fish instead (of which there are approximately six times as many). They are considered “natural” for the purposes of this analysis (and in permits) in order to gauge the maximum effect that even *could* be associated with the research. This is not to say that hatchery fish aren't critical to the species survival and recovery at this point. It is simply that, as a precaution, we are treating mortalities as if they were coming from a component with far fewer fish. Thus, without any further caveats, the *actual maximum* mortality rate would probably be on the order of 6% instead of 37%. But it is unlikely that the rate would ever reach even that high because, second, over the last 10 years, no adult sockeye have been killed by any researcher. As a result, the actual effect in any given year is very likely to be zero.

Third, ongoing Permits 1124 and 1341—which together account for four out of the six possible dead adults—are specifically designed to monitor SnkR sockeye and help them survive and recover. Under Permit 1124, the researchers support the use of captive broodstock and other methods and technologies to capture, preserve, study, and *propagate* the few remaining sockeye salmon. Under Permit 1341, researchers seek to help SnkR sockeye recover and expand their range. Therefore, though these permits could in very rare circumstances have some negative effect on sockeye abundance, it is possible that without the research conducted under them for nearly 30 years, the sockeye salmon might already have gone extinct; and even if that is not the entirety the case, it is

inarguable that the research has been critical to whatever recovery the sockeye salmon have experienced.

And finally, all permits that might allow one or more adult sockeye mortalities contain a special condition stating that if any adult sockeye (natural or hatchery) are killed, the researchers must stop all work and contact NMFS to determine the best way forward—which may involve stopping work altogether, depending on circumstances. We will very carefully monitor all work that could affect adult sockeye salmon to ensure that the actual mortality rates never reach the level contemplated in Table 50.

SacR winter-run Chinook Salmon

Under the research program as a whole, researchers could kill as much as 1.52% of the natural SacR winter-run Chinook Salmon adults. It is important to note that the activities contemplated in this opinion would add only one fish to the total previously allotted. Thus, the 1.52% actually represents only the smallest possible increase in the number of fish that has previously and repeatedly been analyzed, and so the effects of losses of this magnitude are well understood—particularly in light of the fact that those losses arise from efforts to preserve, protect, and better manage the species. In addition, no new evidence has come to light since those previous analyses to indicate that this take level would have more than a minor effect on the species' viability given the context of the purposes to which the research is devoted. And, in any case, the proposed action represents only the smallest possible increase in the absolute numbers of fish that could be killed and, in fact, is actually a considerable decrease in the overall mortality rate from a previous high of 1.9%.

Nonetheless, it is 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 table above. Our research tracking system reveals that over the past five years, researchers ended up taking an average of 0.62% of the natural adult SacR winter-run Chinook salmon they were authorized, and the actual mortality rate was only 1.23% of the mortalities authorized for adults. As a result, the actual effect of take is likely to be about one fiftieth of the effect displayed in the table above, and the activities considered here would add only a very small increment to that effect.

Thus, the losses are very small and have previously been analyzed, the effects are only seen in reductions in abundance and productivity, and the estimates of adult mortalities are almost certainly much greater than the actual numbers are likely to be. And because that slight impact would be distributed throughout the entire listing units' ranges, it would be so attenuated as to have no appreciable effect on spatial structure or diversity. Still, even in the worst-case scenarios the effects are small, restricted to abundance and productivity reductions, and to some degree the negative effects would be offset by the information to be gained—information that in all cases would be used to protect listed fish or promote their recovery.

CCV Steelhead

As it stands, the research program as a whole could potentially kill 2.7% of estimated adult abundance for this DPS. That 2.7% potential mortality figure is combined for natural-origin and

hatchery adult fish because we do not currently have sufficient information to provide reliable estimates of the proportion of hatchery-origin spawners in this DPS. We do know that more than half (170 out of 310) of the fish that may be killed would be hatchery-origin fish and are considered surplus to recovery needs. As a result, we do not expect the loss from that component to have any genuine effect on the species' survival and recovery in the wild. And when those fish are removed from consideration, the actual effect of the maximum mortalities would drop by more than 50%. Moreover, the proposed action represents only a very small increase in the absolute numbers of fish that could be killed and, in fact, is actually a considerable decrease in the overall mortality rate from a previous high of 3.2%. Thus, effects even larger than those proposed have been repeatedly evaluated before and are well understood—particularly in light of the fact that those losses arise from efforts to preserve, protect, and better manage the species. In addition, no new evidence has come to light since those previous analyses to indicate that this take level would have more than a minor effect on the species' viability given the context of the purposes to which the research is devoted.

