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

NMFS Consultation Number: WCRO-2021-03174
ARN: 151422WCR2022PR00001; DOI: 10.25923/vzfh-bb64

Action Agencies: The National Marine Fisheries Service (NMFS)
Northwest Fisheries Science Center (NWFSC)
The Southwest Fisheries Science Center (SWFSC)
The Bureau of Land Management (BLM)
The United States Geological Survey (USGS)
The United States Forest Service (USFS)
The Bureau of Indian Affairs (BIA)
The Bonneville Power Administration (BPA)
The United States Fish and Wildlife Service (USFWS)
The Environmental Protection Agency (EPA)

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely To Adversely Affect Species?	Is Action Likely To Jeopardize the Species?	Is Action Likely To Adversely Affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Puget Sound (PS) Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	No	No
PS steelhead (*O. mykiss*)	Threatened	Yes	No	No	No
Puget Sound/Georgia Basin (PS/GB) bocaccio (*Sebastes paucispinis*)	Endangered	Yes	No	No	No
PS/GB yelloweye rockfish (*S. ruberrimus*)	Threatened	Yes	No	No	No
Hood Canal summer-run (HCS) chum salmon (*O. keta*)	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?
Ozette Lake (OL) sockeye salmon (*O. nerka*)	Threatened	Yes	No	No	No
Upper Columbia River (UCR) spring-run Chinook salmon (*O. tshawytscha*)	Endangered	Yes	No	No	No
Upper Columbia River (UCR) steelhead (*O. mykiss*)	Threatened	Yes	No	No	No
Middle Columbia River (MCR) steelhead (*O. mykiss*)	Threatened	Yes	No	No	No
Snake River (SnkR) spring/summer-run (spr/sum) Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	No	No
Snake River (SnkR) fall-run Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	No	No
Snake River (SnkR) steelhead (*O. mykiss*)	Threatened	Yes	No	No	No
Snake River (SnkR) sockeye salmon (*O. nerka*)	Endangered	Yes	No	No	No
Lower Columbia River (LCR) Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	No	No
Lower Columbia River (LCR) coho salmon (*O. kisutch*)	Threatened	Yes	No	No	No
Lower Columbia River (LCR) steelhead (*O. mykiss*)	Threatened	Yes	No	No	No
Columbia River (CR) chum salmon (*O. keta*)	Threatened	Yes	No	No	No
Upper Willamette River (UWR) Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	No	No
Upper Willamette River (UWR) steelhead (*O. mykiss*)	Threatened	Yes	No	No	No
Oregon Coast (OC) coho salmon (*O. kisutch*)	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?
Southern Oregon/Northern California Coast (SONCC) coho salmon (*O. kisutch*)	Threatened	Yes	No	No	No
Northern California (NC) steelhead (*O. mykiss*)	Threatened	Yes	No	No	No
California Coastal (CC) Chinook salmon (*Oncorhynchus tshawytscha*)	Threatened	Yes	No	No	No
Sacramento River winter-run Chinook salmon (SRWR) (*O. tshawytscha*)	Endangered	Yes	No	No	No
Central Valley spring-run (CVS) Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	No	No
California Central Valley (CCV) steelhead (*O. mykiss*)	Threatened	Yes	No	No	No
Central California Coast (CCC) coho salmon (*O. kisutch*)	Endangered	Yes	No	No	No
Central California Coast (CCC) steelhead (*O. mykiss*)	Threatened	Yes	No	No	No
South-Central California Coast (SCCC) Steelhead (*O. mykiss*)	Threatened	Yes	No	No	No
Southern DPS (SDPS) eulachon (*Thaleichthys pacificus*)	Threatened	Yes	No	No	No
Southern DPS (SDPS) green sturgeon (*Acipenser medirostris*)	Threatened	Yes	No	No	No
Southern Resident killer whale (SRKW) (*Orcinus orca*)	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: Chu E Yate

FOR Scott M. Rumsey, Ph.D.
Acting Regional Administrator

Date: April 14, 2022

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List of Acronyms

AMIP – Adaptive Management and Implementation Plan
ARIS – Adaptive Resolution Imaging Sonar
ARN – Administrative Record Number
BIA – Bureau of Indian Affairs
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
CDFW – California Department of Fish and Wildlife
CFR – Code of Federal Regulation
CH – Critical Habitat
CHART – Critical Habitat Analytical Review Teams
CR – Columbia River
CTWS – Confederated Tribes of Warm Springs
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
IPC – Idaho Power Company
ITS – Incidental Take Statement
KCDNRP – King County Department of Natural Resources and Parks
LCR – Lower Columbia River
LHAC – Listed Hatchery Adipose Clipped
LHIA – Listed Hatchery Intact Adipose
MCR – Middle Columbia River
MPG – Major Population Group
MR – Merrill & Ring
MSA – Magnuson-Stevens Fishery Conservation and Management Act
NCASI – National Council of Air and Stream Improvements

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
PBF – Physical or Biological Features
PCE – Primary Constituent Element
PFMC – Pacific Fishery Management Council
PIT – Passive Integrated Transponder
PS – Puget Sound
PS/GB – Puget Sound/Georgia Basin
PSI – Pacific Shellfish Institute
PTI – Puyallup Tribe of Indians
RK – River Kilometer
ROV – Remotely Operated Vehicle
RPM – Reasonable and Prudent Measure
SDPS – Southern Distinct Population Segment
SBT – Shoshone-Bannock Tribes
SnkR – Snake River
SONCC – Southern Oregon/Northern California Coast
Spr/sum – spring/summer run
SR – Southern Resident
SRWR – Sacramento River winter-run
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
WFC – Wild Fish Conservancy

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 52 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 52 applications for permits to conduct scientific research in Washington, Oregon, Idaho and California (see Table 1 and the text following it):

- 37 applications were to renew existing permits;
- Three applications were to modify existing permits; and
- 12 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)
  - Central Valley spring-run (CVSR)
  - Sacramento River winter-run (SRWR)
  - California Coastal (CC)
  - Central Valley spring-run (CVS)
- Coho salmon
  - Lower Columbia River (LCR)
  - Oregon Coast (OC)
  - Southern Oregon/Northern California Coast (SONCC)
  - Central California Coast (CCC)
- Chum salmon
  - Hood Canal summer-run (HCS)
  - Columbia River (CR)
- Sockeye salmon
  - Ozette Lake (OL)
  - Snake River (SnkR)
- Steelhead
  - Puget Sound (PS)
  - Upper Columbia River (UCR)
  - Middle Columbia River (MCR)
  - Snake River Basin (SnkR)
  - Lower Columbia River (LCR)
  - Northern California (NC)
  - California Central Valley (CCV)
  - Central California Coast (CCC)
  - South-Central California Coast (SCCC)
- Green sturgeon
  - Southern distinct population segment (SDPS)
- Eulachon
  - Southern distinct population segment (SDPS)
- Bocaccio
  - Puget Sound/Georgia Basin (PS/GB)
- Yelloweye rockfish
  - Puget Sound/Georgia Basin (PS/GB)

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

Table 1. The Applications Considered in this Biological Opinion and Their Associated Applicants.

Permit Number	Applicant
1127-6M	The Shoshone-Bannock Tribe (SBT)
1135-11R	The United States Geological Survey (USGS)
1175-10R	The United States Forest Service (USFS)
1339-6R	The Columbia River Inter-tribal Fish Commission (CRITFC)
1341-6R	The SBT
1345-10R	The Washington Department of Fish and Wildlife (WDFW)
1379-8R	CRITFC
1386-10R	The Washington Department of Ecology (DOE)
1410-13M	The Northwest Fisheries Science Center (NWFSC)
1465-5R	The Idaho Department of Environmental Quality (IDEQ)
1564-6R	The University of Washington (UW)
1586-5R	NWFSC
1587-7R	USGS
1598-5R	The Washington State Department of Transportation (WSDOT)
10093-3R	The California Department of Fish and Wildlife (CDFW)
13381-4R	NWFSC
13382-4R	NWFSC
14419-4R	Sonoma County Water
15542-6R	TRPA Fish Biologists
15548-2R	TRPA Fish Biologists
15848-3R	WDFW
15890-3R	WDFW
16021-3R	WDFW
16069-4R	The City of Portland
16091-3R	WDFW
16318-4R	Hagar Environmental Sciences
16521-3R	WDFW
16702-4R	NWFSC
17292-3R	The Southwest Fisheries Science Center (SWFSC)
17299-4R	SWFSC
17306-3R	The Oregon Department of Fish and Wildlife (ODFW)
17916-2R	The Bureau of Land Management (BLM)

Permit Number	Applicant
18012-3R	CDFW
19820-3R	The University of California, Davis (UC Davis)
20104-3R	The Pacific Shellfish Institute
20492-3R	ODFW
21185-2R	The Wild Fish Conservancy (WFC)
21220-2R	The Battelle Memorial National Ecological Observatory Network (NEON)
21330-4R	The U.S. Fish and Wildlife Service (FWS)
22369-2M	NWFSC
23798	River Partners
25839	ICF Consulting
25856	Cramer Fish Sciences
25965	ODFW
26049	The Center for Watershed Sciences, University of California
26287	WDFW
26295	Mount Hood Environmental
26331	ODFW
26334	Center for Watershed Sciences, University of California
26352	Northwest Straits
26359	Washington Sea Grant
26398	South Puget Sound Salmon Enhancement Group (SPSSEG)

Permit 1127-6M—We received a permit renewal request from the Shoshone-Bannock Tribes on June 11, 2021. Edits and clarifications were requested and discussed and the application was completed on January 6, 2022.

Permit 1135-11R—We received a permit renewal request from the USGS on June 6, 2021. Edits and clarifications were requested and discussed and the application was completed on September 24, 2021.

Permit 1175-10R—We received a permit renewal request from the GPNF on March 8, 2021. Edits and clarifications were requested and discussed and the application was completed on September 23, 2021.

Permit 1339-6R—We received a permit renewal request from CRITFC on July 16, 2021. Edits and clarifications were requested and discussed and the application was completed on September 24, 2021.

Permit 1341-6R—We received a permit renewal request from the Shoshone-Bannock Tribes on March 18, 2021. Edits and clarifications were requested and discussed and the application was completed on September 23, 2021.

Permit 1345-10R—We received a permit renewal request from the WDFW on August 13, 2021. The application was deemed complete at that time.

Permit 1379-8R—We received a permit renewal request from CRITFC on September 24, 2021. We reviewed the application and requested additional information. The CRITFC provided the additional information and resubmitted their application on January 10, 2022. We deemed the application complete on that date.

Permit 1386-10R—We received a permit renewal request from the WDOE on April 6, 2021. Edits and clarifications were requested and discussed and the application was completed on December 17, 2021.

Permit 1410-13M—We received a permit modification request from the NWFSC on February 10, 2021. Edits and clarifications were requested and discussed and the application was completed on September 13, 2021.

Permit 1465-5R—We received a permit renewal request from the IDEQ on November 1, 2021. The application was deemed complete at that time.

Permit 1564-6R—We received a permit renewal request from the UW on June 22, 2021. The application was reviewed and determined to be complete on January 28, 2022.

Permit 1586-5R—We received a permit renewal request from the NWFSC on March 22, 2021. Edits and clarifications were requested and discussed and the application was completed on January 28, 2022.

Permit 1587-7R—We received a permit renewal request from the USGS on October 26, 2021. The application was reviewed and determined to be complete on January 28, 2022.

Permit 1598-5R—We received a permit renewal request from the WSDOT on July 14, 2021. The application was deemed complete at that time.

Permit 10093-3R—We received a permit renewal request from the CDFW on December 31, 2021. Edits and clarifications were requested and discussed and the application was completed on February 16, 2022.

Permit 13381-4R—We received a permit renewal request from the NWFSC on April 28, 2021. We reviewed the application and requested additional information. The NWFSC provided that information and resubmitted their application on January 12, 2022. We deemed the application complete on that date.

Permit 13382-4R—We received a permit renewal request from the NWFSC on May 26, 2021. We reviewed the application and requested additional information. The NWFSC provided additional information and resubmitted their application on January 13, 2022. We deemed the application complete at that time.

Permit 14419-4R—We received a permit renewal request from the Sonoma County Water Agency on June 18, 2021. Edits and clarifications were requested and discussed and the application was completed on December 31, 2021.

Permit 15542-6R—We received a permit renewal request from TRPA Fish Biologists (TRPA) on December 15, 2021. Edits and clarifications were requested and discussed and the application was completed on December 31, 2021.

Permit 15548-2R— We received a permit renewal request from TRPA on December 15, 2021. Edits and clarifications were requested and discussed and the application was completed on December 31, 2021.

Permit 15848-3R—We received a permit renewal request from the WDFW on October 11, 2021. The application was reviewed and determined to be complete on January 28, 2022.

Permit 15890-3R—We received a permit renewal request from the WDFW on August 16, 2021. The application was reviewed and determined to be complete on January 28, 2022.

Permit 16021-3R—We received a permit renewal request from the WDFW on October 11, 2021. Edits and clarifications were requested and discussed and the application was completed on January 31, 2022.

Permit 16069-4R—We received a permit modification request from the City of Portland (Oregon) on June 29, 2021. Edits and clarifications were requested and discussed and the application was completed on September 24, 2021.

Permit 16091-3R—We received a permit renewal request from the WDFW on December 30, 2021. Edits and clarifications were requested and discussed and the application was completed on January 28, 2022.

Permit 16318-4R—We received a permit renewal request from the Hagar Environmental Science on March 16, 2021. Edits and clarifications were requested and discussed and the application was completed on December 31, 2021.

Permit 16702-4R—We received a permit renewal request from the NWFSC on January 13, 2022. The application was reviewed and determined to be complete on January 28, 2022.

Permit 16521-3R—We received a permit renewal request from WDFW on September 29, 2021. Edits and clarifications were requested and discussed and the application was completed on October 15, 2021.

Permit 17292-3R—We received a permit renewal request from the SWFSC on September 16, 2021. Edits and clarifications were requested and discussed and the application was completed on December 31, 2021.

Permit 17299-4R—We received a permit renewal request from the SWFSC on December 22, 2021. Edits and clarifications were requested and discussed and the application was completed on December 31, 2021.

Permit 17306-3R—We received a permit renewal request from ODFW on April 13, 2020. Because this was more than a year before the permit was due to expire, we suspended work on the renewal until the summer of 2021. At that point, edits and clarifications were requested and discussed and the application was re-submitted and eventually deemed complete on December 7, 2021.

Permit 17916-2R—We received a permit renewal request from the BLM Arcata Field Office on January 11, 2022. Edits and clarifications were requested and discussed and the application was completed on February 16, 2022.

Permit 18012-3R—We received a permit renewal request from the CDFW Bay Delta Region on January 6, 2021. Edits and clarifications were requested and discussed and the application was completed on December 31, 2021.

Permit 19820-3R—We received a permit renewal request from the UC Davis on August 6, 2021. Edits and clarifications were requested and discussed and the application was completed on December 31, 2021.

Permit 20104-3R—We received a permit renewal request from the Pacific Shellfish Institute on November 22, 2021. The application was reviewed and determined to be complete on February 16, 2022.

Permit 20492-3R—We received a permit renewal request from ODFW on November 18, 2021. The application was deemed complete at that time.

Permit 21185-2R—We received a permit renewal request from the Wild Fish Conservancy on March 1, 2021. The application was reviewed and determined to be complete on January 28, 2022.

Permit 21220-2R—We received a permit renewal request from NEON on January 11, 2021. The application was deemed complete at that time.

Permit 21330-4R—We received a permit renewal request from the U.S. Fish and Wildlife Service on December 21, 2021. The application was reviewed and determined to be complete on February 18, 2022.

Permit 22369-2M—We received a permit renewal request from the NWFSC on February 23, 2021. The application was reviewed and determined to be complete on January 28, 2022.

Permit 23798—We received a new permit request from the River Partners on November 19, 2021. Edits and clarifications were requested and discussed and the application was completed on December 31, 2021.

Permit 25965—We received a new permit request from ODFW on September 24, 2021. We reviewed the application and deemed it complete on October 13, 2021.

Permit 25839—We received a new permit request from the ICF on January 12, 2022. Edits and clarifications were requested and discussed and the application was completed on January 31, 2022.

Permit 25856—We received a permit renewal request from the Cramer Fish Sciences on September 2, 2021. Edits and clarifications were requested and discussed and the application was completed on December 31, 2021.

Permit 26049—We received a permit renewal request from the Center for Watershed Sciences, University of California on September 13, 2021. Edits and clarifications were requested and discussed and the application was completed on December 31, 2021.

Permit 26287—We received a new permit request from the WDFW on December 6, 2021. Edits and clarifications were requested and discussed and the application was completed on January 31, 2022.

Permit 26295—We received a new permit request from Mount Hood Environmental on November 29, 2021. Several edits and clarifications were requested and discussed and the application was completed on January 7, 2022.

Permit 26331—We received a new permit request from ODFW on December 8, 2021. Edits and clarifications were requested and discussed and the application was completed on December 14, 2021.

Permit 26334—We received a permit renewal request from the Center for Watershed Sciences, University of California on December 27, 2021. Edits and clarifications were requested and discussed and the application was completed on December 31, 2021.

Permit 26352—We received a new permit request from the NW Straits Commission on December 29, 2021. Edits and clarifications were requested and discussed and the application was completed on February 9, 2022.

Permit 26359—We received a new permit request from the Washington Sea Grant on December 31, 2021. Edits and clarifications were requested and discussed and the application was completed on February 9, 2022.

Permit 26398—We received a permit renewal request from the SPSSEG on February 3, 2022. Edits and clarifications were requested and discussed and the application was completed on February 9, 2022.

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 16, 2022 asking for public comment on them (86 FR 9490). The public was given 30 days to comment on the permit applications and, once that period closed on March 18, 2022, the consultation was formally initiated on March 21st 2022. The full consultation histories for the actions are lengthy and not directly relevant to the analysis for the proposed actions and so are not detailed here. A complete record of this consultation is maintained by the PRD and kept on file in Portland, Oregon.

1.3 Proposed Federal Action

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

The proposed action here is for NMFS to issue 52 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 1127-6M

The Shoshone-Bannock Tribes are seeking to modify a permit that for more than two decades has allowed them to annually take listed SnkR 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. The modification would involve increasing the number of adult spr/sum Chinook the Tribes may observe and handle by permitting them to work at a currently unused weir in the East Fork Salmon River (Idaho). The modification would also involve greatly decreasing the number of juvenile salmon the Tribes capture and sample in the Yankee Fork of the Salmon River. The fish would continue to benefit from the research in two primary 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 analyze how hatchery supplementation can be used as a tool for salmon recovery.

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, after which they would 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 and no adult salmonids would be electrofished. 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 1135-11R

The United States Geological Survey (USGS) is seeking to renew a permit that for more than 20 years has authorized them to take juvenile LCR steelhead in the Wind River subbasin (Washington). The purpose of the study is to provide information on LCR steelhead growth, survival, habitat use, and life histories. This information would improve understanding of habitat associations and life history strategies for LCR steelhead in the Wind River and that, in turn, would help state, tribal, and Federal efforts to restore LCR steelhead. The USGS proposes to capture juvenile LCR steelhead using backpack electrofishing equipment, hold the fish in buckets of aerated water, anesthetize them with MS-222, measure their length and weight, tag age-0 and age-1 fish with passive integrated transponders (PIT-tags), and release all fish at the site of collection after they recover from anesthesia. The researchers do not propose to kill any fish but a small number may die as an unintended result of research activities.

Permit 1175-10R

The Gifford Pinchot National Forest (GPNF) is seeking to renew for five years a permit that currently allows them to take juvenile LCR Chinook salmon, LCR coho salmon, and LCR and MCR steelhead in the Cowlitz River subbasin (Lewis, Cowlitz, and Washougal Rivers) and middle Columbia-Hood subbasin (Wind, Little White Salmon, and Big White Salmon Rivers) in Washington State. The purpose of this research is to describe fish species presence, distribution, spawning areas, and habitat conditions on lands that the GPNF administers. The GPNF and other agencies would use that information in forest management, habitat restoration, and species recovery efforts. The GPNF proposes to use backpack electrofishing and seines to capture juvenile salmonids, hold them for short periods in aerated buckets, identify them, and then release them at the site where they were captured. The researchers do not propose to kill any fish, but a small number may die as an unintended result of research activities.

Permit 1339-6R

The Nez Perce Tribe (NPT) under the authority of the Columbia River Intertribal Fish Commission (CRITFC) is seeking to renew for five years its permit to annually take adult and juvenile SnkR spr/sum Chinook salmon and SnkR steelhead while conducting research in a number of the tributaries to the Imnaha River (Cow, Lightning, Horse, Big Sheep, Camp, Little Sheep, Freezeout, Grouse, Crazyman, Mahogany, and Gumboot Creeks), the Grande Ronde River (Joseph Creek, Wenaha and Minam rivers), the Clearwater River (South Fork Clearwater River and Lolo Creek), and the Snake River (Lower Granite Dam adult trap). The Imnaha and Grande Ronde Rivers are in northeastern Oregon, the Clearwater River is in Idaho, and the work in the Snake River would take place in Washington. The renewed permit would allow the NPT to continue work they have been conducting for over two decades.

The purpose of the research is to acquire information on the status (escapement abundance, genetic structure, life history traits) of juvenile and adult steelhead in the Imnaha, Grande Ronde, and Clearwater River basins. The research would benefit the listed species by providing status information that fishery managers may use to determine whether recovery actions are helping increase wild Snake River salmonid populations. Baseline information on steelhead populations in the Imnaha, Grande Ronde, and Clearwater River basins would also be used to help guide future management actions. Adult and juvenile salmon and steelhead would be observed, handled, and marked. The researchers would use temporary/portable picket and resistance board weirs and rotary screw traps to capture the fish and would then sample them for biological information (fin tissue and scale samples). They may also mark some of the fish with opercule punches, fin clips, dyes, and PIT, floy, and/or Tyvek disk tags. Adult steelhead carcasses would also be collected and sampled. The researchers do not intend to kill any of the fish being captured, but a small number may die as an unintended result of the activities.

Permit 1341-6R

The Shoshone-Bannock Tribes are seeking to renew for five years their permit to take SnkR sockeye salmon and SnkR spr/sum Chinook salmon while conducting research designed to estimate their overwinter survival and downstream migration survival and timing. The researchers would also conduct limnological studies on Petit and Alturas Lakes (Idaho) and monitor sockeye rearing. This research—which has been conducted every year since 1996—would continue to provide information on the relative success of the Pettit and Alturas Lakes sockeye salmon reintroduction programs and thereby benefit the listed fish by improving those programs.

Juvenile SR sockeye salmon, spr/sum Chinook salmon, and steelhead would be collected using rotary screw traps and weirs. The fish would be sampled for biological information and released or tagged with passive integrated transponders and released. In addition, to determine trap efficiencies, a portion of the tagged juvenile SnkR sockeye salmon would then be released upstream of the traps, captured at the traps a second time, and re-released. Adult fish may be trapped as well if any are released above Sawtooth Fish Hatchery (run by the Idaho Department of Fish and Game); these fish would be tissue-sampled and then immediately released above a temporary weir to spawn in Petit Lake. The Tribes do not intend to kill any of the fish being captured, but a small percentage may die as an unintended result of the activities.

Permit 1345-10R

The Washington Department of Fish and Wildlife (WDFW) is seeking to renew for five years a research permit that currently allows them to take juvenile and adult PS Chinook salmon, LCR

Chinook salmon, LCR coho salmon, LCR steelhead, and PS steelhead. The WDFW administers a multitude of water bodies through the state of Washington, and this permit would cover their work throughout Puget Sound and the Lower Columbia River basin. The purpose of the warmwater fish surveys is to assess stocks of inland game fish communities and thereby improve fishery management. The research would benefit salmonids by helping managers write warmwater fish species harvest regulations in a manner that would reduce potential impacts on listed salmonids. The WDFW proposes capturing fish using boat electrofishing, fyke nets, and gillnets. After being captured, the listed salmon and steelhead would be placed in aerated live wells, identified, and immediately released before other species are processed. The researchers would avoid salmonids and do not propose to kill any, but a small number may die as an unintended result of the activities.

Permit 1379-8R

The CRITFC is seeking to renew for five years a permit that currently allows them to take adult and juvenile UCR steelhead and Chinook while conducting research designed to (1) increase what we know about the status and productivity of various fish populations, (2) collect data on migratory and exploitation (harvest) patterns, and (3) develop baseline information on various population and habitat parameters in order to guide salmonid restoration strategies. Much of the work in the permit has been conducted for nearly 20 years—first under permit 1134, and then under seven previous versions of 1379. The permit would comprise three studies: Project 1--Juvenile Upriver Bright Fall Chinook Sampling at the Hanford Reach; Project 2--Adult Sockeye Sampling at Tumwater and Wells Dams; and Project 3--Acoustic trawl survey for Lake Wenatchee juvenile sockeye salmon.

The research, as a whole, would benefit listed fish by helping managers set in-river and ocean harvest regimes so that they have minimal impacts on listed salmonid populations. It would also help managers prioritize projects in a way that gives maximum benefit to listed species–including projects designed to help the listed fish recover. The researchers would use beach- and stick seines to capture and tag juvenile fish in the Hanford reach of the Columbia River and capture fish during mid-water trawls in Lake Wenatchee (Washington). Those fish that are not immediately released upon capture would be transported to a holding facility where they would be anesthetized, examined for marks, adipose-clipped, coded wire tagged, allowed to recover, and released. The researchers would also collect, anesthetize, tissue-sample, and tag adult salmonids at Priest Rapids and Wells Dams in Washington State. The CRITFC researchers do not intend to kill any of the fish being captured but a small number may die as an unintended result of the activities.

Permit 1386-10R

The Washington Department of Ecology (WDOE) is seeking to renew for five years a research permit that currently allows them to take juvenile and adult PS Chinook salmon, UCR spring-run Chinook salmon, SnkR spr/sum Chinook salmon, SnkR fall-run Chinook salmon, LCR Chinook salmon, HCS chum salmon, CR chum salmon, LCR coho salmon, OL sockeye salmon, SnkR sockeye salmon, LCR steelhead, PS steelhead, MCR steelhead, SnkR steelhead, and UCR steelhead. The purpose of the research is to investigate the occurrence and concentrations of toxic contaminants in non-anadromous freshwater fish tissue, sediment, and water at sites all across Washington. The

WDOE conducts this research in order to meet Federal and state regulatory requirements. This research would benefit listed species by identifying toxic contaminants in resident and prey fish and thereby inform pollution control actions. The WDOE proposes to capture fish using various methods including backpack and boat electrofishing, beach seining, block, fyke, and gill netting, and angling. All captured salmon and steelhead would either be released immediately or held temporarily in an aerated live well to help them recover before release. The researchers do not propose to kill any fish but a small number may die as an unintended result of research activities.

Permit 1410-13M

The Northwest Fisheries Science Center (NWFSC) is seeking to modify a research permit that currently allows them to take juvenile and adult CVS, LCR, PS, SRWR, 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 basin, 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. The modification would largely entail increasing take for some species (e.g., juvenile SnkR spr/sum Chinook salmon) and decreasing take for other species (e.g., SnkR Fall Chinook salmon). 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. This study would work in conjunction with another NWFSC study (permit 22369-2M) by capturing salmonids using a different capture method at deeper locations. The NWFSC proposes to capture fish using a surface trawl, which can cause lethal crushing and descaling injuries to 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). Adult salmonids 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. The researchers do not intend to kill any listed adult salmonids, but some may die as an inadvertent result of the research.

Permit 1465-5R

The Idaho Department of Environmental Quality (IDEQ) is seeking to renew for five years a research permit that currently allows them to take juvenile threatened SnkR steelhead, threatened SnkR fall Chinook salmon, threatened SnkR spr/sum Chinook salmon, and endangered SnkR sockeye salmon during the course of two research projects designed to ascertain the condition of many Idaho streams. The purposes of the research are to (a) determine whether aquatic life is being properly supported in Idaho's rivers, streams, and lakes, and (b) assess the overall condition of Idaho's surface waters. The fish would benefit from the research because the data it produces would be used to inform decisions about how and where to protect and improve water quality in the state. The researchers would use backpack- and boat electrofishing equipment to capture the fish. They would then be weighed and measured (some may be anesthetized to limit stress) and released. The IDEQ does not intend to kill any of the fish being captured, but a small percentage may die as an unintended result of the research activities.

Permit 1564-6R

The University of Washington (UW) is seeking to renew for five years a permit that currently allows them to annually take juvenile natural- and hatchery-origin PS Chinook and steelhead while conducting research designed to monitor the success of habitat restoration projects in the Duwamish River estuary. The goal of these projects is to understand changes in population characteristics among Chinook salmon in response to restoration actions. The habitat restoration work is conducted in association with several entities including King County, the City of Seattle, Long Live the Kings, and Vigor Shipyards. The researchers propose to capture fish using enclosure nets and beach seines. Juvenile salmon and steelhead would be handled (anesthetized, weighed, measured, and checked for marks or tags), and released. Juvenile steelhead and a subsample of Chinook salmon captured may have their stomach contents non-lethally sampled via gastric lavage. The UW researchers do not propose to kill any listed animals as part of this project, but a small number may die as an unintended result of the research activities.

Permit 1586-5R

The NWFSC is seeking to renew for five years a permit that currently allows them to annually take juvenile, subadult, and adult PS Chinook salmon, and juvenile PS steelhead, HCS chum salmon, and Bocaccio and yelloweye rockfish. The purpose of the work is to characterize how wild juvenile PS Chinook salmon and various forage fish species use nearshore habitats in the oceanographic basins of the Puget Sound, the Straits of Juan de Fuca, and the San Juan Islands in Washington State. The permit would also allow the researchers to take adult SDPS eulachon, a species for which there are currently no take prohibitions. The goals of this project are to help managers develop protection and restoration strategies and monitor the effects of recovery actions. To accomplish this, the proposed work would help researchers (a) determine if nearshore populations are increasing or decreasing; and (b) establish baseline abundance, composition, and genetic structure metrics for nearshore populations throughout the Puget Sound.

The researchers propose to capture fish using beach seines, Nordic surface trawls, and hook-and-line sampling. Juvenile salmon and steelhead would be handled (weighed, measured, and checked for marks or tags), and released. A subset of juvenile Chinook salmon would have fin clip samples collected. Adult Chinook salmon may have fin clip or scale samples collected. Captured rockfish, eulachon, and steelhead would be handled and released. A small subset of juvenile Chinook salmon would be lethally sacrificed for contaminant, otolith, and stomach content analyses. Any fish found dead at the time of capture or unintentionally killed during sampling would be used in place of fish that would otherwise be intentionally sacrificed. Aside from the subset to be lethally sampled, the NWFSC does not propose to kill any fish being captured as part of this project—though a small number may die as an unintended result of the research activities.

Permit 1587-7R

The USGS's Western Fisheries Research Center is seeking to renew for five years a permit that currently allows them to annually take juvenile PS Chinook salmon, juvenile PS steelhead, and juvenile HCS chum salmon while conducting two research projects designed to explore the influence of large river deltas on nearshore ecosystem processes and the impacts urbanization has on such processes in the Puget Sound, Washington. The permit would also allow the researchers to take adult SDPS eulachon, a species for which there are currently no take prohibitions. The goals of this work are to understand physio-chemical processes related to nearshore habitat changes that alter trophic webs, community dynamics, and forage fish populations. This information, in turn, would benefit listed fish by helping managers better grasp the processes and considerations critical to understanding (and thereby mitigating) human impacts on nearshore salmonid habitats.

The researchers propose to capture fish using lampara seines, dip nets, beach seines, gill nets, and hook-and-line sampling, and would only target forage fish species (i.e., sand lance, surf smelt, and Pacific herring). Though this study does not target ESA-listed species, some may be unintentionally captured as part of this work. Any such fish would be handled (weighed, measured, and checked for marks or tags) and released near their capture location. The USGS does not propose to kill any listed fish, but a small number may die as an unintended result of the research activities.

Permit 1598-5R

The Washington State Department of Transportation (WSDOT) is seeking to renew for five years a research permit that currently allows them to take juvenile PS Chinook salmon, UCR spring-run Chinook salmon, SnkR spr/sum Chinook salmon, SnkR fall-run Chinook salmon, LCR Chinook salmon, HCS chum salmon, CR chum salmon, LCR coho salmon, OL sockeye salmon, SnkR sockeye salmon, LCR steelhead, PS steelhead, MCR steelhead, SnkR steelhead, and UCR steelhead. The WSDOT research may also cause them to take SDPS eulachon, a species for which there are currently no ESA take prohibitions. Sample sites would be located throughout the state of Washington. The purpose of the study is to determine the distribution and diversity of anadromous fish species in waterbodies crossed by or adjacent to the state transportation systems (highways, railroads, airports, etc.).

This information would be used to assess what impacts projects proposed at those facilities may have on listed species. The research would benefit the listed species by helping WSDOT minimize project impacts on listed fish to the greatest extent possible. Depending on the size of the stream system, the WSDOT proposes to capture fish using dip nets, stick seines, baited minnow traps, or backpack electrofishing. The captured fish would be identified to species and immediately released. The researchers do not propose to kill any listed fish being captured, but a small number may die as an unintended result of the activities.

Permit 10093-3R

The California Department of Fish and Wildlife (CDFW) is seeking to renew a five-year permit to annually take adult and juvenile CC Chinook; CCC and SONCC coho; and NC, SCCC, SC and CCC steelhead in watersheds throughout coastal California. The project goal is to restore salmon and steelhead productivity in coastal California streams through a comprehensive restoration program. The specific goals of this research project are to assess fish abundance and distribution in various streams slated for restoration work. This research would benefit listed species by providing data to help managers assess and direct habitat restoration projects across much of the salmonid-bearing waters of California. Fish would be captured by backpack electrofishing, beach seines, minnow traps, and weirs; they would also be observed during snorkel and spawning ground surveys. Some captured fish would be anesthetized, measured, weighed, tagged, and tissue-sampled for genetic information. The researchers do not expect to kill any listed salmonids but a small number may die as an unintended result of the proposed activities.

Permit 13381-4R

The NWFSC is seeking to renew for five years a permit that currently allows them to annually take natural juvenile SnkR spr/sum Chinook and SnkR steelhead in various places in the Salmon River drainage in Idaho and at Little Goose and Lower Granite Dams on the lower Snake River. The purpose of the research is to continue monitoring parr-to-smolt survival and outmigration behavior among wild SnkR spr/sum Chinook salmon populations from Idaho. Steelhead juveniles that are inadvertently collected would also be tagged to help supplement an ongoing Idaho Department of Fish and Game study.

The research would benefit the fish by continuing to supply managers with the information they need to budget water releases at hydropower facilities in ways designed to help protect migrating juvenile salmonids. The information gained would also be used to build long-term data sets on parr-to-smolt migration behavior and survival rates. This information, coupled with water quality, weather, and climate data, is intended to provide a foundation for understanding these populations' life histories—the knowledge of which is critical to planning effective recovery actions. The listed fish would be captured (using seines, dip nets, and electrofishing), anesthetized, tagged, and released. A portion of these fish would also be re-captured at a smolt bypass facility, anesthetized, weighed, measured, and released. The researchers do not intend to kill any of the fish being captured, but a small percentage may die as an unintended result of the research activities.

Permit 13382-4R

The NWFSC is seeking to renew for five years a permit that currently allows them to annually take juvenile threatened SnkR spr/sum Chinook salmon and juvenile threatened SnkR steelhead at various places in the Snake River in Idaho and in various streams of Southeast Washington and Northeast Oregon. Most of the activities under this permit have been under way for nearly 20 years—first under Permit 1406 and then under previous versions of Permit 13382. Under the permit, the listed fish would be variously captured (using seines, dip nets, traps, and electrofishing), anesthetized, tissue sampled, weighed, measured, and released. In addition, a small number of juvenile fish would be caught using electrofishing methods, anesthetized, and then held in aerated containers of water with varying temperature regimes to measure their cardiac performance. The fish would then in all cases be allowed to recover and returned live to the place of their capture.

The purposes of the research are therefore (1) to continue monitoring the effects of supplementation among steelhead and spr/sum Chinook salmon populations in Idaho, and (2) measure cardiac performance in juvenile salmonids. The research would benefit the fish by generating baseline information on elevated temperature effects and continuing to supply managers with the information they need when seeking to use hatchery programs to conserve listed species. The researchers do not intend to kill any of the fish being captured, but some may die as an unintended result of the process.

Permit 14419-4R

The Sonoma County Water Agency is seeking to renew a five-year permit to annually take adult and juvenile CC Chinook, CCC coho, and CCC steelhead in the Russian River watershed, California. The project's goal is to detect and depict trends in ESA-listed salmonid populations in the Russian River watershed and to monitor the results of salmonid habitat enhancement efforts. This research would benefit listed species by providing life cycle and habitat-specific estimates of residence time, growth, and survival so that resource management agencies can better identify and prioritize key restoration actions in the Russian River watershed.

Fish would be captured by downstream-migrant trapping (rotary screw traps, fyke nets, and pipe/funnel nets), electrofishing (backpack and boat), otter trawl, hook-and-line sampling, and beach seining. Fish would also be observed during snorkel and spawning surveys. Some fish would be anesthetized, measured, weighed, tagged, scale-sampled, and/or tissue-sampled for genetic information. The stomach contents of a small subset of fish would be sampled using non-lethal gastric lavage. A maximum of 130 juvenile steelhead and 150 juvenile Chinook would be sacrificed for otolith microchemistry analysis. Beyond these subsets, the researchers do not intend to kill any listed fish, and any that are inadvertently killed would be used in place of the animals that would otherwise be sacrificed.

Permit 15542-6R

TRPA Fish Biologists (TRPA) is seeking to renew a five-year research permit to annually take juvenile and adult CCV steelhead in Lower Putah Creek in the lower Sacramento River basin, California. The project's goal is to monitor the distribution and relative abundance of fish populations in lower Putah Creek downstream from the Putah Diversion Dam. This research would benefit listed steelhead by providing information on fish response to river flows, and generating baseline information on the distribution and diversity of rainbow trout/steelhead in Putah Creek. Fish would be captured by backpack and boat electrofishing. Captured fish would be identified by species, measured, weighed, allowed to recover, and released. The researchers do not expect to kill any listed salmonids but a small number may die as an unintended result of the research activities.

Permit 15548-2R

TRPA is seeking to renew a five-year research permit to annually take adult and juvenile CCC steelhead in Suisun Creek, Green Valley Creek, and Ledgewood Creek in Solano and Napa Counties, California. The project's goal is to monitor fish distribution, population structure, relative abundance, condition, and general health. The research would benefit CCC steelhead by producing data that would be used to help develop the Solano Habitat Conservation Plan in as fish-friendly a manner as possible. Listed fish would be captured by backpack and boat electrofishing; they would then be identified by species, measured, weighed, allowed to recover, and released. The researchers do not expect to kill any listed salmonids but a small number may die as an unintended result of the research activities.

Permit 15848-3R

The WDFW is seeking to renew for five years a permit that currently allows them to annually take juvenile and adult PS Chinook salmon, PS steelhead, HCS chum salmon, Bocaccio, and yelloweye rockfish, and adult SDPS green sturgeon while conducting research to estimate the relative numerical and biomass abundance of bottom fish in the basins of Puget Sound, Washington. They would also collect other distributional and biological information for key marine resources. The researchers may also capture adult and juvenile SDPS eulachon, a species for which there are currently no take prohibition. The goals of this work are to develop a fishery-independent method for tracking population trends over time and provide managers and stakeholders with information about ecosystem productivity, community structure, and trends. This information would benefit listed species by informing an array of future management decisions.

The researchers would use bottom trawls to capture fish and would not target listed species, but they may unintentionally encounter some during the course of the work. All listed animals that may be captured would be handled (weighed, measured, and checked for marks or tags) and released near their capture location. The WDFW does not propose to kill any listed fish as part of this project, but a small number may die as an unintended result of the proposed activities.

Permit 15890-3R

The WDFW is seeking to renew for five years a permit that currently allows them to annually take juvenile and adult PS Chinook salmon, PS steelhead, HCS chum salmon, Bocaccio, and yelloweye rockfish while conducting research to estimate the abundance of pelagic forage fish species in key areas of the Puget Sound, Washington. The researchers would also encounter SDPS eulachon, a species for which there are currently no take prohibitions. The goals of this work are to compare pelagic species stock abundances over time and gather growth, mortality, and recruitment information about the populations. This information would benefit listed species by informing an array of future fishery management decisions.

The researchers propose to capture fish using midwater trawls and, while they would not target listed species, some may be captured during the course of the work. Any ESA-listed salmon, steelhead, or rockfish captured would be handled (weighed, measured, and checked for marks or tags), tissue-sampled (scale or fin clip), and released near their capture location. Any SDPS eulachon captured would be handled and released. The WDFW does not propose to kill any listed fish as part of this project, but a small number may die as an unintended result of the research activities.

Permit 16021-3R

The WDFW is seeking to renew for five years a permit that currently allows them to annually take juvenile and adult PS Chinook salmon, Bocaccio, and yelloweye rockfish, and SDPS green sturgeon while conducting research to study the stock structure, biology, food web relationships, and abundance of groundfish species in inland marine waters of Puget Sound, Washington. The researchers may also capture adult SDPS eulachon, a species for which there are currently no take prohibitions. The goal of this work is to improve understanding of groundfish stock structure, life history, biology, geographic distribution, habitat use, and food web relationships. The researchers propose to capture fish using hook-and-line angling and live-capture traps and, though they are not targeting ESA-listed species, they may inadvertently capture some. In addition, the researchers propose to use modified dinglebar trolling gear, although it will only be deployed in habitats where they do not anticipate encountering ESA-listed species. All captured rockfish would be handled (weighed, measured, and checked for marks or tags), sampled for stomach contents, tissue-sampled, floy-tagged, and released near the site of their capture. Any ESA-listed salmon, eulachon, or green sturgeon captured would be handled and swiftly released. The WDFW does not propose to kill any ESA-listed species as part of this project, but a small number may die as an unintended result of the proposed activities.

Permit 16069-4R

The City of Portland is seeking to renew for five years a research permit that currently allows them to take juvenile UCR spring-run Chinook salmon, UWR Chinook salmon, SnkR spr/sum Chinook salmon, SnkR fall-run Chinook salmon, LCR Chinook salmon, CR chum salmon, LCR coho salmon, SnkR sockeye salmon, LCR steelhead, UWR steelhead, MCR steelhead, SnkR steelhead, and SDPS green sturgeon in the Columbia and Willamette rivers and some of their tributaries in Oregon. The researchers may also take some adult SDPS eulachon (a species for which there are currently no ESA take prohibitions). This research is part of the Portland Watershed Management Plan—a series of projects designed to improve watershed health in the Portland area. Project staff would annually sample 37 sites across all Portland watersheds and record data on local hydrology, habitat, water chemistry, and biological communities.

The research would benefit listed salmonids by providing information to help managers assess watershed health, critical habitat status, effectiveness of watershed restoration actions, and compliance with regulatory requirements. The City of Portland proposes to capture juvenile fish using backpack and boat electrofishing equipment, hold them in a bucket of aerated water, take caudal fin clips for genetic analysis, and release them. The researchers would avoid contact with adult fish. The researchers do not propose to kill any fish but a small number may die as an unintended result of the proposed activities.

Permit 16091-3R

The WDFW is seeking to renew for five years a permit that currently allows them to annually take juvenile and adult PS Chinook salmon, PS steelhead, Bocaccio, yelloweye rockfish, and adult SDPS green sturgeon while monitoring English sole (*Parophrys vetulus*) for (1) chemical contaminant levels in fish tissues, (2) pathological disorder frequency, and (3) other biomarkers signifying biological effects in in the Puget Sound, Washington. The researchers may also capture SDPS eulachon, a species for which there are currently no take prohibitions. The goal of this work is to monitor contaminants in this indicator benthic fish to better understand toxic contaminant impacts on the benthic food web, measure changes in toxic contaminant levels at a local level, and prioritize cleanup efforts in the Puget Sound. This information would benefit listed fish by helping managers make informed decisions regarding habitat restoration efforts throughout the Puget Sound. The researchers propose to capture fish using bottom trawls and, though they are not targeting listed species, they may capture some as part of this work. Any viable ESA-listed species captured would be handled, allowed to recover, and quickly released. The WDFW does not propose to kill any listed fish, but a small number may die as an unintended result of the research activities.

Permit 16318-4R

Hagar Environmental Services is seeking to renew for five years a permit that currently allows them to annually take juvenile CCC coho and juvenile CCC and SCCC steelhead in Santa Cruz, Monterey, and San Luis Obispo counties, California. The purpose of this study is to gather data on salmonid abundance and distribution and quantify various habitat parameters with the goal of improving watershed management across three counties. This research would benefit listed species by helping managers draft a fish-friendly habitat conservation plan for the City of Santa Cruz and, in general, better inform land management decisions throughout the area. Fish would be captured by backpack electrofishing and beach seines and observed during snorkel surveys. Some fish would be anesthetized, measured, weighed, tagged, and scale- and tissue-sampled for genetic information. The researchers do not expect to kill any listed salmonids but a small number may die as an unintended result of the research activities.

Permit 16521-3R

The WDFW is seeking a to renew for five years their permit to annually capture, handle, and release juvenile UCR steelhead and Chinook salmon in the Hanford reach of the Columbia River and near the Tri-Cities, Washington. The purpose of the research is to gather data on fall Chinook abundance, length frequency distribution, and fish losses in the area. The information collected from these surveys is used to evaluate protections for juvenile fall Chinook under the Hanford Reach Fall Chinook Protection Program Agreement; it has also been used to gauge the efficacy of the coded-wire-tagging program for marking wild up-river bright fall Chinook in the Hanford Reach. These surveys provide biologists and managers with definitive data on fish presence and the impacts both listed and non-listed Chinook and steelhead experience when residing in near-shore habitats in this area of the Columbia River. These data have been (and would continue to be) used to help guide management actions for the benefit of the listed species. The researchers would use beach seines and backpack electrofishing equipment to capture the fish. The captured fish would be anesthetized, measured, allowed to recover, and released back to the river. The researchers do not expect to kill any listed fish, but a small number may die as an unintended result of the research activities.

Permit 16702-4R

The NWFSC is seeking to renew for five years a permit that currently allows them to annually take juvenile PS Chinook salmon and steelhead and adult SDPS eulachon (a species for which there are currently no take prohibitions) while conducting research designed to characterize how wild juvenile PS Chinook salmon use habitats in the Snohomish River estuary and delta in the Puget Sound, Washington. The goal of this project is to identify the life history types of juvenile PS Chinook salmon present, characterize their spatial and temporal distribution, and assess their feeding ecology and interactions with other biota. The gathered data would benefit listed fish by better informing Snohomish-area land management decisions as conditions and opportunities change.

The researchers propose to capture fish using beach seines and fyke nets. Juvenile salmon and steelhead would be handled (weighed, measured, and checked for marks or tags), and released. A small subset of hatchery- and naturally-produced juvenile Chinook salmon would be lethally sacrificed for stable isotope, otolith, and stomach contents analysis. Any fish found dead at the time of capture or unintentionally killed during sampling would be used in place of fish that would otherwise be intentionally sacrificed. Aside from this subset, the NWFSC does not propose to kill any other fish being captured as part of this project, but a small number may die as an unintended result of the research activities.

Permit 17292-3R

NMFS's Southwest Fisheries Science Center (SWFSC) is seeking to renew a five-year research permit to annually take adult and juvenile CC Chinook, CCC and SONCC coho, and NC, SCCC, SC and CCC steelhead. Sampling would be conducted in California on a variety of coastal salmonid populations. The purposes of this research are to: (1) estimate population abundance and dynamics; (2) evaluate factors affecting growth, survival, reproduction, and other life history patterns; (3) assess life-stage specific habitat use and movement; (4) evaluate physiological performance and tolerance; (5) determine the genetic structure of populations; (6) evaluate the effects of water management and habitat restoration; and (7) develop improved sampling and monitoring methods. The research would benefit the coastal California salmon stocks by providing critical information to support their conservation, management, and recovery.

The listed fish would be captured using backpack electrofishing, hook-and-line sampling, hand- and dipnets, beach seines, fyke nets, panel, pipe or rotary screw traps, and weirs. They would also be observed during spawning ground and snorkel surveys. Some fish would be anesthetized, measured, weighed, tagged (coded wire, elastomer, radio, acoustic, PIT, or sonic), and tissue-sampled for genetic information. A small number of juvenile fish would be sacrificed to support laboratory experiments and assess mercury levels and RNA expression, but otherwise the researchers do not intend to kill any of the captured fish—though some may die as an inadvertent result of the activities.

