National Marine Fisheries Service Endangered Species Act (ESA) Section 7 Consultation, Magnuson–Stevens Act Essential Fish Habitat (EFH) Consultation, and Not Likely to Adversely Affect Determination

Consultation on the Evaluation and Determination of Research Programs Submitted for Consideration Under the Endangered Species Act Section 4(d) Rule's Scientific Research Limit [50 CFR 223.203(b)(7)] and Scientific Research and Monitoring Exemptions [50 CFR 223.210(c)(1)]

NMFS ECO Consultation Number: WCRO-2019-03648
Administrative Record Number: 151422WCR2019PR00259

Action Agencies: The National Marine Fisheries Service (NMFS)
The Bonneville Power Administration
The Bureau of Land Management
The U.S. Army Corps of Engineers
The U.S. Bureau of Reclamation
The U.S. Fish and Wildlife Service
The U.S. Forest Service
The U.S. Geological Survey
The U.S. National Park Service

Affected Species and Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species or Critical Habitat?	Is Action Likely To Jeopardize the Species?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*)	Threatened	Yes	No	No
Puget Sound steelhead (*O. mykiss*)	Threatened	Yes	No	No
Hood Canal summer-run chum salmon (*O. keta*)	Threatened	Yes	No	No
Upper Columbia River steelhead (*O. mykiss*)	Threatened	Yes	No	No
Snake River fall Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	No
Snake River spring/summer (spr/sum) Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	No
Snake River steelhead (*O. mykiss*)	Threatened	Yes	No	No
Middle Columbia River steelhead (*O. mykiss*)	Threatened	Yes	No	No
Columbia River chum salmon (*O. keta*)	Threatened	Yes	No	No
Lower Columbia River Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	No
Lower Columbia River coho salmon (*O. kisutch*)	Threatened	Yes	No	No
Lower Columbia River	Threatened	Yes	No	No

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species or Critical Habitat?	Is Action Likely To Jeopardize the Species?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
steelhead (*O. mykiss*)				
Southern Distinct Population Segment of Pacific eulachon (*Thaleichthys pacificus*)	Threatened	Yes	No	No
Upper Willamette River Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	No
Upper Willamette River steelhead (*O. mykiss*)	Threatened	Yes	No	No
Oregon Coast coho salmon (*O. kisutch*)	Threatened	Yes	No	No
Southern Oregon/Northern California Coasts coho salmon (*O. kisutch*)	Threatened	Yes	No	No
California Coastal Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	No
Northern California steelhead (*O. mykiss*)	Threatened	Yes	No	No
Central California Coast steelhead (*O. mykiss*)	Threatened	Yes	No	No
Central Valley spring-run Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	No
California Central Valley steelhead (*O. mykiss*)	Threatened	Yes	No	No
Southern Distinct Population Segment of North American green sturgeon (*Acipenser medirostris*)	Threatened	Yes	No	No
South-Central California Coast steelhead (*O. mykiss*)	Threatened	Yes	No	No
Southern Resident killer whales (*Orcinus orca*)	Endangered	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: Chris E Yates

For Barry A. Thom
Regional Administrator

Date: March 26, 2020 (Expires on: December 31, 2020)

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List of Acronyms

CDFW – California Department of Fish and Wildlife
CFR – Code of Federal Regulation
CR – Columbia River
DPS – Distinct Population Segment
EFH – Essential Fish Habitat
ESA – Endangered Species Act
ESU – Evolutionarily Significant Unit
FR – Federal Register
FWS – United States Fish and Wildlife Service
HCS – Hood Canal summer-run
IDFG – Idaho Department of Fish and Game
ISAB – Independent Scientific Advisory Board
LCR – Lower Columbia River
LCRFB – Lower Columbia River Fish Recovery Board
MCR – Middle Columbia River
MSA – Magnuson-Stevens Fishery Conservation and Management Act
NMFS – National Marine Fisheries Service
NOAA – National Oceanic and Atmospheric Administration
NWFSC – Northwest Fisheries Science Center
ODFW – Oregon Department of Fish and Wildlife
OC – Oregon Coast
PS – Puget Sound
SONNC – Southern Oregon/Northern California Coasts
SDPS – Southern DPS
SR – Snake River
SWFSC – Southwest Fisheries Science Center
UCR – Upper Columbia River
UWR – Upper Willamette River
VSP – Viable Salmonid Population
WDFW – Washington Department of Fish and Wildlife