Also, it is 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 table above. Our research tracking system reveals that over the past five years, researchers ended up taking an average of 6.17% of the adult CCV steelhead they were authorized, and the actual mortality rate was only 3.62% of the mortalities authorized for adults. This would mean that the actual effect of take is likely to be around one thirtieth of the effect displayed in the table above, and the activities considered here would add only a very small increment to that effect.

Thus, the losses are very small and have previously been analyzed, the effects are only seen in reductions in abundance and productivity, and the estimates of adult mortalities are almost certainly much greater than the actual numbers are likely to be. And because that slight impact would be distributed throughout the entire listing units' ranges, it would be so attenuated as to have no appreciable effect on spatial structure or diversity. Still, even if all the fish that could be killed were to be killed in fact, the effects are small, restricted to abundance and productivity reductions, and to some degree the negative effects would be offset by the information to be gained—information that in all cases would be used to protect listed fish or promote their recovery.

Other species

PS/GB bocaccio

For all life-stages combined for PS/GB bocaccio, the existing take authorized in combination with that contemplated in this opinion would be equivalent to lethal take of 0.934% of the abundance of this ESU. However, we know this to be an overestimate of the potential impacts of research. PS/GB bocaccio abundance is underestimated in two ways: (1) adult abundance is based on an ROV survey of only a small part of their range (i.e., the marine waters around the San Juan Islands), and (2) there is no estimate of juvenile abundance specifically. Since we do not have a juvenile estimate for the DPS (which would be expected to be greater than the adult estimate based on demographic structure), we analyze the requested take of PS/BG bocaccio juveniles as though they are adults to make sure we capture the maximum possible effect. This, combined with the only available adult

abundance estimate reflecting only part of the DPS range, means that we knowingly overestimate the impacts research may have on the DPS. It is therefore certain that the impact to the abundance of the population overall is less than the roughly one percent estimated here, and because the majority of requested take is for juveniles any impact on productivity of the DPS would be much less than if all fish to be taken were truly adults.

It is also highly likely that the actual impact of the proposed research will be much lower. None of the permits considered in this opinion primarily target ESA-listed rockfish, so while they contain lethal take requests as a precaution due to their capture methods and locations within the marine waters of Puget Sound, these research programs hope to avoid capturing ESA-listed species entirely. In addition, specific equipment is used to safely release listed rockfish should they be captured to minimize harm; every permit that could collect ESA-listed rockfish take in Puget Sound at depth via hook and line angling is required to have a descending device (e.g. SeaQualizer) that can quickly return the rockfish to their capture depth, reducing the effects of barotrauma. Further, bocaccio are in such low abundance that they are very rarely captured. Since 2012, PS/GB bocaccio take for the entire research program has been very low, with only five captures (all adults) and no mortalities reported.

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 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.

SDPS Green Sturgeon

For SDPS green sturgeon, when combined with already authorized research, the permits contemplated in this opinion could result in lethal take up to what would equal approximately 4.4% of the annual abundance of juveniles and 0.75% of the adults. The research contemplated in this opinion would add three adults and four subadults to that total, and no juveniles. The great majority of this potential lethal take of adults and subadults (41 individuals) and all juveniles has therefore been previously analyzed and the potential effects of such possible losses are well understood—particularly in light of the fact that those losses arise from efforts to preserve, protect, and better manage the species. In addition, no new evidence has come to light since those previous analyses to indicate that this take level would have more than a minor effect on the species' viability given the context of the purposes to which the research is devoted.

In addition, while it appears that this take may affect particular age classes of SDPS green sturgeon, it is important to recognize that the abundance estimates for all age classes come from applying an age structure distribution from prior studies to an estimate of the entire DPS. We do not have abundance estimates generated specifically by tracking the number of maturing juveniles, so the actual demographic structure of southern green sturgeon DPS could be different from these estimates in any given year. Overall, the sum of juvenile, subadult, and adult lethal take authorized in

combination with new proposed take (7 individuals) would be equivalent to 1.3% of the total estimated abundance of SDPS green sturgeon (17,723 individuals). And the fact that the previously authorized research primarily involves juvenile take reduces the risk of authorized take impacting productivity of the species relative to take of subadults or adults.

It is also highly likely that researchers will take fewer fish than estimated, and that the actual effects would be lower than the numbers stated in Table 50 above. For SDPS green sturgeon, our research tracking system reveals that, as described under the individual permits above, researchers ended up lethally taking far fewer individuals of all age classes than they were authorized over the last five years—zero adults and only 0.87% of the juveniles. This is in part because for many studies requesting take of green sturgeon the probability of encounters at each study site is low, but in order to be properly permitted across all of the study locations some individuals are authorized to be taken in each area, which increases the total amount of take authorized for encounters that actually have a low probability of occurring in each instance. Nonetheless, it is likely that in any given year, less than 1% of the permitted juveniles would be killed and probably no adults at all—meaning that the actual yearly effect is most probably something close to zero.