Permit 17299-4R

The SWFSC is seeking to renew a five-year research permit to annually take adult and juvenile CCV steelhead, SRWR and CVS Chinook salmon, and SDPS green sturgeon while conducting research activities in the California Central Valley. The overall goal of this project is to provide critical information to support California salmonid stock conservation and management. The SWFSC would conduct comparative studies on salmon ecology across all Central Valley habitats (streams, rivers, and delta) to increase our knowledge of California's Chinook salmon and steelhead life histories. The proposed action would include six study efforts: (1) producing telemetry data to assess river habitat use, behavior, and survival; (2) estimating predator impacts on salmon; (3) making physiological measurements of aerobic scope across stocks; (4) examining otoliths to identify stocks of salmonids and thereby inform Central Valley project operations and Bay-Delta monitoring; (5) annually updating strontium and sulfur isoscape validation tools for reconstructing juvenile habitat use; and (6) applying isotope methods to reconstruct salmon habitat use and growth studies. The research would benefit the affected species by providing critical information to inform life-cycle modeling efforts at the SWFSC and help guide NMFS's West Coast Region and various Central Valley agencies in their resource management efforts. In addition, results would also be integrated into the Central Valley Project Improvement Act and thereby help prioritize habitat restoration actions.

In situations where the SWFSC are unable to rely on collaborators to capture fish, collection methods would include rotary screw traps, fyke nets, backpack- and boat electrofishing, beach seining, tangle netting, DIDSON (sonar) observations, hook-and-line sampling, and spawning ground and snorkel surveys. Some fish would be anesthetized, measured, weighed, tagged (coded wire, elastomer, radio, acoustic, PIT, or sonic), and tissue sampled (fin clip, scales, stomach lavage). Another subset would be tested in the laboratory to measure aerobic scope under a range of temperature and flow combinations. Most of the fish to be captured would experience no long-term adverse effects, however, a number of hatchery fish that have had their adipose fins removed would be sacrificed to collect otoliths for age/growth analysis, organ tissues for isotope, biochemical and genomic expression assays and parasite infections, and to assess tag effects/retention. It should be noted that there are no take prohibitions for such fish and they are by definition considered excess to the species' recovery needs.

Permit 17306-3R

The Oregon Department of Fish and Wildlife (ODFW) is seeking to renew for five years a permit that currently authorizes them to capture threatened MCR steelhead (adults and juveniles) in the upper Deschutes River, Oregon. The various proposed activities would include adult and juvenile snorkel surveys throughout the basin, screw trapping, backpack and boat electrofishing and mark/recapture studies, hook and line surveys, telemetry, seining, spawning ground surveys using weirs and redd counts, monitoring habitat restoration projects, and setting traps and nets in reservoirs for population monitoring. Most captured fish would be identified, measured and released, though some would also be tissue sampled and/or floy- or PIT-tagged. Data collected from this work would be used to inform management decisions in the Deschutes River watershed for the benefit of MCR steelhead. Biologists from the ODFW have been conducting this work in the area for decades. The researchers do not intend to kill any of the fish being captured, but a small percentage may be killed as an inadvertent result of the activities.

Permit 17916-2R

The Bureau of Land Management (BLM), Arcata Field Office, is seeking to renew a five-year research permit to annually take adult and juvenile CC Chinook salmon, SONCC coho salmon, and NC steelhead in watersheds throughout Northwest California—including the Mattole River, Eel River, the Lost Coast region tributaries to the Pacific Ocean, and some Humboldt Bay tributaries. The purpose of this research is to monitor how current management actions under the Northwest Forest Plan's Aquatic Conservation Strategy are affecting anadromous salmonids and their habitats. In order to monitor land management actions and implement the Northwest Forest Plan in northern California, the BLM needs to obtain updated information on fish distribution and habitat. Thus, the information to be gathered would benefit listed species by informing adaptive management strategies intended to aid salmon recovery. Fish would be captured using backpack electrofishing, hand/or dip nets, beach seines and observed during spawning and snorkel surveys. Some fish would be anesthetized, measured, and weighed. The researchers do not expect to kill any listed salmonids but a small number may die as an unintended result of the research activities.

Permit 18012-3R

The CDFW Bay Delta Region's Central Coast Watershed Restoration and Fisheries Management Program is seeking to renew a five-year research permit to annually take adult and juvenile CC Chinook salmon, CCC coho salmon, and NC, CCC and SCCC steelhead in Sonoma, Mendocino, Napa, Marin, San Mateo, Santa Cruz and Monterey Counties, California. The purpose of this research is to assess salmonid stock status throughout the seven counties and identify factors that may be limiting population growth and recovery. The proposed studies are: (1) juvenile salmonid occurrence, distribution and habitat monitoring; (2) adult salmonid occurrence, passage, and distribution; (3) spawning ground surveys; (4) life cycle station monitoring; and (5) juvenile steelhead lagoon seining and habitat monitoring. This research would benefit listed species by informing proposed habitat restoration project designs, helping prioritize watershed restoration efforts, and helping managers mitigate the negative impacts of various management actions.

Fish would be captured via backpack electrofishing, beach seining, rotary screw trapping, fyke/pipe trapping, and weirs. They would also be observed during spawning and snorkel surveys and at electronic counting stations (by DIDSON (sonar) array, Vaki Riverwatcher, and video weirs). Most juvenile fish would be handled, measured for fork length, weighed, and released. Various subsets of the captured juvenile fish would be anesthetized, tissue-sampled (fin clip) for genetic analysis, scale sampled, marked with an upper caudal fin clip, and/or PIT-tagged. Captured adult salmon would be handled (identified, measured, weighed, and scale- and tissue-sampled), tagged (bi-colored Floy tags and/or opercule-punched), and released. The researchers do not expect to kill any listed salmonids but a small number may die as an unintended result of the research activities.

Permit 19820-3R

The University of California, Davis (UC Davis) Biogeochemistry & Fish Ecology Lab is seeking to renew a five-year research permit to annually take juvenile SRWR and CVS Chinook, juvenile and adult CCC and CCV steelhead, and juvenile SDPS green sturgeon in the San Francisco Bay Area and tributaries. The purpose of this research is to determine the degree to which Longfin Smelt use tributaries of San Pablo and San Francisco bays as spawning and rearing habitat. This information would improve the understanding of how bay tributaries contribute to the overall population of Longfin Smelt and that information, in turn, would benefit listed salmonids by improving our understanding of tributary habitat health in areas not previously monitored.

Although this study principally targets longfin smelt, SRWR and CVS Chinook, CCC and CCV steelhead and SDPS green sturgeon may be encountered during sampling. Fish would be captured with beach seines, fyke nets, and trawls (otter and Kodiak). Captured fish would be identified by species, enumerated, and released. A sub-sample of 30 individuals per species would be measured. The researchers do not propose to kill any fish but a small number may die as an unintended result of research activities.

Permit 20104-3R

The Pacific Shellfish Institute is seeking to renew for five years a permit that currently allows them to annually take juvenile PS Chinook salmon, PS steelhead, and SDPS green sturgeon in eelgrass and mudflat habitats in Samish Bay in the Puget Sound and in Willapa Bay on the coast of Washington. The researchers may also capture SDPS eulachon, a species for which there are currently no take prohibitions. The researchers are also requesting to expand their work to include sites in Hood Canal, South Puget Sound, and Grays Harbor, Washington; Coos Bay, Oregon; and Humboldt Bay, California. They would also seek to also take juvenile HCS chum salmon, OC coho salmon, SONCC coho salmon, CC Chinook salmon, and NC steelhead. The research is designed to quantify the effects shellfish culture and burrowing shrimp have on seagrass and its function as habitat for fish and invertebrates. The researchers would examine the spatial relationships between existing shellfish culture, burrowing shrimp, and seagrass in several Pacific Northwest estuaries. They would also synthesize data and parameterize production functions for higher trophic level species of interest across habitat types. The goal of this project is to help develop a landscape-scale understanding of the influence aquaculture has on estuarine habitats and thereby help managers develop environmentally and economically sustainable shellfish farming practices that would also help conserve listed salmonids and other fish.

The researchers propose to capture fish using beach seines, open-ended fyke nets with cameras, and Breder traps. Captured fish would be handled (weighed, measured, and checked for marks or tags), and released. A small subset of fish from all species captured may also be lethally sacrificed for stable isotope and stomach contents analyses. Any fish found dead at the time of capture or unintentionally killed during sampling would be used in place of fish that would otherwise be intentionally sacrificed. In addition to those intentionally sacrificed, a small number of listed juvenile fish may die as an unintended result of the research activities.

Permit 20492-3R

The ODFW is seeking to renew a permit a permit that currently authorizes research in lake, river, backwater, slough, and estuary habitats in the Willamette and Columbia basins (Oregon) and on the Oregon coast. The permit would continue to allow the ODFW to take juvenile CR Chum, LCR Columbia Chinook, UCR Chinook, SnkR spr/sum Chinook, SnkR fall Chinook, UWR Chinook, LCR Coho, LCR Steelhead, MCR Steelhead, UCR Steelhead, SnkR Steelhead, UWR Willamette Steelhead, SnkR Sockeye Salmon, OC Coho, and adult SDPS green sturgeon. The permit would also allow ODFW to take adult SDPS eulachon—a species for which there are currently no take prohibitions. The information to be collected would be used to monitor population structure and abundance for many species across the landscape. This, in turn, would be used to improve a suite of listed-fish-affecting management actions throughout much of Oregon.

The permit would cover the following projects: (1) Warmwater and Recreational Game Fish Management, (2) District Fish Population Sampling in the Upper Willamette Basin, and (3) Salmonid Assessment and Monitoring in the Deschutes River. The researchers propose to use boat electrofishing to sample fish. Most juveniles and all adults would be allowed to swim away without being handled after they are electroshocked, but some juveniles would be netted, identified, and released immediately. A subset of captured juveniles would be anesthetized, weighed and measured, allowed to recover, and then released. All ESA-listed fish would be processed and released before any non-listed fish are processed. The ODFW does not intend to kill any of the fish being captured, but a small number may die as an unintended result of the activities.

Permit 21185-2R

The Wild Fish Conservancy (WFC) is seeking to renew for five years a permit that currently allows them to annually take juvenile PS Chinook salmon and steelhead while conducting research to validate and correct existing Washington Department of Natural Resources channel water-type classifications regarding tributaries to the Puget Sound and the Deschutes River (Washington). The goal of this work is to generate data that can be used to identify wild fish habitat restoration opportunities and thereby (a) improve regulatory protection of sensitive aquatic habitats for ESA-listed Chinook salmon and steelhead, and (b) help land use planners implement better recovery strategies. The researchers propose to capture fish using backpack electrofishing. Any juvenile PS steelhead captured would be handled (weighed, measured, and checked for marks or tags), tissue-sampled (fin clip or opercule punch), and released. Juvenile PS Chinook salmon captured would be handled and released. The WFC does not propose to kill any listed fish as part of this project, but a small number may die as an unintended result of the research activities.

Permit 21220-2R

The Battelle Memorial National Ecological Observatory Network (NEON) Program is seeking to renew for five years a permit that currently authorizes them to capture adult and juvenile threatened LCR steelhead in Martha Creek, Washington while conducting research designed to monitor climate change, land use alterations, and invasive species distribution. The NEON researchers would continue to use instream and riparian sensors in combination with field sampling to characterize chemical, physical, and biological properties of the stream and riparian ecosystem. The aquatic sampling suite would consist of chemical measurements of surface and shallow ground water, physical measurements of stream and riparian habitat, and biological measurements of the aquatic community (biofilms, macrophytes, algae, invertebrates, and fish).

During times when no LCR steelhead adults or redds are present, NEON would survey fish using three-pass backpack electrofishing with block nets placed at the upper and lower boundaries of each survey reach. The captured fish would be held in buckets of cool stream water, anesthetized with a eugenol solution, identified, photographed, measured, allowed to recover, and then released back to the stream. If any adult steelhead are encountered during electrofishing, NEON would immediately turn off the electrofishing unit, let the fish swim away, and halt surveys until the researchers determine through consultation with NMFS and the Gifford Pinchot National Forest that listed adults or redds are no longer present in the research area. Although NEON's standardized fish survey protocols describe tissue sampling and vouchering fish specimens, NEON does not propose to tissue-sample or intentionally kill any *O. mykiss* at the Martha Creek research site. However, a small number of juvenile LCR steelhead may die as an unintended consequence of the activities.

Permit 21330-4R

The U.S. Fish and Wildlife Service (USFWS) is seeking to renew for five years a permit that currently allows them to annually take juvenile and adult PS Chinook salmon and steelhead while conducting research to document fish presence and abundance in Jim Creek in Snohomish County, Washington. The goal of this work is to provide data regarding fish distribution and abundance in Jim Creek to help the U.S. Navy refine their Integrated Natural Resources Management plan for Naval Radio Station Jim Creek. The Navy would then use this information to design and carry out habitat restoration for the benefit of the listed fish. The researchers propose to capture fish using backpack electrofishing; they would also conduct snorkel and spawning surveys. Any juvenile PS Chinook salmon or steelhead captured would be handled (weighed, measured, and checked for marks or tags) and released. Some juvenile steelhead may also be tissue-sampled (fin clip or opercule punch). The USFWS does not propose to kill any listed fish, but a small number may die as an unintended result of the research activities.

Permit 22369-2M

The NWFSC is seeking to modify a permit that currently allows them to annually take juvenile and adult PS Chinook salmon, PS steelhead, HCS chum salmon, OL sockeye salmon, SnkR fall-run Chinook salmon, SnkR spr/sum Chinook salmon, SnkR sockeye salmon, SnkR steelhead, UCR spring-run Chinook salmon, UCR steelhead, UWR Chinook salmon, MCR steelhead, LCR Chinook salmon, LCR coho salmon, LCR steelhead, CR chum salmon, OC coho salmon, SONCC coho salmon, CC Chinook salmon, SRWR Chinook salmon, CV spring-run Chinook salmon, and SDPS green sturgeon. The researchers may also capture SDPS eulachon, a species for which there are currently no take prohibitions. The research involves using pop-up satellite tags and acoustic tags to identify the ocean distribution of salmonids off the coast of Washington and mouth of the Columbia River. The researchers wish to modify their permit by increasing the amount of take allowed for some of the species they may encounter.

The primary goal of this project is to investigate nearshore behavior, distribution, and migration patterns, diet, growth rates, and habitat use among Chinook salmon, coho salmon, and steelhead. The researchers would also use tissue samples to determine the captured fishes' genetic origins. The researchers propose to capture fish using hook-and-line angling. Coho, chum, and sockeye salmon, as well as eulachon and green sturgeon, would be handled (weighed, measured, and checked for marks or tags), and released. Chinook and steelhead would be anesthetized, tagged with PIT and internal acoustic tags, and have scale and tissue samples collected. A small subset of juvenile Chinook salmon and steelhead would be lethally sacrificed to collect diet, age, and growth information. Aside from this subset, the NWFSC does not propose to kill any other fish being captured as part of this project, though a small number may die as an unintended result of the research activities.

Permit 23798

Michael Rogner, Senior Restoration Ecologist at River Partners is seeking a new, five-year research permit that would allow him to take juvenile SRWR and CVS Chinook salmon, and CCC and CCV steelhead in the Sacramento River, CA. The project's goal is to measure the effectiveness of an experimental approach to prolonging floodplain inundation for the purpose of maximizing growth and survival among outmigrating juvenile salmon. This research would benefit listed species by helping managers find new ways to convert floodplain areas throughout the Central Valley into habitat suitable for rearing juvenile salmon. Fish would be captured with fyke nets and anesthetized, measured, weighed, tagged, and tissue-sampled for genetic information. The researchers do not expect to kill any listed salmonids but a small number may die as an unintended result of the research activities.

Permit 25839

ICF Consulting is seeking a new, five-year research permit to annually take juvenile CCV spring-run Chinook and juvenile CCV steelhead in the Lower Yuba River. The purpose of this research is to quantify habitat productivity and juvenile salmonid growth in seasonally available habitats in the Lower Yuba River. The information would benefit listed fish by improve our understanding of how juvenile salmonids use these habitats for rearing. The researchers would survey main channel, side-channel, and intermittently inundated gravel bar habitats and identify environmental factors underlying differences among the various sites. This information, in turn, would be used to evaluate some of the assumptions about juvenile salmonid growth and habitat suitability that currently guide scientific and restoration efforts—thus improving such efforts' efficacy.

The researchers would employ single-pass transect backpack electrofishing to capture salmonids. Fish would be anesthetized, measured, clipped, weighed, and photographed. While electrofishing collection efforts would target salmonids, the researchers also expect to encounter known salmonid predators (e.g., Sacramento Pikeminnow). Each captured predatory fish would be measured and released. The researchers do not expect to kill any listed salmonids but a small number may die as an unintended result of the research activities.

Permit 25856

Steve Zeug, Senior Scientist at Cramer Fish Sciences is seeking a new, five-year research permit to take adult and juvenile CCV steelhead in the Stanislaus River. The project's goal is to provide information on the river's *O. mykiss* population: annual growth rates, age and spatial structure, contribution of resident and anadromous parents to juvenile production, probability of juvenile outmigration, abundance and survival of downstream migrants, and timing, age, and size structure of outmigrating fish. This research would benefit listed steelhead by improving our fundamental understanding of Central Valley *O. mykiss* biology and ecology—information that would be used to better manage and conserve the species. The fish would be captured by backpack and raft electrofishing, hook-and-line sampling, beach seines, fyke nets and rotary screw traps. Some fish would be anesthetized, measured, weighed, tagged, and tissue-sampled for genetic information. The researchers do not expect to kill any listed salmonids but a small number may die as an unintended result of the research activities.

Permit 25965

The ODFW is seeking a new, five-year research permit to conduct research on hatchery salmon that may become infected with a harmful parasite (*Ceratonova shasta*) between their release into the Deschutes River (Oregon) and their arrival at the Bonneville Dam on the Columbia River. The purpose of this research is to determine whether this parasitic infection is a causal mechanism related to poor smolt-to-adult return rates among non-listed hatchery Chinook salmon originating at the Round Butte hatchery on the Deschutes River. It would also indirectly inform the currently ongoing listed MCR steelhead reintroduction program on the Deschutes River. Both of these efforts would benefit listed salmonids by helping managers quantify the degree of adverse effect the parasite is having in the Deschutes and Columbia Rivers.

Under this permit, PIT-tagged juvenile hatchery spring Chinook would be sampled at the Bonneville Dam juvenile bypass system. The sort-by-code system at the structure would be set to separate PIT-tagged Round Butte Hatchery spring Chinook from the rest of the outmigrating salmon as they move through the dam. The segregated fish would be diverted by watered pipe into a holding tank, transferred as quickly as possible to buckets of aerated fresh water, and passed through a PIT-tag reader to confirm their identity as target fish. The target fish (which are not listed under the ESA) would then be euthanized, but all captured ESA-listed fish would swiftly be transferred to the bypass release tank at the juvenile fish facility and returned to the river without anesthesia or further handling. No listed fish would be killed during the course of this research.

Permit 26049

Dr. Robert Lusardi, Research Ecologist at the Center for Watershed Sciences, University of California, Davis, is seeking a new, five-year research permit to annually take juvenile SRWR chinook and CCV steelhead in the Sacramento River, CA, below Keswick Dam. The project's goal is to gather data on how different environmental variables affect juvenile steelhead growth in spring-fed, runoff, and regulated reaches of the Sacramento River. This research would benefit listed species by providing data to improve our understanding of the mechanisms affecting salmonid growth in different ecosystems across the landscape, but specifically those effects in regulated rivers below dams. The fish would be captured by minnow traps, beach seines, and hook-and-line sampling. The majority of fish would be captured, handled and released without harm, but 25 juvenile CCV steelhead would be sacrificed each year in order to conduct otolith analysis. It is also possible that a very small number of juvenile SRWR Chinook would die as an unintended consequence of the proposed action.

Permit 26287

The WDFW is seeking a new, five-year research permit to sample for invasive European Green Crab (EGC) at several locations in the Puget Sound, along the Washington Coast, and in the Lower Columbia River estuary. Though the researchers would not target listed species, they may encounter juvenile PS Chinook salmon, PS steelhead, HCS chum salmon, OL sockeye salmon, SR fall-run Chinook salmon, SR spr/sum Chinook salmon, SRB steelhead, SR sockeye salmon, UCR spring-run

Chinook salmon, UCR steelhead, UWR Chinook salmon, UWR steelhead, CR chum salmon, LCR Chinook salmon, LCR steelhead, and LCR coho salmon while conducting this work in the lower Columbia River. They may also encounter adult SDPS eulachon, a species for which there are currently no take prohibitions. The researchers would conduct this work in conjunction with the Northwest Straits Commission (under Permit 26352) and Washington Sea Grant (under Permit 26359).

The goal of the research is to determine the extent of the threat posed by the EGC invasion in the in Washington State and, where possible, help mitigate it. The research would benefit listed species by monitoring, trapping, and removing individuals of an invasive species that is known to greatly damage eelgrass beds—an important habitat type upon which juvenile salmonids depend for rearing and food production. The researchers propose to use minnow traps, shrimp traps, and Fukui traps (and equivalent modifications of such traps) to capture the crabs. Trap configurations and locations would be adjusted to minimize the risk of encountering adult salmonids or hindering adult passage through main migration channels. The researchers do not propose to anesthetize, tag, sample, or kill any of the captured fish, but a small number may die as an unintended result of the trapping activities.

Permit 26295

Mount Hood Environmental is seeking a new, five-year research permit to conduct an inventory of all fish and their relative abundances in the Grande Ronde River in Eastern Oregon. The work would concentrate specifically on predators that may target listed salmonids. It is thought that such predators are a major source of listed salmonid mortality in the Grande Ronde subbasin. This research would help determine if that is the case and, ultimately, help managers design actions (e.g. predator mitigation) to benefit the listed animals.

The researchers would use backpack or boat-mounted electrofishing, fyke netting, seining, angling, and minnow trapping to perform the inventories in each study reach. Fyke and minnow traps would be deployed for several days and checked every 4-6 hours during the day. Electrofishing, beach seining, and angling would be take place in conjunction with the trapping efforts. All ESA-listed fish would be released immediately following capture and identification. If any of these fish exhibit sign of stress (gill flaring, loss of equilibrium, slow reaction to touch, etc.) they would be allowed to recover in a holding tank (or bucket) of aerated water before being released. The researchers do not intend to kill any of the fish being captured, but a small number may die as an unintended result of the activities.

Permit 26331

The ODFW is seeking a new, five-year research permit to implant acoustic tags in adult MCR steelhead at Bonneville Dam on the Columbia River and monitor the fishes' subsequent migration patterns and routes. The fish would be taken and tagged as they pass through the Bonneville Dam adult fish facility. Captured adult steelhead would be anesthetized, held in an oxygenated, river-temperature tank, and implanted with an acoustic transmitter once they are fully anesthetized.

Following their recovery from anesthesia, tagged adult steelhead would be released immediately upstream of the adult fish trap and allowed to proceed up the fish ladder to cross Bonneville Dam. The fish would then be tracked by acoustic receiver arrays in upstream reservoirs and dams and at a location near the confluence of the Columbia and John Day Rivers.

The research is intended to generate information about adult MCR steelhead migration and, in particular, it is intended to help managers address the question of why so many steelhead that originate in the John Day River tend to swim past that river and continue up the Columbia River when they return as adults. Currently, approximately 60% of the returning steelhead overshoot the John Day River when they return as adults. If managers can figure out why that is the case and develop measures to reduce that percentage (i.e., help the fish find their way back to their spawning grounds), it could potentially greatly increase their survival and, therefore, improve spawning success and overall steelhead numbers in the John Day River. The researchers do not intend to kill any of the fish being tagged, but a small number may die as an inadvertent result of the capturing and tagging activities.

Permit 26334

Dr. Robert Lusardi, Research Ecologist at the Center for Watershed Sciences, University of California, Davis, is seeking a new, five-year research permit that would allow him to annually take juvenile CCC coho in the Walker Creek drainage, CA. The project's goal is to study juvenile coho movement and characterize how they use over-summering habitat in the drainage. This research would benefit CCC coho by providing data on habitat use and outmigration timing—information that would be used to inform habitat restoration and species recovery efforts. The fish would be dip-netted and observed during snorkel surveys. Some of the captured fish would be anesthetized, measured, weighed, PIT tagged, and tissue-sampled for genetic information. The researchers do not expect to kill any listed salmonids but a small number may die as an unintended result of the research activities.

Permit 26352

The Northwest Straits Commission is seeking a new, five-year research permit that would allow them to interact with listed fish while capturing, monitoring, and removing EGCs at multiple locations in the North Puget Sound, Washington. Though the researchers would not target listed species, they may encounter adult and juvenile PS Chinook and PS steelhead. The researchers would conduct this work in conjunction with the WDFW (under Permit 26287) and Washington Sea Grant (under Permit 26359).

The goal of the research is to determine the extent of the threat posed by the EGC invasion in the North Puget Sound in Washington State and, where possible, help mitigate it. The research would benefit listed species by monitoring, trapping, and removing individuals of an invasive species that is known to greatly damage eelgrass beds—an important habitat type upon which juvenile salmonids depend for rearing and food production. The researchers propose to use minnow traps, shrimp traps, and Fukui traps (and equivalent modifications of such traps) to capture the crabs. Trap configurations and locations would be adjusted to minimize the risk of encountering adult salmonids or hindering adult passage through main migration channels. The researchers do not propose to anesthetize, tag, sample, or kill any of the captured fish, but a small number may die as an unintended result of the trapping activities.

Permit 26359

Washington Sea Grant (WSG) is seeking a new, five-year research permit that would allow them to interact with listed fish while capturing, monitoring, and removing EGCs at several locations in Puget Sound and along the coast of Washington. Though the researchers would not target listed species, they may encounter adult and juvenile PS Chinook and PS steelhead, HCS chum, OL sockeye, and SDPS green sturgeon while sampling and removing the invasive crabs. The researchers may also encounter adult and juvenile SDPS eulachon, a species for which there are currently no take prohibitions. The WSG researchers would carry out this work in conjunction with the WDFW (under permit 26287) and the Northwest Straits Commission (under permit 26352).
The goal of the research is to determine the extent of the threat posed by the EGC invasion in Washington State and, where possible, help mitigate it. The research would benefit listed species by monitoring, trapping, and removing individuals of an invasive species that is known to greatly damage eelgrass beds—an important habitat type upon which juvenile salmonids depend for rearing and food production.

The researchers propose to use minnow traps, shrimp traps, and Fukui traps (and equivalent modifications of such traps) to capture the crabs. Trap configurations and locations would be adjusted to minimize the risk of encountering adult salmonids or hindering adult passage through main migration channels. All listed animals that may be captured would be handled only long enough to identify them to species. They would then swiftly be removed from the trap and released. The researchers do not propose to anesthetize, tag, sample, or kill any of the captured fish, but a small number may die as an unintended result of the trapping activities.

Permit 26398

The South Puget Sound Salmon Enhancement Group (SPSSEG) is seeking a new, five-year research permit that would allow them to annually take adult and juvenile PS Chinook salmon, PS steelhead, and HCS chum salmon while conducting research designed to help plan and monitor habitat restoration projects in several watersheds that drain into central and southern Puget Sound. The goals of this work are to (1) identify potential restoration sites based on fish presence, (2) investigate options to improve restoration design at planned sites, and (3) record and evaluate changes in salmon and steelhead population characteristics in response to estuarine habitat restoration actions.

The researchers propose to capture juvenile fish using electrofishing, minnow traps, beach seines, and hook and line sampling. Juvenile salmon and steelhead would be handled (anesthetized, weighed, measured, and checked for marks or tags), and released. A subset of juvenile salmon and steelhead may be PIT-tagged and have their stomach contents non-lethally sampled via gastric lavage. No adult fish would be targeted for sampling, though some may be unintentionally captured in juvenile sampling gear. The researchers do not propose to kill any fish at all but some may die as an unintended result of the 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, we determined that the proposed action of issuing 52 scientific research permits, individually or in aggregate:

- May adversely affect CC, CVS, LCR, PS, SRWR, SnkR fall, SnkR spr/sum, UCR, and UWR Chinook salmon; CR and HCS chum salmon; CCC, LCR, OC, and SONCC coho salmon; OL and SnkR sockeye salmon; LCR, UWR, MCR, PS, SnkR, UCR, CCV, CCC, and SCCC steelhead, SDPS eulachon, SDPS green sturgeon, 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 CFR402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

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

[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 2019 regulations define effects of the action using the term "consequences" (50 CFR 402.02). As explained in the preamble to the regulations (84 FR 44977), that definition does not change the scope of our analysis and in this opinion we use the terms "effects" and "consequences" interchangeably.

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

- Evaluate the rangewide status of the species and critical habitat expected to be adversely affected by the proposed action.
- Evaluate the environmental baseline of the species and critical habitat.
- Evaluate the effects of the proposed action on species and their habitat using an exposure-response approach.
- Evaluate cumulative effects.
- In the integration and synthesis, add the effects of the action and cumulative effects to the environmental baseline, and, in light of the status of the species and critical habitat, analyze whether the proposed action is likely to: (1) directly or indirectly reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species, or (2) directly or indirectly result in an alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species.
- If necessary, suggest a reasonable and prudent alternative to the proposed action.

2.2 Rangewide Status of the Species and Critical Habitat

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

Climate Change

Climate change is likely to play an increasingly important role in determining the abundance and distribution of ESA-listed species and the conservation value of designated critical habitats in the Pacific Northwest. These changes will not be spatially homogeneous across the Pacific Northwest. The largest hydrologic responses are expected to occur in basins with significant snow accumulation, where warming decreases snow pack, increases winter flows, and advances the timing of spring melt (Mote et al. 2014, Mote 2016). Rain-dominated watersheds and those with significant contributions from groundwater may be less sensitive to predicted changes in climate (Tague et al. 2013, Mote et al. 2014).

During the last century, average regional air temperatures in the Pacific Northwest increased by 1-1.4°F as an annual average, and up to 2°F in some seasons (based on average linear increase per decade; Abatzoglou et al. 2014, Kunkel et al. 2013). Warming is likely to continue during the next century as average temperatures are projected to increase another 3 to 10°F, with the largest increases predicted to occur in the summer (Mote et al. 2014). Decreases in summer precipitation of as much as 30% by the end of the century are consistently predicted across climate models (Mote et al. 2014). Precipitation is more likely to occur during October through March, less during summer months, and more winter precipitation will be rain than snow (ISAB 2007, Mote et al. 2013, Mote et al. 2014). Earlier snowmelt will cause lower stream flows in late spring, summer, and fall, and water temperatures will be warmer (ISAB 2007, Mote et al. 2014). Models consistently predict increases in the frequency of severe winter precipitation events (i.e., 20-year and 50-year events), in the western United States (Dominguez et al. 2012). The largest increases in winter flood frequency and magnitude are predicted in mixed rain-snow watersheds (Mote et al. 2014).

Overall, about one-third of the current cold-water salmonid habitat in the Pacific Northwest is likely to exceed key water temperature thresholds by the end of this century (Mantua et al. 2009). Higher temperatures will reduce the quality of available salmonid habitat for most freshwater life stages (ISAB 2007). Reduced flows will make it more difficult for migrating fish to pass physical and thermal obstructions, limiting their access to available habitat (Mantua et al. 2010; Isaak et al. 2012). Temperature increases shift timing of key life cycle events for salmonids and species forming the base of their aquatic foodwebs (Crozier et al. 2011, Tillmann and Siemann 2011, Winder and Schindler 2004). Higher stream temperatures will also cause decreases in dissolved oxygen and may also cause earlier onset of stratification and reduced mixing between layers in lakes and reservoirs, which can also result in reduced oxygen (Meyer et al. 1999, Winder and Schindler 2004, Raymondi et al. 2013). Higher temperatures are likely to cause several species to become more susceptible to parasites, disease, and higher predation rates (Crozier et al. 2008; Wainwright and Weitkamp 2013; Raymondi et al. 2013).

As more basins become rain-dominated and prone to more severe winter storms, higher winter stream flows may increase the risk that winter or spring floods in sensitive watersheds will damage spawning redds and wash away incubating eggs (Goode et al. 2013). Earlier peak stream flows will also alter migration timing for salmon smolts, and may flush some young salmon and steelhead from rivers to estuaries before they are physically mature, increasing stress and reducing smolt survival (McMahon and Hartman 1989; Lawson et al. 2004).

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

In California, average summer air temperatures are expected to increase according to modeling of climate change impacts (Lindley et al. 2007). Heat waves are expected to occur more often, and heat wave temperatures are likely to be higher (Hayhoe et al. 2004). Total precipitation in California may decline; critically dry years may increase (Lindley et al. 2007, Schneider 2007). Events of both extreme precipitation and intense aridity are projected for California, increasing climactic volatility throughout the state (Swain et al. 2018). Snow pack is a major contributor to stored and distributed water in the state (Diffenbaugh et al. 2015), but this important water source is becoming increasingly threatened. The Sierra Nevada snow pack 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 et al. 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, some models show large increases in precipitation (75 to 200 percent) while other models show decreases of 15 to 30 percent (Hayhoe et al. 2004). 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, nutrient cycling, and sedimentation (Scavia et al. 2002). In marine environments, ecosystems and habitats important to subadult and adult green sturgeon and salmonids are likely to experience changes in temperatures, circulation and chemistry, and food supplies (Feely et al. 2004, Brewer 2008, Osgood 2008, Turley 2008), 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 (Cox and Stephenson 2007).

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

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

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

2.2.1 Status of the Species

For Pacific salmon and steelhead, NMFS commonly uses four parameters to assess the 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	Limiting Factors
Puget Sound Chinook salmon	Threatened 06/28/2005 (70 FR 37160)	SSDC 2007 NMFS 2006	Ford 2022	• 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 2018a (draft)	Ford 2022	• 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 Bocaccio	Endangered 04/28/2010 (75 FR 22276)	NMFS 2017d	NMFS 2016c	• Over harvest • Water pollution • Climate-induced changes to rockfish habitat • Small population dynamics
Puget Sound/ Georgia Basin DPS of Yelloweye Rockfish	Threatened 04/28/2010 (75 FR 22276)	NMFS 2017d	NMFS 2016c	• Over harvest • Water pollution • Climate-induced changes to rockfish habitat • Small population dynamics
Hood Canal summer-run chum salmon	Threatened 06/28/2005 (70 FR 37160)	HCCC 2005 NMFS 2007	Ford 2022	• Reduced floodplain connectivity and function • Poor riparian condition • Loss of channel complexity Sediment accumulation • Altered flows and water quality
Ozette Lake sockeye salmon	Threatened 06/28/2005 (70 FR 37160)	NMFS 2009a	Ford 2022	• Predation by harbor seals, river otters, and predaceous non-native and native species of fish • Reduced quality and quantity of beach spawning habitat in Lake Ozette • Increased competition for beach spawning sites due to reduced habitat availability • Stream channel simplification and increased sediment in tributary spawning areas
Upper Columbia River spring-run Chinook salmon	Endangered 06/28/2005 (70 FR 37160)	UCSRB 2007	Ford 2022	• Effects related to hydropower system in the mainstem Columbia River • Degraded freshwater habitat • Degraded estuarine and nearshore marine habitat

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Limiting Factors
				• 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	Ford 2022	• 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 2009b	Ford 2022	• Degraded freshwater habitat • Mainstem Columbia River hydropower-related impacts • 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	Ford 2022	• 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 2017a	Ford 2022	• Loss of access to historical habitat above Hells Canyon and other Snake River dams • Operational effects of the Hells Canyon Dam Complex and the mainstem lower Snake and Columbia River dams • Mainstem temperatures • Hatchery-related effects • Degraded estuarine and nearshore habitat.
Snake River basin steelhead	Threatened 01/05/2006 (71 FR 834)	NMFS 2017b	Ford 2022	• 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 2015a	Ford 2022	• 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	Limiting Factors
Lower Columbia River Chinook salmon	Threatened 06/28/2005 (70 FR 37160)	NMFS 2013	Ford 2022	• 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 • Contaminants
Lower Columbia River coho salmon	Threatened 06/28/2005 (70 FR 37160)	NMFS 2013	Ford 2022	• 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
Lower Columbia River steelhead	Threatened 01/05/2006 (71 FR 834)	NMFS 2013	Ford 2022	• 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 2013	Ford 2022	• Degraded estuarine and nearshore marine habitat • Degraded freshwater habitat • Degraded stream flow as a result of hydropower and water supply operations • 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
Upper Willamette River Chinook salmon	Threatened 06/28/2005	ODFW and NMFS 2011	Ford 2022	• Degraded freshwater habitat • Degraded water quality

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Limiting Factors
	(70 FR 37160)			• Increased disease incidence • Altered stream flows • Reduced access to spawning and rearing habitats due to migration barriers, impaired fish passage, and increased pre-spawn mortality associated with conditions below dams • Altered food web due to reduced inputs of microdetritus • Predation by native and non-native species, including hatchery fish • Competition related to introduced races of salmon and steelhead • Altered population traits due to fisheries, bycatch, and natural origin fish interbreeding with hatchery origin fish
Upper Willamette River steelhead	Threatened 01/05/2006 (71 FR 834)	ODFW and NMFS 2011	Ford 2022	• 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	Ford 2022	• 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 2014b	Williams et al. 2016	• Lack of floodplain and channel structure • Impaired water quality • Altered hydrologic function • Impaired estuary/mainstem function • Degraded riparian forest conditions • Altered sediment supply • Increased disease/predation/competition • Barriers to migration • Fishery-related effects • Hatchery-related effects
Northern California steelhead	Threatened 6/7/2000 (65 FR 36074)	NMFS 2016a	Williams et al. 2016	• Logging and road construction altering substrate composition, increasing sediment load, and reducing riparian cover • Dams and barriers diminishing downstream habitats through altered flow regimes and gravel recruitment • Climate change

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Limiting Factors
				• 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)
California Coastal Chinook salmon	Threatened 09/16/1999 (64 FR 50394)	NMFS 2016a	Williams et al. 2016	• 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 • 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 2014a	Williams et al. 2016	• 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 2014a	Williams et al. 2016	• 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

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Limiting Factors
				• 'Natural' factors (e.g. ocean conditions)
California Central Valley steelhead	Threatened 3/19/1998 (63 FR 13347)	NMFS 2014a	Williams et al. 2016	• Major dams • Water diversions • Barriers • Levees and bank protection • Dredging and sediment disposal • Mining • Contaminants • Alien species • Fishery-related effects • Hatchery-related effects
Central California Coast coho salmon	Endangered 04/02/2012 (77 FR 19552) 06/28/2005 (70 FR 37160) Threatened 10/31/1996 (61 FR 56138)	NMFS 2012	Williams et al. 2016	• Logging • Agriculture • Mining • Urbanization • Stream modifications - including altered stream bank and channel morphology, elevated water temperature, lost spawning and rearing habitat, habitat fragmentation, impaired gravel and wood recruitment from upstream sources, degraded water quality, lost riparian vegetation, and increased erosion into streams from upland areas • Dams • Wetland loss • Water withdrawals (including unscreened diversions for irrigation)
Central California Coast steelhead	Threatened 8/18/1997 (62 FR 43937)	NMFS 2016a	Williams et al. 2016	• Dams and other barriers to migration • Stream habitat degradation • Estuarine habitat degradation • Hatchery-related effects
South-Central California Coast steelhead	Threatened 8/18/1997 (62 FR 43937)	NMFS 2014a	Williams et al. 2016	• Hydrological modifications- dams, surface water diversions, groundwater extraction • Agricultural and urban development, roads, other passage barriers • Flood control, levees, channelization • Alien species • Estuarine habitat loss • Marine environment threats • Natural environmental variability • Pesticide contaminants
Southern DPS of green sturgeon	Threatened 04/07/2006 (71 FR 17757)	NMFS 2018b	NMFS 2021a	• Reduction of its spawning area to a single known population • Impassible barriers and flood bypass systems • Altered flow and temperature regimes in the Sacramento River • Lack of water quantity

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Limiting Factors
				• Poor water quality • Poaching
Southern DPS of eulachon	Threatened 03/18/2010 (75 FR 13012)	NMFS 2017c	Gustafson et al. 2016	• 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

2.2.1.1 Puget Sound Chinook Salmon

Abundance and Productivity

The current abundance for PS Chinook salmon populations is displayed in Table___, 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*	8,280,000
Juvenile	LHAC**	26,192,500

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

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

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

Life Stage	Origin	Outmigration/Return
Adult	Natural	19,079
Adult	Hatchery	735
Juvenile	Natural	2,253,842
Juvenile	LHIA	87,500
Juvenile	LHAC	186,000

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 2018a) 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 2five 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 Boccacio 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 Boccacio Abundance (Pacunski et al. 2013).

Life Stage	Origin	Abundance
Adult	Natural	47,407

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).

Table 7. Recent Five-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
Juvenile	LHIA*	150,000

*This ESU contains no listed, adipose-fin-clipped fish.

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 Ozette Lake Sockeye Salmon

Abundance and Productivity

To estimate abundance for this ESU, we used weir counts, DIDSON sonar, spawning surveys, data from the Umbrella Creek Hatchery, and other methods. Over the last seven years (2013-2019), it was frequently the case that portions of the run were not enumerated in due to in-river conditions and technical problems. To account for this, expansion estimates and detection rate estimates were used when they could be reasonably ascertained (Ford 20220). In addition, natural spawners were calculated by subtracting the effective catch from the total run size. The effective catch is the number of fish that were removed from the natural spawning population due broodstock take (1983–present). Until 2000, all broodstock was taken from beaches. From 2000 on, the broodstock was taken from Umbrella Creek (Ford 2022).

Table 8. Recent Five-Year Geometric Means for Estimated OL Sockeye Juvenile Outmigrations and Adult Returns (Ford 2022).

Life Stage	Origin	Outmigration/Return
Adult	Natural	5,876
Adult	Hatchery	309
Juvenile	Natural	1,273,337
Juvenile	LHIA	259,250
Juvenile	LHAC	45,750

The geometric mean of abundance from 2015 to 2019 was higher than the previous five-year geometric mean, and the trend over the last 15 years has been positive. Still, there are sufficient data to determine that the total Ozette Lake abundance is well below the desired lower bound for recovery (NMFS 2009a), although the population has increased since the last review and over the past 15 years. Over the last few decades, productivity for the total Ozette Lake population has exhibited a 10–20-year cyclical pattern alternating between negative and positive values. Average rates over the last five- and 15-year periods have been slightly positive, but a negative phase could be starting.

Structure and Diversity

Ozette Lake sockeye salmon ESU comprise one historical population, with substantial sub-structuring of individuals into multiple spawning aggregations. The primary existing spawning aggregations occur in two beach locations, Allen's and Olsen's Beaches, and in two tributaries, Umbrella Creek and Big River (Ford 2022). Defining a historical baseline and assessing the current state of the spatial structure and diversity of the population is difficult due to a paucity of data. In particular, without estimates of abundance for the beach spawning aggregates, it is difficult to assess the degree to which the existing spatial structure is robust to demographic variability. This is especially important because both the abundance and distribution of the beach spawners has declined to a small percentage of historical levels. While no abundance estimates for beach spawners are available, there is relatively strong evidence for a substantial decline during the mid-to-late 2000s, when very few spawners were observed with moderate levels of survey effort. There is also some indication that run timing may have changed since the 1970s.

Currently, it appears that the Umbrella Creek hatchery program has successfully introduced a tributary spawning aggregate. This has increased the spatial and possibly genetic structure of the population while maintaining a genetic reservoir initially established with beach-spawning fish. The addition of the tributary aggregate may have increased or stabilized overall abundance, although this is not yet confirmed by the abundance trends.

Based on an evolving understanding of both the status and the uncertainty in the status of the Ozette Lake sockeye salmon beach-spawning aggregates, believe the biological risk for Ozette Lake sockeye salmon appears to have increased somewhat compared to prior reviews. Extinction risk is determined by our best prediction of the demographic probability of extinction and the uncertainty in that prediction—and more uncertainty results in higher risk. In the case of Ozette Lake sockeye salmon, the uncertainty is high enough that it is not possible to rule out further decline in the VSP parameters over the next couple of decades, which would increase overall risk.

Overall, the Ozette Lake sockeye salmon ESU therefore has mixed viability trends, and is likely at "moderate-to-high" risk of extinction.

2.2.1.6 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 (2016-2020) by using annual abundance estimates provided by the NWFSC (Zabel 2017a, 2017b, 2018, 2020, 2021). 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, PIT-tag studies, and some dam 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 9. Recent Five-Year Geometric Means for Estimated UCR Chinook Juvenile Outmigrations and Adult Returns (Ford 2022; Zabel 2017a, 2017b, 2018, 2020, 2021).

Life Stage	Origin	Outmigration/Return
Adult	Natural	813
Adult	Hatchery	1,140
Juvenile	Natural	518,360
Juvenile	LHIA	443,774
Juvenile	LHAC	591,769

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.

2.2.1.7 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 (2016-2020) by using annual abundance estimates provided by the NWFSC (Zabel 2017a, 2017b, 2018, 2020, 2021). 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 10. Recent Five-Year Geometric Means for Estimated UCR Steelhead Juvenile Outmigrations and Adult Returns (Ford 2022; Zabel 2017a, 2017b, 2018, 2020, 2021).

Life Stage	Origin	Outmigration/Return
Adult	Natural	1,465
Adult	Hatchery	2,893
Juvenile	Natural	161,936
Juvenile	LHIA	132,453
Juvenile	LHAC	743,457

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.

2.2.1.8 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 (2016-2020) by using annual abundance estimates provided by the NWFSC (Zabel 2017a, 2017b, 2018, 2020, 2021). 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, radio-tag studies, PIT-stag studies, 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 11. Recent Five-Year Geometric Means for Estimated MCR Steelhead Juvenile Outmigrations and Adult Returns (Ford 2022; Zabel 2017a, 2017b, 2018, 2020, 2021).

Life Stage	Origin	Outmigration/Return
Adult	Natural	13,598
Adult	Hatchery	713
Juvenile	Natural	375,923
Juvenile	LHIA	115,610
Juvenile	LHAC	432,003

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.

2.2.1.9 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 (2016-2020) by using annual abundance estimates provided by the NWFSC (Zabel 2017a, 2017b, 2018, 2020, 2021). 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, parental-based-tagging, redd counts, weir 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 Spr/sum Chinook Juvenile Outmigrations and Adult Returns (Ford 2022; Zabel 2017a, 2017b, 2018, 2020, 2021).

Life Stage	Origin	Outmigration/Return
Adult	Natural	4,557
Adult	Hatchery	2,822
Juvenile	Natural	822,632
Juvenile	LHIA	728,543
Juvenile	LHAC	4,747,112

The most recent five-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.

2.2.1.10 Snake River Fall-run Chinook Salmon

Abundance and Productivity

To estimate abundance of juvenile natural and hatchery SnkR fall Chinook, 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 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 13. Recent Five-Year Geometric Means for Estimated SnkR Fall Chinook Juvenile Outmigrations and Adult Returns (Ford 2022; Zabel 2017a, 2017b, 2018, 2020, 2021).

Life Stage	Origin	Outmigration/Return
Adult	Natural	7,262
Adult	Hatchery	14,879
Juvenile	Natural	742,699
Juvenile	LHIA	2,954,366
Juvenile	LHAC	2,570,139

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

2.2.1.11 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 (2016-2020) by using annual abundance estimates provided by the NWFSC (Zabel 2017a, 2017b, 2018, 2020, 2021). 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 14. Recent Five-Year Geometric Means for Estimated SnkR Steelhead Juvenile Outmigrations and Adult Returns (Ford 2022; Zabel 2017a, 2017b, 2018, 2020, 2021).

Life Stage	Origin	Outmigration/Return
Adult	Natural	10,796
Adult	Hatchery	3,292
Juvenile	Natural	790,184
Juvenile	LHIA	496,078

Life Stage	Origin	Outmigration/Return
Juvenile	LHAC	3,135,597

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 1five 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.

2.2.1.12 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 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, weir counts, spawning surveys, 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). In addition, there are no LHIA juvenile fish in this ESU because all hatchery fish have their adipose fins clipped.

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

Life Stage	Origin	Outmigration/Return
Adult	Natural	16
Adult	Hatchery	97
Juvenile	Natural	19,047
Juvenile	LHAC*	271,029

*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 Snake River sockeye salmon ESU therefore has likely declined since the time of the last review, and the extinction risk remains very high.