1. INTRODUCTION

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

1.1 Background

On July 10, 2000, NMFS issued a 4(d) rule for 14 threatened salmon and steelhead (65 FR 42422, 50 CFR 223.203) (salmon and steelhead 4(d) rule). The rule applies the take prohibitions of section 9 of the ESA to the threatened salmonid species listed in the rule, but imposed certain limits on those prohibitions. Limit 7 states that the prohibitions of section 9(a)(1) of the ESA (16 U.S.C. 1538(a)(1)) do not apply to scientific research activities (50 CFR 223.203(b)(7)) that are submitted by a state fishery agency as a “research program” (Program), provided that the Program complies with the six factors specified in the rule (see Section 4. Evaluation and Determination) and is authorized in writing by NMFS’ Northwest Regional Administrator. Under the rule, programs NMFS authorizes would be exempt from ESA take prohibitions for one year, at which time NMFS would require annual reports documenting research-related take for the past year.

On June 28, 2005, January 5, 2006, May 11, 2007, February 11, 2008, and September 25, 2008 NMFS issued final listing determinations and protective regulations for 26 threatened salmon and steelhead species (70 FR 37160, 71 FR 834, 72 FR 26722, 73 FR 7816, 73 FR 55451). The protective regulations extended the 4(d) rule to all listed species considered in this evaluation. The protective regulations apply the section 9 protections to natural and listed hatchery salmon and steelhead with an intact adipose fin, but not to listed hatchery fish that have had their adipose fin removed.

On June 2, 2010 NMFS issued final rules establishing take prohibitions for the threatened Southern DPS of North American green sturgeon (hereafter green sturgeon)(75 FR 30714, 50 CFR 223.210). The rule applies the take prohibitions of section 9 of the ESA to green sturgeon, but imposed certain exemptions on those prohibitions. Exemption 1 states that the prohibitions of section 9(a)(1) of the ESA (16 U.S.C. 1538(a)(1)) do not apply to ongoing or future state sponsored scientific research or monitoring activities that are part of a NMFS-approved, ESA-compliant state 4(d) research program provided that the program complies with the four factors specified in the rule (see Section 4. Evaluation and Determination). Under the rule, programs NMFS authorizes would be exempt from ESA take prohibitions for one year, at which time NMFS would require annual reports documenting research-related take for the past year.

The NMFS has not promulgated protective regulations via section 4(d) of the ESA for eulachon. Promulgation of 4(d) take prohibitions for eulachon shall result in a reinitiation of this opinion if the effects of the research program considered in this opinion results in take that is prohibited by the 4(d) rule.

Since 2001, NMFS’ West Coast Region (WCR) has authorized Programs submitted under Limit 7 by state fishery agencies in the WCR— WDFW, IDFG, and ODFW. In 2008, the authorization was extended to include CDFW. Over the years, these Programs have comprised projects affecting green sturgeon and threatened salmon and steelhead. NMFS' WCR Regional Administrator determined that the Programs should be managed as a whole to promote threatened species conservation.

The National Marine Fisheries Service (NMFS) prepared the biological opinion (opinion) and incidental take statement 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 our review of 209 scientific research projects in four state research programs and is based on information provided in the descriptions of those research projects, published and unpublished scientific information on the biology and ecology of listed salmonids, and other sources of information.

We also completed an Essential Fish Habitat (EFH) consultation. It was prepared 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 (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 with the Protected Resources Division in Portland, Oregon.