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 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 three decades, research and monitoring activities conducted on anadromous salmonids 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 juvenile and 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 the cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of PS, UCR, SnkR spr/sum, SnkR fall-run, LCR, UWR, SacR winter-run, CVS, CC Chinook salmon; LCR, OC, and SONCC coho salmon; HCS and CR chum salmon; SnkR sockeye salmon; PS, UCR, MCR, SnkR, LCR, NC, and CCV steelhead; SDPS green sturgeon; SDPS eulachon; PS/GB bocaccio; or PS/GB yelloweye rockfish or destroy or adversely modify their designated critical habitats.

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 "Consultation on the Issuance of 17 ESA Section 10(a)(1)(A) Scientific Research Permits in Oregon, Washington, Idaho and California and One 10(a)(1)(A) Enhancement Permit in Idaho affecting Salmon, Steelhead, Eulachon, and Green Sturgeon in the West Coast Region."

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

In the context of this opinion, no incidental take is anticipated and the reinitiation trigger set out in § 402.16(a)(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 § 402.16(a)(2) and/or (a)(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 2008a).

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 2008a; 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). 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 FR 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 2021b).

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, at least 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 25 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 25 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 3,268 juvenile and 145 adult Chinook salmon (from all components) may be killed during the course of the proposed 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 affected Chinook salmon ESUs are:

- Puget Sound

- Upper Columbia River
- Snake River spring-summer run
- Snake River fall-run
- Lower Columbia River
- Upper Willamette
- CC Chinook
- SacR Chinook
- CVS Chinook

The fact that the research would kill Chinook salmon could affect prey availability to the whales in future years throughout their range. Because SRKW prey on adult salmon, we will need to combine the adult losses with “adult-equivalents” for the juveniles that may be killed. To do that, we take the most recent ten-year average smolt-to-adult ratio (SAR) from PIT-tagged Chinook salmon returns from the Snake River, which indicate that SARs are less than 1% (BPA 2018). If one percent of the 3,268 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 32 adult Chinook salmon. When added to the 145 adults that the research may kill, we conclude that that research as a whole could remove as many as 177 adult Chinook from the whales’ prey base. 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 any SRKW would intercept and feed on many (if any) of those salmon.

If SRKW 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 2019). 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 2021b, 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 proposed research could kill, at a maximum, about 17-18% of one day’s worth of the fish that the SRKW need to survive. Moreover, that figure would only hold if the SRKW could somehow intercept all the fish that might otherwise return to the spawning grounds without the permitted take. So even the maximum effect of a loss of 18% 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 previous sections, 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 18 fish than 177 of them—an effect that is very close to zero.

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. Under the MSA, this consultation is intended to promote the conservation of EFH as necessary to support sustainable fisheries and the managed species' contribution to a healthy ecosystem. For the purposes of the MSA, EFH means “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity”, and includes the physical, biological, and chemical properties that are used by fish (50 CFR 600.10). Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) of the MSA also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH. Such recommendations may include measures to avoid, minimize, mitigate, or otherwise offset the adverse effects of the action on EFH [CFR 600.905(b)]. This analysis is based, in part, on the EFH assessment provided by the NMFS and descriptions of EFH for Pacific Coast salmon (PFMC 2022) 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 2022). 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 the permittees and other local and tribal interests. The document will be available within two weeks at the NOAA Library Institutional Repository [<https://repository.library.noaa.gov/welcome>]. The format and naming adheres to conventional standards for style.

This ESA section 7 consultation on the issuance of the ESA section 10(a)(1)(A) research permit 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 [*and EFH consultation, if applicable*] contain more background on information sources and quality.

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

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

5. REFERENCES

5.1 Federal Register Notices

- June 16, 1993 (58 FR 33212). Designated Critical Habitat; Sacramento River Winter-Run Chinook Salmon.
- January 4, 1994 (59 FR 440). Endangered and Threatened Species; Status of Sacramento River Winter-run Chinook Salmon; Final Rule
- October 31, 1996 (61 FR 56138). Endangered and Threatened Species; Threatened Status for Central California Coast Coho Salmon Evolutionarily Significant Unit (ESU).
- March 23, 1999 (64 FR 14067). Endangered and Threatened Species; Regulations Consolidation.
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