2.2.1.13 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 (2016-2020) by using annual abundance estimates provided by the NWFSC (Zabel 2017a, 2017b, 2018, 2020, 2021). 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 16. Recent Five-Year Geometric Means for Estimated LCR Chinook Juvenile Outmigrations and Adult Returns (Ford 2022; Zabel 2017a, 2017b, 2018, 2020, 2021).

Life Stage	Origin	Outmigration/Return
Adult	Natural	29,298
Adult	Hatchery	20,217
Juvenile	Natural	1,1216,357
Juvenile	LHIA	857,117
Juvenile	LHAC	30,973,516

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 (Dornbusch 2013), 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.

2.2.1.14 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 (2016-2020) by using annual abundance estimates provided by the NWFSC (Zabel 2017a, 2017b, 2018, 2020, 2021). 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).

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

Life Stage	Origin	Outmigration/Return
Adult	Natural	18,714
Adult	Hatchery	15,949
Juvenile	Natural	776,286
Juvenile	LHIA	267,649
Juvenile	LHAC	7,626,390

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 them, 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 Lower Columbia River coho salmon ESU remains at moderate risk, and viability is largely unchanged from the last status review.

2.2.1.15 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 (2016-2020) by using annual abundance estimates provided by the NWFSC (Zabel 2017a, 2017b, 2018, 2020, 2021). 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 prespawn holding (Ford 2022).

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

Life Stage	Origin	Outmigration/Return
Adult	Natural	8,152
Adult	Hatchery	6,382
Juvenile	Natural	371,241
Juvenile	LHIA	15,223
Juvenile	LHAC	1,178,520

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).

2.2.1.16 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 (2016-2020) by using annual abundance estimates provided by the NWFSC (Zabel 2017a, 2017b, 2018, 2020, 2021). 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-stag studies, redd counts, and other methods (Ford 2022).

Table 19. Recent Five-Year Geometric Means for Estimated CR Chum Juvenile Outmigrations and Adult Returns (Ford 2022; Zabel 2017a, 2017b, 2018, 2020, 2021).

Life Stage	Origin	Outmigration/Return
Adult	Natural	17,699
Adult	Hatchery	751
Juvenile	Natural	7,533,081
Juvenile	LHIA*	523,500

*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 that 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 of 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.

2.2.1.17 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 (2016-2020) by using annual abundance estimates provided by the NWFSC (Zabel 2017a, 2017b, 2018, 2020, 2021). 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, comprehensive spawner surveys, radio-tag studies, PIT-stag studies, redd counts, genetic/pedigree studies, and other methods (Ford 2022).

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

Life Stage	Origin	Outmigration/Return
Adult	Natural	6,914
Adult	Hatchery	25,275
Juvenile	Natural	1,164,252
Juvenile	LHIA	0
Juvenile	LHAC	4,547,100

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 (NMFS 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, is 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.

2.2.1.18 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 (2016-2020) by using annual abundance estimates provided by the NWFSC (Zabel 2017a, 2017b, 2018, 2020, 2021). 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 21. Recent Five-Year Geometric Means for Estimated UWR Steelhead Juvenile Outmigrations and Adult Returns (Ford 2022; Zabel 2017a, 2017b, 2018, 2020, 2021).

Life Stage	Origin	Outmigration/Return
Adult	Natural	2,628
Adult	Hatchery	*
Juvenile	Natural	136,980

*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 (NMFS and ODFW 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 2008), 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).

2.2.1.19 Oregon 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 (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).

Table 22. Recent Five-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, Alsea, 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 Oregon Coast coho salmon return (355,600 wild and hatchery spawners) was the highest since at least the 1950s (2011 was the second highest with 352,200; ODFW 2015), 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 Oregon Coast coho salmon (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 be 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 (NMFS 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 Oregon coast coho salmon ESU is therefore at moderate-to-low risk of extinction, with viability largely unchanged from the most recent review.

2.2.1.20 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 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. 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 23. Recent Five-Year Geometric Means for Estimated SONCC coho Juvenile Outmigrations and Adult Returns (SWFSC 2022[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 2022). 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.

2.2.1.21 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 where 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. 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 24. 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 (2021) 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.

2.2.1.22 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 (Williams et al. 2021). 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.

Table 25. Recent Five-Year Means for Estimated CCC Chinook Adult Returns and Estimated Juvenile Outmigrations (Williams et al. 2021).

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 (Williams et al. 2021).

2.2.1.23 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 (Williams et al. 2021). 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 (Williams et al. 2021), 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 Sacramento River winter-run Chinook salmon 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 (NMFS 2022). 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 26. Recent Five-Year Means for Estimated SRWR Chinook Adult Returns and Estimated Juvenile Outmigrations (Williams et al. 2021, NMFS 2022).

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 (Williams et al. 2021). 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 (Williams et al. 2021), and therefore does not indicate long-term improvements.

Structure and Diversity

The Sacramento River winter-run Chinook salmon 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 (Williams et al. 2021). 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 (Williams et al. 2021).

In addition to limited spatial structure, this ESU is also highly dependent on the hatchery-origin fish produced by the LSNFH (Williams et al. 2021). 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 (Williams et al. 2021).

2.2.1.24 Central Valley Spring-run Chinook Salmon

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 (Williams et al. 2021). The Feather River Hatchery (FRH) is the only hatchery that produces Central Valley spring-run Chinook salmon (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 (Williams et al. 2021, Table 27).

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.

Table 27. Recent Three-Year Means for Estimated CVS Chinook Adult Returns and Estimated Juvenile Outmigrations (Williams et al. 2021).

Life Stage	Origin	Outmigration/Return
Adult	Natural	6,756
Adult	Hatchery	2,083

Life Stage	Origin	Outmigration/Return
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 (Williams et al. 2021). 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 (Williams et al. 2021). Most dependent spring-run populations have been experiencing continued and, in some cases, drastic declines (Williams et al. 2021).

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 (Williams et al. 2021). 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 (Williams et al. 2021). 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 (Williams et al. 2021). 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).

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, all within four distinct geographic regions, or diversity groups (Lindley et al. 2004). Of these 18 populations, only three populations currently exist (Mill, Deer, and Butte creeks, which are tributary to the upper Sacramento River) and they represent only the northern Sierra Nevada diversity group.

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 this ESU. 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 (California HSRG 2012; Huber and Carlson 2015; Palmer-Zwahlen et al. 2019; Sturrock et al. 2019).

2.2.1.25 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 (Williams et al. 2021). 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.

Table 28. Recent Three-Year Means for Estimated CCV Steelhead Adult Returns and Estimated Juvenile Outmigrations (Williams et al. 2021).

Life Stage	Origin	Outmigration/Return
Adult	Natural and Hatchery	11,494
Juvenile	Natural	1,307,442
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).

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 (Williams et al. 2021). 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 2021).

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 (Williams et al. 2021). 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 (Williams et al. 2021).

2.2.1.26 Central California Coast Coho Salmon

To estimate annual abundance of adult spawners (natural- and hatchery-origin), we calculate the geometric mean of the most recent years of adult spawner estimates, as reported in SWFSC (2022). Population estimates are based on redd counts from surveys of stream reaches selected according to a Generalized Randomized Tessellation Survey (GRTS) design. Redd counts are then expanded to adult estimates based on spawner:redd ratios estimated at a network of life cycle monitoring (LCM) stations (SFWSC 2022).

Table 29. Geometric Means for Estimated CCC Coho Adult Returns, Estimated Juvenile Outmigrations, and Target Annual Hatchery Releases (SWFSC 2022, CDFW 2020).

Life Stage	Origin	Outmigration/Return
Adult	Natural and hatchery	2,308
Juvenile	Natural	161,560
Juvenile	LHIA	140,000

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, including the Russian River hatchery returns which are allowed to spawn in the wild) to this ESU, one may expect approximately 2.3 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 Central California Coast ESU produces 161,560 juvenile coho salmon annually (Table 29). The CCC coho salmon ESU includes three artificial propagation programs (79 FR 20802), and the combined minimum annual target for hatchery releases for CCC coho salmon is 140,000 LHIA juveniles.

Available data for CCC coho salmon populations indicate that all remain far below recovery targets for abundance (SWFSC 2022). In recent years there have been slight improvements in the abundance of populations in the Lost Coast—Navarro Point and Navarro Point—Gualala Point strata at the northern end of the species' range. However, in the Coastal diversity stratum there has been little change in abundance since the last 5-year status review, and is possibly declining in the Santa Cruz Mountain stratum, although assessment of both of these strata is difficult due to the scarcity of reliable data and how rarely CCC coho salmon are observed in these areas (SWFSC 2022).

Structure and Diversity

The current viability of populations is progressively worse moving north to south in the ESU (SWFSC 2022). While abundance trends appear to be increasing in the Lost Coast diversity stratum and remained stable in the Navarro Point diversity stratum, the already-small population sizes have not improved in the Coastal stratum since 2016. In the Santa Cruz Mountain stratum, natural production of coho salmon is extremely low. In this stratum observations of adult coho salmon are rare in the two historically independent populations, and all dependent populations are either extirpated or at critically low levels. Population persistence in this stratum is also highly dependent on the ongoing captive rearing program, and there has been a loss of genetic diversity in the hatchery broodstock, which necessitated the incorporation of out-of-stratum broodstock into the program. The loss of genetic diversity in this stratum and risk of very low abundance population in this stratum being lost to the ESU negatively affect the diversity and spatial structure of this ESU.

2.2.1.27 Central California Coast Steelhead

Abundance and Productivity

Data for both adult and juvenile abundance are limited for this DPS. Moreover, the record is inconsistent with either no fish being observed or no surveys being conducted in some years. Due to the inconsistency of the record, we have used a 5-year average as an estimate for abundance (2015-2019)(CDFW 2020, Williams et al. 2021). While we currently lack data on naturally produced juvenile CCC steelhead, it is possible to make rough estimates of juvenile abundance from the available adult return data. For steelhead, fecundity estimates range from 3,500 to 12,000; 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 –

953 females), roughly 3.3 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 over 216 thousand natural outmigrants annually. In addition, hatchery managers could produce 520,000 listed hatchery juvenile CCC steelhead each year given hatchery release targets.

Table 30. Recent Five-Year Means for Estimated CCC Steelhead Adult Returns and Estimated Juvenile Outmigrations (Williams et al. 2021).

Life Stage	Origin	Outmigration/Return
Adult	Natural and hatchery	1,906
Juvenile	Natural	216,808
Juvenile	LHAC	520,000

The scarcity of information on steelhead abundance in the CCC Steelhead DPS continues to make it difficult to assess trends in abundance and productivity (Williams et al. 2021). Population-level estimates of adult abundance are entirely lacking for the 25 independent populations in the North Coastal, Interior, Coastal San Francisco Bay, and Interior San Francisco Bay diversity strata identified as essential or supporting in the DPS. A few survey efforts that are targeting coho salmon do collect data on steelhead as well, but generally, surveys do not encompass the entire spawning space of season for steelhead. The implementation of the Coastal Monitoring Plan (CMP) in the Russian River basin has improved our understanding of the overall abundance of steelhead in the watershed, providing basin-wide estimates of abundance of steelhead (combined natural and hatchery-origin) that have ranged from about 800–2,000 over three years, but as population estimates are not produced for individual populations within the basin, direct comparison with recovery targets is not yet possible. Spawner surveys and rotary screw trapping in recent years in selected portions of the Napa River watershed confirm the continued occurrence of steelhead in this watershed, however, there is insufficient data to determine if the population has increased or decreased since the previous status review. Likewise, limited spawner surveys in selected tributaries of the Petaluma River confirmed steelhead presence very small numbers in the watershed, but do not allow conclusions to be drawn about current viability.

Implementation of the CMP in the Santa Cruz Mountain stratum has been intermittent, and difficulties in assigning redds to species (steelhead versus coho) confound interpretation of these data. Scott Creek remains the only population for which robust estimates are available for more than a few years, and while the population appeared to be declining, a sizable return in 2018-2019 indicates that the population is somewhat resilient (Williams et al. 2021). Populations in the San Lorenzo River and Pescadero Creek appear to typically number in the low hundreds of fish, while other independent populations appear to number in the tens of fish. Two dependent populations (Gazos and San Vicente creeks) likewise appear to number in the tens of fish in most years, with considerable variation in numbers among years. Though uncertainty remains high for nearly all of these populations, it is clear that they are well below recovery targets.

Structure and Diversity

All steelhead in the CCC steelhead DPS are winter-run fish. Bjorkstedt et al. (2005) described the CCC steelhead DPS as historically comprised of 37 independent populations and perhaps 30 or more smaller dependent populations of winter-run steelhead. These populations were placed in five geographically based diversity strata (Bjorkstedt et al. 2005; modified in Spence et al. 2008). Most of the coastal populations are assumed to be extant, however many of the Coastal San Francisco Bay and Interior San Francisco Bay populations are likely at high risk of extirpation due to the loss of historical spawning habitat and the heavily urbanized nature of these watersheds (Williams et al. 2011).

Hatchery programs can provide short-term demographic benefits, such as increases in abundance, during periods of low natural abundance. They also can help preserve genetic resources until limiting factors can be addressed. However, the long-term use of artificial propagation can pose a risk to natural productivity and diversity. The Russian River monitoring program has provided quantitative evidence that hatchery-origin steelhead constitute roughly 50% of all fish on natural spawning grounds and that these hatchery fish are being observed throughout the basin. Thus, concerns expressed in the recent status review update about potential genetic consequences of interbreeding between hatchery and wild fish appear well-founded (Williams et al. 2021).

Importantly, this monitoring program has provided quantitative evidence that hatchery-origin steelhead constitute roughly 50% of all fish on natural spawning grounds and that these hatchery fish are being observed throughout the basin. Thus, concerns expressed in prior status reviews about potential genetic consequences of interbreeding between hatchery and wild fish (Williams et al. 2011) appear well founded. Population-level estimates of abundance are non-existent for any populations in the Interior and Coastal San Francisco Bay stratum, thus, the status remains highly uncertain, though it is likely that many populations where historical habitat is now inaccessible due to dams and other passage barriers are likely at high risk of extinction.

2.2.1.28 South-Central California Coast Steelhead

Abundance and Productivity

Data for both adult and juvenile abundance are limited for this DPS. In addition, 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 (2015-2019)(CDFW 2020). While we currently lack data on naturally produced juvenile SCCC steelhead, it is possible to make rough estimates of juvenile abundance from the available adult return data. For steelhead, fecundity estimates range from 3,500 to 12,000; 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 natural-origin spawners – 98 females), roughly 340 thousand 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 22,295 natural outmigrants annually. There are no hatchery components of this DPS.

Table 31. Recent Five-Year Geometric Means for Estimated SCCC Steelhead Juvenile Outmigrations and Adult Returns Williams et al. 2021).

Life Stage	Origin	Outmigration/Return
Adult	Natural	196
Juvenile	Natural	22,295

Data on abundance of adult steelhead and fish density indicate that the recent drought had very large negative impacts on this DPS, with generally negative trends observed in all indicators, most with statistical significance (Williams et al. 2021). However, since the end of the drought in 2017 all indicators of abundance have improved, suggesting that O. mykiss populations have persisted in drought refugia (e.g., lower Pajaro River tributaries, the upper Carmel River, the Big Sur Coast) and are now recovering from the drought. Yet the size of steelhead runs is still extremely low, and the mean fish densities for the past four years are still below the provisional viability criterion of 0.3 fish/m2 (Williams et al. 2021). While monitoring of status and trends continues to be insufficient in this DPS, a draft plan to update the monitoring strategy is in progress.

Spatial Structure and Diversity

The SCCC steelhead DPS consists of 12 discrete sub-populations representing localized groups of interbreeding individuals. Most of these sub-populations are characterized by low population abundance, variable or negative population growth rates, and reduced spatial structure and diversity. In 2002, NMFS surveyed 36 watersheds and found that between 86 and 94 percent of the historic watersheds were still occupied. Also, occupancy was determined for 18 watershed basins with no historical record of steelhead (NMFS 2012b).

Although steelhead are present in most of the streams in the SCCC DPS (Good et al. 2005), their populations remain small, fragmented, and unstable (more subject to stochastic events) (Boughton et al. 2006). In addition, severe habitat degradation and the compromised genetic integrity of the some populations pose a serious risk to the survival and recovery of the S-CCC steelhead DPS (Good et al. 2005). The sub-populations in the Pajaro River and Salinas River watersheds are in particularly poor condition (relative to watershed size) and exhibit a greater lack of viability than many of the coastal populations.

2.2.1.29 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 2017). In addition, WDFW has retrospectively estimated historical SSB in the Columbia River for 2000–2010 using pre-2011 expansions of eulachon larval densities (Gustafson et al 2016). Spawning stock biomass estimates have also been collected for the Fraser River since 1995 (DFO 2022). There are currently no additional data available for abundance trends in other watersheds, and at this time, there are not sufficient data to develop viability criteria or assess the productivity of this DPS (NMFS 2017).

In recent years, abundance estimates of Southern eulachon in the Columbia River have fluctuated from a low of just over 4 million in 2018 to over 96 million in 2021. The geometric mean spawner abundance over the past 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 2016 through 2020 have ranged from a low of an estimated 861,125 fish in 2017 to a high of 15,352,621 fish in 2020 (DFO 2022, estimate based on report weight assuming 11.16 fish per pound).

Table 32. Southern DPS eulachon spawning stock biomass survey estimates (Langness et al. 2020, DFO 2021).

		Fraser River
Year	**Columbia River (mean)**	**Fraser River (mean)**
2017	18,307,100	
2018	4,100,000	
2019	46,684,765	
2020[a,b]	21,280,000	
2021[b]	96,395,712	
2017-2021[c]	**23,513,733**	

[a] Abbreviated estimate; sampling stopped mid-March of 2020
[b] Data are provisional and subject to change
[c] Five-year geometric mean of mean eulachon biomass estimates (2017-2021)

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 2017). We currently do not have the data necessary to determine whether eulachon are one large metapopulation, or comprised of multiple demographically independent populations. Therefore, we consider the four subpopulations identified by the BRT (i.e., Klamath River, Columbia River, Fraser River, and British Columbia coastal rivers) as the minimum set of populations comprising the DPS. Large, consistent spawning runs of eulachon have not been documented in Puget Sound river systems, and therefore eulachon spawning in these watersheds are not considered part of an independent subpopulation. However, eulachon have been observed regularly in many Washington rivers and streams, as well as Puget Sound (Monaco et al. 1990, Willson et al. 2006; as cited in Gustafson et al. 2010).

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

Threats and Limiting Factors

The greatest threat identified to the persistence of southern DPS eulachon was climate change impacts on ocean conditions (Gustafson et al 2016, NMFS 2017). 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 2017). 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 2017), 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 (Table 32). 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 2017).

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 2017). 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 2017). 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 southern DPS eulachon (NMFS 2017).

2.2.1.30 SDPS Green Sturgeon

Green sturgeon are composed of 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 33).

Table 33. 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	
		25th Percentile	75th Percentile
Total DPS	17,723[a]	6,761	37,891
Juvenile	4,431		
Sub-adult	11,165		
Adult	2,127		

[a]Median 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 Southern DPS 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 Southern DPS 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 Southern DPS 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 Southern DPS 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 Southern DPS 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 34, below.

Table 34. Critical habitat, designation date, federal register citation, and status summary for critical habitat considered in this opinion.

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
Puget Sound Chinook salmon	09/02/2005 70 FR 52630	Critical habitat for Puget Sound Chinook salmon includes 1,683 miles of streams, 41 square mile of lakes, and 2,182 miles of nearshore marine habitat in Puget Sounds. The Puget Sound Chinook salmon ESU has 61 freshwater and 19 marine areas within its range. Of the freshwater watersheds, 41 are rated high conservation value, 12 low conservation value, and eight received a medium rating. Of the marine areas, all 19 are ranked with high conservation value. Primary constitute elements relevant for this consultation include: 1) Estuarine areas free of obstruction with water quality and aquatic vegetation to support juvenile transition and rearing; 2) Nearshore marine areas free of obstruction with water quality conditions, forage, submerged and overhanging large wood, and aquatic vegetation to support growth and maturation; 3) Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.
Puget Sound steelhead	02/24/2016 81 FR 9252	Critical habitat for Puget Sound steelhead includes 2,031 stream miles. Nearshore and offshore marine waters were not designated for this species. There are 66 watersheds within the range of this DPS. Nine watersheds received a low conservation value rating, 16 received a medium rating, and 41 received a high rating to the DPS.
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.
HCS chum	09/02/2005 70 FR 52630	Critical habitat for HCS chum 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.
Ozette Lake sockeye salmon	09/02/2005 70 FR 52630	Critical habitat is comprised of a single subbasin containing a single watershed, Ozette Lake Subbasin located in Clallam County, Washington. It encompasses approximately 101 mi^2 and

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
		approximately 317 miles of streams; Ozette Lake, the dominant feature of the watershed, is entirely located within the Olympic National Park. The known beach spawning areas, and three tributaries used by sockeye salmon for spawning, incubation, and migration, are encompassed as part of critical habitat for the listed species. Beach spawning is degraded by historical sediment loading, disrupted hydrology, and encroachment of riparian vegetation. Streams supporting spawning, rearing, and migration are impaired by lack of large wood, excessive fine sediment levels (Big River), and mammalian predation.
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 temporary elevated water temperatures and sediment loads that could restrict sockeye salmon production and survival (NMFS 2015a). Migratory habitat quality in this area has

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
		been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Lower Columbia River Chinook salmon	09/02/2005 70 FR 52630	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 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)
Southern Oregon/Northern	05/05/1999 64 FR 24049	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

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
California Coast coho salmon		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
Northern California steelhead	9/2/2005 70 FR 52488	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.
California Coastal Chinook salmon	09/02/2005 70 FR 52488	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.
Sacramento River winter-run Chinook salmon	06/16/1993 58 FR 33212 Modified 03/23/1999 64 FR 14067	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.
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 freshwater 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 that 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

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
		entities resulting in slightly improved conditions in some areas and a slowing of the negative trend.
Central California Coast coho salmon	05/05/1999 64 FR 24049	Critical habitat encompasses accessible reaches of all rivers (including estuarine areas and tributaries) between Punta Gorda and the San Lorenzo River (inclusive) in California, including two streams entering San Francisco Bay: Arroyo Corte Madera Del Presidio and Corte Madera Creek. Critical habitat includes all waterways, substrate, and adjacent riparian zones below longstanding, naturally impassable barriers (i.e., natural waterfalls in existence for at least several hundred years). NMFS has identified several dams in the CCC coho salmon critical habitat range that currently block access to habitats historically occupied by coho salmon. However, NMFS has not designated these inaccessible areas as critical habitat because the downstream areas are believed to provide sufficient habitat for conserving the ESUs. 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.
Central California Coast steelhead	9/2/2005 70 FR 52488	There are approximately 1,465 miles of stream habitats and 386 square miles of estuary habitats designated as critical habitat for CCC steelhead. NMFS determined that marine areas did not warrant consideration as critical habitat for this DPS. CCC steelhead PBFs are sites and habitat components which support one or more life stages including freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, and nearshore marine areas. There are 46 watersheds within the range of this DPS. For conservation value to the DPS, fourteen watersheds received a low rating, 13 received a medium rating, and 19 received a high rating. Since designation, critical habitat for this species continues to be degraded by several factors listed in the status section. Nonetheless, a number of restoration efforts have been undertaken by local, state, and Federal entities to improve conditions in some areas and slow the negative trend.
South-Central California Coast steelhead	9/2/2005 70 FR 52488	There are approximately 1,249 miles of stream habitats and three square miles of estuary habitats designated as critical habitat for S-CCC steelhead. NMFS determined that marine areas did not warrant consideration as critical habitat for this DPS. S-CCC steelhead PBFs are sites and habitat components which support one or more life stages including freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, and nearshore marine areas. There are 30 watersheds within the range of this DPS. For conservation value to the DPS, six watersheds received a low rating, 11 received a medium rating, and 13 received a rated high. Morro Bay, an estuarine habitat, is used as rearing and migratory habitat for spawning and rearing steelhead. S-CCC steelhead inhabit coastal river basins from the Pajaro River south to, but not including, the Santa Maria River. Major watersheds include Pajaro River, Salinas River, Carmel River, and numerous smaller rivers and streams along the Big Sur coast and southward. Only winter-run steelhead are found in this DPS. The climate is drier and warmer than in the north that is reflected in vegetation changes from coniferous forests to chaparral and coastal scrub. The mouths of many rivers and streams in this DPS are seasonally closed by sand berms that form during the low stream flows of summer. Since designation, critical habitat for this species continues to be degraded by several factors listed in the status section Nonetheless, a number of restoration efforts have been undertaken by local, state, and Federal entities to improve conditions in some areas and slow 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

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
		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 bays and estuaries, as well as the growth and reproductive health of Southern DPS 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).

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, SDPS green sturgeon, SDPS eulachon, and steelhead in all sub-basins of the Pacific Northwest (Washington, Oregon, Idaho) and California (except for those reaches used solely by southern California steelhead). Additionally, the action area includes some marine waters off the West Coast of the contiguous United States (including nearshore waters, from California to the Canadian border and Puget Sound) accessible to listed Chinook salmon, chum salmon, coho salmon, sockeye salmon, steelhead, eulachon, green sturgeon, and rockfish.

Where it is possible to narrow the range of the research, the effects 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. It is also discontinuous. That is, there are large areas in between the various actions’ locations where listed salmonids, sturgeon, eulachon, rockfish, etc., do exist, but where they would not be affected to any degree by any of the proposed activities. As noted earlier, the proposed actions could affect the killer whales’ prey base (Chinook salmon) and those effects are described in the Not Likely to Adversely Affect section (2.11).

In most cases, the proposed research activities would take place in individually very small sites. For example, the researchers might electrofish a few hundred feet of river, deploy a beach seine covering only a few hundred square feet of stream, or operate a screw trap in a few tens of square feet of habitat. Many of the proposed research activities would take place in designated critical habitat. More detailed habitat information (i.e., migration barriers, physical and biological habitat features, and special management considerations) for species considered in this opinion may be found in the Federal Register notices designating critical habitat (Table 34).

2.3.1. Action Areas for the Individual Permits

Permit 1127-6M – 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, another adult weir in the upper Yankee Fork of the Salmon River, and a final adult weir in the East Fork of the Salmon River. The minimally intrusive nature of the proposed activities is such that they are not expected to have any appreciable downstream effects.

Permit 1135-11R—The proposed activities would take place in Trout Creek and the Wind River upstream from Carson National Fish Hatchery in Washington State. The work would concentrate on the headwaters and upper subbasins of both water bodies. The minimally intrusive nature of the proposed activities (electrofishing) is such that they are not expected to have any appreciable downstream effects.

Permit 1175-10R—The proposed activities could take place in any of the rivers and streams found on the Gifford-Pinchot National Forest. Because the activities would be conducted in response to shifting land management decisions and plans, we cannot be more precise than that. In any given year, the proposed survey activities could take place in the subbasins of the Wind, Little White Salmon, Big White Salmon, Lewis, Cowlitz, Washougal, Deschutes or Puyallup Rivers. Based on previous evaluations of the proposed activities, we do not expect that the research would have any downstream effects.

Permit 1339-6R—The proposed activities would take place in portions of three states—Oregon, Washington, and Idaho—and four river subbasins: The Clearwater, Grande Ronde, Imnaha and Lower Snake Rivers. The activities would shift somewhat from year to year and could cover well over a dozen tributaries to those river systems in any particular sample season. In addition, some activities would take place that the Lower Granite Dam adult trap. The minimally intrusive nature of the proposed activities is such that they are not expected to have any appreciable downstream effects.

Permit 1341-6R—The proposed activities would take place at Pettit and Alturas Lakes in Idaho and two small locations in their outlet creeks (Pettit and Alturas Creeks). The sampling, which would be done by screw trap and adult weir, is not expected to have any appreciable downstream effects.

Permit 1345-10R—The proposed activities could take place in essentially any of the waters of Western Washington State at any time. All major lakes, rivers, and tributaries in Washington in the Puget Sound and Lower Columbia River regions could be subject to sampling in any given year. The net-based and electrofishing sampling activities are not expected to generate any appreciable downstream effects.

Permit 1379-8R—The proposed activities would take place at (a) Wells Dam on the Columbia River, (b) Priest Rapids Dam on the Columbia River, (c) Lake Wenatchee in Washington State, and (d) the Hanford Reach of the Columbia River between river miles 345 and 396. The proposed sampling techniques and locations are such that no downstream effects are expected.

Permit 1386-10R—The proposed activities would take place in streams and tributaries throughout the state of Washington. In any given year, any state waterbody could be sampled by means that are not expected to generate any downstream effects.

Permit 1410-13M—The proposed activities would take place in the Pacific Ocean off Oregon and Washington from nearshore out to 50 miles off the coast of Washington near Cape Flattery, La Push, Queets River, Grays Harbor, and Willapa Bay, and off the coast of Oregon near the Columbia River, Cape Meares, Cascade Head, and Newport, Oregon.

Permit 1465-5R—The proposed activities would take place throughout the Salmon and Clearwater River basins in Idaho State. The researchers may sample mainstem and/or tributary habitat in either of those basins (or both) in any given year; they would use techniques that are not expected to generate any downstream effects.

Permit 1564-6R—The proposed activities would take place in the Duwamish River estuary from tidal reaches downstream to Elliott Bay, Washington.

Permit 1586-5R—The proposed activities would take place at sites in littoral and nearshore pelagic zones per basin within Whidbey Basin, North Puget Sound (focused in San Juan Islands), Central and South Puget Sound, and from Discovery Bay west to Freshwater Bay in the Strait of Juan de Fuca, Washington.

Permit 1587-7R—The proposed activities would take place at sites in marine waterways and inlets of the Straits of Juan de Fuca, Skagit Bay and Skagit River delta, Admiralty Inlet, North Puget Sound, San Juan Islands, Bellingham Bay, Samish Bay, and the Nisqually River delta, Washington.

Permit 1598-5R—The proposed activities could take place in any stream adjacent to any highway project in the State of Washington. The yearly sampling would be conducted purely in response to highway project requirements and there is no way to predict where it would be necessary in any given year. Based on previous evaluations of the proposed activities, we do not expect that the research would have any downstream effects.

Permit 10093-3R—The proposed activities would take place across a broad geographic area in coastal watersheds throughout the state of California.

Permit 13381-4R—The proposed activities would take place (a) at Little Goose and/or Lower Monumental Dams on the Snake River and (b) in up to 16 rivers streams in the Snake River Basin (primarily in the Salmon River subbasin) in Idaho State. The proposed sampling techniques are such that no downstream effects are expected.

Permit 13382-4R—The proposed activities would take place in multiple streams in the Snake River Basin. The streams are primarily located in Northeast Oregon and the Salmon River subbasin in Idaho, but in any given year, some sampling could take place in Southeast Washington as well. The proposed sampling techniques are such that no downstream effects are expected.

Permit 14419-4R —The proposed activities would take place in the streams throughout the Russian River watershed, CA.

Permit 15542-6R —The proposed activities would take place in Lower Putah Creek in the lower Sacramento River basin, CA.

Permit 15548-2R—The proposed activities would take place in Suisun Creek, Green Valley Creek, and Ledgewood Creek in Solano and Napa Counties, CA.

Permit 15848-3R—The proposed activities would take place at fixed index station locations a minimum of six sites in northern Puget Sound, Strait of Juan de Fuca, Admiralty Inlet, Hood Canal, the Whidbey Basin, and southern Puget Sound, Washington.

Permit 15890-3R—The proposed activities would take place at fixed transects throughout northern Puget Sound, the Strait of Juan de Fuca, Admiralty Inlet, Hood Canal, the Whidbey Basin, and southern Puget Sound, Washington.

Permit 16021-3R—The proposed activities would take place at a variety of locations selected based on known distribution of target (non-ESA) species, their seasonal movements, and their association with specific habitat types, depths, and currents throughout Puget Sound, Washington.

Permit 16069-4R—The proposed activities would take place from river mile 0 to river mile 19 in the Willamette River (Oregon) and from river mile 101 to river mile 103 in the Columbia River (i.e., the lower Columbia River slough). The proposed sampling techniques are such that no appreciable downstream effects are expected.

Permit 16091-3R—The proposed activities would take place at a variety of locations throughout waters east of Cape Flattery including the Straits of Juan de Fuca and Georgia, the San Juan Islands, Hood Canal, the Whidbey Basin, and the central and southern basins of Puget Sound, Washington.

Permit 16318-4R—The proposed activities would take place in streams throughout Santa Cruz, Monterey, and San Luis Obispo counties, CA.

Permit 16521-3R—The proposed activities would take place in the mainstem Columbia River from the Tri-Cities (Washington) upstream to Priest Rapids Dam (i.e., from river mile 326 to river mile 397). The net-based and electrofishing sampling activities are not expected to generate any appreciable downstream effects.

Permit 16702-4R—The proposed activities would take place in marshes, channels, and delta shorelines of the Snohomish River estuary, from the town of Snohomish to a line from Warm Springs beach to Elliott Point, Washington.

Permit 17292-3R— The proposed activities would take place across a broad geographic area in coastal watersheds throughout the state of California.

Permit 17299-4R—The proposed activities would take place in throughout Sacramento River basin, CA, including Sacramento-San Joaquin delta and tributaries within the Sacramento-San Joaquin watershed.

Permit 17306-3R— The proposed activities would take place in the Crooked and upper Deschutes Rivers (Oregon) and may take place in any tributaries to those water bodies in any given year. The proposed sampling techniques are such that no appreciable downstream effects are expected.

Permit 17916-2R—The proposed activities would take place in in watersheds throughout Northwest California—including the Mattole River, Eel River, the Lost Coast region tributaries to the Pacific Ocean, and some Humboldt Bay tributaries

Permit 18012-3R—The proposed activities would take place in streams throughout Sonoma, Mendocino, Napa, Marin, San Mateo, Santa Cruz and Monterey Counties, California.

Permit 19820-3R—The proposed activities would take place in San Francisco estuary and tributaries including Napa River, Sonoma Creek, Petaluma River, San Pablo Bay, Central Bay, South Bay and the Alviso Marsh.

Permit 20104-3R—The proposed activities would take place at sites in the intertidal zone in eelgrass, bare mud habitat and oyster aquaculture habitat within Samish Bay, Hood Canal and Quilcene Bay, South Puget Sound, Grays Harbor, and Willapa Bay, Washington, Coos Bay, Oregon, and Humboldt Bay, California.

Permit 20492-3R— The proposed activities would take place in dozens of locations throughout Western Oregon, the Deschutes River, and the Columbia River. Many of the tributaries to the Willamette River (Oregon) would be sampled as would a great deal of mainstem-, lake-, and reservoir habitat in salmonid-bearing waters from the Cascade Mountains to the Coast Range in Oregon. The proposed sampling techniques are such that no appreciable downstream effects are expected.

Permit 21185-2R—The proposed activities would take place in tributaries to the Deschutes River and independent tributaries to Puget Sound in the Kennedy-Goldborough Basin, Washington.

Permit 21220-2R— The proposed activities would take place solely in Martha Creek, a tributary to the Wind River in Washington State. Based on previous evaluations of the proposed activities, we do not expect that the research would have any downstream effects.

Permit 21330-4R—The proposed activities would take place in Jim Creek, a tributary to the South Fork Stillaguamish River, within the boundaries of Naval Radio Station Jim Creek in Snohomish County, Washington.

Permit 22369-2M—The proposed activities would take place off the northwest coast of Washington State from Neah Bay to the mouth of the Columbia River.

Permit 23798—The proposed activities would take place in the near the City of Colusa, CA, on the east bank of the Sacramento River.

Permit 25839—The proposed activities would take place in the Lower Yuba River, CA between The Narrows and Daguerre Point Dam.

Permit 25856—The proposed activities would take place in the Stanislaus River, CA between Goodwin Dam and Orange Blossom Bridge.

Permit 25965—The proposed activities would take place solely at the juvenile bypass facility at Bonneville Dam on the Columbia River. The research would have no downstream effects.

Permit 26049—The proposed activities would take place in Sacramento River, CA, below Keswick Dam.

Permit 26287—The proposed activities would take place in marine intertidal and subtidal waters throughout the state of Washington, including Puget Sound, the Washington coast, and south to the Lower Columbia River.

Permit 26295—The proposed activities would take place in lower Catherine Creek, a tributary to the Grande Ronde River in Northeast Oregon, and in approximately 10 miles of the mainstem Grande Ronde River itself just outside of LaGrande, Oregon. The proposed sampling techniques are such that no appreciable downstream effects are expected.

Permit 26331—The proposed activities would take place solely at the adult fish facility at Bonneville Dam on the Columbia River. The research would have no downstream effects.

Permit 26334—The proposed activities would take place entirely within the Walker Creek subbasin—a tributary to Tomales bay in California.

Permit 26352—The proposed activities would take place in estuarine, marine intertidal, and subtidal waters throughout northern Puget Sound, Washington.

Permit 26359—The proposed activities would take place in marine intertidal and subtidal waters throughout Puget Sound and the coast of Washington.

Permit 26398—The proposed activities would take place in estuarine, mainstem, and tributary reaches of the Puyallup, Nisqually, Deschutes, Kitsap, Kennedy-Goldsborough, and Chambers-Clover watersheds draining into central and southern Puget Sound, Washington.

2.4 Environmental Baseline

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

The environmental baseline for this opinion is therefore the result of the impacts that many activities (summarized below and in the species' status sections) have had on the various listed species' survival and recovery. In many cases, the action area under consideration covers individual animals that could come from anywhere in the various listed species' entire ranges (see Sections 1.3 and 2.3). As a result, the effects of these past activities on the species themselves (that is, effects on abundance, productivity, etc.) cannot be tied to any particular population and are therefore displayed individually in the species status section summaries above (see Section 2.2).

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

- Permit 1127-6M
- Permit 1135-11R
- Permit 1341-6R
- Permit 1465-5R
- Permit 1564-6R
- Permit 16702-4R
- Permit 17306-3R
- Permit 21220-2R
- Permit 21330-4R
- Permit 25839
- Permit 25856
- Permit 26295

2.4.1 Summary for all Listed Species

2.4.1.1 Factors Limiting Recovery

The best scientific information presently available demonstrates that a multitude of factors, past and present, have contributed to the decline of west coast salmonids, 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. See Table 2 for summaries of the major factors limiting recovery of the listed species and how various factors have degraded PBFs and harmed listed species considered in this opinion. Also, please see section 2.2 for information regarding how climate change has affected and is affecting species and habitat in the action areas. Climate change was not generally considered a relevant factor when the species were listed and the critical habitat designated, but it is now.

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

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

Research Effects

Although not identified as a factor for decline or a threat preventing recovery, scientific research and monitoring activities have the potential to affect the species' survival and recovery by killing listed salmonids—whether intentionally or not. For the year 2022, NMFS has issued numerous research section 10(a)(1)(A) scientific research permits allowing listed species to be taken and sometimes killed. NMFS has also issued numerous authorizations for state and tribal scientific research programs under ESA section 4(d). Table 35 displays the total take for the ongoing research authorized under ESA sections 4(d) and 10(a)(1)(A).

Table 35. Total Allowed Take of Listed Species for Scientific Research Approved at the end of 2021 *Not Including* the Take from Permits Being Renewed as Part of This Action.

Species	Life Stage	Origin	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
PS Chinook	Adult	Natural	664	28	2.841	0.120
		LHIA[a]	318	7	4.507[b]	0.194
		LHAC[a]	729	38		

Species	Life Stage	Origin	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
	Juvenile	Natural	471,414	9,019	12.644	0.242
		LHIA	79,342	2,585	0.958	0.031
		LHAC	244,955	11,407	0.935	0.044
PS steelhead	Adult	Natural	2,097	42	10.991	0.220
		LHIA	21	0	5.442[b]	0.680
		LHAC	19	5		
	Juvenile	Natural	67,394	1,213	2.990	0.054
		LHIA	2,336	39	2.670	0.045
		LHAC	5,059	97	2.720	0.052
PS/GB Bocaccio	Adult	Natural	26	12	1.672[c]	0.608
	Subadult	Natural	2	1		
	Juvenile	Natural	49	15		
PS/GB Yelloweye Rockfish	Adult	Natural	31	14	0.058[c]	0.030
	Subadult	Natural	2	1		
	Juvenile	Natural	33	19		
HCS Chum	Adult	Natural	1,169	19	4.158	0.068
	Juvenile	Natural	574,015	2,382	13.535	0.056
		LHIA	170	19	0.113	0.013
		LHAC	85	18	-	-
OL Sockeye	Adult	Natural	14	4	0.238	0.068
		LHIA	1	0	0.647[b]	0.000
		LHAC	1	0		
	Juvenile	Natural	83	3	0.007	<0.001
		LHIA	1	0	<0.001	0.000
		LHAC	23	2	0.050	0.004
UCR Chinook	Adult	Natural	137	6	16.851	0.738
		LHIA	150	3	27.456[b]	0.877
		LHAC	163	7		
	Juvenile	Natural	10,488	223	2.023	0.043
		LHIA	1,034	33	0.233	0.007
		LHAC	1,232	61	0.208	0.010
UCR steelhead	Adult	Natural	149	4	10.171	0.273
		LHIA	94	2	10.646[b]	0.277
		LHAC	214	6		
	Juvenile	Natural	32,138	658	19.846	0.406
		LHIA	2,418	69	1.826	0.052
		LHAC	10,260	244	1.380	0.033
MCR steelhead	Adult	Natural	1,072	12	7.884	0.088
		LHIA	38	1	135.063[b]	1.823
		LHAC	925	12		
	Juvenile	Natural	98,176	2,341	26.116	0.623
		LHIA	312	9	0.270	0.008
		LHAC	708	38	0.164	0.009
SnkR Spr/sum Chinook	Adult	Natural	1,698	13	38.425	0.294
		LHIA	186	1	43.834[b]	0.283
		LHAC	1,051	7		
	Juvenile	Natural	554,300	5,497	67.381	0.668
		LHIA	35,109	313	4.819	0.043
		LHAC	69,924	1,010	1.473	0.021
SnkR fall Chinook	Adult	Natural	45	8	0.620	0.110

Species	Life Stage	Origin	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
		LHIA	2	0	0.323[b]	0.087
		LHAC	46	13		
	Juvenile	Natural	1,868	111	0.252	0.015
		LHIA	336	35	0.011	0.001
		LHAC	691	135	0.027	0.005
SnkR steelhead	Adult	Natural	1,894	35	19.007	0.351
		LHIA	69	6	15.951[b]	0.609
		LHAC	455	14		
	Juvenile	Natural	246,776	3,143	31.230	0.398
		LHIA	12,470	140	2.514	0.028
		LHAC	54,516	616	1.739	0.020
SnkR sockeye	Adult	Natural	11	4	68.750	25.000
		LHIA	1	0	2.062[b]	0.000
		LHAC	1	0		
	Juvenile	Natural	3,453	318	18.129	1.670
		LHIA	1	0	-	-
		LHAC	259	256	0.096	0.094
LCR Chinook	Adult	Natural	311	16	1.062	0.055
		LHIA	12	0	0.792[b]	0.069
		LHAC	137	13		
	Juvenile	Natural	379,363	5,556	3.382	0.050
		LHIA	195	30	0.023	0.004
		LHAC	2,103	577	0.007	0.002
LCR coho	Adult	Natural	914	16	4.884	0.085
		LHIA	31	0	3.887[b]	0.251
		LHAC	589	40		
	Juvenile	Natural	147,086	1,957	18.947	0.252
		LHIA	515	110	0.192	0.041
		LHAC	11,155	1,005	0.146	0.013
LCR steelhead	Adult	Natural	2,816	32	34.544	0.393
		LHAC	72	4	1.128	0.063
	Juvenile	Natural	57,689	873	15.540	0.235
		LHIA	3	0	0.020	0.000
		LHAC	24,598	290	2.087	0.025
CR chum	Adult	Natural	35	6	0.202	0.035
		LHIA	1	0	0.087	0.000
	Juvenile	Natural	28,057	384	0.372	0.005
		LHIA	385	15	0.074	0.003
		LHAC	10	0	-	-
UWR Chinook	Adult	Natural	171	6	1.624	0.057
		LHAC	140	12	0.552	0.047
	Juvenile	Natural	39,204	775	3.367	0.067
		LHIA	46	4	-	-
		LHAC	9,975	281	0.219	0.006
UWR steelhead	Adult	Natural	220	4	8.371	0.152
	Juvenile	Natural	13,438	276	9.810	0.201
OC coho	Adult	Natural	8,725	108	14.392	0.178
		LHAC	21	4	3.292	0.627
	Juvenile	Natural	527,894	11,948	12.310	0.279
		LHAC	339	21	0.565	0.035

Species	Life Stage	Origin	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
SONCC coho	Adult	Natural	1,676	24	32.308[c]	0.427
		LHIA	1,808	17		
		LHAC	600	13		
	Juvenile	Natural	143,535	2,365	16.221	0.267
		LHIA	7,506	562	10.008	0.749
		LHAC	3,916	72	0.681	0.013
NC Steelhead	Adult	Natural	616	17	7.372	0.203
	Juvenile	Natural	74,604	1,872	7.849	0.197
CC Chinook	Adult	Natural	338	20	2.567	0.152
	Juvenile	Natural	46,107	784	1.927	0.033
SRWR Chinook	Adult	Natural	1,510	24	127.426	2.025
		LHAC	1,465	11	54.320	0.408
	Juvenile	Natural	428,153	11,513	342.418	9.208
		LHAC	201,199	6,924	126.656	4.359
CVS Chinook	Adult	Natural	1,380	21	20.426	0.311
		LHAC	353	37	16.947	1.776
	Juvenile	Natural	406,131	12,200	22.085	0.663
		LHAC	4,337	2,532	0.217	0.127
CCV steelhead	Adult	Natural	3,352	110	49.826	2.401
		LHAC	2,375	166		
	Juvenile	Natural	68,529	1,996	5.241	0.153
		LHAC	24,382	1,231	2.322	0.117
CCC coho	Adult	Natural	1,453	25	72.270	1.430
		LHIA	215	8		
	Juvenile	Natural	99,241	2,129	61.427	1.318
		LHIA	30,416	574	21.726	0.410
CCC steelhead	Adult	Natural	1,445	26	76.495	1.731
		LHAC	13	7		
	Juvenile	Natural	135,202	2,897	62.360	1.336
		LHAC	376	9	0.072	0.002
SCCC steelhead	Adult	Natural	886	12	452.041	6.122
	Juvenile	Natural	38,618	873	173.214	3.916
SDPS eulachon	Adult	Natural	32,815	30,457	0.127	0.118
	Subadult	Natural	1,030	1,030		
	Juvenile	Natural	160	104		
SDPS green sturgeon	Adult	Natural	318	8	14.951	0.376
	Subadult	Natural	247	9	2.212	0.081
	Juvenile	Natural	1,834	73	41.390	1.647
	Larvae	Natural	11,208	1,038	-	-
	Egg	Natural	1,866	1,866		

[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.

Actual take levels associated with these activities are almost certain to be a substantially lower than the permitted levels. There are three reasons for this. First, most researchers do not handle the full number of juveniles or adults they are allowed. That is, for the vast majority of scientific research permits, history has shown that researchers generally take far fewer salmonids than the allotted number of salmonids every year (20.45% of requested take and 14.74% of requested mortalities were used in ID, OR, and WA Section 10a1A permits from 2008 to 2017). Over the five years from 2014 through 2019, all section 10(a)(1)(A) permits active in California for ESA-listed steelhead and salmon resulted in only 8.8% of the requested handling (i.e., non-observation) take and 3.6% of the requested mortalities. (More recent figures on less-than-allotted take for individual permits 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 Table 35.

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, 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 that 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 measurable affect any of the listed species' habitat. The actions are therefore not likely to measurably affect any of the listed species by reducing that habitat's ability to contribute to their survival and recovery.

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

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

Capture/handling

The primary effect of the proposed research on the listed species would be in the form of capturing and handling fish. We discuss effects from handling 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.

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

Electrofishing

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

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

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

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

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

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

The preceding discussion focused on the effects 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 morality would be negligible, as fish lost off the hook are unlikely to be deeply hooked and would have little or no wound and bleeding (Cowen et al. 2007).