1.2 Consultation History

The four state fishery agencies on the West Coast— Idaho Department of Fish and Game (IDFG), Oregon Department of Fish and Wildlife (ODFW), Washington Department of Fish and Wildlife (WDFW), and California Department of Fish and Wildlife (CDFW)—have submitted scientific research and monitoring programs (Programs) for review under the salmon and steelhead 4(d) rule's Limit 7 for scientific research (see below for an explanation of the 4(d) rules) (Table 1). On December 3, 2019, the IDFG submitted their Program, which contains 16 projects in Idaho. On December 13, 2019, the ODFW submitted their Program, which contains 75 projects in Oregon. On December 17, 2019, the WDFW submitted their Program, which contains 34 projects in Washington. On December 19, 2019, the CDFW submitted their Program, which contains 84 projects in California. Upon receipt of the final request, we initiated consultation on December 19, 2019.

Table 1: Number of research projects in the state fishery agency programs, number of listed species, and the date the program was submitted to NMFS.

State Agency	Number of Projects in Program	Number of Listed Species Included in Program	Date the Program was Submitted to NMFS
IDFG	16	3	12/03/2019
ODFW	75	14	12/13/2019
WDFW	34	14	12/17/2019
CDFW	84	9	12/19/2019

State Agency	Number of Projects in Program	Number of Listed Species Included in Program	Date the Program was Submitted to NMFS
Total	209	24	-

This biological opinion is based on the information contained in the Programs, the individual research project proposals, and NMFS' evaluation of the Programs with respect to the factors identified in the 4(d) rules and additional considerations germane to those factors: Evaluation and Determination of Research Programs Submitted by the IDFG, ODFW, WDFW, and CDFW (Evaluation/Determination Document). One of the primary purposes of NMFS evaluation is to highlight areas of both general and specific concern (e.g., issues, projects, or techniques that bear close monitoring). NMFS worked with the state fishery agencies to develop conditions and requirements that address these concerns.

The Programs contain a total of 209 projects that would affect 24 fish species listed as "threatened" under the ESA in Idaho, Oregon, Washington, and California. We did not receive any projects that might affect Ozette Lake sockeye salmon.

Because the proposed projects may affect listed Chinook salmon, the proposed actions also have the potential to affect Southern Resident killer whales and their critical habitat by diminishing the whales' preferred prey base. However, we concluded that the proposed actions are not likely to adversely affect killer whales or their critical habitat and the full analysis is found in the "Not Likely to Adversely Affect" Determinations section (2.11).

All projects contained in the Programs would either be conducted by or coordinated with the state fishery agencies. Complete descriptions of the projects, including amounts of take proposed, descriptions of the study designs, justifications for the take, and descriptions of the techniques to be used, can be found on our permit website at https://apps.nmfs.noaa.gov.

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 lead action agency is NMFS and the primary action is our proposed authorization of the Programs under the salmon and steelhead Limit 7 4(d) rule. In addition to our proposed action of authorizing the Programs, some of the research projects in the Programs may be funded or carried out by NMFS, The Bonneville Power Administration, The Bureau of Land Management, The U.S. Army Corps of Engineers, The U.S. Bureau of Reclamation, The U.S. National Park Service, The U.S. Fish and Wildlife Service, The U.S. Forest Service, and The U.S. Geological Survey.

In our analysis of the effects of the action, we also consider whether or not the proposed action would cause any other activities and determined that it would not.

Our approval of the Programs is based on a determination that the Programs (1) meet the factors described in the 4(d) rules, (2) fulfill additional considerations germane to research programs, and (3) act to conserve the affected threatened species. Our review of those Programs is set out in the March 25, 2020, Evaluation/Determination Document. The 4(d) research exception would apply to the Programs for one year (through December 31, 2020), at which time NMFS would require annual reports documenting research-related take for the past year.