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

Observation

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

Rockfish barotrauma

Fish have two different types of swim bladders: physotome (open swim bladder) and physoclist (closed swim bladder). Physostome fish (such as salmonids) have a swim bladder connected to the esophagus via the pneumatic duct that allows them to gulp air to fill their swim bladder or quickly release the air when necessary. Physoclist fish (such as rockfish) lack the duct connection to the esophagus (Hallacher 1974) and are dependent upon passive gas exchange through their blood in the rete mirabile within their swim bladders (Alexander 1966). This allows them to become buoyant at much deeper depths than physotome fish, but they are unable to offload gases quickly during a rapid ascent.

For rockfish caught in waters deeper than 60 feet (18.3 m), the primary cause of injury and death is often barotrauma (NMFS 2017d). During rapid decompression, swim bladder gases expand exponentially which is further exacerbated by temperature increases. This results in swim bladder expansion; reduction in body cavity space; and displacement, eversion, and/or injury to the heart, kidneys, stomach, liver, and other internal organs (Rogers et al. 2008, Pribyl et al. 2009, Pribyl et al. 2011). Further, expanding gas can rupture and escape from the swim bladder filling the orbital space behind the eyes, stretching the optic nerve, and causing exophthalmia (Rogers et al. 2008). Once on the surface, rockfish can become positively buoyant, meaning they are unable to return to their previous water depth become susceptible to predation (Starr et al. 2002, Hannah et al. 2008, Jarvis and Lowe 2008).

Methods for reducing barotrauma impacts on rockfish include handling rockfish below the surface, decreasing handling time at the surface, and rapidly submerging them to their capture depth (Parker et al. 2006, Hannah and Matteson 2007, Hannah et al. 2008). Hannah et al. (2008) observed that rockfish that failed to submerge either (1) did not attempt to submerge or only made weak attempts to do so, or (2) vigorously attempted to submerge and failed, leading to his conclusion that buoyancy is not the sole cause of submergence failure. Starr et al. (2002) captured rockfish and brought them up to 20m below the surface (below the local thermocline) where divers surgically implanted sonic tags in rockfish, placed them in a recovery cage, and released them. Because they observed no mortalities or abnormal swimming when these methods were employed, Starr et al. (2002) deduced that reducing surface handling time appears to improve survivorship. Jarvis and Lowe (2008) noted a 78% survivorship rate after recompression for rockfish released within 10 minutes of landing, which increased to 83% when the fish were released within 2 minutes.

Another method for increasing survival for captured rockfish involves rapidly submerging the rockfish after capture and handling. Though the rockfish do not avoid effects of barotrauma when handled in this manner, the immediate impacts of decompression will stop when they are returned to their capture depth. Hochhalter and Reed (2011) compared submergence success of yelloweye rockfish released at the surface and at depth in a mark-recapture study. Though 91% of the individuals showed external signs of barotrauma after capture, the 17-day survival rate was 98.8% after resubmergence, though survival was size-dependent. Yelloweye rockfish released at the surface successfully submerged only 22.1% of the time and had an unknown survivorship rate. In a different study, Hannah and Matteson (2007) researched nine different rockfish different species from six different sites off the Oregon coast. After being captured, rockfish were briefly handled (less than two minutes), placed in a release cage with a video camera, and returned to capture depth/neutral buoyancy. Release behavior was visually observed and scored for behavioral impairment. The behavioral effects of barotrauma appeared to be highly species-specific (probably due to anatomical differences among rockfish species) and health condition at the surface did not appear to be a good indicator of survivorship potential after recompression. In addition, barotrauma effects increase with capture depth.

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 (NMFS 2003b). 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.

Tangle Netting

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

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

Tagging/Marking

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

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

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

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

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

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

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

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

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

Tissue Sampling

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

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

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

Trawls

Trawls are cone-shaped, mesh nets that are towed, often, along benthic habitat (Hayes 1983, Hayes et al. 1996). Rectangular doors, attached to the towing cables, keep the mouth of the trawl open. Most trawls are towed behind a boat, but small trawls can be operated by hand. As fish enter the trawl, they tire and fall to the 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, and rockfish. Since there are no measurable 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.

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. Table 36 displays the estimated annual abundance of hatchery-propagated and naturally produced listed fish.

In conducting the following analyses, we have tied the effects of each proposed action to its impacts on individual populations (or population groups) wherever it was possible to do so. In those instances, the status of the local population will be discussed and taken into account. In other instances, the nature of the project (e.g., it is broadly distributed or situated in mainstem habitat) is such that the take cannot reliably be assigned to any population or group of populations. In those cases, the effects of the action are measured in terms of how they are expected to affect each listed unit's total abundance by life stage and origin rather than at the population scale.

Table 36. Estimated annual abundance of ESA listed fish (Ford 2022, Williams et al. 2021, SWFSC 2022, CDFW 2020)(LHAC= Listed Hatchery, Adipose-clipped, LHIA= Listed Hatchery, Intact Adipose).

Species	Life Stage	Origin	Abundance
PS Chinook	Adult	Natural	23,371
		Listed Hatchery[a]	23,232
	Juvenile	Natural	3,728,240
		LHIA	8,280,000
		LHAC	26,192,500
PS steelhead	Adult	Natural	19,079
		Listed Hatchery[a]	735
	Juvenile	Natural	2,253,842
		LHIA	87,500
		LHAC	186,000
PS/GB bocaccio	Adult[c]	Natural	4,606
PS/GB yelloweye rockfish	Adult[c]	Natural	114,494
HCS Chum	Adult	Natural	28,117
	Adult	Listed Hatchery[a]	881
	Juvenile	Natural	4,240,958
		LHIA	150,000
OL Sockeye	Adult	Natural	5,876
		Listed Hatchery[a]	309
	Juvenile	Natural	1,273,337
		LHIA	259,250
		LHAC	45,750

Species	Life Stage	Origin	Abundance
UCR Chinook	Adult	Natural	813
		Listed Hatchery[a]	1,140
	Juvenile	Natural	518,360
		LHIA	443,774
		LHAC	591,769
UCR steelhead	Adult	Natural	1,465
		Listed Hatchery[a]	2,893
	Juvenile	Natural	161,936
		LHIA	132,453
		LHAC	743,457
MCR steelhead	Adult	Natural	13,598
		Listed Hatchery[a]	713
	Juvenile	Natural	375,923
		LHIA	115,610
		LHAC	432,003
SnkR spr/sum Chinook	Adult	Natural	4,419
		Listed Hatchery[a]	2,822
	Juvenile	Natural	822,632
		LHIA	728,543
		LHAC	4,747,112
SnkR fall Chinook	Adult	Natural	7,262
		Listed Hatchery[a]	14,879
	Juvenile	Natural	742,699
		LHIA	2,954,366
		LHAC	2,570,139
SnkR steelhead	Adult	Natural	9,965
		Listed Hatchery[a]	3,285
	Juvenile	Natural	790,184
		LHIA	496,078
		LHAC	3,135,597
SnkR sockeye	Adult	Natural	16
		Listed Hatchery[a]	97
	Juvenile	Natural	19,047
		LHAC	271,029
LCR Chinook	Adult	Natural	29,298
		Listed Hatchery[a]	18,814
	Juvenile	Natural	11,216,357
		LHIA	857,117
		LHAC	30,973,516
LCR coho	Adult	Natural	18,714
		Listed Hatchery[a]	15,949
	Juvenile	Natural	776,286
		LHIA	267,649
		LHAC	7,626,390
LCR steelhead	Adult	Natural	8,152
		Listed Hatchery[a]	6,382
	Juvenile	Natural	371,241
		LHIA	15,223
		LHAC	1,178,520
CR chum	Adult	Natural	17,305
		Listed Hatchery[a]	1,145
	Juvenile	Natural	7,533,081

Species	Life Stage	Origin	Abundance
		LHIA	523,500
UWR Chinook	Adult	Natural	10,531
		Listed Hatchery[a]	25,380
	Juvenile	Natural	1,164,252
		LHIA	0
		LHAC	4,547,100
UWR steelhead	Adult	Natural	2,628
	Juvenile	Natural	136,980
OC coho	Adult	Natural	60,624
		Listed Hatchery[a]	638
	Juvenile	Natural	4,288,340
		LHAC	60,000
SONCC coho	Adult	Natural and Listed Hatchery[b]	12,641
	Juvenile	Natural	884,870
		LHIA	75,000
		LHAC	575,000
NC Steelhead	Adult	Natural and Listed Hatchery[b]	8,356
	Juvenile	Natural	950,495
CC Chinook	Adult	Natural	13,169
	Juvenile	Natural	2,392,807
SRWR Chinook	Adult	Natural	1,185
		Listed Hatchery[a]	2,697
	Juvenile	Natural	125,038
		LHAC	158,855
CVS Chinook	Adult	Natural	6,756
		Listed Hatchery[a]	2,083
	Juvenile	Natural	1,838,954
		LHAC	2,000,000
CCV steelhead	Adult	Natural and Listed Hatchery[b]	11,494
	Juvenile	Natural	1,307,442
		LHAC	1,050,000
CCC coho	Adult	Natural and Listed Hatchery[b]	2,308
	Juvenile	Natural	161,560
		LHIA	140,000
CCC steelhead	Adult	Natural and Listed Hatchery[b]	1,906
	Juvenile	Natural	216,808
		LHAC	520,000
SCCC steelhead	Adult	Natural and Listed Hatchery[b]	196
	Juvenile	Natural	22,295
SDPS eulachon	Adult	Natural	26,797,375
SDPS green sturgeon		Natural	2,127
	Subadult	Natural	11,165
	Juvenile	Natural	4,431

[a] Abundances for adult hatchery salmonids are LHAC and LHIA combined.
[b] Abundances for all adult components are combined.
[c] Abundances for all life stages are combined.

Please note that the juvenile abundance numbers presented above for each species should be viewed with caution because 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.). Thus, as stated previously, we purposefully under-estimate abundances—particularly for juvenile fish—in order to account for information gaps and ensure that we remain as conservative a possible when estimating the effects of the proposed actions. We kept these variables in mind (as well as the suit of other factors described in "Research Effects") when conducting the following analyses.

Permit 1127-6M

The Shoshone-Bannock Tribes are seeking to modify 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. The modification would involve adding some take for adult spr/sum Chinook that the Tribes may observe and handle by permitting them to work at a currently unused weir in the East Fork Salmon River (Idaho). The modification would also involve *greatly* decreasing the number of juvenile and adult salmon the Tribes capture and sample in the Yankee Fork of the Salmon River. As noted previously, the researchers would use screw traps, weirs, electrofishing, and hook-and-line angling gear to capture the listed fish. The researchers are not proposing to kill any of the fish they capture, but some may die as an unintended result of the research. The researchers are requesting the amounts of take displayed in the table 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 37. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 1127-6M (C=Capture, H=Handle, R=Release, O=Observe, T=Tag, M=Mark, ST-Sample Tissue, D=Dead Animal).

Species	Life Stage	Origin	Take Action	Prior Total Take	Prior Lethal Take	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
SnkR Spr/sum Chinook	Adult	Natural	C/M/T/ST/R	1,000	0	-500	1	-	0.023
		LHIA	C/M/T/ST/R	0	0	100	1		0.071
		LHAC	C/M/T/ST/R	1,000	0	-995	1		
	Juvenile	Natural	C/H/R	2,650	65	0	0		-
		Natural	C/M/T/ST/R	15,000	398	-10,000	-300		
		LHIA	C/H/R	550	20	0	0		

		LHIA	C/M/T/ ST/R	6,500	131	-1,000	-30		
SnkR Steelhead		Natural	C/H/R	2,400	44	0	0		
		Natural	C/M/T/ ST/R	7,150	166	-2,000	-60		
		LHIA	C/M/T/ ST/R	150	4	-100	-3		
		LHAC	C/H/R	800	11	-100	-3		

*As noted above, there are no take prohibitions on LHAC fish (and therefore they will not appear in any permit), but they are still listed under the ESA and the effects of taking them must therefore be evaluated.

Because this permit is a modification, we examine only the increment of change that has been added to the previously analyzed and approved take levels. The reason we take this approach is that any take the permit previously contained has already been analyzed and the permit expiration date has not been extended; therefore the only effect in addition to take already accounted for in the baseline (and previously consulted upon) stems from whatever new take is being proposed at this time—and that is what we examine. We do not, however, analyze the relative positive effect that comes from *reducing* take (as reflected in the negative numbers in the table above). This is done out of an abundance of caution: by leaving the permit's original take as part of the overall research program, we can be sure the effect analysis remains as conservative as possible until such time as the researchers seek to renew the permit—at which point we would re-analyze the entirety of the proposed take.

Thus, because the SBT researchers are largely reducing the amount of take they have previously been allotted, the only effects to be examined are the potential losses of one additional natural adult SnkR spr/sum Chinook, one additional LHAC adult SnkR spr/sum Chinook, and one additional adult LHIA fish. This could result in 0.023% of the ESU's natural component and 0.071% of the ESU's hatchery component being killed, respectively. These effects are very small and unlikely to have more than a very minor effect on abundance or productivity and probably none on structure or diversity. However, the effect would be magnified somewhat by the fact that it would be felt by only one population: that in the East Fork Salmon River. Given that the most recent natural returns to that population have averaged 138 fish (Ford 2022), this would signify that the local effect would be a loss of something on the order of 0.7% of the returning natural fish. Thus, even at the local level, the effect would be a small decrease in abundance (and therefore productivity), and likely no measureable effect on structure or diversity. The same is also true for the loss of two hatchery adult spr/sum Chinook. Assuming the hatchery returns are similar in magnitude to the natural returns (though they are probably greater), the two adults would represent a loss of about 1.4% of the local hatchery fish. However, half of that loss would be of an LHAC fish—one that (a) has no take prohibitions and (b) is considered surplus to recovery needs. The actual loss would therefore be on the (maximum) order of 0.7 of the fish considered part of the listed hatchery component and thus would have little effect on abundance or productivity and even less on structure or diversity.

Further, it is very likely that the impacts will be even smaller than those described above. Over the most recent five years, the researchers have taken only 4.6% of their requested take and killed 2.4% of their requested mortalities, so it is most likely that the actual effect will be much, much smaller than that displayed in the table above. Nevertheless, even if the full losses were to be felt in any given year, they would be offset to some degree by the fact that the research would benefit the listed fish by continuing to help guide management, restoration, recovery, and supplementation actions.

Permit 1135-11R

The USGS has been conducting work under various iterations of Permit 1135 for more than 20 years. The most recent version, 1135-10M, expired on December 31, 2021. That permit authorized the USGS to take listed species by backpack electrofishing in Trout Creek and the Wind River upstream from Carson National Fish Hatchery (Washington). The USGS proposes to renew their permit and would not change sampling locations, methods, or any other aspect of their research relative to what has been authorized for a number of years. The researchers do not propose to kill any fish, but a small number may die as an unintended result of the research activities. The researchers are requesting the following amounts of take:

Table 38. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 1135-11R (C=Capture, H=Handle, R=Release, O=Observe, T=Tag, M=Mark, ST-Sample Tissue).

<table>
<tr><th>Species</th><th>Life Stage</th><th>Origin</th><th>Take Action</th><th>Requested Take</th><th>Lethal Take</th><th>Percent of ESU/DPS Taken</th><th>Percent of ESU/DPS Killed</th></tr>
<tr><td rowspan="2">LCR Steelhead</td><td>Juvenile</td><td>Natural</td><td>C/H/R</td><td>4,500</td><td>135*</td><td rowspan="2">1.077</td><td rowspan="2">0.032</td></tr>
<tr><td>Juvenile</td><td>Natural</td><td>C/H/M/T/ ST/R</td><td>3,500</td><td>105</td></tr>
</table>

*In this and all other instances where unintentional mortality is listed, the numbers *come out* of the requested take they are not added to it. So for example, the 135 natural LCR steelhead in the first row of the Lethal Take column in the table above would be one out of the requested fish found in the fifth column.

Because the vast 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 are best seen in the context of the fish that the action may kill. To determine the effect of these losses, it is necessary to compare them to the total outmigrant numbers expected for these species (and their components) and (b) the total average returns over the last five years for which we have data (see status section and Table 36). That calculation (ratio) is displayed in the last column of the table above. It signifies that the research, in total, would kill at most 0.032% of the natural juveniles produced in the LCR steelhead DPS. This effect is very small, would not impact adults at all, and would be restricted to minor effects on abundance an productivity—but those minor effects *would* be magnified by the fact that the losses would be concentrated on only a portion of the DPS.

Given that an average of approximately 8,151 adult LCR steelhead have returned to the DPS over the last five years and 626 of them have been from the Wind River, the effect of the research would about 13 times larger at the local level (if Trout Creek and other nearby areas are included) (Ford 2022). That is the research, in total, might kill as many as 0.4% of the locally outmigrating smolts from this DPS. This is a very small effect and would only be measurable in terms of slight reductions in abundance and productivity—signifying that even at the local level, diversity and structure are unlikely to be affected a great deal. It is also likely that the impacts will be smaller than those laid out above. Over the most recent five years, the researchers have taken only 47.1% of their requested take, and killed 25.1% of their requested mortalities, so it is very likely that the actual mortality rates associated with the research would not exceed about one-quarter of the impact displayed and discussed above.

An effect of the research that cannot be quantified is the benefit it would have with respect to species conservation. Juvenile steelhead sampled under this permit would provide data on life histories, life-stage survival, and habitat use in the Wind River and neighboring drainages. Specifically, parr growth and migration data would be collected and used to describe the various rearing strategies juvenile steelhead employ and track how these life-history expressions contribute to population viability. This information, in turn, would continue to be used to help guide state, tribal, and Federal efforts to recover LCR steelhead and restore their habitat.

Permit 1175-10R

The Gifford Pinchot National Forest (GPNF) is seeking to renew for five years a permit that currently allows them to take juvenile LCR Chinook salmon, LCR coho salmon, and LCR steelhead in any of the Forest's waters in Washington State. They are also adding MCR steelhead and PS Chinook salmon and steelhead to the species they may take. The purpose of the research is to describe fish species presence, distribution, spawning areas, and habitat conditions throughout the forest. The GPNF proposes to use backpack electrofishing, seines, and angling to capture juvenile salmonids, hold fish for short periods in aerated buckets, identify, and then release the fish. The researchers do not propose to kill any fish, but a small number may die as an unintentional result of research activities. The researchers are requesting the following amounts of take.

Table 39. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 1175-10R (C=Capture, H=Handle, R=Release).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
PS Chinook	Juvenile	Natural	C/H/R	60	3	0.002	<0.001
PS steelhead	Juvenile	Natural	C/H/R	60	3	0.003	
MCR steelhead	Juvenile	Natural	C/H/R	50	2	0.013	
LCR Chinook	Juvenile	Natural	C/H/R	50	3	<0.001	
LCR coho	Juvenile	Natural	C/H/R	300	14	0.039	0.002
LCR steelhead	Juvenile	Natural	C/H/R	300	14	0.081	0.004

Because the vast 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 are best seen in the context of the fish that the action may kill. To determine the effect of these losses, it is necessary to compare them to the total outmigrant numbers expected for these species (and their components) and (b) the total average returns over the last five years for which we have data (see status section and Table 36). Given the GPNF's proposed research methods, we expect at least 95% of the fish captured during research activities to survive with no long-term consequences. Moreover, the numbers of fish that may be take are artificially inflated because the researchers were required to add take for every possible method they may employ, but is extremely unlikely that they would employ every method proposed. That is, it is very unlikely in any given year that they would electrofish, seine, and hook-and-line angle for each species. Thus, if the already-inflated mortality rates remain at less than 0.001% of the listed unit, we conduct our analysis only at the DPS/ESU scale. If, however, that rate rises *above* the level of killing fewer than one in ten thousand juvenile fish, we place those mortalities in the context of the local population group (we cannot resolve the effect to the level of single populations).

As a result, we analyze the effects on local population groups for LCR steelhead and LCR coho We have no direct measurements of juvenile salmonid abundance, but estimates of adult abundance are available at the population scale. So we estimated the effects on juvenile abundance for each population by assuming that the ratios of population:ESU and population:DPS are the same for juveniles as they are for adults.

The GPNF's proposed research has the potential to affect all populations of LCR coho except the Sandy, Clackamas, and "Oregon Upper Gorge tributaries and Hood River early coho" populations. This would mean that the effects of the research would be concentrated on approximately 80% of the listed unit (Ford 2022). Thus the local effect of the proposed losses would only be about 20% larger than that displayed, or approximately 0.0024%. This effect is vanishingly small even at the local level and is unlikely to have more than a very minor effect on abundance and productivity and effectively no effect on structure or diversity.

The GPNF's proposed research has the potential to affect all populations of LCR steelhead except those in the Sandy, Clackamas, and Hood Rivers. This would mean that the effects of the research would be concentrated on approximately 13% of the listed unit (Ford 2022). Thus, the local effect of the proposed losses would be about 8 times larger than that displayed, or approximately 0.032%. This effect is very small even at the local level and is unlikely to have more than a very minor impact on abundance and productivity and effectively none on structure or diversity.

The proposed research would have a very small impact on abundance, a similarly small impact on productivity, and no measureable effect on spatial structure or diversity for any of the species listed in Table 39. The GPNF has requested what they expect would be the maximum possible amount of take. Annual reports for this project show that they tend to catch far fewer fish than authorized. In the nine years from 2010 to 2019, the GPNF did not captured any juvenile LCR Chinook. In the same timeframe, the GPNF reported no unintentional mortalities and their nonlethal take ranged from 0-7% of levels authorized for LCR steelhead and 0-26% of levels authorized for LCR coho; therefore, the actual effects of the proposed research are likely to be something very close to negligible for all species. This is especially given the fact that over the most recent 4 years (through 2021), the researchers have neither taken nor killed any fish at all. However, if the research is conducted, it has the potential to benefit listed salmonids by providing the GPNF with information to improve forest management and guide habitat restoration and species recovery efforts.

Permit 1339-6R

Under Permit 1339-6R, the NPT would continue (and actually reduce) research they have been performing for nearly two decades. The researchers would conduct their work in a number of tributary streams to the Imnaha, Grand Ronde, and Clearwater Rivers. They would also perform some work at the adult fish trap at Lower Granite Dam. They would observe, capture, and handle adult and juvenile salmon and steelhead as well as mark and tag them at temporary/portable picket and resistance board weirs and rotary screw traps. Many of the captured fish would also be sampled for biological information. Biological samples would include fin tissue and scale samples. Marks would include opercule punches, fin clips, dyes, and PIT, floy, and/or Tyvek disk tags. Adult steelhead carcasses would also be collected and sampled for tissues, scales, and biological information. The researchers do not intend to kill any of the fish being captured but a small number may die as an unintended result of the activities. The NPT researchers are requesting the following amounts of take.

Table 40. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 1339-6R (C=Capture, H=Handle, R=Release, O=Observe, T=Tag, M=Mark, ST-Sample Tissue, D=Dead Animal).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
SnkR spr/sum Chinook	Adult	Natural	C/H/R	105	2	1.754	0.023
		Natural	O/H	50	0		
		LHIA	C/H/R	100	2	10.631*	0.142*
		LHIA	O/H	50	0		
		LHAC	C/H/R	100	2		
		LHAC	O/H	50	0		
	Juvenile	Natural	C/H/R	5,000	50	0.608	0.006
		Natural	C/M/T/ST/R	5,000	50		
		LHIA	C/H/R	5,000	50	0.686	0.007
		LHIA	C/M/T/ST/R	5,000	50		
		LHAC	C/H/R	5,000	50	0.105	0.001
		LHAC	C/M/T/ST/R	5,000	50		
SnkR fall Chinook	Adult	Natural	C/H/R	30	1	0.413	0.014
		LHIA	C/H/R	30	1	0.403*	0.013*
		LHAC	C/H/R	30	1		
	Juvenile	Natural	C/H/R	1,500	105	0.202	0.014
		LHIA	C/H/R	1,500	105	0.051	0.004
		LHAC	C/H/R	1,500	105	0.058	
SnkR steelhead	Adult	Natural	C/H/R	3,720	37	22.127	0.191
		Natural	C/M/T/ST/R	3,850	39		

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
		Natural	O/H	50	0		
		Natural	O/STD	1,200	0		
		LHIA	C/H/R	920	11	186.910*	1.522*
		LHIA	C/M/T/ST/R	1,000	12		
		LHIA	O/H	50	0		
		LHIA	O/STD	850	0		
		LHAC	C/H/R	1,170	13		
		LHAC	C/M/T/ST/R	1,250	14		
		LHAC	O/H	50	0		
		LHAC	O/STD	850	0		
	Juvenile	Natural	C/H/R	15,000	150	2.215	0.051
		Natural	C/M/T/ST/R	20,000	650		
		LHIA	C/H/R	16,000	250	2.167	0.031
		LHIA	C/M/T/ST/R	5,500	55		
		LHAC	C/H/R	16,000	250	0.343	0.005
		LHAC	C/M/T/ST/R	5,500	55		

*Because adult returns are not broken out by whether the fish have had their adipose fins removed, the percentages above reflect the effects that the take and the mortalities on the adult hatchery component of each species as a whole. That is, the LHAC and LHIA take requests are combined and divided by the total number of hatchery fish that have returned, on average, over the last five years.

Because the vast 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 are best seen in the context of the fish that the action may kill. To determine the effect of these losses, it is necessary to compare them to the total outmigrant numbers expected for these species (and their components) and (b) the total average returns over the last five years for which we have data (see status section and Table 36). These calculations are displayed in the last column of the table above. They signify that the research may have a maximum effect of killing up to 1.5% of the returning adult hatchery SnkR steelhead, but in most cases the degree of effect would be an order of magnitude smaller (or more) than that figure. And for the 1.5% figure, it is important to note that over half of it reflects effects on fish for which there are no take prohibitions and that are considered surplus to recovery needs. (In fact, they are specifically propagated to allow harvest opportunities). As a result, the actual effect on the DPS is probably something much closer to a 0.75% mortality rate which, while not insignificant, is unlikely to have a more than minor effect on abundance and productivity at the DPS level (and, because they are also hatchery fish, almost none on structure or diversity).

However, that small effect would be magnified by the fact that while the research encompasses a large portion of the DPS's range, it does not cover all of it. Unfortunately, there are currently very few good data on steelhead abundance in the areas where the actions are proposed. (In fact, this research is designed, among other things, to fill that data gap.) Thus, we can say that the effect would be magnified, but not by how much. We estimate that over 50% of the natural returns to the DPS take place in the areas that would be covered by the research (Ford 2022). If that holds true for the hatchery component as well, then the local mortality rate effect could be on the order of 2-3%. This is still a small effect and, again, would be ameliorated by the fact that half of the fish are considered surplus to recovery needs. Moreover, for reasons given below, we believe the effect will actually be much smaller than even that displayed.

Aside from the above maximum for hatchery steelhead adults, the research would kill no more than a few fractions of a percent of either the juvenile outmigrants or returning adults for any other species or component thereof. Because SR fall Chinook are considered to have only one population, the mortalities would affect that population just as displayed above and cannot be discerned to have variable effects on different components of the species. As a result, the effects on SnkR fall Chinook would be extremely small and unlikely to affect the species' viability beyond very minor reductions in abundance and productivity.

For SnkR spr/sum Chinook, these effects *would* be magnified somewhat by the fact that, while they are spread out over a large portion of all the species' range, the activities do not encompass the range's entirety. The data for spr/sum Chinook are more complete than they are for steelhead, but not for all areas being considered. In general, the activities would take place largely in the Imnaha, Grande Ronde, and Clearwater subbasins. For spr/sum Chinook, that means that the activities would have the chance to affect approximately 40% of the entire species' natural abundance (Ford 2022), and we assume that the hatchery fish abundance does not diverge widely from that figure. Thus, the effects on spr/sum Chinook displayed above may be magnified by slightly more than a factor of two. Nevertheless, even when more than doubled to a maximum mortality of 0.30% of the hatchery-origin adults in these populations, the impact remains very small. And, as noted above, is likely to be made even smaller due to the fact that at least half the fish that may be captured and killed would be considered surplus to recovery needs and are created expressly for the purpose of allowing them to be harvested.

In addition, the actual research effects are very likely to be much smaller than those displayed. That is, if the past may be used as an indicator, in the more than 20 years the NPT has been performing this research, they have never taken anything close to the number of fish allotted in their permit. Over the most recent five years, the researchers have taken only 4.2% of their requested take, and killed 0.3% of their requested mortalities, so it is most likely that the actual effect will be more than an order of magnitude smaller than the effects displayed in the table above.

Therefore, while these figures certainly could represent minor negative effects on local abundance and productivity (but not on structure or diversity), they are unlikely to compromise the viability of the individual populations, let alone any species as a whole. In addition, the information derived from the research is used to help fisheries managers determine if recovery actions are benefiting wild Snake River salmonid populations as expected and therefore would be used to guide future management actions in the three subbasins in which the work would take place. The research they are asking to perform (and have been performing for over two decades) is designed to fill critical data gaps in our knowledge of the species' status and has been deemed a priority in every relevant salmonid recovery forum in the region.

Finally, the amounts being requested are generally smaller than amounts that have previously been analyzed and permitted. The NPT is requesting to reduce their previously-approved take by hundreds of adults (primarily steelhead); they are also similarly decreasing their mortality request. This signifies that the take in the permit would, even under the most pessimistic scenario, have less impact than their previous work—which for more than two decades has been found to not operate to the listed species' disadvantage.

Permit 1341-6R

Under Permit 1341-6R, the SBT would continue work they have been conducting for decades in the upper Salmon River, Idaho. Under the renewed permit, the SBT researchers would continue to annually take SnkR sockeye salmon and SR spr/sum Chinook salmon while conducting research to estimate overwinter survival, downstream migration survival, and downstream migration timing and use that information to evaluate various release strategies and calculate smolt-to-adult return rates. Juvenile SnkR sockeye salmon and spr/sum Chinook salmon would continue to be collected at Pettit and Alturas Lakes (Idaho) using rotary screw traps and weirs. The fish would be sampled for biological information and released or PIT-tagged and released. In addition, to determine trap efficiencies, a portion of the juvenile SR sockeye salmon captured would be PIT-tagged, released upstream of the traps, captured at the traps a second time, inspected for the tag, and released. The SBT researchers are requesting the following amounts of take:

Table 41. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 1341-6R. (C=Capture, H=Handle, R=Release, O=Observe, T=Tag).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
SnkR spr/sum Chinook	Juvenile	Natural	C/H/R	1,025	11	0.125	0.001
SnkR sockeye	Adult	Natural	C/M/T/ST/R	100	2	625.00	12.500
	Juvenile	Natural	C/H/R	5,000	100	19.688	0.394
		Natural	C/M/T/ST/R	2,500	50		

Because the vast 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 are best seen in the context of the fish that the action may kill. To determine the effect of these losses, it is necessary to compare them to the total outmigrant numbers expected for these species (and their components) and (b) the total average returns over the last five years for which we have data (see status section and Table 36). These calculations are displayed in the last column of the table above. These figures signify that the research may have a maximum effect of possibly killing as much as 12.5% of the recent adult sockeye returns, approximately 0.001% of the SR spr/sum Chinook outmigration, and 0.39% of the natural origin sockeye outmigration. These last could be the progeny of adult sockeye that were released to spawn in Pettit and Alturas lakes, smolts that developed from outplanted eyed-eggs, or fry released into Pettit and Alturas lakes.

Because the SnkR sockeye salmon ESU has only one population, the local effects would be the same as those displayed in the table above. The potential loss of roughly 0.4% of the natural-origin sockeye outmigration from this ESU is not likely to have more than a very minor negative effect on the ESU's viability. There could negative shifts in abundance and productivity but, especially considering the program is intended to expand the species range and production, there would likely be no negative changes in structure or diversity. However, the possible death of 12.5% of the returning natural adults has the potential to create a notable negative effect on both abundance and productivity. That effect is extremely unlikely to occur at all (see below), but it is important to keep in mind the fact that *any* adult loss, however unlikely, would be incurred while evaluating efforts specifically designed to help recover the species and, as such, must be viewed in that context. The sockeye salmon reintroduction programs to Pettit and Alturas Lakes have for decades been considered critical to helping the species' continued survival and recovery, and the research under Permit 1341 has provided information on the relative success of the programs' techniques and thereby helped guide their implementation for that entire time. Thus, every loss, while potentially impactful, would result from a program that, in total, has been helping the sockeye survive for decades.

For the SR spr/sum Chinook, that effect would be magnified by the fact that the take would all be concentrated in a small portion of the species' range. While it is not known how many SR spr/sum Chinook are likely to outmigrate from the areas of Pettit and Alturas lakes, it is known that an average of approximately 240 adults have returned to the upper Salmon River areas near Redfish lake over the last several years (Ford 2022). Thus, the number of outmigrants is certainly many thousand at the least. The 11 juveniles that may die, then, constitute a very small portion of the local population and a negligible fraction of the ESU as a whole. As a rough estimate, assuming 120 females with (conservatively) 2,500 eggs each, and an egg-to-smolt survival of 5%, the loss would locally be approximately 0.07%. Such a loss in abundance (and therefore productivity) is unlikely to negatively affect population viability. This is especially true given the fact that most of the fish that may be taken would likely be in the fry life stage—a stage with many more individuals and a higher natural mortality rate than the smolt stage. As a result, the proposed action is unlikely to have much more than a very minor effect on SnkR spr/sum Chinook abundance and productivity, even at the local level.

It is also very likely that the impacts will be a great deal smaller than those displayed above. Over the most recent five years, the researchers have taken only 0.1% of their requested take, and killed *none* of their requested mortalities, so it is most likely that the actual effect will continue to be effectively negligible. In addition, in many future years there very well could be no adult trapping at all and thus no adult losses. Any adult trapping operations would be contingent upon operations at Sawtooth Fish Hatchery (i.e., if an adult is trapped and immediately released above Sawtooth, the Pettit weir would be installed). If no adults are observed at Sawtooth hatchery, then there would be no reason to install the adult weir in Pettit Lake Creek. This is likely to be the case in at least some of the years during which the permit would be in effect.

Thus, based on past performance and probable future operations, the largest possible effect—a maximum 12.5% mortality rate for adult sockeye—is exceedingly unlikely to ever occur. But even if two adults were somehow to be killed (an unprecedented event for this program), those deaths (and those of the juveniles) would take place in the context of supporting actions that are (a) specifically called for in numerous draft and final recovery plans, and (b) designed to help sockeye persist in the wild and, eventually, recover.

Permit 1345-10R

The WDFW is seeking to renew for five years a research permit that currently allows them to take juvenile and adult LCR Chinook salmon, LCR coho salmon, and LCR steelhead, while adding PS Chinook and PS steelhead to the species they are permitted to take. The purpose of the WDFW study is to assess inland game fish communities to aid in fishery management. The WDFW proposes to capture fish using boat electrofishing, fyke nets, and gillnets. After capture, listed salmon and steelhead would be held in aerated live wells, identified, and released. The researchers do not propose to kill any listed fish, but a small number may die as an unintended result of the activities. The researchers are requesting the following amounts of take.

Table 42. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 1345-10R (C=Capture, H=Handle, R=Release).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
PS Chinook	Adult	Natural	C/H/R	6	0	0.026	0.000
		LHAC	C/H/R	6	0		
	Juvenile	Natural	C/H/R	30	2	<0.001	<0.001
		LHAC	C/H/R	30	2		
PS steelhead	Adult	Natural	C/H/R	6	0	0.031	0.000
		LHAC	C/H/R	6	0	0.816	
	Juvenile	Natural	C/H/R	30	2	0.001	<0.001
		LHAC	C/H/R	30	2	0.016	0.001
LCR Chinook	Adult	Natural	C/H/R	6	0	0.020	0.000
		LHAC	C/H/R	6	0	0.032	
	Juvenile	Natural	C/H/R	30	2	<0.001	<0.001

		LHAC	C/H/R	30	2		
LCR coho	Adult	Natural	C/H/R	6	0	0.032	0.000
		LHAC	C/H/R	6	0	0.038	
	Juvenile	Natural	C/H/R	30	2	0.004	<0.001
		LHAC	C/H/R	30	2	<0.001	
LCR steelhead	Adult	Natural	C/H/R	6	0	0.074	0.000
		LHAC	C/H/R	6	0	0.094	
	Juvenile	Natural	C/H/R	30	2	0.008	<0.001
		LHAC	C/H/R	30	2	0.003	

Because the vast 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 are best seen in the context of the fish that the action may kill. To determine the effect of these losses, it is necessary to compare them to the total outmigrant numbers expected for these species (and their components) and (b) the total average returns over the last five years for which we have data (see status section and Table 36). These calculations are displayed in the last column of the table above and signify that the research could kill, at most, 0.001% of any juvenile component from any listed species and, in most cases, the effect would be even smaller than that. Moreover, because the research could take place in any lake, tributary, or mainstem habitat in the lower Columbia River and Puget Sound management areas, the effects of that take effects would be spread out across the entirety of each listed unit and no single population would be disproportionately affected. Thus, the effects displayed must be analyzed in the context of each listed unit as a whole and, at those levels, the impacts are very close to zero.

Moreover, it is most likely that the impacts will be even smaller than those laid out above. Over the most recent five years, the researchers have taken only 0.1% of their requested take, and killed none of their requested mortalities. Thus, it is most likely that the actual effect will be less than that displayed in the table above and would probably actually be no measurable effect at all in most years. But even if the entirety of the effect were actually to take place in any given year, it would have only the most minor impact on abundance and productivity and create no appreciable change in structure or diversity for any of the species in the permit. Nonetheless, even those minor negative effects would be offset to some degree by the fact that the research would benefit salmonids by helping managers write warmwater fish harvest regulations with the express purpose of reducing potential impacts on listed salmonids.

Permit 1379-8R

Under Permit 1379 – 7R, CRITFC would continue work they have been doing in the Columbia River basin for nearly two decades. The permit currently allows CRITFC to annually take adult and juvenile UCR Chinook and steelhead at Bonneville and Tumwater Dams, in the Wenatchee River, and in the Hanford reach of the Columbia River. The CRITFC researchers propose to renew their permit and would not change sampling locations, methods, or any other aspect of their research relative to what has been authorized for a number of years. Many of the fish would simply be captured, handled, and released, but some would be anesthetized, measured, and checked for marks and tags as well. The researchers are requesting the following amounts of take.

Table 43. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 1379-8R (C=Capture, H=Handle, R=Release).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
UCR Chinook	Adult	Natural	C/H/R	53	0	6.519	0.000
		LHIA	C/H/R	2	0	0.351	
		LHAC	C/H/R	2	0		
	Juvenile	Natural	C/H/R	205	4	0.040	<0.001
		LHAC	C/H/R	136	3	0.023	
UCR steelhead	Adult	Natural	C/H/R	53	0	3.618	0.000
	Juvenile	Natural	C/H/R	35	1	0.022	<0.001
		LHAC	C/H/R	4	0	<0.001	0.000

Because the vast majority of the juvenile fish and all adult fish that could be captured are expected to recover with no ill effects, the true effects of the proposed action are best seen in the context of the fish that the action may kill. To determine the effect of these losses, it is necessary to compare them to the total outmigrant numbers expected for these species (and their components) and (b) the total average returns over the last five years for which we have data. These calculations are displayed in the last column of the table above. This signifies that the research would in no case kill even as much as 0.001% of any juvenile component from any listed species and no adults at all. Moreover, because the research would take place primarily in the mainstem Columbia River (and no animals would be killed in Lake Wenatchee), the effects of that take effects would be spread out across the entirety of each listed unit and no single population would be disproportionately affected. Thus, the effects displayed must be analyzed in the context of each listed unit as a whole, and at those levels, the impacts are vanishingly small.

In addition, it is most likely that the impacts would be even smaller than those laid out above. Over the most recent five years, the researchers have taken only 1.8% of their requested take, and killed none of their requested mortalities. Thus, the actual effect will likely be less than that displayed in the table above and would probably be zero in most years. But even if the entirety of the effect were actually to take place in any given year, it would have only the most minor impact on abundance and productivity and create no measureable change in structure or diversity for either of the species in the permit. And even those minor negative effects would be offset to some degree by the information to be gained and applied to harvest management in the future.

Permit 1386-10R

The WDOE is seeking to renew for five years a research permit that would allow them to take adult and juvenile listed salmonids through most of the state of Washington. The purpose of the research is to investigate the occurrence and concentrations of toxic contaminants in non-anadromous freshwater fish tissue, sediment, and water, in order to meet Federal and state regulatory requirements. The WDOE proposes to capture fish using backpack and boat electrofishing, beach seining, block, fyke, and gill netting, and angling. All captured juvenile salmon and steelhead would be released immediately or held temporarily in an aerated live well before release. Any adult fish they encounter would be avoided entirely or released immediately without handling. The researchers do not propose to kill any fish but a small number may die as an unintended result of research activities. The researchers are requesting the following amounts of take.

Table 44. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 1386-10R (C=Capture, H=Handle, R=Release).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
PS Chinook	Adult	Natural	C/H/R	10	1	0.043	0.004
		LHAC	C/H/R	10	1		
	Juvenile	Natural	C/H/R	20	1	<0.001	<0.001
		LHAC	C/H/R	20	1		
PS steelhead	Adult	Natural	C/H/R	5	0	0.026	0.000
		LHAC	C/H/R	5	0	0.680	
	Juvenile	Natural	C/H/R	10	1	<0.001	<0.001
		LHAC	C/H/R	10	1	0.005	
HCS chum	Adult	Natural	C/H/R	5	0	0.018	0.000
	Juvenile	Natural	C/H/R	10	1	<0.001	<0.001
OL sockeye	Adult	Natural	C/H/R	5	0	0.085	0.000
		LHAC	C/H/R	5	0	1.618	
	Juvenile	Natural	C/H/R	10	1	<0.001	<0.001
		LHAC	C/H/R	10	1	0.022	0.002
UCR Chinook	Adult	Natural	C/H/R	5	0	0.615	0.000
		LHAC	C/H/R	5	0	0.439	
	Juvenile	Natural	C/H/R	10	1	0.002	<0.001
		LHAC	C/H/R	10	1		
UCR steelhead	Adult	Natural	C/H/R	5	0	0.341	0.000
		LHAC	C/H/R	5	0	0.173	
	Juvenile	Natural	C/H/R	10	1	0.006	<0.001
		LHAC	C/H/R	10	1	0.001	
MCR steelhead	Adult	Natural	C/H/R	5	0	0.037	0.000
		LHAC	C/H/R	5	0	0.701	
	Juvenile	Natural	C/H/R	10	1	0.003	<0.001
		LHAC	C/H/R	10	1	0.002	
	Adult	Natural	C/H/R	5	0	0.113	0.000

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
SnkR spr/sum Chinook		LHAC	C/H/R	5	0	0.177	
	Juvenile	Natural	C/H/R	10	1	0.001	<0.001
		LHAC	C/H/R	10	1	<0.001	
SnkR fall Chinook	Adult	Natural	C/H/R	5	0	0.069	0.000
		LHAC	C/H/R	5	0	0.034	
	Juvenile	Natural	C/H/R	10	1	0.001	<0.001
		LHAC	C/H/R	10	1	<0.001	
SnkR steelhead	Adult	Natural	C/H/R	5	0	0.050	0.000
		LHAC	C/H/R	5	0	0.152	
	Juvenile	Natural	C/H/R	10	1	0.001	<0.001
		LHAC	C/H/R	10	1	<0.001	
LCR Chinook	Adult	Natural	C/H/R	5	0	0.017	0.000
		LHAC	C/H/R	5	0	0.027	
	Juvenile	Natural	C/H/R	10	1	<0.001	<0.001
		LHAC	C/H/R	10	1		
LCR coho	Adult	Natural	C/H/R	5	0	0.027	0.000
		LHAC	C/H/R	10	1	0.063	0.006
	Juvenile	Natural	C/H/R	10	1	0.001	<0.001
		LHAC	C/H/R	20	1	<0.001	
LCR steelhead	Adult	Natural	C/H/R	5	0	0.061	0.000
		LHAC	C/H/R	5	0	0.078	
	Juvenile	Natural	C/H/R	10	1	0.003	<0.001
		LHAC	C/H/R	10	1	<0.001	
CR chum	Adult	Natural	C/H/R	5	0	0.029	0.000
	Juvenile	Natural	C/H/R	10	1	<0.001	<0.001

Because the vast 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 are best seen in the context of the fish that the action may kill. To determine the effect of these losses, it is necessary to compare them to the total outmigrant numbers expected for these species (and their components) and (b) the total average returns over the last five years for which we have data (see status section and Table 36). These calculations are displayed in the last column of the table above. This signifies that the research proposed under Permit 1386-10R would kill no more than one juvenile from any component of any species and, at most, one adult natural PS Chinook salmon and one adult adipose-fin-clipped hatchery LCR coho—resulting in mortality rates that range from 0.0% to 0.006%.

Thus the mortality rates are in every case either zero or as close to zero as it is possible to come. In addition, because the researchers would sample all over the state of Washington and in the Columbia River, no population is likely to experience a disproportionate amount of even those small losses. Therefore, the research is unlikely to have a lasting negative effect on any VSP parameter at any level for the species being taken: the effects on abundance and productivity would effectively be negligible and the effects on spatial structure and diversity would be unmeasurably small. Moreover, the actual take levels are very likely to be even smaller than even those requested. Over the most recent five years, the researchers have taken only 0.9% of their requested take, and killed 1.4% of their requested mortalities, so it is most likely that the actual effect will be less than that displayed in the table above by as much as two orders of magnitude. But even if the most pessimistic scenario were to ensue and the researchers were take all the fish allowed by the permit, those small losses would be offset to some extent by the fact that this research is designed to help managers study contaminant presence throughout the waters of Washington State—information that has been used for years to direct cleanup operations and generally benefit the state's fish and wildlife.

Permit 1410-13M

Under permit 1410-13M the NWFSC is seeking to modify a permit that would authorize them to take juvenile PS Chinook, 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 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, Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and SDPS eulachon in order to study the distribution, abundance, condition, and survival of juvenile Columbia River salmon and better understand the climate-ocean linkages and mechanisms that influence their marine survival.

Small numbers of juvenile salmonids would be collected via Nordic surface trawl and be intentionally lethally sacrificed for analysis of growth, genetics, parasites, pathogens, diet (stomach contents), and physiological condition. Adult salmon and steelhead may also be captured by the surface trawl, but would only be held in aerated live-wells until they could be identified, weighed, measured, and checked for marks or tags, and then released. While not the target of these studies, adult and subadult eulachon may also be captured, and if captured, are expected to have a 100% mortality rate with the trawl sampling gear. However, take of eulachon is not prohibited, and this study has not captured eulachon in the past 20 years.

The researchers are proposing to kill a small number of juvenile listed salmon and steelhead, and a small number of juveniles and adult eulachon may additionally be killed as an inadvertent result of these activities. The majority of this take was previously evaluated through the issuance of permit #1410-12R, which does not expire until the end of 2023. However, due to fluctuating abundances of juveniles being encountered the researchers are requesting to increase take of juveniles for some species. They are not requesting to increase take of any adult fish. Because the effects of the previously authorized take have already been evaluated, here we analyze only the increase in take currently being requested by this modification. The amount of take the NWFSC is requesting is 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 1410-13M. (C=Capture, H=Handle, R=Release, IM-Intentional Mortality)

Species	Life Stage	Origin	Take Action	Prior Total Take	Prior Lethal Take	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
PS Chinook	Juvenile	Natural	IM	1	1	11	11	<0.001	<0.001
		LHIA	IM	1	1	7	7	<0.001	<0.001
		LHAC	IM	1	1	19	19	<0.001	<0.001
UCR Chinook	Juvenile	Natural	IM	2	2	1	1	<0.001	<0.001
		LHIA	IM	1	1	0	0	0.000	0.000
		LHAC	IM	19	19	8	8	0.001	0.001
UCR Steelhead	Juvenile	Natural	IM	7	7	0	0	0.000	0.000
		LHIA	IM	7	7	0	0	0.000	0.000
		LHAC	IM	21	21	0	0	0.000	0.000
MCR Steelhead	Juvenile	Natural	IM	25	25	0	0	0.000	0.000
		LHAC	IM	11	11	0	0	0.000	0.000
SnkR Spr/sum Chinook	Adult	Natural	C/H/R	2	0	0	0	0.000	0.000
		LHAC	C/H/R	1	0	0	0	0.000	0.000
	Juvenile	Natural	IM	16	16	7	7	<0.001	<0.001
		LHIA	IM	1	1	0	0	0.000	0.000
		LHAC	IM	164	164	66	66	0.001	0.001
SnkR Fall Chinook	Adult	Natural	C/H/R	2	0	0	0	0.000	0.000
		LHAC	C/H/R	2	0	0	0	0.000	0.000
	Juvenile	Natural	IM	32	32	13	13	0.002	0.002
		LHIA	IM	3	3	0	0	0.000	0.000
		LHAC	IM	75	75	29	29	0.001	0.001
SnkR Steelhead	Adult	LHAC	C/H/R	1	0	0	0	0.000	0.000
	Juvenile	Natural	IM	14	14	0	0	0.000	0.000
		LHIA	IM	6	6	0	0	0.000	0.000
		LHAC	IM	30	30	0	0	0.000	0.000
SnkR Sockeye	Juvenile	LHAC	IM	6	6	0	0	0.000	0.000
LCR Chinook	Adult	Natural	C/H/R	29	0	0	0	0.000	0.000
		LHIA	C/H/R	7	0	0	0	0.000	0.000
		LHAC	C/H/R	48	0	0	0	0.000	0.000
	Juvenile	Natural	IM	31	31	13	13	<0.001	<0.001
		LHIA	IM	14	14	5	5	<0.001	<0.001
		LHAC	IM	124	124	49	49	<0.001	<0.001
LCR Coho	Adult	Natural	C/H/R	30	0	0	0	0.000	0.000
		LHIA	C/H/R	30	0	0	0	0.000	0.000
		LHAC	C/H/R	264	3	0	0	0.000	0.000
	Juvenile	Natural	IM	100	100	0	0	0.000	0.000
		LHIA	IM	100	100	0	0	0.000	0.000
		LHAC	IM	880	880	0	0	0.000	0.000
LCR Steelhead	Juvenile	Natural	IM	24	24	0	0	0.000	0.000
		LHAC	IM	24	24	0	0	0.000	0.000
LCR Chum	Juvenile	Natural	IM	36	36	0	0	0.000	0.000
		LHIA	IM	12	12	0	0	0.000	0.000
UWR Chinook	Adult	Natural	C/H/R	2	0	0	0	0.000	0.000
		LHAC	C/H/R	5	0	0	0	0.000	0.000
	Juvenile	Natural	IM	8	8	3	3	<0.001	<0.001
		LHIA	IM	1	1	1	1	-	-
		LHAC	IM	73	73	30	30	<0.001	<0.001
UWR Steelhead	Juvenile	Natural	IM	4	4	0	0	0.000	0.000
OC Coho	Adult	Natural	C/H/R	30	0	0	0	0.000	0.000

Species	Life Stage	Origin	Take Action	Prior Total Take	Prior Lethal Take	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
		LHAC	C/H/R	1	0	0	0	0.000	0.000
	Juvenile	Natural	IM	100	100	0	0	0.000	0.000
		LHAC	IM	10	10	0	0	0.000	0.000
SONCC Coho	Adult	Natural	C/H/R	3	0	0	0	0.000	0.000
		LHAC	C/H/R	3	0	0	0	0.000	0.000
	Juvenile	Natural	IM	10	10	0	0	0.000	0.000
		LHAC	IM	10	10	0	0	0.000	0.000
SRWR Chinook	Juvenile	Natural	IM	1	1	0	0	0.000	0.000
		LHAC	IM	1	1	0	0	0.000	0.000
CVS Chinook	Juvenile	Natural	IM	1	1	1	1	<0.001	<0.001
		LHAC	IM	1	1	7	7	<0.001	<0.001
SDPS eulachon	Adult	Natural	C/H/R	100	100	0	0	0.000	0.000
	Subadult	Natural	C/H/R	1,000	1,000	0	0		

Because the majority of the fish that would be captured and released are expected to recover with minimal 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, either intentionally or inadvertently. 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 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.
It is also likely that the imp acts will be smaller than those laid out above. Over the most recent four years of reporting, the researchers have taken only 12.2% of their requested take, and killed 12.4% of their requested mortalities, so it is most likely that the actual mortality will be much less than that displayed in the table above.

An effect of the research that cannot be quantified is the benefit it would have with respect to species conservation. Juvenile salmon and steelhead sampled under this permit would provide data on how changing ocean conditions will affect salmonid growth and survival, and will allow us to better understand how ocean and Columbia River plume conditions affect juvenile salmonids. This information, in turn, would continue to be used to help managers respond to changing river, plume, and ocean conditions to better help these species recover.

Permit 1465-5R

Under Permit 1465-5R, researchers from the IDFG would continue work they have been performing for nearly two decades. The IDFG does not propose to change sampling locations, methods, or any other aspect of their research relative to what has been authorized for a number of years. They would continue to use backpack- and boat electrofishing equipment to capture the juvenile fish in various streams throughout much of Idaho (Salmon and Clearwater River basins) and the mainstem of the Snake River. The captured fish would be measured and immediately released. Some of the fish may be anesthetized and measured, but for the most part, the fish would be handled as little as possible and swiftly released back to the water. The researchers are requesting the following amounts of take.

Table 46. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 1465-5R (C=Capture, H=Handle, R=Release).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
SnkR spr/sum Chinook	Juvenile	Natural	C/H/R	400	4	0.049	<0.001
		LHAC	C/H/R	100	2	0.002	

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
SnkR fall Chinook		Natural	C/H/R	100	1	0.013	
		LHAC	C/H/R	100	2	0.004	
SnkR steelhead		Natural	C/H/R	800	8	0.101	0.001
		LHAC	C/H/R	100	2	0.003	<0.001
SnkR sockeye		Natural	C/H/R	100	2	0.525	0.011
		LHAC	C/H/R	100	2	0.037	<0.001

Because the vast 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 are best seen in the context of the fish that the action may kill. To determine the effect of these losses, it is necessary to compare them to the total outmigrant numbers expected for these species (and their components) and (b) the total average returns over the last five years for which we have data (see status section and Table 36). These calculations are displayed in the last column of the table above. This signifies that the research proposed under Permit 1465-5R would kill no adults and, at most, no more than 0.01% of the outmigrating SnkR sockeye—and in all other cases the effect would be an order of magnitude or more smaller than that.

Because the research would take place different streams in the Clearwater and Salmon River subbasins from year to year (and the mainstem Snake River), it is difficult to narrow down the populations from which the juveniles would likely originate. For the sockeye, there is only one population, so the effect there would be for the listed unit as a whole. The same is true for fall Chinook salmon. For the other species, the majority of their production takes place in the proposed action area, so the effect would largely be as displayed. But even if the areas to be sampled constituted only half of the spawning habitat that actually produce SnkR spr/sum Chinook and steelhead instead of the majority (and thereby doubled the effective percentages given in the table above), the overall effects would still be vanishingly small—0.002% at most—and they would be seen only as very slight reductions in the species' abundance and productivity.

In addition, there is the fact that over the last several years this permit has been in force, the researchers have never taken nor killed all the fish they were allotted. Over the most recent five years, the researchers have taken only 13.4% of their requested take, and killed 11.3% of their requested mortalities, so it is most likely that the actual effect will be as much as an order of magnitude smaller than that displayed in the table above. But even if the all the fish permitted to be taken were to actually be taken, the result could be seen only as extremely small reductions in abundance and productivity. And even those small effects would still be offset to some degree by the fact that the research has for years been employed to monitor species and habitat health in Idaho, and that information, in turn, is used to inform a variety of management decisions throughout the region.

Permit 1564-6R

Under permit 1564-6R the University of Washington (UW) is seeking to renew a permit that would authorize them to take juvenile PS Chinook and PS steelhead in order to evaluate the success of habitat restoration projects within the Duwamish River. The researchers do not propose to change sampling locations, methods, or any other aspect of their research relative to what has been authorized for a number of years. Under the permit, juvenile salmon and steelhead would be continue to be collected via beach seine. The fish would be captured, handled (anesthetized, weighed, measured, and checked for marks or tags), and released. A subsample of captured juveniles would be anesthetized and non-lethally sampled for stomach contents via gastric lavage for diet analysis prior to release. 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 UW is requesting is 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 1564-6R (C=Capture, H=Handle, R=Release, T=Tag, M=Mark, ST=Sample Tissue).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
PS Chinook	Juvenile	Natural	C/H/R	100	1	0.003	<0.001
		Natural	C/M/T/ST/R	100	1		
		LHIA	C/H/R	24	0	<0.001	0.000
		LHIA	C/M/T/ST/R	16	0		
		LHAC	C/H/R	276	3	<0.001	<0.001
		LHAC	C/M/T/ST/R	184	2		
PS Steelhead	Juvenile	Natural	C/M/T/ST/R	25	1	0.001	<0.001
		LHIA	C/M/T/ST/R	8	0	0.009	0.000
		LHAC	C/M/T/ST/R	17	0		

Because the majority of the fish that would be captured are expected to recover with minimal 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. However, because this sampling is focused on only one tributary within the ESU and DPS there is the potential for effects to disproportionately affect the Green River populations of PS Chinook and steelhead. By applying the same fecundity and survival estimates used to estimate juvenile abundances for the ESU and DPS as a whole from the 5-year geomean of spawners reported in Ford (2022), we estimate that the spawning adults returning to the Green River would produce nearly 210 thousand natural-origin juvenile PS Chinook and over 146 thousand natural-origin juvenile PS steelhead. As a result, though the research is likely to affect a single population disproportionately, the lethal take of a very few individual juveniles will still barely affect the abundance of this population, and it would in no measurable way impact productivity, 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 five years, the researchers have taken only 0.4% of their requested take, and *none* of the mortalities permitted, so it is most likely that the actual effect will be negligible. An effect of the research that cannot be quantified is the benefit it would have with respect to species conservation. Juvenile salmon and steelhead sampled under this permit would provide data on how population characteristics among Chinook salmon change in response to restoration of estuarine habitat. This information, in turn, would continue to be used to help managers determine the effectiveness of recently completed projects and better plan future restoration efforts to help recover these species.

Permit 1586-5R

Under permit 1586-5R the NWFSC is seeking to renew a permit that would authorize them to take adult PS Chinook and SDPS eulachon, as well as juvenile PS Chinook, PS steelhead, PS/GB Bocaccio, PS/GB yelloweye, and HCS chum in order to characterize how wild, juvenile PS Chinook and various forage fish species use nearshore habitats in the oceanographic basins of Puget Sound, the Straits of Juan de Fuca, and the San Juan Islands. The researchers do not propose to change sampling locations, methods, or any other aspect of their research relative to what has been authorized for a number of years.

Juvenile salmon and steelhead as well as adult Chinook salmon would be collected via surface trawl, beach seine, hook and line angling. Some captured Chinook salmon would be handled (anesthetized, weighed, measured, and checked for marks or tags), and released, and a subsample of captured juvenile and adult Chinook salmon would have a fin, opercle, or scale tissue sample collected prior to release. An additional number of captured Chinook salmon juveniles—LHAC fish implanted with coded wire tags—would intentionally be sacrificed to collect information on hatchery releases, otoliths for saltwater entry information, scales for genetic data, tissue for chemistry analysis, and stomach contents for diet analyses. A small number of hatchery-origin subadult Chinook salmon would also be intentionally sacrificed for such analyses. Adult SDPS eulachon may be captured by trawls or beach seining, and all ESA-listed fish that are not Chinook salmon would be released as soon as feasible.

The researchers are proposing to kill a small number of listed PS Chinook, and a small number of fish may additionally be killed as an inadvertent result of these activities. The amount of take the NWFSC is requesting is 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 1586-5R (C=Capture, H=Handle, R=Release, T=Tag, M=Mark, ST=Sample Tissue).

Species	Life	Origin	Take	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
PS Chinook	Adult	Natural	C/H/R	40	4	0.203	0.011
		Natural	C/M/T/ ST/R	55	1		
		LHIA	C/H/R	50	0	1.184	0.129
		LHIA	C/M/T/ ST/R	75	5		
		LHAC	C/H/R	50	0		
		LHAC	C/M/T/ ST/R	75	0		
		LHAC	IM	25	25		
	Juvenile	Natural	C/H/R	5,050	31	0.070	0.001
		Natural	C/M/T/ ST/R	2,700	19		
		Natural	IM	100	100		
		LHIA	C/H/R	3,500	25	0.021	0.0010
		LHIA	C/M/T/ ST/R	1,500	20		
		LHIA	IM	200	200		
		LHAC	C/H/R	3,500	25	0.006	0.001
		LHAC	C/M/T/ ST/R	750	20		
		LHAC	IM	750	750		
PS Steelhead	Juvenile	Natural	C/H/R	75	2	0.003	<0.001
		LHIA	C/H/R	50	2	0.057	0.002
		LHAC	C/H/R	50	2	0.027	0.001
PS/GB Bocaccio	Juvenile	Natural	C/H/R	5	1	0.109	0.022
PS/GB yelloweye	Juvenile	Natural	C/H/R	9	1	0.008	<0.001
HCS chum	Juvenile	Natural	C/H/R	200	4	0.005	<0.001
		LHIA	C/H/R	80	2	0.053	0.001
SDPS eulachon	Adult	Natural	C/H/R	110	14	<0.001	<0.001

Because the majority of the fish that would be captured and released are expected to recover with minimal 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 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.

It is also likely that the impacts will be smaller than those laid out above. Over the most recent five years of reporting, the researchers have taken only 8.8% of their requested take, and killed 3.1% 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 benefit it would have with respect to species conservation. Fish sampled under this permit would provide data on ecological health of PS Chinook and forage fish populations in the context of changes in land use and foodwebs, and gain knowledge of the ecology and origin of wild, listed, PS Chinook, and their forage fish prey. This information, in turn, would continue to be used to help managers develop protection and restoration strategies and monitor the effects of recovery actions by tracking changes in abundance, composition, and genetic structure of nearshore populations of Chinook salmon and their prey throughout Puget Sound.

Permit 1587-7R

Under permit 1587-7R the USGS is seeking to renew a permit that would authorize them to take juvenile PS Chinook, PS Steelhead, HCS chum, and adult SDPS eulachon in order to study effects of urbanization of nearshore ecosystems and support restoration of Puget Sound deltas. The researchers do not propose to change sampling locations, methods, or any other aspect of their research relative to what has been authorized for a number of years.

Fish would be collected via lampara seines and hand or dip nets. Fish would be captured, handled (weighed, measured, and checked for marks or tags), and released. The researchers are not proposing to kill any of the listed fish being captured, but a small number may be killed as an inadvertent result of these activities. The amount of take the USGS is requesting is found in the table below.

Table 49. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 1587-7R (C=Capture, H=Handle, R=Release).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
PS Chinook	Juvenile	Natural	C/H/R	226	6	0.006	<0.001
		LHAC	C/H/R	346	8	0.001	<0.001
PS Steelhead	Juvenile	Natural	C/H/R	14	1	<0.001	<0.001
HCS chum	Juvenile	Natural	C/H/R	110	3	0.003	<0.001

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
SDPS eulachon	Adult	Natural	C/H/R	20	4	<0.001	<0.001

Because the majority of the fish that would be captured are expected to recover with minimal 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 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.

It is also likely that the impacts will be smaller than those laid out above. Over the most recent five years, the researchers have taken only 11.7% of their requested take, and killed 1.9% of their requested mortalities, so it is most likely that the actual effect will be more than an order of magnitude smaller than that displayed in the table above.

An effect of the research that cannot be quantified is the benefit it would have with respect to species conservation. Sampling under this permit would provide a better understanding of the fundamental physical, chemical, biological, and human processes that occur in nearshore ecosystems of Puget Sound, illuminate the linkages between watershed and marine systems, and gauge the effects human activities have on nearshore ecosystem processes. This information would continue to improve insight into these issues and assist resource managers with adaptive management of nearshore ecosystems and foodwebs to support PS Chinook and steelhead recovery.

Permit 1598-5R

Under the renewed Permit 1598-5R, the WDOT would continue to conduct snorkel surveys and capture (using seines, minnow traps, or backpack electrofishing), identify, and release listed fish. No adult salmonids would be captured, but a few SDPS eulachon might be encountered. The currently proposed work is identical to the work they have been conducting for the last five years. The research would take place throughout the State of Washington in different streams from year to year—depending on the WDOT's workload and the areas where projects are proposed. The NMFS electrofishing guidelines would be followed in all cases, sample sizes would be kept to a minimum, and boat electrofishing would only be conducted at times and in locations where adults of listed species are not normally present. And, if large numbers of juvenile salmonids are encountered, the researchers would cease operation and modify the location or timing of their sampling to reduce or eliminate encounters. The same would hold true if adults were to be encountered. The researchers are requesting the following amounts of take.

Table 50. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 1598-5R (C=Capture, H=Handle, R=Release).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
PS Chinook	Juvenile	Natural	C/H/R	22	1	<0.001	<0.001
	Juvenile	LHAC	C/H/R	48	2		
PS steelhead	Juvenile	Natural	C/H/R	22	1	0.0010	
	Juvenile	LHAC	C/H/R	44	2	0.024	0.001
HCS chum	Juvenile	Natural	C/H/R	4	1	<0.001	<0.001
OL Sockeye	Juvenile	Natural	C/H/R	5	1		
	Juvenile	LHAC	C/H/R	10	1	0.022	0.002
UCR Chinook	Juvenile	Natural	C/H/R	13	1	0.003	<0.001
	Juvenile	LHAC	C/H/R	21	1	0.004	
UCR steelhead	Juvenile	Natural	C/H/R	10	1	0.006	
	Juvenile	LHAC	C/H/R	20	1	0.003	
MCR steelhead	Juvenile	Natural	C/H/R	11	1		
	Juvenile	LHAC	C/H/R	22	1	0.005	
SnkR spr/sum Chinook	Juvenile	Natural	C/H/R	5	1	<0.001	
	Juvenile	LHAC	C/H/R	10	1		
SnkR fall Chinook	Juvenile	Natural	C/H/R	5	1		
	Juvenile	LHAC	C/H/R	10	1		
SnkR steelhead	Juvenile	Natural	C/H/R	10	1	0.001	
	Juvenile	LHAC	C/H/R	20	1	<0.001	
SnkR sockeye	Juvenile	Natural	C/H/R	5	1	0.026	0.005
	Juvenile	LHAC	C/H/R	10	1	0.004	<0.001
LCR Chinook	Juvenile	Natural	C/H/R	6	1	<0.001	
	Juvenile	LHAC	C/H/R	12	1		
LCR coho	Juvenile	Natural	C/H/R	30	1	0.004	
	Juvenile	LHAC	C/H/R	30	1	<0.001	
LCR steelhead	Juvenile	Natural	C/H/R	5	1	0.001	
	Juvenile	LHAC	C/H/R	10	1	<0.001	
CR chum	Juvenile	Natural	C/H/R	30	1		
SDPS eulachon	Adult	Natural	C/H/R	10	2		

Because the vast 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 are best seen in the context of the fish that the action may kill. To determine the effect of these losses, it is necessary to compare them to the total outmigrant numbers expected for these species (and their components) and (b) the total average returns over the last five years for which we have data (see status section and Table 36). These calculations are displayed in the last column of the table above and signify that the researchers would kill, at most, one juvenile from each component of each listed species except for (a) PS Chinook and steelhead that have had their adipose fins clipped (i.e., components for which there are no take prohibitions), and (b) two adult eulachon. That is, even in the worst case scenario, the researchers would in almost every instance cause an effect that is as close to zero impact as it is possible for them to have. Moreover, the research would take place throughout Washington State, so it is not possible to determine from where in the listed units the fish would originate and thus we cannot ascribe the impact to individual populations or to any group smaller than the entire listing units. As a result, the deaths of the juvenile salmonids and two adult eulachon must be placed in the contexts of their entire ESUs and DPSs, and the effect at those scales is vanishingly small. In no instance would the effect exceed the death of five thousandths of a percent of the outmigration for any given species—and for the adult eulachon, the effect is even smaller than that.

Thus, the research would have, at most, only a very small impact on abundance and productivity and no appreciable impact structure or diversity for any species, and even those nearly-zero losses are likely to be smaller in actuality. Over the most recent five years, the researchers have only neither take nor killed any listed fish at all, so it is most likely that the actual effect will be negligible in most years. But even if the entirety of the allowable take were taken in any given year, those small losses would be offset to some extent by the information generated from the research—information that would be used to guide WDOT maintenance projects so that they have the smallest possible impact on listed salmonids.

Permit 10093-3R

The CDFW has been conducting work under various iterations of permit 10093 for nearly 20 years. The most recent version 10093-2R, expired December 31, 2021. That permit authorized CDFW to take listed fish in streams throughout coastal CA. Fish would be captured by backpack electrofishing, beach seine, minnow traps, and weirs, and they would be observed during snorkel and spawning ground surveys. Some fish would be anesthetized, measured, weighed, tagged, and tissue sampled for genetic information. The researchers do not propose to change sampling locations, methods, or any other aspect of their research relative to what has been authorized for a number of years. The researchers are requesting the following levels of take:

Table 51. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 10093-3R (C=Capture, H=Handle, R=Release, T=Tag, M=Mark, ST=Sample Tissue, O=Observe, H=Harass).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
SONCC Coho	Adult	Natural	O/H	2,000	0	15.822	0.000
	Juvenile	Natural	C/H/R	1,300	13	0.264	<0.001

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
		Natural	C/M/T/ ST/R	1,200	12		
		Natural	O/H	4,500	0		
NC Steelhead	Adult	Natural	C/M/T/ ST/R	650	7	54.452	0.084
		Natural	O/H	3,900	0		
	Juvenile	Natural	C/H/R	24,550	246	1.611	0.013
		Natural	C/M/T/ ST/R	16,400	132		
		Natural	O/H	5,000	0		
CC Chinook	Adult	Natural	C/M/T/ ST/R	50	1	13.858	0.004
		Natural	O/H	3,600	0		
	Juvenile	Natural	C/H/R	1,250	13	0.187	0.001
		Natural	C/M/T/ ST/R	7,200	72		
		Natural	O/H	5,000	0		
CCC Coho	Adult	Natural	C/M/T/ ST/R	2,000	20	151.646	0.867
		Natural	O/H	1,500	0		
	Juvenile	Natural	C/H/R	33,250	333	12.988	0.108
		Natural	C/M/T/ ST/R	25,200	192		
		Natural	O/H	4,500	0		
CCC Steelhead		Natural	C/H/R	550	13	0.415	0.002
		Natural	C/M/T/ ST/R	150	2		
		Natural	O/H	2,000	0		

Because the research would be spread out across various Coastal California watersheds and streams, we do not expect the research to have a disproportionate effect on any one population. Even if we had determined that a population level analysis was warranted, we do not have abundance information for all of the coastal streams. We therefore compare the number of fish that may be affected by the research to the abundance of each ESU and DPS. 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 species (see status section and Table 36). That ratio is presented in the last column of the table above.

With the exception of CCC coho, the permitted activities may kill, at most, 0.084% of the expected abundance of any individual component of listed species and would therefore have only very small effects on those species' abundance and productivity. For CCC coho, the permitted activities may kill, at most, 20 adult CCC coho, which represents 0.867% of the expected abundance. That take (and any of its potential impacts) would be spread out over a broad geographic range of coastal watersheds throughout the state of California. Thus, no population is likely to experience a disproportionate amount of even these small losses and, as a result, the activities are likely to have only a small impact on species abundance (and therefore productivity) and no appreciable impact on structure or diversity.

Moreover, though the CDFW researchers have requested what they expect would be a maximum amount of take, it is very likely that they will catch far fewer fish than are found in their request. It is also likely that the impacts will be smaller than those laid out above. Over the most recent five years, the researchers have taken only 29.9% of their requested take, and killed 12.6% of their requested mortalities, so it is most likely that the actual effect will be on the order of one-tenth of that displayed in the table above.

An effect of the research that cannot be quantified is the benefit it would have with respect to species conservation. The project goal is to restore salmon and steelhead productivity in coastal California streams through a comprehensive restoration program. The specific goals of this research project are to assess and monitor streams to assess fish abundance and distribution. This research would benefit listed species by providing data to assess restoration projects and direct future habitat restoration needs.

Permit 13381-4R

Under Permit 13381 – 2R, the NWFSC would continue research in the Salmon River subbasin that they have been conducting for well over a decade under a previous version of this permit and under an earlier permit of a different number (1406). The researchers do not propose to change sampling locations, methods, or any other aspect of their research relative to what has been authorized for a number of years. The researchers would use seines, dipnets, and electrofishing equipment to capture the fish. Most fish would simply be released, but a substantial fraction would be handled, measured, tissue-sampled, and given a PIT-tag. The researchers would work primarily in multiple streams tributary to the Salmon River in Idaho, but they would also capture some fish at Little Goose Dam or Lower Granite Dam on the Snake River. The researchers do not intend to kill any of the fish they capture, but a small number may die as an inadvertent result of the activities. The researchers are requesting the following amounts of take.

Table 52. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 13381-4R (C=Capture, H=Handle, R=Release, T=Tag, M=Mark, ST-Sample Tissue).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
SnkR spr/sum Chinook	Juvenile	Natural	C/H/R	7,690	170	1.592	0.033
		Natural	C/M/T/ST/R	18,500	380		
SnkR steelhead		Natural	C/H/R	3,500	80	0.272	0.006
		Natural	C/M/T/ST/R	800	10		

Because the vast 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 are best seen in the context of the fish that the action may kill. To determine the effect of these losses, it is necessary to compare them to the total outmigrant numbers expected for these species (and their components) and (b) the total average returns over the last five years for which we have data (see status section and Table 36). These calculations are displayed in the last column of the table above.

This signifies that at the level of the listed units, the research may kill the up to 0.033% of the outmigrating spr/sum Chinook salmon and 0.006% of the outmigrating steelhead. However, these effects would be somewhat magnified by the fact that most of the fish would come the Salmon River subbasin (approximately 1,200 of the 26,200 spr/sum Chinook, though, would be collected at little Goose Damn—so those fish could come from anywhere in the ESU). The effects would be somewhat evenly distributed over approximately 16 streams during every field season—and the collection sites would likely change slightly from year to year—so it is unlikely that any particular population would suffer a disproportionate amount of loss. Given, though, that the collections would be restricted to only a portion of the DPS's range, the local effects in the Salmon River subbasin would indeed be slightly higher than the percentages in the table above would suggest. Yet, even if those impacts were doubled—and the Salmon River produces about 62% of the SnkR spr/sum Chinook and more than half of the SnkR steelhead (Ford 2022)—they would still represent only very small reductions in abundance and productivity (0.07% and 0.0012% for salmon and steelhead, respectively) and no measureable impact on structure or diversity. And once again, those impacts would be well-distributed throughput the subbasin, so no individual population is likely to be affected to a greater degree than any other.

Lastly, it is also likely that the impacts will be smaller than those laid out above. Over the most recent five years, the researchers have taken only 20.8% of their requested take, and killed 13.6% of their requested mortalities, so it is most likely that the actual effect would be as much as an order of magnitude smaller than that displayed in the table above. But even if the all the take permitted in a given year were actually to occur, that small effect would be offset by the information generated by the research—information that would be used to help recover the listed fish by helping budget water releases at the Columbia and Snake River dams and improving our understanding of the fishes' early life stage behavior and response to climate conditions.

Permit 13382-4R

Under Permit 13382-4R, the NWFSC would continue work they have been conducting under various authorizations for more than two decades in Idaho, SE Washington, and NE Oregon. Much work is essentially identical to work that has been previously analyzed three times and approved for the last 20 years. For most of the study, the NWFSC would capture juvenile fish using seines and electrofishing equipment, anesthetize, measure, and tissue-sample (fin clip) a portion of them, allow them to recover from the anesthetic, and release them back to their capture sites. They would also sample some fish that are handled under other permits for hatchery operations.

However, some of the study has for the last five years involved an extra procedure for some of the fish being taken. For that additional study, 16 additional juvenile Chinook and steelhead from each site would be anesthetized and held in cold, aerated water until they are run through thermal experiments. For these experiments, the fish would be exposed to brief but tolerable levels of heat stress and monitored individually, measuring cardiac output. Temperatures would be increased at a rate of 1 degree every 6 minutes. Because each fish is monitored individually, in the event a fish does reach its critical temperature it would immediately be returned to cool water for recovery. Following the experiment, all fish would be allowed to recover from the anesthetic, and then released live back into their stream of origin. It should be noted that as before, the additional procedure would not add any listed fish to the number authorized to be taken for the last nearly 20 years, nor would it increase the number of mortalities. The researchers are requesting the following amounts of take.

Table 53. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 13382-4R (C=Capture, H=Handle, R=Release, M=Mark, ST=Sample Tissue, T=Tag).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
SnkR spr/sum Chinook	Juvenile	Natural	C/H/R	319	7	0.083	0.001
		Natural	C/M/T/ST/R	1,050	16		
		LHIA	C/H/R	100	2	0.034	<0.001
		LHIA	C/M/T/ST/R	400	8		
		LHAC	C/H/R	500	10	0.021	
		LHAC	C/M/T/ST/R	1,500	40		
SnkR steelhead		Natural	C/H/R	340	7	0.057	0.001
		Natural	C/M/T/ST/R	553	11		
		LHIA	C/H/R	340	7	0.090	0.002

		LHIA	C/M/T/ ST/R	553	11		
		LHAC	C/H/R	500	15	0.024	<0.001
		LHAC	C/M/T/ ST/R	1,000	30		

Because the vast 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 are best seen in the context of the fish that the action may kill. To determine the effect of these losses, it is necessary to compare them to the total outmigrant numbers expected for these species (and their components) and (b) the total average returns over the last five years for which we have data (see status section and Table 36). These calculations are displayed in the last column of the table above and signify that the researchers would in all cases kill (at most) two-thousandths of a percent of any component of the steelhead or spr/sum Chinook outmigrations. Moreover, because that take would be spread out over tributaries in three states and locations would vary from year to year, it is impossible to assign that take to any grouping smaller than the entire listing units themselves and therefore no individual smaller unit (i.e., population) would suffer a disproportionate amount of the likely effects.

In addition, if the past is any indication, the likely effects would probably be a good deal smaller than those displayed. Over the most recent five years, the researchers have taken only 10% of their requested take, and killed 7.3% of their requested mortalities. So it is most likely that the actual effect could be 10 times (or more) smaller than the figures displayed in the table above. But even if the researchers were to take all the fish contemplated in the tables above, the losses would still be very small and would only be seen as slight reductions in abundance and productivity and would not measurably affect diversity or structure. Another thing to consider is the fact that for years the researchers have been providing important information about hatchery effects in the Snake River basin—information that continues to be used to inform a range of management decisions.

Permit 14419-4R

The Sonoma County Water Agency has been conducting work under various iterations of permit 14419 for a number of years. The most recent version 14419-3A, expired December 31, 2021. That permit authorized Sonoma County Water Agency to take listed fish in the Russian River watershed, CA. The researchers do not propose to change sampling locations, methods, or any other aspect of their research relative to what has been authorized for a number of years. Under the permit, fish would be captured by downstream-migrant trapping (rotary screw traps, fyke nets, and pipe/funnel nets), electrofishing (backpack and boat), otter trawl, hook-and-line sampling, and beach seining. Fish would also be observed during snorkel and spawning surveys. Some fish would be anesthetized, measured, weighed, tagged, scale-sampled, and/or tissue-sampled for genetic information. The stomach contents of a small subset of fish would be sampled using non-lethal gastric lavage. A maximum of 130 juvenile steelhead and 150 juvenile Chinook would be sacrificed for otolith microchemistry analysis. Beyond these subsets, the researchers do not intend to kill any listed fish, and any that are inadvertently killed would be used in place of the animals that would otherwise be sacrificed. The researchers are requesting the following levels of take:

Table 54. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 14419-4R (C=Capture, H=Handle, R=Release, T=Tag, M=Mark, ST=Sample Tissue, O=Observe, H=Harass, IM=Intentional Mortality, D=Dead Animal).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
CC Chinook	Adult	Natural	O/H	1,000	0	4.556	0.000
		Natural	O/ST D	200	0		
	Juvenile	Natural	C/H/R	2,050	62	0.173	0.007
		Natural	C/M/T/ ST/R	10,200	306		
		Natural	IM	150	150		
CCC Coho	Adult	Natural	O/H	1,000	0	129.983	0.000
		Natural	O/ST D	400	0		
		LHIA	O/H	1,000	0		
		LHIA	O/ST D	600	0		
	Juvenile	Natural	C/H/R	1,540	15	4.840	0.048
		Natural	C/M/T/ ST/R	14,100	141		
		LHIA	C/H/R	2,100	21	16.868	0.169
		LHIA	C/M/T/ ST/R	45,130	451		
CCC Steelhead	Adult	Natural	C/H/R	36	0	255.299	0.000
		Natural	O/H	2,000	0		
		Natural	O/ST D	400	0		
		LHAC	C/H/R	30	0		
		LHAC	O/H	2,000	0		
		LHAC	O/ST D	400	0		
	Juvenile	Natural	C/H/R	12,000	360	9.615	0.308
		Natural	C/M/T/ ST/R	50,410	1,512		
		Natural	IM	130	130		
		LHAC	C/H/R	8,500	255	1.409	0.042
		LHAC	C/M/T/ ST/R	6,150	185		

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 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 species (see status section). That ratio is presented in the last column of the table above. It signifies that the research, in total, would kill at most 0.308% of the juvenile abundance of any ESU/DPS for any of the listed salmon or steelhead.

The researchers do not propose to kill any adult fish. However, because the sampling is focused on the Russian River, there is potential for effects to disproportionality affect the populations of CC chinook, CCC coho, and CCC steelhead in the Russian River watershed. For CC Chinook, the juvenile fish that may be killed (518) represents 0.113% of the Russian River population. For CCC coho, the juvenile fish that make be killed represents (1.904%) for natural-origin fish (156) and 0.429% for hatchery-origin fish (472). For CCC steelhead, we do not have population data for natural-origin fish. For CCC steelhead hatchery-origin juveniles, the fish that may be killed (440) represents 0.088% of the population. It is important to note that the numbers of fish that may be killed are artificially inflated because the researchers were required to add take for every possible method they may employ, but is extremely unlikely that they would employ every method proposed. That is, it is very unlikely in any given year that they would electrofish, seine, trawl and hook-and-line angle for each species. Thus, even if all the authorized mortality did occur, there would only be very small impacts on the species' abundance and productivity, and no discernible effect on population 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 taken only 11% of their requested take, and killed 1.7% of their requested mortalities, so it is most likely that the actual effect would be less than one-fiftieth of that displayed in the table above.

An effect of the research that cannot be quantified is the benefit it would have with respect to species conservation. The project's goal is to detect and depict trends in ESA-listed salmonid populations in the Russian River watershed and to monitor the results of salmonid habitat enhancement efforts. This research would benefit listed species by providing life cycle and habitat-specific estimates of residence time, growth, and survival so that resource management agencies can better identify and prioritize key restoration actions in the Russian River watershed.

Permit 15542-6R

TRPA has been conducting work under various iterations of Permit 15542 for more than 10 years. The most recent version, 15542-5A, expired on December 31, 2021. That permit authorized TRPA to take listed species by backpack electrofishing in Lower Putah Creek, CA. TRPA proposes to renew their permit with the addition of a tissue sampling but otherwise would not change sampling locations, methods, or other aspect of their research relative to what has been authorized for a number of years. The researchers do not propose to intentionally kill any fish, but a small number may die as an unintended result of the research activities. The researchers are requesting the following levels of take:

Table 55. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 15542-6R (C=Capture, H=Handle, R=Release, T=Tag, M=Mark, ST=Sample Tissue).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
CCV Steelhead	Adult	Natural	C/H/R	2	0	0.017	0.000
	Juvenile	Natural	C/H/R	210	7	0.010	<0.001
		Natural	C/M/T/ ST/R	40	1		

We do not have any abundance information for Putah Creek, so we compare the number of fish that may be killed by the research to the abundance of the DPS. 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 species (see status section and Table 36). That ratio is presented in the last column of the table above. It signifies that the research, in total, would kill at most <0.001% of the juveniles produced in the CCV steelhead DPS. Thus, even if all the authorized mortality did occur, there would only be very small impacts on the species' abundance and productivity, and no discernible effect on population structure or diversity. This is also true at the population level: even without data on how many fish return to Putah Creek, the potential loss of eight juveniles that are unlikely to survive to adulthood in any case would very probably have no more than a very small effect on even local abundance and productivity.

It is also likely that the impacts will be smaller than those laid out above. Over the most recent five years, the researchers have taken only 24.7% of their requested take, and killed 5.8% of their requested mortalities. So it is most likely that the actual annual effect will be around one-twentieth of that displayed in the table above—which would mean that in any given year the researchers are unlikely to kill any fish at all.

An effect of the research that cannot be quantified is the benefit it would have with respect to species conservation. The project's goal is to monitor the distribution and relative abundance of fish populations in Putah Creek downstream from the Putah Diversion Dam. This research would benefit listed steelhead by providing information on fish response to river flows, and generating baseline information on the distribution and diversity of rainbow trout/steelhead in Putah Creek.

Permit 15548-2R

TRPA has been conducting work under various iterations of Permit 15548 for more than 10 years. The most recent version, 15548, expired on December 31, 2021. That permit authorized TRPA to take listed species by backpack electrofishing in in Suisun Creek, Green Valley Creek, and Ledgewood Creek in Solano and Napa Counties, CA. Listed fish would be captured by backpack and boat electrofishing; they would then be identified by species, measured, weighed, allowed to recover, and released. The researchers do not propose to change sampling locations, methods, or any other aspect of their research relative to what has been authorized for a number of years. The researchers are requesting the following levels of take:

Table 56. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 15548-2R (C=Capture, H=Handle, R=Release).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
CCC Steelhead	Adult	Natural	C/H/R	2	0	0.105	0.000
	Juvenile	Natural	C/H/R	250	8	0.115	0.004

We do not have abundance information for these creeks so we compare the number of fish that may be killed by the research to the abundance of the DPS. 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 species (see status section and Table 36). That ratio is presented in the last column of the table above. It signifies that the research, in total, would kill at most 0.004% of the juveniles produced in the CCC steelhead DPS. Thus, even if all the authorized mortality did occur, there would only be very small impacts on the species' abundance and productivity, and no discernible effect on population structure or diversity. And even without data on the how many fish return to these four creeks, Creek, the potential loss of eight juveniles that are unlikely to survive to adulthood in any case would very probably have no more than a very small effect on local abundance and productivity and little or none on diversity or structure.

It is also likely that the impacts will be smaller than those laid out above. Over the most recent five years, the researchers have taken only 18.5% of their requested take, and killed 5% of their requested mortalities. So it is most likely that the actual annual effect will be around one-twentieth of that displayed in the table above—which would mean that in any given year the researchers are unlikely to kill any fish at all.

An effect of the research that cannot be quantified is the benefit it would have with respect to species conservation. The project's goal is to monitor fish distribution, population structure, relative abundance, condition, and general health. The research would benefit CCC steelhead by producing data that would be used to help develop the Solano Habitat Conservation Plan.

Permit 15848-3R

Under permit 15848-3R the WDFW is seeking to renew a permit that would authorize them to take juvenile and adult PS Chinook, PS Steelhead, PS/GB Bocaccio, PS/GB yelloweye, HCS chum, SDPS eulachon, and adult southern DPS green sturgeon in order to estimate the relative numerical and biomass abundance of bottomfish in Puget Sound, and to collect information on the distribution and biology of key marine vertebrate and invertebrate resources. The researchers do not propose to change sampling locations, methods, or any other aspect of their research relative to what has been authorized for a number of years.

Adult and juvenile fish would be collected via bottom trawl. ESA-listed adult and juvenile fish would be captured, handled (anesthetized, weighed, measured, and checked for marks or tags), and released. The researchers are not proposing to kill any of the listed fish being captured, but because of the sampling method, a subset of ESA-listed salmon and steelhead captured may be killed as an inadvertent result of these activities, and no eulachon captured via this sampling method are expected to survive. The researchers are requesting the following amounts of take.

Table 57. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 15848-3R. (C=Capture, H=Handle, R=Release)

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
PS Chinook	Adult	Natural	C/H/R	5	1	0.021	0.004
		LHAC	C/H/R	10	2	0.043	0.009
	Juvenile	Natural	C/H/R	5	1	<0.001	<0.001
		LHAC	C/H/R	10	2		
PS Steelhead	Adult	Natural	C/H/R	3	1	0.016	0.005
		LHAC	C/H/R	2	1	0.272	0.136
	Juvenile	Natural	C/H/R	3	1	<0.001	<0.001
		LHAC	C/H/R	2	1	0.001	
PS/GB Bocaccio	Adult	Natural	C/H/R	5	2	0.434	0.152
	Juvenile	Natural	C/H/R	15	5		
PS/GB yelloweye	Adult	Natural	C/H/R	2	1	0.004	0.002
	Juvenile	Natural	C/H/R	3	1		
HCS chum	Adult	Natural	C/H/R	2	1	0.007	0.004
	Juvenile	Natural	C/H/R	3	1	<0.001	<0.001
SDPS eulachon	Adult	Natural	C/H/R	300	300	0.001	0.001
	Juvenile	Natural	C/H/R	100	100		
Southern DPS green sturgeon	Adult	Natural	C/H/R	1	0	0.047	0.000

Because the majority of fish released alive after capture are expected to recover with minimal 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 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.

It is also likely that the impacts will be smaller than those laid out above. Over the most recent five years, the researchers have taken only 4.8% of their requested take, and killed 5.3% of their requested mortalities, so it is most likely that the actual effect in any given year will be around one-twentieth of that displayed in the table above.

An effect of the research that cannot be quantified is the benefit it would have with respect to species conservation. Sampling under this permit would provide scientists, managers, and stakeholders with information about the demographic structure of populations, growth rates, genetic structure, food web relationships, ecosystem patterns, and ecological productivity within Puget Sound, which affects predator-prey relationships and survival of ESA-listed salmon and steelhead populations migrating through Puget Sound. This information would continue to be used to characterize the biology and distribution of key and minor groundfish species, develop food web and ecosystem model inputs, inform commercial and recreational fishery management policy, and promulgate effective fishery regulations.

Permit 15890-3R

Under permit 15890-3R the WDFW is seeking to renew a permit that would authorize them to take adult and juvenile PS Chinook, PS Steelhead, PS/GB Bocaccio, PS/GB yelloweye, HCS chum, SDPS eulachon in order to estimate the abundance of pelagic species in key areas in Puget Sound and to obtain important demographic information about forage fish stocks. The researchers do not propose to change sampling locations, methods, or any other aspect of their research relative to what has been authorized for a number of years.

Adults and juveniles would be collected via midwater trawl. Adult and juvenile fish would be captured, handled (weighed, measured, and checked for marks or tags), and released. Salmon, steelhead, and rockfish captured may also have fin clip or scale samples collected prior to release. The researchers are not proposing to kill any of the listed fish being captured, but because of the sampling method a subset of ESA-listed salmon, steelhead, or rockfish captured may be killed as an inadvertent result of these activities, and no eulachon captured via this sampling method are expected to survive. The amount of take the WDFW is requesting is found in the table below.

Table 58. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 15890-3R (C=Capture, H=Handle, R=Release, T=Tag, M=Mark, ST=Sample Tissue).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
PS Chinook	Adult	Natural	C/M/T/ ST/R	5	1	0.021	0.004
		LHAC	C/M/T/ ST/R	5	1	0.022	
	Juvenile	Natural	C/M/T/ ST/R	50	5	0.001	<0.001
		LHAC	C/M/T/ ST/R	100	25	<0.001	<0.001
PS Steelhead	Adult	Natural	C/M/T/ ST/R	1	0	0.005	0.000
		LHAC	C/M/T/ ST/R	1	0	0.136	0.000
	Juvenile	Natural	C/M/T/ ST/R	10	2	<0.001	<0.001
		LHAC	C/M/T/ ST/R	10	2	0.005	0.001
PS/GB Bocaccio	Adult	Natural	C/M/T/ ST/R	1	1	0.043	0.043
	Juvenile	Natural	C/M/T/ ST/R	1	1		
PS/GB yelloweye	Adult	Natural	C/M/T/ ST/R	1	1	0.002	0.002
	Juvenile	Natural	C/M/T/ ST/R	1	1		
HCS chum	Adult	Natural	C/M/T/ ST/R	5	1	0.018	0.004
	Juvenile	Natural	C/M/T/ ST/R	50	5	0.001	<0.001
SDPS eulachon	Adult	Natural	C/H/R	100	100	<0.001	<0.001
	Juvenile	Natural	C/H/R	50	50		

Because the majority of the fish released alive after capture are expected to recover with minimal 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 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.

It is also likely that the impacts will be smaller than those laid out above. Over the most recent six years of reporting, the researchers have taken only 0.3% of their requested take, and killed none of their requested mortalities, so it is most likely that the proposed activities' effects will actually be negligible in any given year.

An effect of the research that cannot be quantified is the benefit it would have with respect to species conservation. Sampling under this permit would provide scientists, managers, and stakeholders with biological and distribution information on ESA-listed salmon and steelhead in Puget Sound, as well as other pelagic species with which they interact. This study would also collect samples of zooplankton, and potentially ichthyoplankton, to gain knowledge about different trophic levels of the southern Salish Sea. Local, state, tribal, and federal fishery and ecosystem managers and scientists would continue to use this information would continue to be used to track population and demographic trends of fish populations and food webs in the Puget Sound.

Permit 16021-3R

Under permit 16021-3R the WDFW is seeking to renew a permit that would authorize them to take juvenile and adult PS Chinook, PS/GB Bocaccio, PS/GB yelloweye, and adult SDPS eulachon, and southern DPS green sturgeon in order to study the stock structure, biology, food web relationships, and abundance of groundfish species in Puget Sound. Most of the research would remain the same as it has been for years, but the researchers are proposing to add a new collection method: dinglebar trolling

Juveniles and adults would be collected via live-capture traps and hook-and-line angling. As noted, dinglebar trolling will also be utilized, but only in locations, depths, and timing windows where ESA-listed species are not known to occur. Captured fish would be handled (weighed, measured, and checked for marks or tags), and released. Bocaccio and yelloweye rockfish captured via hook and line angling would have a fin or opercle tissue sample collected, and be Floy-tagged prior to release. The researchers are not proposing to kill any of the listed fish being captured, but because of the sampling method, a subset of ESA-listed salmon, steelhead, or rockfish captured may be killed as an inadvertent result of these activities, and any eulachon captured via this sampling method are not expected to survive. The amount of take the WDFW is requesting is found in the table below.

Table 59. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 16021-3R. (C=Capture, H=Handle, R=Release, T=Tag, M=Mark, ST=Sample Tissue)

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
PS Chinook	Adult	Natural	C/H/R	5	1	0.021	0.004
		LHAC	C/H/R	5	1	0.022	0.004
	Juvenile	Natural	C/H/R	5	1	<0.001	<0.001
		LHAC	C/H/R	5	1		
PS/GB Bocaccio	Adult	Natural	C/M/T/ST/R	1	1	0.065	0.043
	Juvenile	Natural	C/H/R	1	0		
		Natural	C/M/T/ST/R	1	1		

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
PS/GB yelloweye	Adult	Natural	C/M/T/ST/R	5	5	0.010	0.009
	Juvenile	Natural	C/H/R	1	0		
		Natural	C/M/T/ST/R	5	5		
SDPS Eulachon	Adult	Natural	C/H/R	10	10	<0.001	<0.001
SDPS Green Sturgeon	Adult	Natural	C/H/R	1	0	0.047	0.000

Because the majority of the fish released alive after capture are expected to recover with minimal 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 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.

It is also likely that the impacts will be smaller than those laid out above. Over the most recent five years, the researchers have taken only 1.7% of their requested take, and killed none of their requested mortalities, so it is most likely that the actual effect will be negligible in any given year.

An effect of the research that cannot be quantified is the benefit it would have with respect to species conservation. Sampling under this permit would provide information on behavior, feeding, maturity, growth, species composition, stock identity, mate and site fidelity, and mortality of rockfish in the Puget Sound, where limited information is available on ESA-listed rockfish species due to their very low abundance. This research program would also provide information on the settlement patterns of rockfishes and other small, benthic groundfishes that are important components of the ecosystem. Growth, age, and reproductive information will inform spatially-explicit population models, species distribution maps, and food web analyses for rockfish, and data collected on listed species would be used for genetic and population modeling efforts that inform and guide on-going and future recovery efforts of listed Puget Sound/Georgia Basin rockfish DPSs.