As noted, the projects identified in the Programs will be funded, conducted, or authorized by the Federal agencies listed above (Federal Action Agencies). These Federal agencies must comply with section 7 of the ESA because their actions may affect threatened species or designated critical habitat. The Federal actions are expected to take (or cause to be taken) listed salmon, steelhead, sturgeon, and eulachon. The activities include:

- Determining the abundance, distribution, growth rate, and condition of adult and juvenile fish.
- Conducting disease and genetic studies.
- Determining diet composition.
- Evaluating salmonid production (i.e., smolt-to-adult survival rates).
- Determining stock composition, population trends, and life history patterns.
- Evaluating habitat restoration projects.
- Evaluating the effects artificial production and supplementation have on listed fish.
- Investigating migration timing and migratory patterns.
- Evaluating fish passage facilities, screens and other bypass systems.
- Investigating fish behaviors in reservoirs and off channel areas.
- Evaluating salmon spawning below dams.
- Monitoring effects of dam removal.
- Assessing point-source discharge effects on fish communities.

2. ENDANGERED SPECIES ACT BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, Federal agencies must ensure that their 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 provides 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 incidental take statement (ITS) that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures and terms and conditions to minimize such impacts.

This opinion constitutes formal consultation and an analysis of effects solely for the evolutionarily significant units (ESUs) and distinct population segments (DPSs) that are the subject of this opinion.[1] Herein, the NMFS determined that the proposed action of issuing 18 scientific research permits, individually or in aggregate:

- May adversely affect PS, SR fall-run, SR spr/sum-run, LCR, UWR, CC, and CVS Chinook salmon; HCS and CR chum salmon; LCR, OC, and SONCC coho salmon; PS, UCR, MCR, SR, LCR, UWR, NC, CCC, SCCC, and CCV steelhead, S eulachon, and S green sturgeon; but would not jeopardize their continued existence.
- Is not likely to adversely affect SR killer whales or critical habitat designated for any of the subject species. 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 “to jeopardize the continued existence of” a listed species, which is “to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species” (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

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

The designation(s) of critical habitat for (species) use(s) the term primary constituent element (PCE) or essential features. The new critical habitat regulations (81 FR 7414) replace 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.

[1] An ESU of Pacific salmon (Waples 1991) and a DPS of steelhead (71 FR 834) are considered to be “species” as the word is defined in section 3 of the ESA. In addition, it should be noted that the terms “artificially propagated” and “hatchery” are used interchangeably in the Opinion, as are the terms “naturally propagated” and “natural.”

- 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 discusses the current function of the essential PBFs that help to form that conservation value.

2.2.1 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^{o}C (1.8-6.7^{o}F) by the end of the century (IPCC 2014). Habitat loss, shifts in species' ranges and abundances, and altered marine food webs could have substantial consequences to anadromous, coastal, and marine species in the Pacific Northwest (Tillmann and Siemann 2011, Reeder et al. 2013).

Moreover, as atmospheric carbon emissions increase, increasing levels of carbon are absorbed by the oceans, changing the pH of the water. Acidification also impacts 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 impact 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.

2.2.2 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. These attributes are influenced by survival, behavior, and experiences throughout a species' entire life cycle, and these characteristics, in turn, are influenced by habitat and other environmental conditions.

"Spatial structure" refers both to the spatial distributions of individuals in the population and the processes that generate that distribution. A population's spatial structure depends on habitat quality and spatial configuration, and the dynamics and dispersal characteristics of individuals in the population.

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

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

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

For species with multiple populations, once the biological status of a species' populations has been determined, we assess 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 to allow functioning as metapopulations (McElhany *et al.* 2000).