Permit 16069-4R

Under Permit 16069-4R, the City of Portland would continue to conduct yearly research that would include capturing, handling, and releasing fish from all species passing through the lower Columbia

River. The work would be conducted in the lower Willamette River, the Columbia Slough, and the Columbia River mainstem and would employ backpack- and boat electrofishing equipment. All captured fish would be retained in aerated water long enough for them to recover and then would be released. Juvenile fish would also have a small (2mm X 2mm) piece of tissue taken from their caudal fines for genetic analysis so, in most cases, only juveniles would be affected, and in no case would adults be killed. The researchers would work in cooperation with the Environmental Protection Agency to monitor the health of watersheds under the City's jurisdiction and determine the effectiveness of habitat restoration projects. The NMFS electrofishing guidelines would be followed, sample sizes would be kept to a minimum, and boat electrofishing would only be conducted at times and in locations where adults of listed species are not normally present. Moreover, if at any point the researchers encounter large numbers of juvenile salmonids, they would cease operation and modify the location or timing of their sampling. The same would hold true if any adults were to be encountered. The researchers are requesting the following amounts of take.

Table 60. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 16069-4R (C=Capture, H=Handle, R=Release, T=Tag, M=Mark, ST-Sample Tissue).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
UCR Chinook	Juvenile	Natural	C/M/T/ ST/R	20	1	0.004	<0.001
		LHAC	C/M/T/ ST/R	20	1	0.003	
UCR steelhead		Natural	C/M/T/ ST/R	20	1	0.012	
		LHAC	C/M/T/ ST/R	20	1	0.003	
MCR steelhead	Adult	Natural	C/H/R	3	0	0.022	0.000
		LHAC	C/H/R	3	0	0.421	
	Juvenile	Natural	C/M/T/ ST/R	40	1	0.011	<0.001
		LHAC	C/M/T/ ST/R	40	1	0.009	
SnkR spr/sum Chinook		Natural	C/M/T/ ST/R	20	1	0.002	
		LHAC	C/M/T/ ST/R	20	1	<0.001	
SnkR fall Chinook		Natural	C/M/T/ ST/R	20	1	0.003	
		LHAC	C/M/T/ ST/R	20	1	<0.001	
SnkR steelhead		Natural	C/M/T/ ST/R	20	1	0.003	
		LHAC	C/M/T/ ST/R	20	1	<0.001	
SnkR sockeye		Natural	C/M/T/ ST/R	20	1	0.105	0.005

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
		LHAC	C/M/T/ ST/R	20	1	0.007	<0.001
LCR Chinook	Adult	Natural	C/H/R	3	0	0.010	0.000
		LHAC	C/H/R	3	0	0.016	
	Juvenile	Natural	C/M/T/ ST/R	300	9	0.003	<0.001
		LHAC	C/M/T/ ST/R	310	9	0.001	
LCR coho	Adult	Natural	C/H/R	3	0	0.016	0.000
		LHAC	C/H/R	3	0	0.019	
	Juvenile	Natural	C/M/T/ ST/R	290	9	0.037	0.001
		LHAC	C/M/T/ ST/R	325	10	0.004	<0.001
LCR steelhead	Adult	Natural	C/H/R	3	0	0.037	0.000
		LHAC	C/H/R	3	0	0.047	
	Juvenile	Natural	C/M/T/ ST/R	250	8	0.067	0.002
		LHAC	C/M/T/ ST/R	245	8	0.021	<0.001
CR chum		Natural	C/M/T/ ST/R	40	2	<0.001	
UWR Chinook	Adult	Natural	C/H/R	3	0	0.028	0.000
		LHAC	C/H/R	3	0	0.012	
	Juvenile	Natural	C/M/T/ ST/R	150	5	0.013	<0.001
		LHAC	C/M/T/ ST/R	190	6	0.004	
UWR steelhead	Adult	Natural	C/H/R	3	0	0.114	0.000
	Juvenile	Natural	C/M/T/ ST/R	150	5	0.110	0.004
SDPS eulachon	Adult	Natural	C/H/R	20	1	<0.001	<0.001
SDPS green sturgeon		Natural	C/H/R	1	0	0.047	0.000

Because the vast 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 are best seen in the context of the fish that the action may kill. To determine the effect of these losses, it is necessary to compare them to the total outmigrant numbers expected for these species (and their components) and (b) the total average returns over the last five years for which we have data (see status section and Table 36). These calculations are displayed in the last column of the table above and signify that the research would kill no adult salmonids, but could kill, at most, 0.005% of the juvenile outmigration for any of the species considered listed in the table above. The researchers may also kill as much as one adult eulachon, which would constitute far less than 0.001% of the DPS.

Because the research would take place in Columbia Slough and the lower mainstem Willamette River, it is not possible to determine from where in the listed units the juveniles would originate, and thus we cannot ascribe the impact to individual populations or to any group smaller than the entire listing units. As a result, the deaths of the single eulachon and the juvenile salmonids must be placed in the contexts of the entire ESUs and DPSs, and the effect at those scales is vanishingly small. As noted above, the loss of one adult eulachon is nearly effectively negligible, and in no instance would the research kill more than a few one-thousandths of a percent of the outmigration for any given salmonid species. Thus, the research would have, at most, only a very small impact on abundance and productivity and no appreciable impact structure or diversity. In fact, in many cases, the impact is as close to zero as it is possible for the researchers to get.

Furthermore, it is likely that the impacts will be much smaller than those laid out above. Over the most recent five years, the researchers have taken only 1.6% of their requested take, and killed 0.9% of their requested mortalities. As a result, it is most likely that the actual effect will be more than an order of magnitude smaller than that displayed in the table above. But even should the maximum permitted take actually occur in any given year, those small losses would be offset to some extent by the information generated from the research—information the City of Portland uses to help guide habitat restoration and protection efforts so that they may have the greatest possible positive impact on listed salmonids.

Permit 16091-3R

Under permit 16091-3R the WDFW is seeking to renew a permit that would authorize them to take adult and juvenile PS Chinook, PS Steelhead, PS/GB Bocaccio, PS/GB yelloweye, HCS chum, SDPS eulachon, and adult southern DPS green sturgeon in order to monitor English sole (as an indicator species) throughout the greater Puget Sound area for tissue levels of toxic chemical contaminants, and biomarkers signifying adverse health effects. The researchers do not propose to change sampling locations, methods, or any other aspect of their research relative to what has been authorized for a number of years.

Juveniles and adults would be collected via bottom trawl. All ESA-listed fish captured would be handled (weighed, measured, and checked for marks or tags), and released. The researchers are not proposing to kill any of the listed fish being captured, but because of the sampling method, a subset of Chinook salmon captured may be killed as an inadvertent result of these activities, and none of the eulachon, chum salmon, steelhead, or rockfish that may be captured via this sampling method are expected to survive. The amount of take the WDFW is requesting is found in the table below.

Table 61. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 16091-3R (C=Capture, H=Handle, R=Release).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
PS Chinook	Adult	Natural	C/H/R	6	2	0.026	0.009
		LHAC	C/H/R	6	2	0.026	0.009
	Juvenile	Natural	C/H/R	50	12	0.001	<0.001

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
		LHAC	C/H/R	200	50	<0.001	<0.001
PS Steelhead	Adult	Natural	C/H/R	1	1	0.005	0.005
		LHAC	C/H/R	1	1	0.136	0.136
	Juvenile	Natural	C/H/R	1	1	<0.001	<0.001
		LHAC	C/H/R	1	1	<0.001	<0.001
PS/GB Bocaccio	Adult	Natural	C/H/R	5	5	0.217	0.217
	Juvenile	Natural	C/H/R	5	5		
PS/GB yelloweye	Adult	Natural	C/H/R	5	5	0.009	0.009
	Juvenile	Natural	C/H/R	5	5		
HCS chum	Adult	Natural	C/H/R	1	1	0.004	0.004
	Juvenile	Natural	C/H/R	1	1	<0.001	<0.001
SDPS eulachon	Adult	Natural	C/H/R	60	60	<0.001	<0.001
	Juvenile	Natural	C/H/R	100	100		
Southern DPS green sturgeon	Adult	Natural	C/H/R	1	0	0.047	0.000

Many of the fish captured under this research permit would survive without further ill effect, but most would 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 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.

It is also likely that the impacts will be smaller than those displayed above. Over the most recent five years, the researchers have taken only 0.4% of their requested take, and killed 0.6% of their requested mortalities, so it is most likely that the actual effect in any given year will be more than an order of magnitude smaller than that displayed in the table above.

An effect of the research that cannot be quantified is the benefit it would have with respect to species conservation. Sampling under this permit would provide information on the extent and magnitude of toxic chemical contamination over time in the Puget Sound benthic food web, assess the effects of contamination on the health of Puget Sound fishes, and identify and track progression of local contamination issues. This information would continue to be used by natural resource managers to better understand toxic contaminant impacts on the benthic food web, monitor changes in toxic contaminant levels on a local level, and prioritize cleanup efforts to maximize advances towards recovery.

Permit 16318-4R

Hagar Environmental Science (HES) has been conducting work under various iterations of permit 16318 for a number of years. The most recent version 16318-3M, expired December 31, 2021. That permit authorized HES to take listed fish in streams throughout Santa Cruz, Monterey, and San Luis Obispo counties, CA. Fish would be captured with beach seines and backpack electrofishing. Fish would be enumerated, measured, and observed for external condition. A subset of the captured fish would be anesthetized, measured, weighed, PIT tagged, have a tissue sample taken, allowed to recover, and released. HES would also observe fish during snorkel/dive surveys. HES proposes to renew their permit and have requested a few minor sampling location changes but would not change methods, or other aspect of their research relative to what has been authorized for the last several years. The researchers do not propose to intentionally kill any fish, but a small number may die as an unintended result of the research activities. The researchers are requesting the following levels of take:

Table 62. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 16318-4R (C=Capture, H=Handle, R=Release, T=Tag, M=Mark, ST=Sample Tissue, O=Observe, H=Harass).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
CCC Coho	Juvenile	Natural	C/H/R	600	12	0.309	0.004
		Natural	O/H	400	0		
		LHIA	C/H/R	20	1	0.014	<0.001
CCC Steelhead		Natural	C/H/R	12,800	128	3.349	0.040
		Natural	C/M/T/ ST/R	6,580	132		
		Natural	O/H	2,400	0		

Because the research would be spread out across various central CA coast watersheds and streams, we do not expect the research to have a disproportionate effect on any one population. Even if we had determined that a population level analysis was warranted, we do not have abundance information for all of the watersheds. We therefore compare the number of fish that may be killed by the research to the abundance of the ESU/DPS.

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 species (see status section and Table 36). That ratio is presented in the last column of the table above. It signifies that the research, in total, would kill at most 0.040% of the abundance of any ESU/DPS for any of the listed salmon or steelhead. Thus, even if all the authorized mortality did occur, there would only be very small impacts on the species' abundance and productivity, and no discernible effect on population 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 taken only 19.1% of their requested take, and killed 11.4% of their requested mortalities, so it is most likely that the actual effect in any given year would be nearly an order of magnitude smaller than 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 purpose of this study is to assess salmonid habitat, presence, and abundance in order to inform watershed management and establish baseline population abundances before habitat conservation measures are implemented. This research would benefit listed species by providing population, distribution and habitat data that would be used to draft a Habitat Conservation Plan for the City of Santa Cruz.

Permit 16521-3R

Under Permit 16521-3R, the WDFW's primary activity would be to employ beach seines to capture, anesthetize (with MS-222), measure, and release juvenile fish in the Hanford reach of the Columbia River. The researchers do not propose to change sampling locations, methods, or any other aspect of their research relative to what has been authorized for a number of years. Once captured, the fish would be held in a floating net pen until sampled. All fish would be identified to species and enumerated. Up to 100 individuals of each species they encounter would also have their lengths measured. All fish would be allowed to recover and then be released back to the river. As a secondary activity, the WDFW would also use backpack electrofishing equipment and hand nets to capture a few fish trapped in pools when the river level recedes, transport them back to the Columbia River, and release them. The sampling to assess juvenile fall Chinook abundance and length frequency distribution would generally begin when the fry emerge in early March and continue through mid- to late June, but the surveys and the rescue operations could come before or after that period if the researchers determine they need more information on the impacts operations at McNary Dam may be having on the (non-listed) Hanford reach Chinook. The researchers are requesting the following amounts of take.

Table 63. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 16521-3R (C=Capture, H=Handle, R=Release).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
UCR Chinook	Juvenile	Natural	C/H/R	55	1	0.011	<0.001
		LHAC	C/H/R	55	1	0.009	
UCR steelhead		Natural	C/H/R	15	1		
		LHAC	C/H/R	15	1	0.002	

Because the vast 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 are best seen in the context of the fish that the action may kill. To determine the effect of these losses, it is necessary to compare them to the total outmigrant numbers expected for these species (and their components) and (b) the total average returns over the last five years for which we have data (see status section and Table 36). These calculations are displayed in the last column of the table above and signify that the research would kill no adult salmonids and only one juvenile from any component of any listed species. These effects are so small that they would have no more than a negligible effect on the species' abundance and productivity and essentially no effect at all on their structure or diversity at the level of the listed unit.

This is equally true for population-level effects. Because the research would take place in the mainstem Columbia River, it is not possible to determine from where in the listed units the juveniles would originate, and thus we cannot ascribe the impact to individual populations or to any group smaller than the entire listing units. As a result, the deaths of the juveniles must be placed in the contexts of the entire species, and the effect at those scales is vanishingly small—in fact, as close to zero as it is possible to get. In no instance would the effect exceed the deaths of a few ten-thousandths of a percent of the outmigration for any given species. Thus the research would have, at most, nearly zero impact on either species' abundance or productivity and no appreciable impact their structure or diversity.

Moreover, it also likely that the impacts will be even smaller than those laid out above. Over the most recent four years, the researchers have neither taken nor killed any fish at all, so it is most likely that the actual effect will be effectively zero in any given year. But even if the loss were to be the maximum permitted, it would offset by the information generated from the research—information that is be used to evaluate and improve protections for listed and non-listed salmonids under the Hanford Reach Fall Chinook Protection Program Agreement.

Permit 16702-4R

Under permit 16702-4R the NWFSC is seeking to renew a permit that would authorize them to take juvenile PS Chinook and PS Steelhead, and adult SDPS eulachon in order to monitor the response of juvenile PS Chinook to tidal wetland restoration in the Snohomish River estuary. The researchers do not propose to change sampling locations, methods, or any other aspect of their research relative to what has been authorized for a number of years.

Juvenile salmon and steelhead and adult eulachon would be collected via fyke net or beach seine, and would be captured, handled (weighed, measured, and checked for marks or tags), and released. A subsample of captured juvenile Chinook salmon would intentionally be lethally sacrificed for otolith, stable isotope, and stomach contents analysis. In addition, a small number of listed fish may be killed as an inadvertent result of these activities. The amount of take the NWFSC is requesting is found in the table below.

Table 64. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 16702-4R (C=Capture, H=Handle, R=Release, IM=Intentional Mortality).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
PS Chinook	Juvenile	Natural	C/H/R	5,300	0	0.087	0.016
		Natural	IM	1,200	1,200		

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
		LHIA	C/H/R	400	0	0.004	0.001
		LHIA	IM	240	240		
		LHAC	C/H/R	3,500	0	0.009	0.002
		LHAC	IM	960	960		
PS Steelhead	Juvenile	Natural	C/H/R	100	1	0.004	<0.001
SDPS eulachon	Adult	Natural	C/H/R	5	2	<0.001	<0.001

Because the majority of the fish that would be captured and released are expected to recover with minimal 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. However, because this sampling is focused on only one estuary within the ESU and DPS there is the potential for effects to disproportionately affect the populations of PS Chinook and steelhead that migrate through the Snohomish estuary. By applying the same fecundity and survival estimates used to estimate juvenile abundances for this ESU and DPS as a whole from the 5-year geomean of spawners reported in Ford (2022), we estimate that the spawning adults returning to the Skykomish, Snoqualmie, and Snohomish Rivers would produce over 316 thousand natural-origin juvenile PS Chinook and over 135 thousand natural-origin juvenile PS Steelhead.

As a result, though the research is likely to impact a single population disproportionately, the lethal take of 1,200 natural-origin Chinook salmon juveniles would still represent less than 0.4% of the juveniles passing through this estuary in a year, and would therefore have small effects on the abundance and productivity of this population and in no measurable way impact spatial structure or diversity of the PS Chinook ESU. Skykomish hatchery stock PS Chinook are also released into the Skykomish River and Tulalip Bay with annual release targets of up to 300 thousand adipose-intact and 6.9 million adipose-clipped juveniles in 2022 (WDFW 2021), so take of hatchery juveniles in this study would also only be equivalent to 0.2% and 0.06% of the LHIA and LHAC components expected to be present annually in this system, respectively. As a result, though the research may in some instances have a very small impact on species abundance and productivity in this population, it would in no measurable way impact structure or diversity for the PS Chinook ESU. Mortality of a single individual juvenile steelhead would still barely affect the abundance of this population, and it would in no measurable way impact productivity, structure, or diversity of the PS Steelhead DPS.

It is also likely that the impacts will be smaller than those described above. Over the most recent five years, the researchers have taken only 22.8% of their requested take, and killed 22.7% of their requested mortalities, so it is likely that the actual effect will be less than a quarter of that displayed in the table above.

An effect of the research that cannot be quantified is the benefit it would have with respect to species conservation. Sampling under this permit would provide information on the response of juvenile Chinook salmon habitat use to restoration action, and whether such action has increased the quantity and quality of rearing habitat in the nearshore, estuary, and mainstem of the Snohomish River. This information would continue to be used by natural resource managers to adaptively respond to changing conditions and opportunities to improve factors limiting recovery of salmon and steelhead in Puget Sound.

Permit 17292-3R

The SWFSC has been conducting work under various iterations of Permit 17292 for a number of years. The most recent version, 17292-2A, expired on December 31, 2021. That permit authorized the SWFSC to take listed species by backpack electrofishing, hook-and-line sampling, hand- and dipnets, beach seines, fyke nets, panel, pipe or rotary screw traps, and weirs in coastal CA watersheds. The SWFSC proposes to renew their permit and would not change sampling locations, or research methods relative to what has been authorized for a number of years. However, they are seeking to add one new study examining the effects of fire on juvenile steelhead. Under the renewed permit, a small number of juvenile fish would be sacrificed to support laboratory experiments to assess mercury levels and RNA expression, but otherwise the researchers do not intend to kill any of the captured fish—though some may die as an inadvertent result of the activities. The researchers are requesting the following levels of take:

Table 65. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 17292-3R (C=Capture, H=Handle, R=Release, T=Tag, M=Mark, ST=Sample Tissue, O=Observe, H=Harass, Tr=Transport, D=Dead Animal).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
CCC Coho	Adult	Natural	C/M/T/ST/R	850	17	242.851	1.906
		Natural	C/ST/Tr	115	0		
		Natural	O/H	800	0		
		Natural	O/STD	600	0		
		LHIA	C/M/T/ST/R	1,325	27		
		LHIA	C/ST/Tr	115	0		
		LHIA	O/H	1,000	0		
		LHIA	O/STD	800	0		
	Juvenile	Natural	C/H/R	7,800	156	4.905	0.089
		Natural	C/M/T/ST/R	15,800	316		
		Natural	IM	100	100		
		Natural	O/H	8,000	0		
		LHIA	C/H/R	8,000	160	6.786	0.131

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
		LHIA	C/M/T /ST/R	19,600	392		
		LHIA	C/ST/ Tr	900	0		
CCC Steelhead	Adult	Natural	C/M/T /ST/R	1,000	21	148.216	1.154
		Natural	C/ST/ Tr	25	1		
		Natural	O/H	1,000	0		
		Natural	O/ST D	800	0		
	Juvenile	Natural	C/H/R	14,300	286	5.249	0.103
		Natural	C/M/T /ST/R	19,000	380		
		Natural	IM	225	225		
		Natural	O/H	12,000	0		
		LHAC	C/ST/ Tr	500	0	0.096	0.000

Because the research would be spread out across various Coastal California watersheds and streams, we do not expect the research to have a disproportionate effect on any one population. Even if we had determined that a population level analysis was warranted, we do not have abundance information for all of the coastal streams. We therefore compare the number of fish that may be killed by the research to the abundance of the ESU/DPS.

For juvenile fish, the research would kill at most 0.131% of the abundance of any ESU/DPS. For adult fish, the research would kill at most 1.906% of the adult CCC coho and 1.154 CCC steelhead. The percent column (ESU/DPS killed) in the above table represents the worst-case scenario based on the number of adults the researchers may encounter.

For the last five years, the SWFSC researchers have not killed a single adult fish. Additionally, if mortalities did occur, they would be spread out over the whole of the ESU or DPS and therefore no population would be likely to be more affected than any other. Moreover, the numbers of fish that may be taken are artificially inflated because the researchers were required to add take for every possible method they may employ, but is extremely unlikely that they would employ every method proposed. That is, it is very unlikely in any given year that they would electrofish, seine, and hook-and-line angle for each species. Thus, even if all the authorized mortality did occur, there would only be very small impacts on the species' abundance and productivity, and no discernible effect on population structure or diversity. Further, those small losses would take place in the context of generating information to be used in species recovery; this research will provide critical information on the abundance and timing of listed fish coastal California watersheds.

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 6.6% of their requested take, and killed 2.4% of their requested mortalities, so it is most likely that the actual effect will be slightly less than one-fortieth 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) estimate population abundance and dynamics; (2) evaluate factors affecting growth, survival, reproduction and life-history patterns; (3) assess life-stage specific habitat use and movement; (4) evaluate physiological performance and tolerance; (5) determine the genetic structure of populations; (6) evaluate the effects of water management and habitat restoration; and (7) develop improved sampling and monitoring methods. Specifically, the goals are to identify the life-history types present, their spatial and temporal distribution, their feeding ecology, and the interactions with other biota. The research would benefit the affected species by providing critical information in support of the conservation, management and recovery of Coastal California salmon stocks.

Permit 17299-4R

The SWFSC has been conducting work under various iterations of Permit 17299 for several years. The most recent version, 17299-3M, expired on December 31, 2021. That permit authorized the SWFSC to take listed species by rotary screw traps, fyke nets, backpack and boat electrofishing, beach seining, tangle netting, DIDSON (sonar) observations, hook-and-line sampling, and spawning ground and snorkel surveys throughout the Sacramento River basin. The SWFSC proposes to renew their permit and have added additional studies: a stock identification study, an isoscape validation habitat study, and a habitat use and growth study. Most of the fish to be captured would experience no long-term adverse effects, however, a number of hatchery fish that have had their adipose fins removed would be sacrificed to collect otoliths for age/growth analysis, organ tissues for isotope, biochemical and genomic expression assays and parasite infections, and to assess tag effects/retention. The researchers are requesting the following levels of take:

Table 66. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 17299-4R (C=Capture, H=Handle, R=Release, T=Tag, M=Mark, ST=Sample Tissue, O=Observe, H=Harass, IM=Intentional Mortality, Tr=Transport, D=Dead Animal).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
SRWR Chinook	Adult	Natural	C/H/R	10	0	0.844	0.000
		Natural	O/H	10	0		
		LHAC	C/H/R	10	0	2.225	1.483
		LHAC	IM	40	40		
		LHAC	O/H	10	0		
	Juvenile	Natural	C/H/R	10	1	0.296	0.004
		Natural	C/M/T/ST/R	700	13		
		Natural	O/ST D	400	0		
		LHIA	O/ST D	200	0	-	-

Species	Life Stage	Origin	Take Action	Requeste d Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
		LHAC	C/H/R	10	1	0.536	0.102
		LHAC	C/M/T/ST/R	2,000	40		
		LHAC	C/ST/Tr	1,000	20		
		LHAC	IM	750	750		
		LHAC	O/ST D	500	0		
CVS Chinook	Adult	Natural	C/H/R	10	0	0.617	0.010
		Natural	C/M/T/ST/R	75	2		
		Natural	O/H	40	0		
		LHAC	C/H/R	10	0	7.921	2.016
		LHAC	C/M/T/ST/R	75	2		
		LHAC	IM	40	40		
		LHAC	O/H	40	0		
	Juvenile	Natural	C/H/R	100	3	0.033	0.008
		Natural	C/M/T/ST/R	1,700	51		
		Natural	IM	550	550		
		Natural	O/ST D	100	0		
		LHAC	C/H/R	100	3	0.046	
		LHAC	C/M/T/ST/R	2,600	52		
		LHAC	C/ST/Tr	500	10		
		LHAC	IM	750	750		
		LHAC	O/ST D	600	0		
CCV Steelhead	Adult	Natural	C/H/R	10	0	2.697	0.392
		Natural	C/M/T/ST/R	150	2		
		LHAC	C/H/R	10	1		
		LHAC	C/M/T/ST/R	100	2		
		LHAC	IM	40	40		
	Juvenile	Natural	C/H/R	100	3	0.023	<0.001
		Natural	C/M/T/ST/R	500	11		
		LHAC	C/H/R	100	3	0.113	0.019
		LHAC	C/M/T/ST/R	2,900	59		
		LHAC	IM	550	550		
SDPS Green Sturgeon	Adult	Natural	C/H/R	10	0	0.470	0.000
		Natural	C/M/T/ST/R	10	0		
		Natural	O/H	10	0		
	Juvenile	Natural	C/H/R	10	1	0.226	0.008
		Natural	C/M/T/ST/R	10	0		
		Natural	O/H	10	0		

Because the research would be conducted in the mainstem of the Sacramento River we do not expect the research to have a disproportionate effect on any one population. We therefore compare the number of fish that may be killed by the research to the abundance of the ESU/DPS. The 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 species (see status section and Table 36). That ratio is presented in the last column of the table above. It signifies that the research, in total, for juvenile fish, would kill at most 0.019% of the abundance of any ESU/DPS.

For adult fish, the research, in total, would kill at most 2.016% CVS hatchery-origin Chinook adults and 0.392% CCV steelhead adults. However, it is important to note that all the CVS Chinook hatchery adults that may be sacrificed come from a component of the species for which there are no take prohibitions and that are considered surplus to recovery needs. (In fact, they are specifically propagated to allow harvest opportunities). The same is largely true for the CCV steelhead: 43 of the 45 adult fish that may be killed would come from the component considered surplus to be species' recovery needs. Because we do not have a breakdown of hatchery vs. natural adults for this species, all of the dead adult fish would use the total of 11,494 adult fish we expect to return as the denominator for determining effect (see table 36). Therefore the mortality rate of 0.392% is largely made up of fish propagated for harvest opportunities and would not, by definition, affect the species' viability. Thus the actual mortality for CCV steelhead adults derives from the two adult natural fish that may be killed and would actually be 0.017%, which is unlikely to have a more than minor effect on abundance and productivity and would not appreciably affect structure or diversity.

Moreover, the percent column (ESU/DPS killed) in the above table represents the worst case scenario based on the number of adults the researchers may encounter. The SWFSC has not inadvertently killed a single adult fish in the last 20 years. Additionally, if mortalities did occur, the mortalities would be spread out over the whole of the ESU or DPS and therefore no population would be likely to be more affected than any other. Thus, even if all the authorized mortality did occur, there would only be very small impacts on the species' abundance and productivity, and no discernible effect on population 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 taken only 6.1% of their requested take, and killed 0.6% of their requested mortalities, so it is most likely that the actual effect will be more than an order of magnitude smaller than that displayed in the table above.

An effect of the research that cannot be quantified is the benefit it would have with respect to species conservation. The research would benefit the affected species by providing critical information to inform life-cycle modeling efforts at the SWFSC and help guide NMFS's West Coast Region and various Central Valley agencies in their resource management efforts. In addition, results would also be integrated into the Central Valley Project Improvement Act and thereby help prioritize habitat restoration actions.

Permit 17306-3R

Under Permit 17306-3R, the ODFW would continue work they have been doing for decades but for which they now require a permit because MCR steelhead have been reintroduced to the upper Deschutes River. The researchers would use a variety of means to capture the fish (seines, traps, electrofishing, hook-and-line) and about 40% of the time would simply measure and release the fish. In their screw trap operations, some juvenile fish would also be sampled and tagged or marked. No adults would be targeted and, in all instances, they would be released as soon as possible. In no case would the researchers conduct electrofishing for adults, and if any are encountered during the boat electrofishing operations, the equipment would immediately be turned off and the fish allowed to escape. The researchers are requesting the following amounts of take.

Table 67. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 17306-3R (C=Capture, H=Handle, R=Release, T=Tag, M=Mark, ST-Sample Tissue).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
MCR steelhead	Adult	Natural	C/H/R	130	5	1.213	0.018
		Natural	O/H	200	0		
		LHIA	C/H/R	130	5	46.283	0.701
		LHIA	O/H	200	0		
	Juvenile	Natural	C/H/R	3,260	56	0.740	0.009
		Natural	C/M/T/ ST/R	5,000	50		
		Natural	O/H	80	0		
		LHIA	C/H/R	3,260	56	2.405	0.031
		LHIA	C/M/T/ ST/R	5,000	50		
		LHIA	O/H	80	0		

Because the vast 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 are best seen in the context of the fish that the action may kill. To determine the effect of these losses, it is necessary to compare them to the total outmigrant numbers expected for these species (and their components) and (b) the total average returns over the last five years for which we have data (see status section and Table 36). These calculations are displayed in the last column of the table above and signify that the research could, in a worst-case scenario, kill a small number of hatchery and natural juvenile MCR steelhead and smaller numbers of adult fish. However, it must be noted that all of these fish would come from an introduced experimental population—one that is currently considered surplus to the species' recovery needs (see more below).

In any case, the mortality rates are low enough (a maximum of 0.7% of adult hatchery fish) that effects of the research on MCR steelhead would be very small and would likely only affect abundance and, to some extent, productivity. It should be noted, however, that the effects would be concentrated on the Deschutes River population that has been reintroduced above Pelton and Roundbutte Dams, so they would be magnified at the local level. At the moment, the only fish that have been reintroduced are unfed hatchery fry. The most recent outplanting of hatchery fry was 415,000 fish. That means that the effect of the take would be to kill something on the order of 0.05% of the (total) fish that may inhabit the system. For natural fish, the effect may be slightly larger, but this effect has thus far not been evident and would likely remain unapparent for the next few years. It is hoped that in future years fisheries managers would be able to pass 100 (or more) returning steelhead above the Pelton and Round Butte Dams on the Deschutes River. These fish could produce something on the order of 12,500 smolts (estimating 50 females, 2,500 eggs each, 5% survival to smolthood) and therefore the research may kill, at most 0.9% of those possible progeny—but that is leaving aside the continued influx of hatchery fry which would reduce the overall effect by orders of magnitude. Thus, the research would have a very small effect on the local outmigrations' abundances (and therefore productivity) and a negligible effect on the DPS as a whole; neither structure nor diversity is likely to be affected at either level. This is especially true given that a great many of the fish that may be captured would in actuality probably be resident, unlisted rainbow trout—fish that we count as listed juvenile MCR steelhead fish because it is extremely difficult to tell them apart in the field.

The effect on the adult returns is very small, but it is actually most likely to be zero. Given that the researchers may not electrofish for adults and that in all other cases the adults would be avoided, the chances are very good that no adults at all would be killed. In fact, none have even been encountered in the last four years the research has been undertaken. Furthermore, no juveniles have been killed in the last four years, either. So the effects are actually very likely to be much closer to zero than those displayed above. But even if all the permitted adults and juveniles were to be killed, the effect even at the local level would be slight reductions in abundance and productivity and no measurable effect on structure or diversity because the experimental population contributes to neither.

Which is the main thing to consider when looking at the effects of the take in this instance: as noted above, this entire introduced population is currently considered excess to the species' survival and recovery needs. The population is designated as an experimental one so that organizations like ODFW can monitor and develop conservation measures for the population without incurring the usual ESA liabilities for take. In the Final Rule designating the population (78 FR 2893), NMFS made the following statement: "Thus the loss of some of the [Nonessential Experimental Population] will not appreciably reduce the likelihood of survival and recovery for this DPS." It has therefore already been determined that this work cannot *by definition* jeopardize the MCR steelhead or operate to their disadvantage at either the local population level or the species level.

Permit 17916-2R

The BLM has been conducting work under various iterations of Permit 17916 for several years. The most recent version, 17219, expired on December 31, 2021. That permit authorized the BLM to take listed species by backpack electrofishing, hand/or dip nets, beach seines and observed during spawning and snorkel surveys in watersheds throughout Northwest California. The BLM proposes to renew their permit and would not change sampling locations, methods, or any other aspect of their research relative to what has been authorized for a number of years. The researchers do not propose to intentionally kill any fish, but a small number may die as an unintended result of the research activities. The researchers are requesting the following levels of take:

Table 68. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 17916-2R (C=Capture, H=Handle, R=Release, O=Observe, H=Harass).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
SONCC Coho	Adult	Natural	O/H	650	0	5.142	0.000
	Juvenile	Natural	C/H/R	1,000	18	0.141	0.001
		Natural	O/H	1,500	0		
NC Steelhead	Adult	Natural	O/H	400	0	4.787	0.000
	Juvenile	Natural	C/H/R	1,521	33	0.238	0.002
		Natural	O/H	3,000	0		
CC Chinook	Adult	Natural	O/H	350	0	2.658	0.000
	Juvenile	Natural	C/H/R	320	10	0.031	<0.001
		Natural	O/H	1,150	0		

Because the research would be spread out across Northern CA watersheds and streams, we do not expect the research to have a disproportionate effect on any one population. We therefore compare the number of fish that may be killed by the research to the abundance of the ESU/DPS. 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 species (see status section and Table 36). That ratio is presented in the last column of the table above. It signifies that the research, in total, would kill at most 0.024% of the juvenile abundance of any ESU/DPS (and no adult fish would be killed at all). Thus, even if all the authorized mortality did occur, there would only be very small impacts on the species' abundance and productivity, and no discernible effect on population structure or diversity.

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 5.6% of their requested take, and killed 0% of their requested mortalities, so it is most likely that the actual effect will be very close to zero in any given year.

An effect of the research that cannot be quantified is the benefit it would have with respect to species conservation. The purpose of this research is to monitor how current management actions under the Northwest Forest Plan's Aquatic Conservation Strategy are affecting anadromous salmonids and their habitats. In order to monitor land management actions and implement the Northwest Forest Plan in northern California, the BLM needs to obtain updated information on fish distribution and habitat. Thus, the information to be gathered would benefit listed species by informing adaptive management strategies intended to aid salmon recovery.

Permit 18012-3R

The CDFW has been conducting work under various iterations of Permit 18012 for more than five years. The most recent version, 18012-2A, expired on December 31, 2021. That permit authorized the CDFW to take listed species by backpack electrofishing, beach seining, rotary screw trapping, fyke/pipe trapping, and weirs in CA central coast watersheds. The CDFW proposes to renew their permit and would not generally change sampling locations or methods—except that they have removed one study and the take associated with it. The researchers do not propose to intentionally kill any fish, but a small number may die as an unintended result of the research activities. The researchers are requesting the following levels of take:

Table 69. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 18012-3R (C=Capture, H=Handle, R=Release, T=Tag, M=Mark, ST=Sample Tissue, O=Observe, H=Harass).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
NC Steelhead	Adult	Natural	O/H	260	0	3.112	0.000
	Juvenile	Natural	C/H/R	300	4	0.054	<0.001
		Natural	C/M/T/ST/R	250	3		
		Natural	O/H	1,000	0		
CC Chinook	Adult	Natural	O/H	250	0	1.898	0.000
	Juvenile	Natural	C/H/R	300	3	0.011	<0.001
		Natural	C/M/T/ST/R	250	3		
CCC Coho	Adult	Natural	O/H	400	0	25.130	0.000
		LHIA	O/H	180	0		
	Juvenile	Natural	C/H/R	5,850	59	2.837	0.018
		Natural	C/M/T/ST/R	2,800	29		
		Natural	O/H	5,100	0		
		LHIA	C/H/R	350	4	0.232	0.001
		LHIA	O/H	300	0		
CCC Steelhead	Adult	Natural	C/H/R	12	0	45.750	0.000
		Natural	O/H	740	0		
		LHAC	O/H	120	0		
	Juvenile	Natural	C/H/R	13,150	133	3.705	0.029
		Natural	C/M/T/ST/R	4,950	53		
		Natural	O/H	6,000	0		
SCCC Steelhead	Adult	Natural	O/H	100	0	51.020	0.000
	Juvenile	Natural	C/H/R	325	3	1.682	0.012
		Natural	C/M/T/ST/R	500	5		
		Natural	O/H	300	0		

Because the research would be spread out across various central California coastal watersheds and streams, we do not expect the research to have a disproportionate effect on any one population. Even if we had determined that a population level analysis was warranted, we do not have abundance information for all of the coastal streams. We therefore compare the number of fish that may be killed by the research to the abundance of the ESU/DPS.

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 species (see status section and Table 36). That ratio is presented in the last column of the table above. It signifies that the research, in total, would kill at most 0.029% of the juvenile abundance of any ESU/DPS (and no adult fish would be killed at all). Therefore, even if all the authorized mortality did occur, there would only be very small impacts on the species' abundance and productivity, and no discernible effect on population structure or diversity.

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 8.7% of their requested take, and killed 5.1% of their requested mortalities, so it is most likely that the actual effect will be one the order of one-twentieth of the magnitude displayed above.

An effect of the research that cannot be quantified is the benefit it would have with respect to species conservation. This research would benefit listed species by informing proposed habitat restoration project designs, helping prioritize watershed restoration efforts, and helping managers mitigate the negative impacts of various management actions.

Permit 19820-3R

The UC Davis has been conducting work under various iterations of Permit 19820 for five years. The most recent version, 19820-2A, expired on December 31, 2021. That permit authorized UC Davis to take listed species by beach seines, fyke nets, and trawls in San Francisco Bay Area and tributaries. The UC Davis proposes to renew their permit and would not change sampling locations, methods, or any other aspect of their research relative to what has been authorized for a number of years. The researchers do not propose to intentionally kill any fish, but a small number may die as an unintended result of the research activities. The researchers are requesting the following levels of take:

Table 70. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 19820-3R (C=Capture, H=Handle, R=Release).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
SRWR Chinook	Juvenile	Natural	C/H/R	3	0	0.002	0.000
CVS Chinook		Natural	C/H/R	15	1	<0.001	<0.001
CCV Steelhead	Adult	Natural	C/H/R	5	1	0.044	0.009
	Juvenile	Natural	C/H/R	15	1	0.001	<0.001

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
CCC Steelhead		Natural	C/H/R	15	1	0.007	
SDPS Green Sturgeon	Subadult	Natural	C/H/R	3	0	0.027	0.000

Because the research would be conducted in the mainstem of the Sacramento River and across the lower reaches of various tributaries of the San Pablo and San Francisco bays, we do not expect the research to have a disproportionate effect on any one population. We therefore compare the number of fish that may be killed by the research to the abundance of the ESU/DPS.

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 species (see status section and Table 36). That ratio is presented in the last column of the table above. It signifies that the research, in total, would kill at most 0.009% of the juvenile abundance of any ESU/DPS (and no adult fish would be killed at all). Therefore, even if all the authorized mortality did occur, there would only be very small impacts on the species' abundance and productivity, and no discernible effect on population structure or diversity.

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 0.4% of their requested take, and killed 0% of their requested mortalities, so it is most likely that the actual effect will be very close to 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. Though the purpose of the study is to monitor habitat use of longfin smelt, this research will also generate information on the location and distribution CVSR and SRWR Chinook and CCV and CCC steelhead in San Pablo and San Francisco Bay. This information will increase managers' our understanding of status and trends monitoring and thereby benefit recovery planning actions.

Permit 20104-3R

Under permit 20104-3R the Pacific Shellfish Institute is seeking to renew a permit that would authorize them to take juvenile PS Chinook, PS steelhead, HCS chum, Oregon Coast coho salmon, Southern Oregon/Northern California Coast coho salmon, Northern California steelhead, California Coastal Chinook salmon, SDPS eulachon, and southern DPS green sturgeon in order to Measure and quantify the effect of shellfish culture and burrowing shrimp on seagrass and their function as habitat for fish and invertebrates. The researchers propose to renew their permit and would not change sampling locations, methods, or any other aspect of their research relative to what has been authorized for a number of years.

Juvenile salmon, steelhead, and sturgeon and adult eulachon would be collected via beach seine or Breder trap, and observed via a modified fyke net camera trap. Captured fish would be handled (weighed, measured, and checked for marks or tags), and released. A subsample of captured fish would be anesthetized, have stomach contents collected via gastric lavage, and have fin or opercle tissue sampled prior to release.

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 Pacific Shellfish Institute is requesting is found in the table below.

Table 71. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 20104-3R (C=Capture, H=Handle, R=Release, T=Tag, M=Mark, ST=Sample Tissue, O/H=Observe/Harass).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
PS Chinook	Juvenile	Natural	C/H/R	2,800	70	0.053	<0.001
		Natural	C/M/T/ST/R	120	3		
		Natural	O/H	3,000	0		
		LHAC	C/H/R	1,300	35	0.003	<0.001
		LHAC	C/M/T/ST/R	120	3		
PS Steelhead	Juvenile	Natural	C/H/R	2,800	70	0.088	0.001
		Natural	C/M/T/ST/R	120	3		
		Natural	O/H	3,000	0		
		LHAC	C/H/R	1,300	35	0.382	0.010
		LHAC	C/M/T/ST/R	120	3		
HCS chum	Juvenile	Natural	C/H/R	1,000	30	0.024	<0.001
		Natural	C/M/T/ST/R	40	1		
		Natural	O/H	2,000	0		
		LHIA	C/H/R	500	15	0.180	0.005
		LHIA	C/M/T/ST/R	40	1		
OC Coho	Juvenile	Natural	C/H/R	800	20	0.022	<0.001
		Natural	C/M/T/ST/R	40	1		
		Natural	O/H	2,000	0		
SONCC Coho	Juvenile	Natural	C/H/R	1,000	20	0.077	<0.001
		Natural	C/M/T/ST/R	40	1		
		Natural	O/H	1,000	0		
NC Steelhead	Juvenile	Natural	C/H/R	1,000	20	0.072	<0.001
		Natural	C/M/T/ST/R	40	1		
		Natural	O/H	1,000	0		
	Juvenile	Natural	C/H/R	1,000	20	0.028	<0.001

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
CC Chinook		Natural	C/M/T/ST/R	40	1		
		Natural	O/H	1,000	0		
SDPS eulachon	Adult	Natural	C/H/R	3,620	89	0.010	<0.001
		Natural	C/M/T/ST/R	200	5		
		Natural	O/H	4,100	0		
SDPS green sturgeon	Juvenile	Natural	C/H/R	4,500	110	79.666	0.873
		Natural	C/M/T/ST/R	240	6		
		Natural	O/H	5,850	0		

Because the majority of the fish that would be captured are expected to recover with minimal 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 would therefore be spread over the range of SDPS eulachon and green sturgeon. Similarly, because sampling would be performed in marine areas and bays of Puget Sound that could contain migrating salmon or steelhead juveniles from several populations, the potential losses cannot be ascribed to any population and must therefore be viewed in the context of those listed units as individual wholes.

Only in Coos Bay, Oregon, and Humboldt Bay, California, could the proposed take disproportionately affect one population in a way that can be evaluated. However, in the case of Humboldt Bay, applying the same fecundity and survival estimates we did in the Status of the Species section to the number of spawners reported in SWFSC (2022), we estimate there will be nearly 112 thousand natural-origin juvenile Southern Oregon/Northern California coho salmon in the Humboldt Bay tributaries in a given year. Therefore, the proposed lethal take of 21 individuals would not have a measurable impact on the productivity of this population. Similarly, for Northern California steelhead, applying survival and fecundity estimates to adult returns to Humboldt Bay would predict nearly 20 thousand juveniles will be present in this system, and the proposed take would result in the loss of only 0.1% of this population.

We do not have sufficient population-specific data to analyze the population-level effects on California Coastal Chinook salmon in Humboldt Bay, although with large populations in the adjacent Eel and Mad Rivers it is also unlikely the loss of 21 individuals would create a measurable change in productivity in this area. In Coos Bay, by applying the same fecundity and survival estimates to the number of adults returning to the Coos River (as reported in Ford (2022)) as we did to the ESU as a whole, over 280 thousand natural-origin juveniles would be expected to be present in this system annually, as compared to the 21 juveniles proposed to be lethally taken. 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 listed species proposed to be taken in Humboldt Bay or Coos Bay.

It is also likely that the impacts will be smaller than those laid out above. Last year, in the location this project was able to be implemented (Samish Bay) the research team did not encounter any listed species, and over the past five years other researchers in the Section 10(a)(1)(A) program have reported taking approximately 9% and killing approximately 7% of the juveniles that were authorized across all species, so it is 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 benefit it would have with respect to species conservation. Sampling under this permit would provide information on the effects of shellfish culture and burrowing shrimp on eelgrass habitats and their function for fish and invertebrates. Eelgrass habitats are highly valuable rearing habitats for juvenile salmonids, and protection of these highly productive estuarine habitats is important to the recovery of many ESA-listed salmonids. By determining spatial relationships between existing shellfish culture, burrowing shrimp and seagrass in several Pacific Northwest estuaries, models can be developed for managers to evaluate areas of proposed culture, and the ability of those habitats to support salmon, steelhead, and sturgeon.

Permit 20492-3R

Under Permit 20492-3R, the ODFW would continue to use boat- and backpack electrofishing equipment to conduct fish assessment and monitoring surveys in many of the state's waterbodies. The ODFW proposes to renew their permit and would not change sampling locations, methods, or any other aspect of their research relative to what has been authorized for a number of years. Some of the captured fish would be anesthetized, sampled for length and weight, allowed to recover from the anesthesia, and released. Most salmonids would only be shocked and allowed to swim away, though some may be netted and released immediately.

The researchers would minimize take by using low pulse rate (30 pulses/s), a narrow pulse width (< 6 msec), and low peak voltage (500 V). They would use the hull of the aluminum boat as the cathode and two anode arrays with a total of 12 droppers which allows the use of lower voltages with reduced field strength in the vicinity of the electrodes. The NMFS electrofishing guidelines would be followed and trainers from Smith-Root, Inc. have consulted with project staff to recommend equipment adjustments to reduce salmonid mortalities. Further, sample sizes would be kept as small as possible and boat electrofishing would only be conducted at times and in locations where adults of listed species are not likely to be present. And, if large numbers of juvenile salmonids are accidentally encountered, the researchers would cease operation and modify the location or timing of their sampling to reduce or eliminate encounters. The researchers are requesting the following amounts of take.

Table 72. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 20492-3R (C=Capture, H=Handle, R=Release).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
UCR Chinook	Juvenile	Natural	C/H/R	5	0	0.0010	0.000
		LHAC	C/H/R	10	0	0.002	
UCR steelhead		Natural	C/H/R	5	0	0.003	
		LHAC	C/H/R	5	0	<0.001	
MCR steelhead		Natural	C/H/R	30	2	0.008	<0.001
		LHAC	C/H/R	20	2	0.005	
SnkR spr/sum Chinook		Natural	C/H/R	5	0	<0.001	0.000
		LHAC	C/H/R	10	0		
SnkR fall Chinook		Natural	C/H/R	5	0		
		LHAC	C/H/R	10	0		
SnkR steelhead		Natural	C/H/R	5	0		
		LHAC	C/H/R	5	0		
SnkR sockeye		Natural	C/H/R	2	0	0.011	
		LHAC	C/H/R	2	0	<0.001	
LCR Chinook		Natural	C/H/R	395	10	0.004	<0.001
		LHIA	C/H/R	120	6	0.014	
		LHAC	C/H/R	120	6	<0.001	
LCR coho		Natural	C/H/R	150	6	0.019	
		LHIA	C/H/R	45	2	0.017	
		LHAC	C/H/R	340	16	0.004	
LCR steelhead		Natural	C/H/R	60	3	0.016	
		LHAC	C/H/R	120	4	0.010	
CR chum		Natural	C/H/R	55	3	<0.001	
UWR Chinook	Adult	Natural	C/H/R	4	0	0.038	0.000
	Juvenile	Natural	C/H/R	620	22	0.053	0.002
		LHAC	C/H/R	250	11	0.005	<0.001
UWR steelhead	Adult	Natural	C/H/R	4	0	0.152	0.000
	Juvenile	Natural	C/H/R	460	15	0.336	0.011
OC coho		Natural	C/H/R	500	25	0.012	<0.001
SDPS eulachon	Adult	Natural	C/H/R	5	1	<0.001	
SDPS green sturgeon		Natural	C/H/R	5	1	0.235	0.047

Because the vast 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 are best seen in the context of the fish that the action may kill. To determine the effect of these losses, it is necessary to compare them to the total outmigrant numbers expected for these species (and their components) and (b) the total average returns over the last five years for which we have data (see status section and Table 36). These calculations are displayed in the last column of the table above and signify that the research would kill no adult salmonids, possibly one adult SDPS green sturgeon and one adult SDPS eulachon, and a maximum of 0.11% of any component of any listed juvenile salmonid. However, in most cases, fewer than one juvenile in one hundred thousand would be killed.