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

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

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Puget Sound Chinook salmon	Threatened 06/28/2005 (70 FR 37160)	SSDC 2007 NMFS 2006	NWFSC 2015	This ESU comprises 22 populations distributed over five geographic areas. Most populations within the ESU have declined in abundance over the past 7 to 10 years, with widespread negative trends in natural-origin spawner abundance, and hatchery-origin spawners present in high fractions in most populations outside of the Skagit watershed. Escapement levels for all populations remain well below the Technical Recovery Team (TRT) planning ranges for recovery, and most populations are consistently below the spawner-recruit levels identified by the TRT as consistent with recovery.	• Degraded floodplain and in-river channel structure • Degraded estuarine conditions and loss of estuarine habitat • Degraded riparian areas and loss of in-river large woody debris • Excessive fine-grained sediment in spawning gravel • Degraded water quality and temperature • Degraded nearshore conditions • Impaired passage for migrating fish • Severely altered flow regime
Puget Sound steelhead	Threatened 05/11/2007 (72 FR 26722)	NMFS 2018a (draft)	NWFSC 2015	This DPS comprises 32 populations. The DPS is currently at very low viability, with most of the 32 populations and all three population groups at low viability. Information considered during the most recent status review indicates that the biological risks faced by the Puget Sound Steelhead DPS have not substantively changed since the listing in 2007, or since the 2011 status review. Furthermore, the Puget Sound Steelhead TRT recently concluded that the DPS was at very low viability, as were all three of its constituent MPGs, and many of its 32 populations. In the near term, the outlook for environmental conditions affecting Puget Sound steelhead is not optimistic. While harvest and	• 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

				hatchery production of steelhead in Puget Sound are currently at low levels and are not likely to increase substantially in the foreseeable future, some recent environmental trends not favorable to Puget Sound steelhead survival and production are expected to continue.	
Hood Canal summer-run chum salmon	Threatened 06/28/2005 (70 FR 37160)	HCCC 2005 NMFS 2007	NWFSC 2015	This ESU is made up of two independent populations in one major population group. Natural-origin spawner abundance has increased since ESA-listing and spawning abundance targets in both populations have been met in some years. Productivity was quite low at the time of the last review, though rates have increased in the last five years, and have been greater than replacement rates in the past two years for both populations. However, productivity of individual spawning aggregates shows only two of eight aggregates have viable performance. Spatial structure and diversity viability parameters for each population have increased and nearly meet the viability criteria. Despite substantive gains towards meeting viability criteria in the Hood Canal and Strait of Juan de Fuca summer chum salmon populations, the ESU still does not meet all of the recovery criteria for population viability at this time.	• Reduced floodplain connectivity and function • Poor riparian condition • Loss of channel complexity Sediment accumulation • Altered flows and water quality
Upper Columbia River steelhead	Threatened 01/05/2006 (71 FR 834)	UCSRB 2007	NWFSC 2015	This DPS comprises four independent populations. Three populations are at high risk of extinction while 1 population is at moderate risk. Upper Columbia River steelhead populations have increased relative to the low levels observed in the 1990s, but natural origin abundance and productivity remain well below viability thresholds for three out of the four populations. The status of the Wenatchee River steelhead population continued to	• 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

				improve based on the additional year's information available for the most recent review. The abundance and productivity viability rating for the Wenatchee River exceeds the minimum threshold for 5% extinction risk. However, the overall DPS status remains unchanged from the prior review, remaining at high risk driven by low abundance and productivity relative to viability objectives and diversity concerns.	
Middle Columbia River steelhead	Threatened 01/05/2006 (71 FR 834)	NMFS 2009b	NWFSC 2015	This DPS comprises 17 extant populations. The DPS does not currently include steelhead that are designated as part of an experimental population above the Pelton Round Butte Hydroelectric Project. Returns to the Yakima River basin and to the Umatilla and Walla Walla Rivers have been higher over the most recent brood cycle, while natural origin returns to the John Day River have decreased. There have been improvements in the viability ratings for some of the component populations, but the DPS is not currently meeting the viability criteria in the MCR steelhead recovery plan. In general, the majority of population level viability ratings remained unchanged from prior reviews for each major population group within the DPS.	• 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	NWFSC 2015	This ESU comprises 28 extant and four extirpated populations. All expect one extant population (Chamberlin Creek) are at high risk. Natural origin abundance has increased over the levels reported in the prior review for most populations in this ESU, although the increases were not substantial enough to change viability ratings. Relatively high ocean survivals in recent years were a major factor in recent abundance patterns. While there have been improvements in abundance and	• Degraded freshwater habitat • Effects related to the hydropower system in the mainstem Columbia River, • Altered flows and degraded water quality • Harvest-related effects • Predation