Because the research would take place in dozens of tributary and mainstem habitats from the Deschutes River to the Coast Range in Oregon, it is not possible to determine from where in the listed units any of the fish might be taken and thus we cannot ascribe the impact to individual populations or to any group smaller than the entire listing units. As a result, the possible mortalities must be placed in the contexts of the entire ESUs and DPSs, and the effect at those scales is extremely small—nearly zero, in many cases. For the juvenile salmonids, the maximum loss would be one fish in a thousand for OC coho salmon. In all other cases, the loss would be nearly an order of magnitude smaller than that effect (and in most instances, even smaller). For adult SDPS eulachon, the loss would be smaller than one fish in ten thousand and thus have a nearly negligible effect. The possible loss of one adult SDPS green sturgeon would result in very minor decrease in abundance and, therefore, productivity, but that loss would be very small and extremely unlikely to affect the species' viability. Thus, the research would have, at most, only a very small impact on any species' abundance and productivity and no appreciable impact on structure or diversity.

Moreover, it is very likely that the impacts will be even smaller than those laid out above. Over the most recent five years, the researchers have taken only 0.2% of their requested take, and killed no fish at all, so it is most likely that the actual effect will be very close to zero in most years. But even if all the permitted fish were to be take (and at the listed mortality rates), the effect would be very small and offset to some extent by the information to be gained—information that would be used to improve a suite of management actions that could affect listed fish throughout much of Oregon.

Permit 21185-2R

Under permit 21185-2R the WFC is seeking to renew a permit that would authorize them to take juvenile PS Chinook and PS steelhead in order to validate stream typing classifications and upper extent of fish presence in selected sub-basins and floodplain areas of tributaries to the Deschutes River and the Kennedy-Goldborough Basin. The WFC proposes to renew their permit and would not change sampling locations, methods, or any other aspect of their research relative to what has been authorized for a number of years.

Juveniles would be collected via backpack electrofishing. Juvenile fish would be captured, handled (weighed, measured, and checked for marks or tags), and released. A subsample of captured juvenile steelhead would be anesthetized, and sampled for fin or opercle tissue prior to release.

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 Wild Fish Conservancy is requesting is found in the table below.

Table 73. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 21185-2R (C=Capture, H=Handle, R=Release, T=Tag, M=Mark, ST=Sample Tissue).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
PS Chinook	Juvenile	Natural	C/H/R	7	0	<0.001	0.000
PS Steelhead	Juvenile	Natural	C/M/T/ ST/R	40	2	0.002	<0.001

Because the majority of the fish that would be captured are expected to recover with minimal 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 only a small percent of juvenile PS Chinook and kill almost none (and would affect no adults at all). While this work is confined to only a few tributaries, the number of individuals that may be lethally taken is so small that the research would still 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. Over the most recent 4 years, the researchers have taken only 0.5% of their requested take, and killed none of their requested mortalities, so it is most likely that the actual effect will be zero in most years.

An effect of the research that cannot be quantified is the benefit it would have with respect to species conservation. Sampling under this permit would verify the extent of fish-bearing waters, provide information to fill data gaps regarding fish passage impediments (tidegates, culverts, etc.), and update fish species composition and distribution in these watersheds. This information would continue to be used by natural resource managers to identify, prioritize, and implement effective restoration projects.

Permit 21220-2R

Under Permit 20220-2R, NEON would continue to capture, handle, and then release a small number of LCR Chinook annually in Martha Creek (Washington). The adults may be observed during electrofishing surveys, and if they are, the researchers would immediately turn off electricity, allow the fish to swim away, and suspend electrofishing surveys until a date when adults and eggs were no longer present. The researchers would also collect other fish, benthic invertebrates, plants, microbes, and a host of habitat information as they conduct their intensive surveys. The researchers are seeking the flowing amounts of take.

Table 74. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 21220-2R (C=Capture, H=Handle, R=Release).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
LCR steelhead	Adult	Natural	C/H/R	3	0	0.037	0.000
	Juvenile	Natural	C/H/R	500	15	0.135	0.004

Because the vast 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 are best seen in the context of the fish that the action may kill. To determine the effect of these losses, it is necessary to compare them to the total outmigrant numbers expected for these species (and their components) and (b) the total average returns over the last five years for which we have data (see status section and Table 36). These calculations are displayed in the last column of the table above and signify that the research would kill no adult salmonids and a maximum of only 0.004% of the natural juvenile outmigration for LCR steelhead.

This loss is a very small one, but would be magnified by the fact that it would be concentrated on the Wind River LCR steelhead population. Given that an average of approximately 627 natural adult steelhead have returned to the Wind River in recent years (Ford 2022), the 15 dead juveniles would equate to a loss of about 0.07% of the 21,607 fish that may outmigrate from the Wind River population. There are no direct measurements of juvenile steelhead abundance for that population, so we estimated smolt abundance for the Wind River population using estimates for the number of spawners (627-see above) proportion of spawners that are female (assumed 50%), fecundity (4923, from Quinn, 2005) and egg-to-smolt survival (0.014, Quinn, 2005), this gives:

 # smolts = 627 spawners x 0.5 females/spawner x 4923 eggs/female x 0.014 smolt/egg

Which translates to possible loss of 0.07% of the population's juvenile outmigration—demonstrating that even at the local population level, the research would have only a very small effect on abundance and productivity and essentially none on structure and diversity.

But, for two reasons, it is very likely that the impacts will be even smaller than those laid out above. First, over the most recent five years, the researchers have taken only 31.9% of their requested take, and killed 9.3% of their requested mortalities, so it is most likely that the actual effect will be something like an order of magnitude smaller than that displayed in the table above. Second, it is very probable that some of the fish the researchers capture and count as LCR steelhead juveniles would actually be local resident redband trout instead. We ask that all such fish be treated as if they were LCR steelhead because it is very difficult to tell the two species apart in the wild.

Still, even if the researchers were somehow to kill all 15 juvenile LCR steelhead in the permit, that small loss would be offset to some degree by the information coming from the long-term data sets being generated on the animals' health, abundance, and status in general. Those data would be used to inform management decisions on the Gifford Pinchot National Forest and the lower Columbia

River ecosystem. In addition, the proposed research would contribute to an unprecedented effort to better understand the ecological impacts of climate change, land-use change, and invasive species at a continental scale.

Permit 21330-4R

Under permit 21330-4R the USFWS is seeking to renew a permit that would authorize them to take juvenile, adult, and spawned adult/carcass PS Chinook and PS steelhead in order to document fish presence and abundance within the boundaries of Naval Radio Station Jim Creek in Jim Creek, a tributary to the South Fork Stillaguamish River. The USFWS proposes simply to renew their permit and would not change sampling locations, methods, or any other aspect of their research relative to what has been authorized for a number of years.

Juveniles would be collected via backpack electrofishing, and adults and juveniles would be observed via snorkel survey. Juvenile fish would be captured, handled (anesthetized, weighed, measured, and checked for marks or tags), and released. A subsample of captured juvenile steelhead would have a fin or opercle tissue sample taken prior to release. Spawned adults or post-spawn carcasses would be enumerated during spawning 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. The amount of take the USFWS is requesting is found in the table below.

Table 75. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 21330-4R. (C=Capture, H=Handle, R=Release, T=Tag, M=Mark, ST=Sample Tissue, O/H=Observe/Harass)

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
PS Chinook	Adult	Natural	O/H	1	0	0.004	0.000
	Juvenile	Natural	C/H/R	5	1	<0.001	<0.001
		Natural	O/H	1	0		
PS Steelhead	Adult	Natural	O/H	1	0	0.005	0.000
	Juvenile	Natural	C/M/T/ST/R	300	20	0.007	<0.001
		Natural	O/H	1	0		

Because the majority of the fish that would be captured are expected to recover with minimal 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 either listed unit—and kill an even smaller percent of juveniles from those units (and no adults at all). Using the same adult returns reported in Ford (2022) and applying the same fecundity and survival estimates as we applied to each ESU and DPS as a whole, we estimate there would be over 55 thousand natural-origin PS steelhead within the Stillaguamish River, and over seven thousand natural-origin PS Chinook in the South Fork Stillaguamish River, annually. Therefore, even at the population level, the effect of the proposed take would represent less than 0.04% of the Stillaguamish River steelhead population, and only 0.01% of the PS Chinook in the South Fork Stillaguamish River. As a result, though the research may in some instances have a very small, localized impact on abundance and productivity, it would in no measurable way impact structure or diversity for either species.

It is also likely that the impacts will be smaller than those laid out above. Over the most recent five years, the researchers have taken only 21.9% of their requested take, and killed 15.8% of their requested mortalities, so it is most likely that the actual effect will be far less than that displayed in the table above.

An effect of the research that cannot be quantified is the benefit it would have with respect to species conservation. Sampling under this permit would monitor for the presence of ESA-listed fish species within streams at Naval Radio Station Jim Creek and document habitat conditions.

Permit 22369-2M

Under permit 22369-2M the NWFSC is seeking to modify a permit that would authorize them to take adult and juvenile PS Chinook, PS steelhead, HCS chum, Ozette Lake sockeye 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 Columbia River coho salmon, Lower Columbia River steelhead, Columbia River chum salmon, 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, and Central California Coast coho salmon, and adult SDPS eulachon and southern DPS green sturgeon in order to study Pacific salmon marine ecology during their critical first summer in marine waters.

Juveniles and adults would be collected via microtrolling/hook and line angling, purse seine, beach seine, or Kodiak trawl, handled (weighed, measured, and checked for marks or tags), and released. A subsample of captured adult and juvenile salmon and steelhead would be anesthetized, have fin clip and scale samples collected, be PIT-tagged, and have an acoustic transmitter surgically implanted (if the fish is of sufficient size) prior to release. An additional subsample of captured juvenile salmon and steelhead would be intentionally lethally sacrificed for otolith, muscle tissue, and diet analyses. Adult SDPS eulachon and green sturgeon would be captured, handled (weighed, measured, and checked for marks or tags), and released.

The researchers are proposing to kill a small number of listed fish, and a small number of fish may be additionally killed as an inadvertent result of handling and tagging activities. The majority of this take was previously evaluated through the issuance of permit #22369, which does not expire until the end of 2023. However, due to fluctuating abundances of listed species being encountered the researchers are requesting to increase take of juveniles for some species. They are not requesting to increase take of any adult fish, and for most species are not requesting a change in any take levels. Because the effects of the previously authorized take have already been evaluated, here we analyze only the increase in take currently being requested by this modification. The amount of take the NWFSC is requesting is found in the table below.

Table 76. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 22369-2M. (C=Capture, H=Handle, R=Release, T=Tag, M=Mark, ST=Sample Tissue, IM=Intentional Mortality)

Species	Life Stage	Origin	Take Action	Prior Total Take	Prior Lethal Take	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
PS Chinook	Adult	Natural	C/M/T/ ST/R	1	0	0	0	0.000	0.000
		LHIA	C/M/T/ ST/R	1	0	0	0	0.000	0.000
		LHAC	C/M/T/ ST/R	1	0	0	0	0.000	0.000
	Juvenile	Natural	C/M/T/ ST/R	1	0	0	0	0.000	0.000
		Natural	IM	1	1	0	0		
		LHIA	C/M/T/ ST/R	1	0	0	0	0.000	0.000
		LHIA	IM	1	1	0	0		
		LHAC	C/M/T/ ST/R	1	0	0	0	0.000	0.000
		LHAC	IM	1	1	0	0		
PS Steelhead	Adult	Natural	C/M/T/ ST/R	5	0	0	0	0.000	0.000
		LHIA	C/M/T/ ST/R	5	0	0	0	0.000	0.000
		LHAC	C/M/T/ ST/R	5	0	0	0	0.000	0.000
	Juvenile	Natural	C/M/T/ ST/R	5	0	0	0	0.000	0.000
		Natural	IM	5	5	0	0		
		LHIA	C/M/T/ ST/R	5	0	0	0	0.000	0.000
		LHIA	IM	5	5	0	0		
		LHAC	C/M/T/ ST/R	5	0	0	0	0.000	0.000
		LHAC	IM	5	5	0	0		
HCS chum	Adult	Natural	C/H/R	5	0	0	0	0.000	0.000
	Juvenile	Natural	C/H/R	5	0	0	0	0.000	0.000
OL Sockeye	Adult	Natural	C/H/R	1	0	0	0	0.000	0.000
		LHIA	C/H/R	1	0	0	0	0.000	0.000
		LHAC	C/H/R	1	0	0	0	0.000	0.000
	Juvenile	Natural	C/H/R	1	0	0	0	0.000	0.000
		LHIA	C/H/R	1	0	0	0	0.000	0.000
		LHAC	C/H/R	1	0	0	0	0.000	0.000
UCR Chinook	Adult	Natural	C/M/T/ ST/R	5	0	0	0	0.000	0.000
		LHAC	C/M/T/ ST/R	2	0	0	0	0.000	0.000
	Juvenile	Natural	C/M/T/ ST/R	5	0	0	0	0.000	0.000
		Natural	IM	5	5	0	0		

Species	Life Stage	Origin	Take Action	Prior Total Take	Prior Lethal Take	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
		LHAC	C/M/T/ ST/R	2	0	1	0	<0.001	<0.001
		LHAC	IM	2	2	1	1		
UCR Steelhead	Adult	Natural	C/M/T/ ST/R	4	0	0	0	0.000	0.000
		LHIA	C/M/T/ ST/R	4	0	0	0	0.000	0.000
		LHAC	C/M/T/ ST/R	5	0	0	0	0.000	0.000
	Juvenile	Natural	C/M/T/ ST/R	4	0	0	0	0.000	0.000
		Natural	IM	4	4	0	0		
		LHIA	C/M/T/ ST/R	4	0	0	0	0.000	0.000
		LHIA	IM	4	4	0	0		
		LHAC	C/M/T/ ST/R	5	0	0	0	0.000	0.000
		LHAC	IM	5	5	0	0		
MCR steelhead	Adult	Natural	C/M/T/ ST/R	5	0	0	0	0.000	0.000
		LHAC	C/M/T/ ST/R	5	0	0	0	0.000	0.000
	Juvenile	Natural	C/M/T/ ST/R	5	0	0	0	0.000	0.000
		Natural	IM	5	5	0	0		
		LHAC	C/M/T/ ST/R	5	0	0	0	0.000	0.000
		LHAC	IM	5	5	0	0		
SnkR spr/sum Chinook	Adult	Natural	C/M/T/ ST/R	2	0	0	0	0.000	0.000
		LHAC	C/M/T/ ST/R	10	0	0	0	0.000	0.000
	Juvenile	Natural	C/M/T/ ST/R	2	0	0	0	0.000	0.000
		Natural	IM	2	2	0	0		
		LHAC	C/M/T/ ST/R	10	0	2	0	<0.001	0.000
		LHAC	IM	10	10	0	0		
SnkR Fall Chinook	Adult	Natural	C/M/T/ ST/R	3	0	0	0	0.000	0.000
		LHAC	C/M/T/ ST/R	5	0	0	0	0.000	0.000
	Juvenile	Natural	C/M/T/ ST/R	3	0	0	0	0.000	0.000
		Natural	IM	3	3	0	0		
		LHAC	C/M/T/ ST/R	5	0	0	0	0.000	0.000
		LHAC	IM	5	5	0	0		
SnkR Steelhead	Adult	Natural	C/M/T/ ST/R	5	0	0	0	0.000	0.000
		LHIA	C/M/T/ ST/R	3	0	0	0	0.000	0.000
		LHAC	C/M/T/ ST/R	5	0	0	0	0.000	0.000

Species	Life Stage	Origin	Take Action	Prior Total Take	Prior Lethal Take	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
	Juvenile	Natural	C/M/T/ ST/R	5	0	0	0	0.000	0.000
		Natural	IM	5	5	0	0		
		LHIA	C/M/T/ ST/R	3	0	0	0	0.000	0.000
		LHIA	IM	3	3	0	0		
		LHAC	C/M/T/ ST/R	5	0	0	0	0.000	0.000
		LHAC	IM	5	5	0	0		
SnkR Sockeye	Adult	Natural	C/H/R	1	0	0	0	0.000	0.000
		LHIA	C/H/R	1	0	0	0	0.000	0.000
		LHAC	C/H/R	1	0	0	0	0.000	0.000
	Juvenile	Natural	C/H/R	1	0	0	0	0.000	0.000
		LHIA	C/H/R	1	0	0	0	-	-
		LHAC	C/H/R	1	0	0	0	0.000	0.000
LCR Chinook	Adult	Natural	C/M/T/ ST/R	2	0	0	0	0.000	0.000
		LHIA	C/M/T/ ST/R	5	0	0	0	0.000	0.000
		LHAC	C/M/T/ ST/R	5	0	0	0	0.000	0.000
	Juvenile	Natural	C/M/T/ ST/R	2	0	3	0	<0.001	<0.001
		Natural	IM	2	2	3	3		
		LHIA	C/M/T/ ST/R	5	0	0	0	0.000	0.000
		LHIA	IM	5	5	0	0		
		LHAC	C/M/T/ ST/R	5	0	17	0	<0.001	<0.001
		LHAC	IM	5	5	10	10		
LCR Coho	Adult	Natural	C/H/R	1	0	0	0	0.000	0.000
		LHIA	C/H/R	1	0	0	0	0.000	0.000
		LHAC	C/H/R	1	0	0	0	0.000	0.000
	Juvenile	Natural	IM	5	5	0	0	0.000	0.000
		LHIA	IM	5	5	0	0	0.000	0.000
		LHAC	IM	5	5	0	0	0.000	0.000
LCR steelhead	Adult	Natural	C/M/T/ ST/R	5	0	0	0	0.000	0.000
		LHAC	C/M/T/ ST/R	5	0	0	0	0.000	0.000
	Juvenile	Natural	C/M/T/ ST/R	5	0	0	0	0.000	0.000
		Natural	IM	5	5	0	0		
		LHAC	C/M/T/ ST/R	5	0	0	0	0.000	0.000
		LHAC	IM	5	5	0	0		
CR Chum	Adult	Natural	C/H/R	1	0	0	0	0.000	0.000
		LHIA	C/H/R	1	0	0	0	0.000	0.000
UWR Chinook	Juvenile	Natural	C/M/T/ ST/R	0	0	5	0	<0.001	<0.001
		Natural	IM	0	0	3	3		
		LHAC	C/M/T/ ST/R	0	0	16	0	<0.001	<0.001
		LHAC	IM	0	0	9	9		
OC Coho	Adult	Natural	C/H/R	1	0	0	0	0.000	0.000
	Juvenile	Natural	IM	2	2	0	0	0.000	0.000

Species	Life Stage	Origin	Take Action	Prior Total Take	Prior Lethal Take	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
SONCC Coho	Adult	Natural	C/H/R	1	0	0	0	0.000	0.000
	Juvenile	Natural	IM	2	2	0	0	0.000	0.000
CC Chinook	Adult	Natural	C/M/T/ ST/R	2	0	0	0	0.000	0.000
	Juvenile	Natural	C/M/T/ ST/R	2	0	0	0	0.000	0.000
		Natural	IM	2	2	0	0		
SRWR Chinook	Adult	Natural	C/M/T/ ST/R	2	0	0	0	0.000	0.000
	Juvenile	Natural	C/M/T/ ST/R	2	0	0	0	0.000	0.000
		Natural	IM	2	2	0	0		
CVS Chinook	Adult	Natural	C/M/T/ ST/R	2	0	0	0	0.000	0.000
	Juvenile	Natural	C/M/T/ ST/R	2	0	0	0	0.000	0.000
		Natural	IM	2	2	0	0		
CCC Coho	Adult	Natural	C/H/R	1	0	0	0	0.000	0.000
	Juvenile	Natural	IM	2	2	0	0	0.000	0.000
SDPS eulachon	Adult	Natural	C/H/R	20	10	0	0	0.000	0.000
SDPS green sturgeon	Adult	Natural	C/H/R	1	0	0	0	0.000	0.000

Because the majority of the fish that would be captured are expected to recover with minimal 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 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.

It is also likely that the impacts will be smaller than those laid out above. Over the most recent three years, the researchers have taken only 2.2% of their requested take, and killed 1% of their requested mortalities, so it is most likely that the actual effect will be more than an order of magnitude smaller than that displayed in the table above.

An effect of the research that cannot be quantified is the benefit it would have with respect to species conservation. The spatial distribution and behavior of Pacific salmon during the marine portion of their life stage is currently not well understood. Data collected from this project would fill this existing data gap by obtaining individual-level information on the movement behavior and spatiotemporal distribution of depleted Pacific salmon and trout populations within the ocean. This study would also provide information on nearshore behavior and migration patterns, diet, growth rates, and habitat use for Chinook salmon, coho salmon, and steelhead, and the degree to which fish from different origins use near-shore habitats. This information would then be used by managers to better understand and predict juvenile salmonid survival in response to ocean conditions, and to improve river management to support listed salmon and steelhead ocean survival in early life stages.

Permit 23798

Permit 23798 is a new permit that would authorize the River Partners to take listed fish by fyke nets in the Sacramento River, CA. Captured fish would be anesthetized, measured, weighed, tagged, and tissue-sampled for genetic information. The researchers do not propose to intentionally kill any fish, but a small number may die as an unintended result of the research activities. The researchers are requesting the following levels of take:

Table 77. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 23798 (C=Capture, H=Handle, R=Release, T=Tag, M=Mark, ST=Sample Tissue, O=Observe, H=Harass).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
SRWR Chinook	Juvenile	Natural	C/M/T/ ST/R	200	6	0.160	0.005
		LHAC	C/M/T/ ST/R	200	6	0.126	0.004
CVS Chinook		Natural	C/M/T/ ST/R	200	6	0.011	<0.001
		LHAC	C/M/T/ ST/R	200	6	0.010	
CCV Steelhead		Natural	C/M/T/ ST/R	200	6	0.015	
		LHAC	C/M/T/ ST/R	200	6	0.019	

Because the research would be conducted in the mainstem of the Sacramento River we do not expect the research to have a disproportionate effect on any one population. In addition, the researchers are not proposing to kill any fish, though a small percent may die. As the above table shows, for each species, the researchers would kill at most 6 individuals which represents a few small percent of the ESU or DPS. 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 species (see status section and Table 36). That ratio is presented in the last column of the table above. It signifies that the research, in total, would kill at most 0.005% of the abundance of any ESU/DPS. Thus, even if all the authorized mortality did occur, there would only be very small impacts on the species' abundance and productivity, and no discernible effect on population 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 9% and killing approximately 7% of the juveniles that were authorized across all species—this is while have using similar or identical capture methods. As a result, it is most likely that the actual effect will be a good deal less than that displayed in the table above.

An effect of the research that cannot be quantified is the benefit it would have with respect to species conservation. The project's goal is to measure the effectiveness of an experimental approach to prolonging floodplain inundation for the purpose of maximizing growth and survival among outmigrating juvenile salmon. This research would benefit listed species by helping managers find new ways to convert floodplain areas throughout the Central Valley into habitat suitable for rearing juvenile salmon.

Permit 25839

Permit 25839 is a new permit that would authorize ICF to take listed fish by backpack electrofishing in the Lower Yuba River, CA. Captured fish would be anesthetized, measured, clipped, weighed, and photographed. The researchers do not propose to intentionally kill any fish, but a small number may die as an unintended result of the research activities. The researchers are requesting the following levels of take:

Table 78. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 25839 (C=Capture, H=Handle, R=Release, T=Tag, M=Mark, ST=Sample Tissue).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
CVS Chinook	Juvenile	Natural	C/M/T/ST/R	400	4	0.022	<0.001
CCV Steelhead		Natural	C/H/R	400	4	0.031	

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 species (see status section and Table 36). It signifies that the research, in total, would kill at most <0.001% of the abundance of any ESU/DPS. We do not have any population-level data for CVS Chinook in the Yuba River, but the loss of four juveniles from any listed population on the West Coast would have only a very small on abundance and no appreciable effect on productivity, diversity, or structure. For CCV steelhead, the four juvenile fish that may be killed represents 0.038% of the Yuba River CV steelhead population. Thus, even if all the authorized mortality did occur, there would only be very small impacts on the species' abundance and productivity, and no discernible effect on population 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 9% and killing approximately 7% of the juveniles that were authorized across all species—this is while have using similar or identical capture methods. As a result, it is most likely that the actual effect will be a good deal less than that displayed in the table above.

An effect of the research that cannot be quantified is the benefit it would have with respect to species conservation. The purpose of this research is to quantify habitat productivity and juvenile salmonid growth in seasonally available habitats in the Lower Yuba River. The information would benefit listed fish by improve our understanding of how juvenile salmonids use these habitats for rearing.

Permit 25856

Permit 25856 is a new permit that would authorize Cramer Fish Sciences to take listed fish by backpack and raft electrofishing, hook-and-line sampling, beach seines, fyke nets and rotary screw traps in the Stanislaus River, CA. Captured fish would be anesthetized, measured, weighed, tagged, and tissue-sampled for genetic information. The researchers do not propose to intentionally kill any fish, but a small number may die as an unintended result of the research activities. The researchers are requesting the following levels of take:

Table 79. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 25856 (C=Capture, H=Handle, R=Release, T=Tag, M=Mark, ST=Sample Tissue).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
CVS Chinook	Adult	LHAC	C/M/T/ ST/R	25	3	1.200	0.144
	Juvenile	Natural	C/M/T/ ST/R	405	9	0.022	<0.001
CCV Steelhead	Adult	Natural	C/M/T/ ST/R	25	3	0.435	0.052
		LHAC	C/M/T/ ST/R	25	3		
	Juvenile	Natural	C/M/T/ ST/R	2,700	45	0.207	0.003

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 species (see status section and Table 36). That ratio is presented in the last column of the table above. It signifies that the research, in total, would kill at most 0.144% of the abundance of any ESU/DPS. 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.

We do not have any population-level data for CVS Chinook in the Stanislaus River. But the loss of 3 adult LHAC fish would not affect the species' viability (even at the local level) because these fish are surplus to recovery needs and propagated to allow harvest opportunities. The loss of nine juvenile fish from any listed population on the West Coast would have only a very small on abundance and no appreciable effect on productivity, diversity, or structure.

For CCV steelhead, the above take represents a large portion of the adults (6 of 13 estimated adult CCV steelhead = 46%) and 3.04% (45/1479) for juvenile fish. Of the 6 adults that may be killed, 3 adults are natural-origin and 3 adults are LHAC fish and are considered surplus to be species' recovery needs. The numbers of adult and juvenile fish that may be taken are artificially inflated because the researchers were required to add take for every possible method they may employ, but is extremely unlikely that they would employ every method proposed. That is, it is very unlikely in any given year that they would electrofish, seine, and hook-and-line angle for each species. Additionally, the CCV steelhead the population-level estimate is based on very little data so this research will help develop better population estimates in the Stanislaus River. Though the research take numbers represent a large portion of the fish for the adult life stage, based on previous research in the Sacramento basin, we expect the researchers to encounter orders of magnitude fewer fish and to kill even fewer.

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 9% and killing approximately 7% of the juveniles that were authorized, and only taking roughly 5% and killing roughly 3% 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 benefit it would have with respect to species conservation. This research would benefit listed steelhead by improving our fundamental understanding of Central Valley *O. mykiss* biology and ecology—information that would be used to better manage and conserve the species.

Permit 25965

The ODFW is seeking a new, five-year research permit to conduct research on hatchery salmon that may become infected with a harmful parasite (*Ceratonova shasta*) between their release into the Deschutes River (Oregon) and their arrival at the Bonneville Dam on the Columbia River. *Ceratonova shasta* is a known parasite of spring Chinook salmon. It is endemic to the Deschutes River and is known to cause mortality in juvenile and adult salmonids. Pre- and post-release spring Chinook have been monitored for the parasite for several years, but none of the sampling has been coordinated to date to be able to compare parasite prevalence in pre-release fish to that in adult returns. Under the permit, target fish would be sorted to a holding tank at the juvenile bypass facility at Bonneville Dam. Immediately after the 24-hour sorting period ends, fish would be netted out of the holding tank into buckets of fresh water to be identified and confirmed to have a PIT-tag. Target fish will then be euthanized in a bucket of MS-222 and transferred to a fish health lab so that their lower intestines may be subsampled for the parasite. All listed fish would go into another bucket of fresh water with an aerator so they may be transferred unharmed to a release tank. The researchers are requesting the following amounts of take.

Table 80. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 25965 (C=Capture, H=Handle, R=Release).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
UCR Chinook	Juvenile	Natural	C/H/R	1	0	<0.001	0.000
		LHIA	C/H/R	1	0		
		LHAC	C/H/R	2	0		
UCR steelhead		Natural	C/H/R	1	0		
		LHIA	C/H/R	1	0		
		LHAC	C/H/R	2	0		
MCR steelhead		Natural	C/H/R	4	0	0.001	
SnkR spr/sum Chinook		Natural	C/H/R	1	0	<0.001	
		LHIA	C/H/R	1	0		
		LHAC	C/H/R	1	0		
SnkR fall Chinook		Natural	C/H/R	1	0		
		LHIA	C/H/R	1	0		
		LHAC	C/H/R	1	0		
SnkR steelhead		Natural	C/H/R	2	0		
		LHIA	C/H/R	1	0		
		LHAC	C/H/R	2	0		
LCR coho		Natural	C/H/R	1	0		

Because the proposed research would affect no adults and kill no listed juveniles at all, it would not be likely to alter any VSP parameter for any listed species. In addition, the research would take place at Bonneville Dam, so the fish that would be captured, handled, and released could come from any of the listed units' populations. Thus, even the miniscule effect of handling and releasing the juveniles would be spread out over the entirety of each listed ESU and DPS. As a result, the research would have no more than a completely negligible effect on any species' abundance, structure, diversity, or productivity, but it *would* generate valuable information about parasite presence and prevalence in the Deschutes and Columbia Rivers.

Permit 26049

Permit 26049 is a new permit that would authorize Dr. Robert Lusardi to take listed fish by minnow traps, beach seines, and hook-and-line in the Sacramento River, CA. Most captured fish would be handled and released without harm, but 25 juvenile CCV steelhead would be sacrificed each year in order to conduct otolith analysis. The researchers are requesting the following levels of take:

Table 81. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 26049 (C=Capture, H=Handle, R=Release, IM=Intentional Mortality).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
SRWR Chinook	Juvenile	Natural	C/H/R	100	2	0.080	0.002
CCV Steelhead		Natural	C/H/R	100	0	0.005	0.0010
		Natural	IM	25	25		

Because the research would be conducted in the mainstem of the Sacramento River we do not expect the research to have a disproportionate effect on any one population. We therefore compare the number of fish that may be killed by the research to the abundance of the ESU/DPS. 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 species (see status section and Table 36). That ratio is presented in the last column of the table above. It signifies that the research, in total, would kill at most 0.002% of the abundance of any ESU/DPS. Thus, even if all the authorized mortality did occur, there would only be very small impacts on the species' abundance and productivity, and no discernible effect on population structure or diversity. This is also true at the population level: the potential loss of two juveniles that are unlikely to survive to adulthood in any case would very probably have no more than a very small effect on even local abundance and productivity.

For CCV steelhead, the researchers are proposing to intentionally kill 25 juvenile CCV steelhead. At the DPS scale, 25 fish represent 0.001% of the CCV steelhead DPS. However, the effect might be magnified by the fact that the losses would be from one population: Clear Creek population. These fish represent 0.099% (25/25,139) of the estimated abundance of juvenile CCV steelhead in Clear Creek. Thus, there would only be very small impacts on the species' abundance and productivity, and no discernible effect on population structure or diversity.

We do not have abundance information for SRWR Chinook in the Sacramento River so we compare the number of fish that may be killed by the research to the abundance of the ESU. That ratio is presented in the last column of the table above. It signifies that the research, in total, would kill at most 0.002% of the abundance of SRWR Chinook. Thus, even if all the authorized mortality did occur, there would only be very small impacts on the species' abundance and productivity, and no discernible effect on population structure or diversity. This is also true at the population level, the potential loss of two juveniles that are unlikely to survive to adulthood in any case would very probably have no more than a very small effect on even local abundance and productivity.

It is also likely that the impacts will be smaller than those laid out above. Aside from the fish that would be sacrificed, Over the past five years other researchers in the Section 10(a)(1)(A) program have reported taking approximately 9% and killing approximately 7% of the juveniles that were authorized, and only taking roughly 5% and killing roughly 3% 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 26287

Under permit 26287 the WDFW is seeking a new permit that would authorize them to take juvenile PS Chinook, PS steelhead, HCS chum, Ozette Lake sockeye salmon, Upper Columbia River spring-run Chinook salmon, Upper Columbia River spring-run NEP 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 Columbia River coho salmon, Lower Columbia River steelhead, Columbia River chum salmon, Upper Willamette River Chinook salmon, Upper Willamette River steelhead, and adult and juvenile SDPS eulachon in order to conduct a pilot study monitoring the distribution and abundance of the invasive European green crab.

Juveniles would be collected via shrimp, Gee minnow, or modified Fukui trap. Any listed fish captured would be handled (identified, checked for marks or tags), 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 amount of take the WDFW is requesting is found in the table below.

Table 82. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 26287 (C=Capture, H=Handle, R=Release).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
PS Chinook	Juvenile	Natural	C/H/R	10	1	<0.001	<0.001
		LHAC	C/H/R	10	1	<0.001	<0.001
PS Steelhead	Juvenile	Natural	C/H/R	10	1	<0.001	<0.001
		LHAC	C/H/R	10	1	0.005	<0.001
HCS chum	Juvenile	Natural	C/H/R	10	1	<0.001	<0.001
		LHIA	C/H/R	10	1	0.007	<0.001
OL Sockeye	Juvenile	Natural	C/H/R	10	1	<0.001	<0.001
		LHAC	C/H/R	10	1	0.022	0.002
UCR Chinook	Juvenile	Natural	C/H/R	10	1	0.002	<0.001
		LHAC	C/H/R	10	1	0.002	<0.001
UCR NEP Chinook	Juvenile	Natural	C/H/R	10	1	-	-
		LHAC	C/H/R	10	1		
UCR Steelhead	Juvenile	Natural	C/H/R	10	1	0.006	<0.001
		LHAC	C/H/R	10	1	0.001	<0.001
MCR Steelhead	Juvenile	Natural	C/H/R	10	1	0.003	<0.001
		LHAC	C/H/R	10	1	0.002	<0.001
SnkR Spr/sum Chinook	Juvenile	Natural	C/H/R	10	1	0.001	<0.001
		LHAC	C/H/R	10	1	<0.001	<0.001

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
SnkR Fall Chinook	Juvenile	Natural	C/H/R	10	1	0.001	<0.001
		LHAC	C/H/R	10	1	<0.001	<0.001
SnkR Steelhead	Juvenile	Natural	C/H/R	10	1	0.001	<0.001
		LHAC	C/H/R	10	1	<0.001	<0.001
SnkR Sockeye	Juvenile	Natural	C/H/R	10	1	0.053	0.005
		LHAC	C/H/R	10	1	0.004	<0.001
LCR Chinook	Juvenile	Natural	C/H/R	10	1	<0.001	<0.001
		LHAC	C/H/R	10	1	<0.001	<0.001
LCR Coho	Juvenile	Natural	C/H/R	10	1	0.001	<0.001
		LHAC	C/H/R	10	1	<0.001	<0.001
LCR Steelhead	Juvenile	Natural	C/H/R	10	1	0.003	<0.001
		LHAC	C/H/R	10	1	<0.001	<0.001
CR Chum	Juvenile	Natural	C/H/R	10	1	<0.001	<0.001
		LHIA	C/H/R	10	1	0.002	<0.001
UWR Chinook	Juvenile	Natural	C/H/R	10	1	<0.001	<0.001
		LHAC	C/H/R	10	1	<0.001	<0.001
UWR Steelhead	Juvenile	Natural	C/H/R	10	1	0.007	<0.001
SDPS eulachon	Adult	Natural	C/H/R	10	1	<0.001	<0.001
	Juvenile	Natural	C/H/R	10	1		

Because the majority of the fish that would be captured are expected to recover with minimal 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 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, at the ESU and DPS levels, the proposed research would have, at most, an effect that is as close to zero as it is possible to get. Species abundance could be affected, but only to the smallest possible degree, and productivity, diversity, and structure would not be appreciably affected.

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 9% and killing approximately 7% of the juveniles that were authorized, and only taking roughly 5% and killing roughly 3% 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 benefit it would have with respect to species conservation. Sampling under this permit would verify the distribution and abundance of invasive European green crab, a species that is highly destructive to eelgrass habitats in areas it has colonized along the coast of Washington and Oregon. Highly productive estuarine eelgrass habitats are important for migration and rearing of juvenile salmon and steelhead for many ESA-listed species on the West Coast, and therefore actions to protect these habitats support recovery of these species. This information would be used by managers to adaptively target monitoring for this invasive species, and effectively coordinate removal efforts to minimize negative impacts to eelgrass habitats and associated food webs that salmon and steelhead rely on.

Permit 26295

Under permit 26295, researchers from Mount Hood Environmental would conduct an inventory of all fish and their relative abundances in a small portion of the Grande Ronde River in Eastern Oregon and, by expanding their results, thereby determine what effect local predators may be having on listed salmonids throughout the Grande Ronde system. The researchers would use backpack or boat-mounted electrofishing, fyke netting, seining, angling, and minnow trapping to perform the inventories in each study reach. All listed fish would be released immediately following capture and identification. If any of these fish exhibit sign of stress, they would be allowed to recover in a holding tank (or bucket) of aerated water before being released. The researchers would coordinate their activities with local ODFW biologists to ensure that their work has the smallest possible effect on listed species. In addition, they would seek, to the best of their ability, to avoid listed fish entirely during their surveys—especially when temperatures begin to rise above 64 degrees Fahrenheit. The researchers are requesting the following amounts of take.

Table 83. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 26295 (C=Capture, H=Handle, R=Release).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
SnkR spr/sum Chinook	Juvenile	Natural	C/H/R	60	2	0.007	<0.001
		LHIA	C/H/R	60	2	0.008	
		LHAC	C/H/R	60	2	0.001	
SnkR steelhead		Natural	C/H/R	60	2	0.008	
		LHIA	C/H/R	60	2	0.012	
		LHAC	C/H/R	60	2	0.002	

Because the vast 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 are best seen in the context of the fish that the action may kill. To determine the effect of these losses, it is necessary to compare them to the total outmigrant numbers expected for these species (and their components) and (b) the total average returns over the last five years for which we have data (see status section and Table 36). These calculations are displayed in the last column of the table above and signify that the research would kill no adult salmonids and less than one juvenile in one hundred thousand for SnkR spr/sum Chinook or steelhead.

These losses are very small, but they would be magnified by the fact that it would be concentrated on the Catherine Creek and upper Grande Ronde River populations of listed Chinook and steelhead. Given that an average of a little over 3% of the natural SnkR spr/sum Chinook return to these populations (i.e., about 135 adults (Ford 2022)) and probably a similar proportion of the hatchery fish, it would mean that the local effect could be as much as 30 times higher than that displayed. But even at that magnification, this is still a very small effect: with a maximum of only two juveniles from each component being killed (including two LHAC hatchery fish for which there are no take prohibitions), the effect, even at a maximum, would be nearly zero at the local level and smaller still at the level of the listed unit.

For steelhead, the local effect of these losses would probably be more than ten times smaller than even the minor effects described for Chinook. The most recent average for natural SnkR steelhead returns to the upper Grande Ronde mainstem population (Ford 2022) is 1,638 fish (and likely a similar amount for hatchery fish). Given that this population could (conservatively) produce 200,000 smolts (819 females X 5,000 eggs X 0.05% egg-to-smolt survival), this signifies that the loss of two juveniles from each component would have almost no effect on abundance and productivity at the local level and no measurable effect on either structure or diversity. Nonetheless, even this very small effect would be offset to some extent by the information to be gained regarding salmonid predator presence and possible mitigation.

Permit 26331

Under Permit 26331, the ODFW would implant acoustic tags in adult MCR steelhead at Bonneville Dam on the Columbia River and monitor the fishes' subsequent migration patterns and routes. The fish would be separated from other steelhead by researchers working in a section of the Bonneville Dam complex known as the Adult Fish Facility (AFF). The fish would be checked for tags and marks and indications that they are in fact MCR steelhead, and then anesthetized, tagged, and released immediately upstream of the adult fish trap and allowed to proceed up the fish ladder to cross Bonneville Dam. The fish would then be tracked by acoustic receiver arrays in upstream reservoirs and dams and at a location near the confluence of the Columbia and John Day Rivers. The researchers are requesting the following amounts of take.

Table 84. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 26331 (C=Capture, H=Handle, R=Release, T=Tag, M=Mark, ST-Sample Tissue).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
UCR steelhead	Adult	Natural	C/M/T/ ST/R	30	0	2.048	0.000
MCR steelhead		Natural	C/M/T/ ST/R	170	2	1.250	0.015
SnkR steelhead		Natural	C/M/T/ ST/R	100	1	1.004	0.010

Because the vast 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 are best seen in the context of the fish that the action may kill. To determine the effect of these losses, it is necessary to compare them to the total outmigrant numbers expected for these species (and their components) and (b) the total average returns over the last five years for which we have data (see status section and Table 36). These calculations are displayed in the last column of the table above and signify that the research would affect no juveniles and could kill, at most, the equivalent of about one natural adult out of one thousand from both the MCR and SnkR steelhead DPSs.

These effects are very small and, because the collection would take place a Bonneville Dam, the fish could come from anywhere in each DPS. As a result, the impacts associated with this work cannot be ascribed to any individual population (or group of them) and must be analyzed in the context of each listed unit as a whole. At that level, there would be slight decreases in abundance and productivity for MCR and SnkR steelhead; but because the fish could come from any population in any given year, there would likely be no measurable effect on structure or diversity for either species.

One thing to note about this research is that ODFW has actually been conducting it for two years under another authority associated with the operation of Bonneville Dam. They believe it is likely that they will once again get approval to do the work under that authority but they are not certain, so their permit application in this case is entirely a back-up measure. The most probable outcome is that this permit will be withdrawn, the work will be conducted on steelhead that have already been analyzed for take, and the effects described above will never even occur. And even if it does go forward, the mortality estimates are, as noted before, intentionally inflated. Nonetheless, if all three of the possible mortalities were to occur, they would still entail only minor effects, and would be offset to some degree by the knowledge regarding steelhead migration the research is designed to generate.

Permit 26334

Permit 26334 is a new permit that would authorize Dr. Robert Lusardi to take listed fish by dip-netting and observing them during snorkel surveys in the Walker Creek watershed, CA. Captured fish would be anesthetized, measured, weighed, PIT tagged, and tissue-sampled for genetic information. The researchers do not propose to intentionally kill any fish, but a small number may die as an unintended result of the research activities. The researchers are requesting the following levels of take:

Table 85. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 26334 (C=Capture, H=Handle, R=Release, T=Tag, M=Mark, ST=Sample Tissue, O=Observe, H=Harass).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
CCC Coho	Juvenile	Natural	C/M/T/ST/R	400	8	0.433	0.002
		Natural	O/H	1,000	0		

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 species (see status section and Table 36). That ratio is presented in the last column of the table above. It signifies that the research, in total, would kill at most 0.002% juvenile CCC coho. This effect is very small and no adults would be affected at all. Though this research is targeting one population of CCC coho, we do not have population-level data for this population. The potential loss of eight juvenile fish that are unlikely to survive to adulthood in any case would very probably have no more than a very small effect on local abundance and productivity and little or none on diversity or structure.

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 9% and killing approximately 7% of the juveniles that were authorized, and only taking roughly 5% and killing roughly 3% 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 benefit it would have with respect to species conservation. This research would benefit CCC coho by providing data on habitat use and outmigration timing—information that would be used to inform habitat restoration and species recovery efforts.

Permit 26352

Under permit 26352 the NW Straits Commission is seeking a new permit that would authorize them to take juvenile and adult PS Chinook and PS steelhead in order to conduct a pilot study monitoring the distribution and abundance of the invasive European green crab.

Juveniles would be collected via shrimp, Gee minnow, or modified Fukui trap. It is possible that adults could also unintentionally be collected in a modified Fukui trap. Any listed fish captured would be handled (identified, checked for marks or tags), and released. 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 amount of take the NW Straits Commission is requesting is found in the table below.

Table 86. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 26352 (C=Capture, H=Handle, R=Release).

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
PS Chinook	Adult	Natural	C/H/R	1	0	0.004	0.000
		LHAC	C/H/R	1	0	0.004	0.000
	Juvenile	Natural	C/H/R	10	1	<0.001	<0.001
		LHAC	C/H/R	10	1	<0.001	<0.001

PS Steelhead	Adult	Natural	C/H/R	1	0	0.005	0.000
		LHAC	C/H/R	1	0	0.136	0.000
	Juvenile	Natural	C/H/R	10	1	<0.001	<0.001
		LHAC	C/H/R	10	1	0.005	<0.001

Because the majority of the fish that would be captured are expected to recover with minimal 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 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, at the ESU and DPS levels, the proposed research would have, at most, an effect that is as close to zero as it is possible to get. Species abundance could be affected, but only to the smallest possible degree, and productivity, diversity, and structure would not be appreciably affected.

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 9% and killing approximately 7% of the juveniles that were authorized, and only taking roughly 5% and killing roughly 3% 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 benefit it would have with respect to species conservation. Sampling under this permit would verify the distribution and abundance of invasive European green crab, a species that is highly destructive to eelgrass habitats in areas it has colonized along the coast of Washington and Oregon. Highly productive estuarine eelgrass habitats are important for migration and rearing of juvenile salmon and steelhead for many ESA-listed species on the West Coast, and therefore actions to protect these habitats support recovery of these species. This information would be used by managers to adaptively target monitoring for this invasive species, and effectively coordinate removal efforts to minimize negative impacts to eelgrass habitats and associated food webs that salmon and steelhead rely on.

Permit 26359

Under permit 26359 the Washington Sea Grant is seeking a new permit that would authorize them to take juvenile and adult PS Chinook, PS steelhead, HCS chum, SDPS eulachon, and juvenile Ozette Lake sockeye salmon while conducting a pilot study monitoring the distribution and abundance of the invasive European green crab.

Juvenile salmon and steelhead and juvenile and adult SDPS eulachon would be collected via shrimp, Gee minnow, or modified Fukui trap. It is possible that adult salmon and steelhead could also unintentionally be collected in a modified Fukui trap. Any listed fish captured would be handled (identified, checked for marks or tags), and released. The researchers are not proposing to kill any of the listed fish being captured, but a small number of juvenile salmon and steelhead or juvenile and adult eulachon may be killed as an inadvertent result of these activities. The amount of take the Washington Sea Grant is requesting is found in the table below.

Table 87. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 26359. (C=Capture, H=Handle, R=Release)

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
PS Chinook	Adult	Natural	C/H/R	1	0	0.004	0.000
		LHAC	C/H/R	1	0	0.004	0.000
	Juvenile	Natural	C/H/R	10	1	<0.001	<0.001
		LHAC	C/H/R	10	1	<0.001	<0.001
PS Steelhead	Adult	Natural	C/H/R	1	0	0.005	0.000
	Juvenile	Natural	C/H/R	10	1	<0.001	<0.001
HCS chum	Adult	Natural	C/H/R	1	0	0.004	0.000
	Juvenile	Natural	C/H/R	10	1	<0.001	<0.001
OL Sockeye	Juvenile	Natural	C/H/R	5	1	<0.001	<0.001
SDPS eulachon	Adult	Natural	C/H/R	10	1	<0.001	<0.001
	Juvenile	Natural	C/H/R	10	1		

Because the majority of the fish that would be captured are expected to recover with minimal 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 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, at the ESU and DPS levels, the proposed research would have, at most, an effect that is as close to zero as it is possible to get. Species abundance could be affected, but only to the smallest possible degree, and productivity, diversity, and structure would not be appreciably affected.

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 9% and killing approximately 7% of the juveniles that were authorized, and only taking roughly 5% and killing roughly 3% 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 benefit it would have with respect to species conservation. Sampling under this permit would verify the distribution and abundance of invasive European green crab, a species that is highly destructive to eelgrass habitats in areas it has colonized along the coast of Washington and Oregon. Highly productive estuarine eelgrass habitats are important for migration and rearing of juvenile salmon and steelhead for many ESA-listed species on the West Coast, and therefore actions to protect these habitats support recovery of these species. This information would be used by managers to adaptively target monitoring for this invasive species, and effectively coordinate removal efforts to minimize negative impacts to eelgrass habitats and associated food webs that salmon and steelhead rely on.

Permit 26398

Under permit 26398, the South Puget Sound Salmon Enhancement Group is seeking a new permit that would authorize them to take juvenile PS Chinook, PS steelhead, HCS chum, and adult SDPS eulachon in order to plan for and monitor the success of habitat restoration projects in several watersheds that drain into central and southern Puget Sound.

Juvenile salmon and steelhead and adult eulachon would be collected via backpack electrofishing, hook and line angling, beach seine, and minnow trap, and observed via snorkel surveys. A subsample of captured juveniles would be anesthetized, have stomach contents collected via gastric lavage, have a fin or opercle tissue sample collected, and be PIT-tagged prior to release. 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 South Puget Sound Salmon Enhancement Group is requesting is found in the table below.

Table 88. Proposed Take and Comparison of Possible Lethal Take to Annual Abundance at the ESU/DPS Scale Under Permit 26398. (C=Capture, H=Handle, R=Release, T=Tag, M=Mark, ST=Sample Tissue, O/H=Observe/Harass)

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
PS Chinook	Juvenile	Natural	C/M/T/ST/R	6,800	68	0.467	<0.001
		Natural	O/H	28,000	0		
		LHAC	C/M/T/ST/R	2,400	24	0.020	<0.001
		LHAC	O/H	8,000	0		
PS Steelhead	Juvenile	Natural	C/M/T/ST/R	6,800	68	0.772	0.002
		Natural	O/H	28,000	0		
		LHAC	C/M/T/ST/R	2,400	24	2.796	0.006
		LHAC	O/H	8,000	0		
HCS chum	Juvenile	Natural	C/M/T/ST/R	1,400	14	0.087	<0.001
		Natural	O/H	6,000	0		
		LHIA	C/M/T/ST/R	600	6	0.867	0.002
		LHIA	O/H	2,000	0		
SDPS eulachon	Adult	Natural	C/H/R	800	16	0.002	<0.001
		Natural	O/H	400	0		

Because the majority of the fish that would be captured are expected to recover with minimal 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.

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 9% and killing approximately 7% of the juveniles that were authorized, and only taking roughly 5% and killing roughly 3% 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 benefit it would have with respect to species conservation. Sampling under this permit would provide information on freshwater and estuarine habitat use by ESA-listed fish species, and the response of juvenile salmonids to restoration actions. This information would continue to be used by natural resource managers to identify and prioritize new potential salmon habitat restoration projects in southern Puget Sound, which would ultimately increase the availability of suitable habitat for PS Chinook, chum salmon, and steelhead.

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.[2] The recovery plans, status summaries, and limiting factors that are part of the analysis of this Opinion are discussed in detail in Table 2 (Section 2.2.1).

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

Future state, tribal, and local government actions will likely be in the form of legislation, administrative rules, or policy initiatives. Government and private actions may include changes in land and water uses, including ownership and intensity, any of which could affect 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.

[2] https://www.fisheries.noaa.gov//action/2016-5-year-reviews-28-listed-species-pacific-salmon-steelhead-and-eulachon

Puget Sound/Western Washington

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

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.

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[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"

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.

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 factors 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 89), (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 90).

Table 89. 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
PS Chinook	Adult	Natural	134	11	0.573	0.047
		LHIA	125	5	1.373[a]	0.159
		LHAC	194	32		
	Juvenile	Natural	24,791	1,540	0.665	0.041
		LHIA	5,887	492	0.071	0.006
		LHAC	14,548	1,935	0.056	0.007
PS Steelhead	Adult	Natural	18	2	0.094	0.010
		LHIA	0	0	2.177[a]	0.272
		LHAC	16	2		
	Juvenile	Natural	10,440	182	0.463	0.008
		LHIA	58	2	0.066	0.002
		LHAC	4,004	75	2.153	0.040
PS/GB Bocaccio	Adult	Natural	12	9	0.868[c]	0.478
	Juvenile	Natural	28	13		
PS/GB Yelloweye Rockfish	Adult	Natural	13	12	0.032[c]	0.022
	Juvenile	Natural	24	13		
HCS Chum	Adult	Natural	14	3	0.050	0.011
	Juvenile	Natural	2,838	63	0.067	0.001
		LHIA	1,230	25	0.820	0.017
OL Sockeye	Adult	Natural	5	0	0.085	0.000
		LHIA	0	0	1.618[a]	
		LHAC	5	0		
	Juvenile	Natural	30	4	0.002	<0.001
		LHIA	0	0	0.000	0.000
		LHAC	30	3	0.066	0.007
UCR Chinook	Adult	Natural	58	0	7.134	0.000
		LHIA	2	0	0.789[a]	
		LHAC	7	0		
	Juvenile	Natural	320	10	0.062	0.002

Species	Life Stage	Origin	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
		LHIA	1	0	<0.001	0.000
		LHAC	274	17	0.046	0.003
		LHAC	10	1		
Upper Columbia River steelhead	Adult	Natural	88	0	6.007	0.000
		LHIA	0	0	0.173 [a]	
		LHAC	5	0		
	Juvenile	Natural	106	6	0.065	0.004
		LHIA	1	0	<0.001	0.000
		LHAC	86	5	0.012	<0.001
MCR Steelhead	Adult	Natural	308	7	2.265	0.051
		LHIA	130	5	19.355 [a]	0.701
		LHAC	8	0		
	Juvenile	Natural	8,415	114	2.238	0.030
		LHIA	8,260	106	7.145	0.092
		LHAC	102	6	0.024	0.001
SnkR Spr/sum Chinook	Adult	Natural	-390	3	-	0.068
		LHIA	200	3		0.213 [a]
		LHAC	-890	3		
	Juvenile	Natural	29,102	401	3.538	0.049
		LHIA	9,561	82	1.312	0.011
		LHAC	11,289	194	0.238	0.004
SnkR Fall Chinook	Adult	Natural	35	1	0.482	0.014
		LHIA	30	1	0.437 [a]	0.013
		LHAC	35	1		
	Juvenile	Natural	1,664	123	0.224	0.017
		LHIA	1,501	105	0.051	0.004
		LHAC	1,690	140	0.066	0.005
SnkR Steelhead	Adult	Natural	7,675	77	77.020	0.773
		LHIA	1,920	23	132.268 [a]	1.522
		LHAC	2,425	27		
	Juvenile	Natural	39,110	862	4.949	0.109
		LHIA	22,354	322	4.506	0.065
		LHAC	23,127	355	0.738	0.011
SnkR Sockeye	Adult	Natural	100	2	625.000	12.500
		LHIA	0	0	0.000 [a]	0.000
		LHAC	0	0		
	Juvenile	Natural	7,637	155	40.096	0.814
		LHIA	0	0	-	-
		LHAC	142	5	0.052	0.002
LCR Chinook	Adult	Natural	14	0	0.048	0.000
		LHIA	0	0	0.074 [a]	
		LHAC	14	0		
	Juvenile	Natural	820	43	0.007	<0.001
		LHIA	125	11	0.015	0.001
		LHAC	568	79	0.002	<0.001
LCR Coho	Adult	Natural	14	0	0.075	0.000
		LHIA	0	0	0.119 [a]	0.006
		LHAC	19	1		
	Juvenile	Natural	821	34	0.106	0.004
		LHIA	45	2	0.017	<0.001

Species	Life Stage	Origin	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
		LHAC	755	31	0.010	
LCR Steelhead	Adult	Natural	17	0	0.209	0.000[b]
		LHAC	14	0	0.219	
	Juvenile	Natural	9,165	285	2.469	0.077
		LHAC	425	17	0.036	0.001
CR Chum	Adult	Natural	5	0	0.029	0.000 [b]
		LHIA	0	0	0.000	
	Juvenile	Natural	145	8	0.002	<0.001
		LHIA	10	1		
UWR Chinook	Adult	Natural	7	0	0.066	0.000 [b]
		LHAC	3	0	0.012	
	Juvenile	Natural	791	34	0.068	0.003
		LHIA	1	1	-	-
		LHAC	505	57	0.011	0.001
UWR Steelhead	Adult	Natural	7	0	0.266	0.000
	Juvenile	Natural	620	21	0.453	0.015
OC Coho	Adult	Natural	0	0	0.000	0.000
		LHAC	0	0		
	Juvenile	Natural	1,340	46	0.031	0.001
		LHAC	0	0	0.000	0.000
SONCC Coho	Adult	Natural	0	0	0.000	0.000
		LHAC	0	0	0.000	0.000
	Juvenile	Natural	4,540	64	0.513	0.007
		LHAC	0	0	0.000	0.000
NC Steelhead	Adult	Natural	650	7	7.779	0.084
	Juvenile	Natural	44,061	439	4.636	0.046
CC Chinook	Adult	Natural	50	1	0.380	0.008[b]
	Juvenile	Natural	22,760	640	0.951	0.027
SRWR Chinook	Adult	Natural	10	0	0.844	0.000
		LHAC	50	40	1.854	1.483
	Juvenile	Natural	1,013	22	0.810	0.018
		LHAC	3,960	817	2.493	0.514
CVS Chinook	Adult	Natural	85	2	1.258	0.030
		LHAC	150	45	7.201	2.160
	Juvenile	Natural	3,371	625	0.183	0.034
		LHAC	4,157	828	0.208	0.041
CCV Steelhead	Adult	Natural	192	6	3.193 [b]	0.452
		LHAC	175	46		
	Juvenile	Natural	4,290	103	0.328	0.008
		LHAC	3,750	618	0.357	0.059
CCC Coho	Adult	Natural	2,965	37	190.858 [b]	2.773
		LHIA	1,440	27		
	Juvenile	Natural	107,440	1,361	66.502	0.842
		LHIA	76,100	1,029	54.357	0.735
CCC Steelhead	Adult	Natural	1,075	22	57.975 [b]	1.154
		LHAC	30	0		
	Juvenile	Natural	134,510	3,363	62.041	1.551
		LHAC	15,150	440	2.913	0.085
SCCC Steelhead		Natural	825	8	3.700	0.036
	Adult	Natural	5,280	606	0.021	0.003

Species	Life Stage	Origin	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
SDPS Eulachon	Subadult	Natural	0	0		
	Juvenile	Natural	270	252		
SDPS Green Sturgeon	Adult	Natural	29	1	1.363	0.047
	Subadult	Natural	3	0	0.027	0.000
	Juvenile	Natural	4,760	117	107.425	2.640

[a] Abundances for adult hatchery salmonids are LHAC and LHIA combined.
[b] Abundances for all adult components are combined.
[c] Abundance for these species are only known for the adult life stage which is used to represent the entire DPS.

Thus, the activities contemplated in this opinion may kill—in combination and at most—as much as 12.5% of the fish from any component of any listed species; that component is adult natural SnkR sockeye salmon (see discussion under Permit 1341-6R and below). In all other instances found in the table above, the effect is (at most) about one-sixth of 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 90. Total expected take of the ESA listed species for scientific research and monitoring already approved for 2022 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
PS Chinook	Adult	Natural	798	39	3.414	0.167
		LHIA	443	12	5.880	0.353
		LHAC	923	70		
	Juvenile	Natural	496,205	10,559	13.309	0.283
		LHIA	85,229	3,077	1.029	0.037
		LHAC	259,503	13,342	0.991	0.051
PS Steelhead	Adult	Natural	2,115	44	11.085	0.231
		LHIA	21	0	7.619	0.952
		LHAC	35	7		
	Juvenile	Natural	77,834	1,395	3.453	0.062
		LHIA	2,394	41	2.736	0.047
		LHAC	9,063	172	4.873	0.092
PS/GB Bocaccio	Adult	Natural	38	21	2.540	1.086
	Subadult	Natural	2	1		
	Juvenile	Natural	77	28		
PS/GB Yelloweye Rockfish	Adult	Natural	44	26	0.090	0.052
	Subadult	Natural	2	1		
	Juvenile	Natural	57	32		
HCS Chum	Adult	Natural	1,183	22	4.207	0.078
	Juvenile	Natural	576,853	2,445	13.602	0.058
		LHIA	1,400	44	0.933	0.029
		LHAC	85	18	-	-
OL Sockeye	Adult	Natural	19	4	0.323	0.068
		LHIA	1	0	2.265	0.000
		LHAC	6	0		
	Juvenile	Natural	113	7	0.009	<0.001

Species	Life Stage	Origin	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
		LHIA	1	0	<0.001	0.000
		LHAC	53	5	0.116	0.011
UCR Chinook	Adult	Natural	195	6	23.985	0.738
		LHIA	152	3	28.246	0.877
		LHAC	170	7		
	Juvenile	Natural	10,808	233	2.085	0.045
		LHIA	1,035	33	0.233	0.007
		LHAC	1,506	78	0.254	0.013
Upper Columbia River steelhead	Adult	Natural	237	4	16.177	0.273
		LHIA	94	2	10.819	0.277
		LHAC	219	6		
	Juvenile	Natural	32,244	664	19.912	0.410
		LHIA	2,419	69	1.826	0.052
		LHAC	10,346	249	1.392	0.033
MCR Steelhead	Adult	Natural	1,380	19	10.149	0.140
		LHIA	168	6	154.418	2.525
		LHAC	933	12		
	Juvenile	Natural	106,591	2,455	28.354	0.653
		LHIA	8,572	115	7.415	0.099
		LHAC	810	44	0.187	0.010
SnkR Spr/sum Chinook	Adult	Natural	1,308	16	29.599	0.362
		LHIA	386	4	19.383	0.496
		LHAC	161	10		
	Juvenile	Natural	583,402	5,898	70.919	0.717
		LHIA	44,670	395	6.131	0.054
		LHAC	81,213	1,204	1.711	0.025
SnkR Fall Chinook	Adult	Natural	80	9	1.102	0.124
		LHIA	32	1	0.759	0.101
		LHAC	81	14		
	Juvenile	Natural	3,532	234	0.476	0.032
		LHIA	1,837	140	0.062	0.005
		LHAC	2,381	275	0.093	0.011
SnkR Steelhead	Adult	Natural	9,569	112	96.026	1.124
		LHIA	1,989	29	148.219	2.131
		LHAC	2,880	41		
	Juvenile	Natural	285,886	4,005	36.180	0.507
		LHIA	34,824	462	7.020	0.093
		LHAC	77,643	971	2.476	0.031
SnkR Sockeye	Adult	Natural	111	6	693.750	37.500
		LHIA	1	0	2.062	0.000
		LHAC	1	0		
	Juvenile	Natural	11,090	473	58.224	2.483
		LHIA	1	0	-	-
		LHAC	401	261	0.148	0.096
LCR Chinook	Adult	Natural	325	16	1.109	0.055
		LHIA	12	0	0.866	0.069
		LHAC	151	13		
	Juvenile	Natural	380,183	5,599	3.390	0.050
		LHIA	320	41	0.037	0.005
		LHAC	2,671	656	0.009	0.002
LCR Coho	Adult	Natural	928	16	4.959	0.085

Species	Life Stage	Origin	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
		LHIA	31	0	4.007	0.257
		LHAC	608	41		
	Juvenile	Natural	147,907	1,991	19.053	0.256
		LHIA	560	112	0.209	0.042
		LHAC	11,910	1,036	0.156	0.014
LCR Steelhead	Adult	Natural	2,833	32	34.752	0.393
		LHAC	86	4	1.348	0.063
	Juvenile	Natural	66,854	1,158	18.008	0.312
		LHIA	3	0	0.020	0.000
		LHAC	25,023	307	2.123	0.026
CR Chum	Adult	Natural	40	6	0.231	0.035
		LHIA	1	0	0.087	0.000
	Juvenile	Natural	28,202	392	0.374	0.005
		LHIA	395	16	0.075	0.003
		LHAC	10	0	-	-
UWR Chinook	Adult	Natural	178	6	1.690	0.057
		LHAC	143	12	0.563	0.047
	Juvenile	Natural	39,995	809	3.435	0.069
		LHIA	47	5	-	-
		LHAC	10,480	338	0.230	0.007
UWR Steelhead	Adult	Natural	227	4	8.638	0.152
	Juvenile	Natural	14,058	297	10.263	0.217
OC Coho	Adult	Natural	8,725	108	14.392	0.178
		LHAC	21	4	3.292	0.627
	Juvenile	Natural	529,234	11,994	12.341	0.280
		LHAC	339	21	0.565	0.035
SONCC Coho	Adult	Natural	1,676	24	32.308	0.427
		LHIA	1,808	17		
		LHAC	600	13		
	Juvenile	Natural	148,075	2,429	16.734	0.275
		LHIA	7,506	562	10.008	0.749
		LHAC	3,916	72	0.681	0.013
NC Steelhead	Adult	Natural	1,266	24	15.151	0.287
	Juvenile	Natural	118,665	2,311	12.485	0.243
CC Chinook	Adult	Natural	388	21	2.946	0.159
	Juvenile	Natural	68,867	1,424	2.878	0.060
SRWR Chinook	Adult	Natural	1,520	24	128.270	2.025
		LHAC	1,515	51	56.174	1.891
	Juvenile	Natural	429,166	11,535	343.228	9.225
		LHAC	205,159	7,741	129.149	4.873
CVS Chinook	Adult	Natural	1,465	23	21.684	0.340
		LHAC	503	82	24.148	3.937
	Juvenile	Natural	409,502	12,825	22.268	0.697
		LHAC	8,494	3,360	0.425	0.168
CCV Steelhead	Adult	Natural	3,544	116	53.019	2.854
		LHAC	2,550	212		
	Juvenile	Natural	72,819	2,099	5.570	0.161
		LHAC	28,132	1,849	2.679	0.176
CCC Coho	Adult	Natural	4,418	62	263.128	4.203
		LHIA	1,655	35		
	Juvenile	Natural	206,681	3,490	127.928	2.160

Species	Life Stage	Origin	Requested Take	Lethal Take	Percent of ESU/DPS Taken	Percent of ESU/DPS Killed
		LHIA	106,516	1,603	76.083	1.145
CCC Steelhead	Adult	Natural	2,520	48	134.470	2.886
		LHAC	43	7		
	Juvenile	Natural	269,712	6,260	124.401	2.887
		LHAC	15,526	449	2.986	0.086
SCCC Steelhead	Adult	Natural	886	12	452.041	6.122
	Juvenile	Natural	39,443	881	176.914	3.952
SDPS Eulachon	Adult	Natural	38,095	31,063	0.148	0.121
	Subadult	Natural	1,030	1,030		
	Juvenile	Natural	430	356		
SDPS Green Sturgeon	Adult	Natural	347	9	16.314	0.423
	Subadult	Natural	250	9	2.239	0.081
	Juvenile	Natural	6,594	190	148.815	4.288
	Larvae	Natural	11,208	1,038	-	-
	Egg	Natural	1,866	1,866		

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

However, in 21 cases involving 13 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 89 and 90 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 with research already authorized would potentially kill more than one half of one percent of the estimated natural abundance of an adult or juvenile component of the following listed species: UCR Chinook, MCR steelhead, SnkR spr/sum Chinook, SnkR sockeye, SnkR steelhead, SRWR Chinook salmon, CVS Chinook salmon, CCV steelhead, CCC coho salmon, CCC steelhead, and SCCC steelhead. 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 90). 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. This is true in all cases except for SnkR sockeye salmon—

and they are discussed in detail below). The loss of hatchery fish with intact adipose fins could have some effect, but it would be greatly attenuated by the fact that in no case are recovery goals directly tied to hatchery fish abundance. That is while in some cases, non-clipped hatchery fish may be allowed to spawn in the wild, delisting criteria are always tied to natural fish rather than hatchery components. Also, in the two instances where the mortality rates for LHIA fish exceed 0.5% (SONCC and CCC coho), the rates are for juvenile fish, many of which would be in the fry stage rather than the smolt stage and therefore their loss would be less impactful. Also, the abundance data we have for both those species are poor and undoubtedly underestimates of the actual numbers. Therefore, we focus on the naturally produced ESU and 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. Also, as noted throughout 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 degrees to which these values are likely overestimates, based on actual reported data from recent years of the research program, are discussed for each species and age class in the individual permit analyses and in the following subsections.

Another reason effects on natural-origin components of each listed unit may be smaller than the values in the tables above is 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 recover.

Juvenile Salmonids

Middle Columbia River Steelhead

A figure requiring a closer view is the 0.653% of the natural-origin MCR steelhead juveniles killed by research activities in the Deschutes River basin. The actions considered in this opinion would appear to add 114 fish to the total being allotted, but in fact 113 of those additional fish come from permit renewals so, though they are not currently considered part of the baseline, they have been such for a number of years and their take has previously been analyzed and found not to jeopardize the species. Also, 106 of those fish come from an introduced experimental population (See Permit 17306-3R)—one that currently considered surplus to the species recovery needs. Thus, the 0.653% actually represents little increase in an amount of take that has previously repeatedly been found to not jeopardize the species.

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 0.653%.

Moreover, and out of an abundance of caution, we analyze the effect of removing juveniles from the NEP as if they were part of the listed unit, but in fact it will be three years until they are actually considered to be part of the MCR steelhead DPS. 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.

In addition, it should also be noted that over the last five years (a time when all the permits being renewed were in effect), the amount of natural MCR steelhead juvenile taken was only 23.94% of what was permitted—and the mortality rate was only 13% 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 around 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, 0.753% of the natural-origin juvenile SnkR spr/sum Chinook salmon may be killed in a given year. The actions considered in this opinion would appear to add 401 fish to the total being allotted, but in fact very nearly all (397) of those additional fish come from permit renewals. Thus, though they are not currently considered part of the baseline, they have been such for a number of years and, as a result, take levels almost exactly the same as the 0.753% have previously been analyzed. This minor effect on abundance and (therefore) productivity has thus repeatedly been determined to not jeopardize the species.

Moreover, it should be noted that over the last five years (a time when all the permits being renewed were in effect), the amount of natural SnkR spr/sum Chinook salmon juvenile taken was only 13.56% of what was permitted and the mortality rate was only 4.78% 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, the activities analyzed here would add little increment to impacts that have previously been examined, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

Snake River Steelhead

Under the research program as a whole, 0.514% of the natural-origin juvenile SnkR steelhead may be killed in a given year. The actions considered in this opinion would appear to add 862 fish to the total being allotted, but in fact very nearly all (858) of those additional fish come from permit renewals. Thus, though they are not currently considered part of the baseline, they have been such for a number of years and, as a result, mortality rates very nearly the same as the 0.514% have previously been analyzed. As a result, this minor effect on abundance and (therefore) productivity has thus repeatedly been determined to not jeopardize the species.

In addition, the mortality rate for this species is undoubtedly less 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 0.514%.

Moreover, it should be noted that over the last five years (a time when all the permits being renewed were in effect), the amount of natural SnkR steelhead juvenile taken was only 17.49% of what was permitted and the mortality rate was only 5.49% 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 around a 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.

Snake River Sockeye Salmon

When combined with scientific research and monitoring permits already approved, the potential mortality for juvenile natural-origin SnkR sockeye salmon is 2.483%. While this figure should be viewed with caution, there are two important caveats associated with the mortality numbers: many of the fish that are listed as "natural" would in actuality probably be hatchery fish (of which there are 10 times as many), but they are considered "natural" for the purposes of this analysis in order to lay out the worst-case scenario associated with the research. Second, these truly are worst-case numbers. Over the last 10 years, the IDFG researchers under Permit 1124 (the main permit under which sockeye salmon are taken) have killed less than 20% of the permitted mortalities. That is also true for the other main permit under which this species is taken. Permit 1341 (renewed in this opinion) is held by the Shoshone-Bannock tribes and over the most recent five years, the researchers have taken only 0.1% of their requested take, and killed *none* of their requested mortalities. Thus, it is most likely that the actual effect will continue to be effectively negligible—on the order of 0.0% to 0.5% rather than the 2.4% displayed. 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 actions.

So the 2.5% figure is one that bears careful consideration. However, in this instance, it is necessary to emphasize two things: First, while the take contemplated in this opinion would appear to add 155 fish to the total being allotted, in fact all of those additional fish come from permit renewals. Thus, though they are not currently considered part of the baseline, they have previously been considered such for a number of years and, as a result, take levels almost exactly the same as the 2.483% have previously been repeatedly analyzed and found not to jeopardize the species. Second, the entire purpose of both the permits with the most juvenile SnkR sockeye salmon take (Permit 1124—held by the IDFG, and 1341—held by the SBT) is to help the sockeye salmon survive and recover. Under Permit1124, 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 (as noted previously), researchers seek to help SnkR sockeye recover and expand their range. Though these permits could have some minor negative effect on sockeye abundance, it is possible that without the research conducted under them, the sockeye salmon might 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.

Sacramento River Winter Run Chinook salmon

When combined with scientific research and monitoring permits already approved, the potential mortality for juvenile SRWR Chinook salmon would be 9.225% for naturally produced fish. This represents a notable portion of the species' total abundance, however there are a two caveats to this number. First, the research contemplated in this opinion would add only 22 dead natural juvenile SRWR Chinook to the total, and 14 of those fish would come from permit renewals. Thus, though they are not currently considered part of the baseline, they have been such for a number of years and, as a result, mortality rates similar to the 9.2% have previously been analyzed and found not to jeopardize the species. But even if all 22 juvenile fish contained in this opinion were killed, the effect on species viability would be a very small one.

Second, 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 (a time when the permits being renewed were in effect), researchers took 20.22% of the naturally produced SRWR Chinook salmon juveniles they were authorized, and the actual lethal take rate of natural-origin juveniles was only 10.98% of the mortalities authorized. This would mean that the actual effect is likely to be roughly one tenth of what is 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. 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 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.

Central Valley Spring Run Chinook salmon

When combined with scientific research and monitoring permits already approved, the potential mortality for naturally produced juvenile CVS Chinook salmon would be about 0.7% (Table 90). The activities contemplated in this opinion represent a small portion (less than 5%) of that number; the majority of this take has therefore previously been analyzed and found not to jeopardize the CVS Chinook salmon ESU. The potential additional mortality of CVS Chinook salmon resulting from activities contemplated in this opinion would equate to only 0.03% of the abundance of natural-origin juveniles (Table 90), and would therefore be unlikely to have a measurable impact on the abundance and productivity of this ESU even if take occurred at the maximum authorized amount.

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 17.8% of the juveniles they requested, and the actual mortality rates also averaged only 11.5% 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 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 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.

Central California Coast coho salmon

When combined with scientific research and monitoring permits already approved, the potential mortality for juvenile CCC coho salmon would be 2.2% for natural-origin fish and 1.1% for hatchery-origin fish (Table 90). The activities contemplated in this opinion represent only portions of those small numbers. The potential mortality for natural-origin CCC coho salmon resulting from activities contemplated in this opinion would account for about 39% of the permitted lethal take for the region. Therefore, the majority of the total potential mortality for natural-origin juveniles has been previously analyzed and found not to jeopardize the species. For the hatchery component of this ESU, about 64% percent of the juvenile mortality authorized across the region would result from activities contemplated in this opinion. However, we do not anticipate mortality of these hatchery-origin juveniles will meaningfully impact the abundance or productivity of the ESU as these fish are considered surplus to recovery needs, and annual releases can be increased in response to other factors. Therefore, activities contemplated in this opinion that could result in additional mortalities equivalent to up to 0.8% of natural-origin juveniles in this ESU could have a small impact on abundance and productivity if they occurred at the maximal rates authorized.

It is also 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 table above. Our research tracking system reveals that in total for the past five years, researchers ended up taking 18% of the juveniles they requested and the actual mortality was only 4.2% of the juveniles authorized to be killed. We would therefore expect that the actual mortality numbers are very likely to be less than one-twentieth of the numbers stated 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—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.

Central California Coast steelhead

When combined with scientific research and monitoring permits already approved, the potential mortality for natural juvenile CCC steelhead would be 2.9% of estimated species abundance (Table 90). The activities contemplated in this opinion represent only a portion of that small number. The potential mortality for natural-origin CCC steelhead resulting from activities contemplated here would account for roughly half (53.7%) of the permitted lethal take for the region, representing only 1.6% of the naturally produced juvenile abundance (Table 90). Therefore, additional mortalities resulting from activities contemplated in this opinion that could have a small impact on abundance and productivity of this DPS if they occurred at the maximal rates authorized.

In addition, the mortality rate for this species is undoubtedly less than that displayed due to the overlap of CCC 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 CCC 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 CCC 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 2.9%.

In addition, the true numbers of fish that would actually be taken would most likely be smaller than the amounts authorized. Our research tracking system reveals that for the past five years, researchers ended up taking in total only 12% of the juvenile CCC steelhead they requested and the actual mortality was only 3.8% of the juveniles authorized to be killed. This would mean that the actual effect of mortalities is likely to be on the order of one twenty-fifth 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—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.

South-Central California Coast steelhead

Under the research program as a whole, 3.952% of the natural-origin juvenile SCCC steelhead may be killed in a given year. The actions considered in this opinion would appear to add 8 fish to the total being allotted, but in fact very nearly all of those additional fish come from permit renewals. Thus, though they are not currently considered part of the baseline, they have been such for a number of years and, as a result, mortality rates very nearly the same as the 3.952% have previously been analyzed. As a result, this minor effect on abundance and (therefore) productivity has thus repeatedly been determined to not jeopardize the species.

In addition, the mortality rate for this species is undoubtedly less than that displayed due to the overlap of SCCC 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 SCCC 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 SCCC 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 3.952%.

Moreover, 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 for the past five years, researchers ended up taking 17% of the juvenile naturally-produced SCCC steelhead they were authorized, and the actual mortality rate was only 3.2% of the mortalities authorized for juveniles. This would mean that the actual effect of mortalities is likely to be less than a twentieth 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 believe the impact of the program—even in its entirety—would be 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

Upper Columbia River Spring-run Chinook Salmon

The research program as a whole would permit up to six natural adult the UCR Chinook to be killed in any given year; this would constitute 0.738% of that component of the ESU. However, the research contemplated in this opinion would add no fish at all to that total. This signifies that the entirety of the research take has been analyzed in the past on more than one occasion and been found not to jeopardize the species; it is therefore unnecessary to repeat that analysis here.

Snake River Steelhead

Under the research program as a whole, 1.184% of the natural-origin adult SnkR steelhead may be killed in a given year. The actions considered in this opinion would appear to add 77 fish to the total being allotted, but in fact all but one of those additional fish come from permit renewals. Thus, though they are not currently considered part of the baseline, they have been such for a number of years and, as a result, take levels nearly identical to the 1.184% rate have previously been analyzed and found not to jeopardize the species.

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 12.14% of the adult naturally produced SnkR steelhead they were authorized, and the actual mortality rate was only 1.36% of the mortalities authorized for juveniles. This would mean that the actual effect of mortalities is likely to be about one-hundredth 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—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.

Snake River Sockeye Salmon

Under the research program as a whole, researcher 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 appear to add two fish to the total being allotted, but in fact both of those additional fish come from permit renewals. Thus, though they are not currently considered part of the baseline, they have been such for a number of years and have therefore been part of several previous analyses. Nonetheless, the 37.5% mortality rate is very high and could genuinely operate to the species disadvantage should it ever occur; as such, it requires careful consideration.

To that end, there are a number of caveats associated with that figure. First, the 6 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 lay out the worst-case scenario associated with the research. However, 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, these truly are worst-case numbers. 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, and as noted previously, 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 Permit1124, 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 (as noted in section 2.4), 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 20 years, the sockeye salmon 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.

And finally, henceforth all permits that might allow one or more adult sockeye mortalities will 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 90.

Sacramento River Winter Run Chinook Salmon

When combined with scientific research and monitoring permits already approved the potential mortality for adult SRWR Chinook salmon would range 1.9% for hatchery-origin fish to 2.0% for naturally produced fish in this ESU (Table 90). The projected total lethal take for all research and monitoring activities represents a notable portion of the species' total abundance, however, no new lethal take of natural-origin adults would be authorized as part of this opinion. The activities contemplated in this opinion represent a large portion of the lethal take authorized for hatchery-origin SRWR adults. However, absolute numbers of these authorized mortalities are low (51 individuals in total), and we do not expect the potential mortality of adult hatchery-origin fish to have any genuine effect on the species' survival and recovery in the wild as these fish are considered surplus to recovery needs.

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 not taking or killing any of the naturally produced adults they requested and were authorized to take. This would mean that the actual effect is very likely to be far less than what is displayed in the tables above, and is unlikely to cause any additional mortalities of natural-origin adults compared to the baseline. 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. 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—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.

California Central Valley Steelhead

When combined with scientific research and monitoring permits already approved, the potential mortality for adult CCV steelhead could be equivalent to roughly 2.8% of estimated adult abundance for this DPS (Table 90). The 2.8% potential mortality figure is combined for natural-origin and hatchery adult fish, as available data are not currently sufficient to provide reliable estimates of the proportion of hatchery-origin spawners in this DPS overall. The hatchery-origin fish are considered surplus to recovery needs, therefore, we do not expect the loss from that component to have any genuine effect on the species' survival and recovery in the wild. The 116 natural-origin adults that would be permitted to be taken when these actions were combined with research and monitoring already authorized would be equivalent to 1.0% of the DPS adult abundance overall, though an unknown proportion of the natural-origin adult component of the DPS.

The projected total lethal take for all research and monitoring activities represents a notable portion of the species' total abundance. The activities contemplated in this opinion constitute about 16% of the authorized take in the region (52 of 328 mortalities of hatchery and natural-origin adults), although only about 5% of the authorized lethal take of natural-origin adults (6 of 116 mortalities). The remainder of this authorized take has been previously analyzed and found not to jeopardize the species. As previously noted, we do not expect the potential mortality of 46 adult hatchery-origin fish contemplated in this opinion to have any genuine effect on the species' survival and recovery in the wild as these fish are considered surplus to recovery needs. The potential mortality of six natural-origin adults contemplated in this opinion could have a small impact on the abundance and productivity of this ESU when combined with previously authorized mortalities, if they occurred.

It is very likely that researchers will take fewer fish than estimated, and that the actual effect is likely to be lower than the numbers stated in the tables above. For naturally produced CCV steelhead, our research tracking system reveals that for the past five years researchers only ended up capturing or handling 5.7% of the natural-origin adults they were authorized, and killed none of the adults they were authorized to lethally take. This would mean that the actual effect of take is likely to be much less than the effect displayed in the table above, and is unlikely to cause additional natural-origin adult mortalities compared to the baseline.

Thus, the losses are very small, 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.

Central California Coast Coho Salmon

When combined with scientific research and monitoring permits already approved, the potential mortality for CCC coho salmon could be equivalent to up to 4.2% of estimated adult abundance for this ESU (Table 90). Over a third of the requested adult mortalities are for hatchery-origin fish (which, again, are considered surplus to recovery needs and are allowed to be retained in fisheries). The remaining total potential mortality for adult natural-origin CCC coho salmon is equivalent to 2.7% of estimated adult abundance for the ESU overall, though an unknown proportion of the natural-origin adult component of the ESU. This is a notable portion of the species' abundance, however, the absolute numbers of proposed take are low. Activities contemplated in this opinion would authorize 37 additional natural-origin adult mortalities, which represents 60% of the natural-origin mortalities authorized for the region in total, and roughly 1.6% of the estimated abundance of natural origin CCC coho salmon. Therefore, the potential mortality of 37 natural-origin adults contemplated in this opinion could have a small impact on the abundance and productivity of this ESU when combined with previously authorized mortalities, if they occurred.

It is also very likely that researchers will take fewer fish than estimated for take that is authorized, and that the actual effect is likely to be lower than the numbers stated in Table 90. Our research tracking system reveals that for the past five years researchers ended up capturing or handling only 16% of natural-origin CCC coho salmon adults authorized, and the actual total number of adults killed across the research program was only 11% of the authorized natural-origin adult mortalities (or 14 individuals over 5 years). We would therefore expect that the actual effects of these activities would likely be on the order of one-sixth to one-tenth of the effect displayed in Table 90 above. We therefore find the impact of the program—even in its entirety—is a small effect on abundance and productivity, the activities analyzed here would not add to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

Central California Coast Steelhead

When combined with scientific research and monitoring permits already approved, the potential mortality for natural and hatchery-origin adult CCC steelhead would be 2.9% of estimated adult abundance for this DPS (Table 90). The majority of these adults are natural-origin, although they include the lethal take of seven hatchery-origin adults, which are considered surplus to recovery needs and therefore are not expected to have any genuine effect on the species' survival and recovery in the wild. The remaining natural-origin adult mortalities authorized previously and considered in this opinion would be equivalent to 2.5% of the estimated adult abundance for CCC steelhead, though an unknown proportion of the natural-origin adult component of the DPS. The activities contemplated in this opinion represent less than half (22 of 48) of the natural-origin adult take authorized for CCC steelhead in the region. The majority of the displayed potential mortality has been previously analyzed and found not to jeopardize the species. The potential mortality of the remaining 22 natural-origin adults contemplated in this opinion could have a small impact on the abundance and productivity of this DPS when combined with previously authorized mortalities, if they occurred.

It is also very likely that researchers will take fewer fish than estimated for take that is already authorized, and that the actual effect is likely to be lower than the numbers stated in Table 90. Our research tracking system reveals that for the past five years researchers ended up capturing or handling only 11% of natural-origin CCC steelhead adults authorized, and killed no natural or hatchery-origin adults. We would therefore expect that the actual effects of previously authorized activities would likely be a small fraction of the effect displayed in Table 90, above, and is unlikely to cause additional mortalities of adults compared to the baseline. We therefore find the impact of the program—even in its entirety—is a small effect on abundance and productivity, the activities analyzed here would not add to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

South-Central California Coast Steelhead

When combined with scientific research and monitoring permits already approved, the potential mortality for natural adult SCCC steelhead would be 6.1% of the adult abundance in this DPS. However, the research contemplated in this opinion would add no fish at all to that total. This signifies that the entirety of the research take has been analyzed in the past on more than one occasion and been found not to jeopardize the species; it is therefore unnecessary to repeat that analysis here.

Other species

Beyond the 27 salmonid ESUs and DPSs discussed above, are four additional DPSs of four species—none of which have any hatchery components. Of these four, two DPSs merit additional discussion.

Southern DPS Green Sturgeon

For southern DPS 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 4.3% of the annual abundance of juveniles. However, a portion of this take has already been analyzed in previous opinions and been determined not to jeopardize this DPS. The potential mortality of southern DPS green sturgeon resulting from activities contemplated in this opinion would equate to

2.64% of the juvenile abundance, or just over 61% of the total authorized lethal juvenile take for the region (Table 90).

While it appears that this take of juveniles may highly impact a particular age class of southern DPS 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 (208 individuals) would be equivalent to only one percent of the total estimated abundance of southern DPS green sturgeon (17,723 individuals), and the fact that primarily juveniles would be taken 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 the tables 89 and 90 above. For southern DPS 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. 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.

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

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 1.086% 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 in an overabundance of caution. This, combined with the only available adult abundance estimate reflecting only part of the DPS range, means that we knowingly overestimate the impacts of research to the DPS. It is therefore certain that the impact to the abundance of the population overall is less than the 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 in the worst case scenario all the fish authorized as mortalities were to be killed in actuality, this would represent only a small reduction in overall abundance and productivity, and because that slight impact would be distributed throughout the species' range, it would be so attenuated as to have no appreciable effect on spatial structure or diversity. And finally, regardless of its relative magnitude, all the negative effect associated with the research program on this species would to some extent be offset by gaining information that would be used to help the species survive and recover.

Critical Habitat

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

Summary

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

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

For over two decades, research and monitoring activities conducted on anadromous salmonids along the West Coast 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 dozens 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 endangered to threatened, or (c) have its status changed from threatened to endangered. 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 generally slight, the actions—even in combination—would have no appreciable effect on the species' diversity or structure. Moreover, we expect the actions to provide lasting benefits for the listed fish and that all habitat effects would be negligible. And finally, we expect the program as a whole and the permit actions considered here to generate information we need to fulfill our mandate under the ESA.

2.8 Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, the effects of other activities caused by the proposed action, and cumulative effects, it is NMFS' biological opinion that the proposed actions are not likely to jeopardize the continued existences of CC, CVS, LCR, PS, SRWR, SnkR fall-run, SnkR spr/sum-run, UCR spring-run, and UWR Chinook salmon; CR and HCS chum salmon; CCC, LCR, OC, and SONCC coho salmon; SnkR and OL sockeye salmon; LCR, MCR, PS, SnkR, UCR, NC, CCV, CCC, SCCC, and UWR steelhead, SDPS eulachon, SDPS green sturgeon, PS/GB bocaccio, and PS/GB yelloweye rockfish or destroy or adversely modify any of 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 52 ESA Section 10(a)(1)(A) Scientific Research Permits in Oregon, Washington, Idaho, and California affecting Salmon, Steelhead, Eulachon, Green Sturgeon, and Rockfish in the West Coast Region."

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

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

2.11 "Not Likely to Adversely Affect" Determination

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

Southern Resident Killer Whales Determination

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

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

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

SRKWs consist of three pods (J, K, and L) and inhabit coastal waters off Washington, Oregon, and Vancouver Island and are known to travel as far south as central California and as far north as

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

SRKWs consume a variety of fish species (22 species) and one species of squid (Ford et al. 1998; Ford 2000; Ford and Ellis 2006; Hanson et al. 2010; Ford et al. 2016), but salmon are identified as their primary prey. The diet of SRKWs is the subject of ongoing research, including direct observation of feeding, scale and tissue sampling of prey remains, and fecal sampling. The diet data suggest that SRKWs are consuming mostly larger (i.e., generally age 3 and up) Chinook salmon (Ford and Ellis 2006). Scale and tissue sampling from May to September in inland waters of Washington and British Columbia, Canada, indicate that their diet consists of a high percentage of Chinook salmon (monthly proportions as high as >90%) (Hanson et al. 2010; Ford et al. 2016). Ford et al. (2016) confirmed the importance of Chinook salmon to SRKWs in the summer months using DNA sequencing from whale feces. Salmon and steelhead made up to 98% of the inferred diet, of which almost 80% were Chinook salmon. Coho salmon and steelhead are also found in the diet in inland waters in spring and fall months when Chinook salmon are less abundant (Ford et al. 1998; Ford and Ellis 2006; Hanson et al. 2010; Ford et al. 2016). Prey remains and fecal samples collected in inland waters during October through December indicate Chinook salmon and chum salmon are primary contributors of the whale's diet (Hanson et al. 2021).

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

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

The proposed actions may affect SRKWs indirectly by reducing availability of their preferred prey, Chinook salmon. This analysis focuses on Chinook salmon availability in the ocean because the best available information indicates that salmon are the preferred prey of SRKWs year round, including in coastal waters, and that Chinook salmon are the preferred salmon prey species. Focusing on Chinook salmon provides a conservative estimate of potential effects of the action on SRKWs because the total abundance of all salmon and other potential prey species is orders of magnitude larger than the total abundance of Chinook. To assess the indirect effects of the proposed action on the Southern Resident killer whale DPS, we considered the geographic area of overlap in the marine distribution of Chinook salmon affected by the action, and the range of SRKWs. We also considered the importance of the affected Chinook salmon ESUs compared to other Chinook salmon runs in the SRKW diet composition, and the influence of hatchery mitigation programs. As described in the effects analysis for salmonids, an absolute maximum of 8,196 juvenile and 148 adult Chinook salmon may be killed during the course of the research. As the previous effects analysis illustrated, these losses—even in total—are expected to have only very small effects on salmonid abundance and productivity and no appreciable effect on diversity or distribution for any Chinook salmon ESUs. The affected Chinook salmon ESUs are:

- Puget Sound
- Upper Columbia River
- Snake River spring-summer run
- Snake River fall-run
- Lower Columbia River
- Upper Willamette
- California Coastal Chinook salmon
- Sacramento River winter-run Chinook salmon
- Central Valley spring-run Chinook salmon

The fact that the research would kill Chinook salmon could affect prey availability to the whales in future years throughout their range. For the adult take, approximately 2/3 the148 fish (natural and hatchery) that could, at maximum, be killed from these ESUs would only be taken by research after they return to shallower bays, estuaries, and their natal rivers, and are therefore very unlikely to be available as prey to the whales that typically feed in coastal offshore areas. This would signify that the research could (conservatively) remove something on the order of 50 adult Chinook (again, natural and hatchery) from the SRKW's prey base.

Because SRKWs prey on adult salmon, to determine effect the juvenile losses might have on SRKWs, we must convert those fish to adult equivalents: the most recent ten-year average smolt-to-adult ratio (SAR) from PIT-tagged Chinook salmon returns is from the Snake River, and indicates that SARs are less than 1% (BPA 2018). If one percent of the 8,196 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 80 adult Chinook salmon.

Taken together, this would mean that the research, in total, could remove something on the order of 138 adult Chinook from the SRKW prey base in any given year. Given that the number of adult Chinook (listed and unlisted) in the ocean at any given time is orders of magnitude greater than that figure, it is unlikely that SRKW would intercept and feed on many (if any) of these salmon.

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

Using methods described in NMFS 2021d, we combined the sex and age specific maximum daily prey energy requirement information with the population census data to estimate daily energetic requirements for all members of the SRKW population, based on the population size as of summer 2020 (72 whales) and using ages for the year 2021. Assuming again a Chinook caloric density of 16,386, a SRKW population of 72 whales, ≥1 year of age, need 755-906 fish/day. Using an energy density of 13,868 kcal/fish (O'Neill et al. 2014, Columbia river fall run energy content), 72 whales would need 892-1071 fish/day. These numbers depend a lot on the ages of the killer whales, as well as the run, size, and calorie content of the salmon prey. But, using these values, this means that the research contemplated in this opinion could kill, in its entirety and at a conservative maximum, about 15% of one day's worth of the fish that the SRKWs need to survive (138 fish out of 892). Moreover, that figure would only hold if the SRKWs could somehow intercept all the fish that might otherwise reach maturity without the permitted take. So even the maximum effect of a loss of 15% of one day's worth of SRKW food could only occur under circumstances so unlikely as to effectively be impossible. However, because there is no available information on the whales' foraging efficiency, it is unknown how much more fish need to be available in order for the whales to capture and consume enough prey to meet their needs.

In addition, as described in Sections 2.4 and 2.5, the estimated Chinook salmon mortality is likely to be much smaller than stated. First, the mortality rate estimates for most of the proposed studies are purposefully inflated to account for potential accidental deaths and it is therefore very likely that fewer salmonids will be killed by the research than stated. In fact, as described in Section 2.4 according to our take tracking in the past, researchers have general 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 14 than 140 fish.

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

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

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

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

3.1 Essential Fish Habitat Affected by the Project

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

3.2 Adverse Effects on Essential Fish Habitat

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

3.3 Essential Fish Habitat Conservation Recommendations

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

3.4 Statutory Response Requirement

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

3.5 Supplemental Consultation

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

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

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

4.1 Utility

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

This ESA section 7 consultation on the 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.

May 5, 1999 (64 FR 24049). Final Rule: Designated Critical Habitat: Critical Habitat for 19 Evolutionarily Significant Units of Salmon and Steelhead in Washington, Oregon, Idaho, and California.

September 16, 1999 (64 FR 50394). Endangered and Threatened Species; Threatened Status for Two Chinook Salmon Evolutionarily Significant Units (ESUs) in California.

October 25, 1999 (64 FR 57399). Final Rule: Designated Critical Habitat: Revision of Critical Habitat for Snake River Spring/Summer Chinook Salmon.

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

September 2, 2005 (70 FR 52488). Final Rule: Endangered and Threatened Species: Designation of Critical Habitat for Seven Evolutionarily Significant Units of Pacific Salmon and Steelhead in California.

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

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

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

April 7, 2006 (71 FR 17757). Endangered and Threatened Wildlife and Plants: Threatened Status for Southern Distinct Population Segment of North American Green Sturgeon

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

May 11, 2007 (72 FR 26722). Final Rule: Endangered and Threatened Species: Final Listing Determination for Puget Sound Steelhead.

February 11, 2008 (73 FR 7816). Final Rule: Endangered and Threatened Species: Final Threatened Determination, Final Protective Regulations, and Final Designation of Critical Habitat for Oregon Coast Evolutionarily Significant Unit of Coho Salmon.

October 9, 2009 (74 FR 52300). Final Rulemaking to Designate Critical Habitat for the Threatened Southern Distinct Population Segment of North American Green Sturgeon.

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