				productivity in several populations relative to prior reviews, those changes have not been sufficient to warrant a change in ESU status.	
Snake River fall-run Chinook salmon	Threatened 06/28/2005 (70 FR 37160)	NMFS 2017a	NWFSC 2015	This ESU has one extant population. Historically, large populations of fall Chinook salmon spawned in the Snake River upstream of the Hells Canyon Dam complex. The extant population is at moderate risk for both diversity and spatial structure and abundance and productivity. The overall viability rating for this population is 'viable.' Overall, the status of Snake River fall Chinook salmon has clearly improved compared to the time of listing and compared to prior status reviews. The single extant population in the ESU is currently meeting the criteria for a rating of 'viable' developed by the ICTRT, but the ESU as a whole is not meeting the recovery goals described in the recovery plan for the species, which require the single population to be "highly viable with high certainty" and/or will require reintroduction of a viable population above the Hells Canyon Dam complex.	• Degraded floodplain connectivity and function • Harvest-related effects • Loss of access to historical habitat above Hells Canyon and other Snake River dams • Impacts from mainstem Columbia River and Snake River hydropower systems • Hatchery-related effects • Degraded estuarine and nearshore habitat.
Snake River basin steelhead	Threatened 01/05/2006 (71 FR 834)	NMFS 2017b	NWFSC 2015	This DPS comprises 24 populations. Two populations are at high risk, 15 populations are rated as maintained, 3 populations are rated between high risk and maintained, 2 populations are at moderate risk, 1 population is viable, and 1 population is highly viable. Four out of the five MPGs are not meeting the specific objectives in the draft recovery plan based on the updated status information available for this review, and the status of many individual populations remains uncertain A great deal of uncertainty still remains regarding the relative proportion of hatchery fish in	• 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

				natural spawning areas near major hatchery release sites within individual populations.	
Lower Columbia River Chinook salmon	Threatened 06/28/2005 (70 FR 37160)	NMFS 2013	NWFSC 2015	This ESU comprises 32 independent populations. Twenty-seven populations are at very high risk, 2 populations are at high risk, one population is at moderate risk, and 2 populations are at very low risk Overall, there was little change since the last status review in the biological status of this ESU, although there are some positive trends. Increases in abundance were noted in about 70% of the fall-run populations and decreases in hatchery contribution were noted for several populations. Relative to baseline VSP levels identified in the recovery plan, there has been an overall improvement in the status of a number of fall-run populations, although most are still far from the recovery plan goals.	• 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
Lower Columbia River coho salmon	Threatened 06/28/2005 (70 FR 37160)	NMFS 2013	NWFSC 2015	Of the 24 populations that make up this ESU, 21 populations are at very high risk, 1 population is at high risk, and 2 populations are at moderate risk. Recent recovery efforts may have contributed to the observed natural production, but in the absence of longer term data sets it is not possible to parse out these effects. Populations with longer term data sets exhibit stable or slightly positive abundance trends. Some trap and haul programs appear to be operating at or near replacement, although other programs still are far from that threshold and require supplementation with additional hatchery-origin spawners .Initiation of or improvement in the downstream juvenile facilities at Cowlitz Falls, Merwin, and North Fork Dam are likely to further improve the status of the associated upstream populations. While	• Reduced access to spawning and rearing habitat • Hatchery-related effects • Harvest-related effects on fall Chinook salmon • An altered flow regime and Columbia River plume • Reduced access to off-channel rearing habitat • Reduced productivity resulting from sediment and nutrient-related changes in the estuary • Contaminant

				these and other recovery efforts have likely improved the status of a number of coho salmon populations, abundances are still at low levels and the majority of the populations remain at moderate or high risk. For the Lower Columbia River region land development and increasing human population pressures will likely continue to degrade habitat, especially in lowland areas. Although populations in this ESU have generally improved, especially in the 2013/14 and 2014/15 return years, recent poor ocean conditions suggest that population declines might occur in the upcoming return years	
Lower Columbia River steelhead	Threatened 01/05/2006 (71 FR 834)	NMFS 2013	NWFSC 2015	This DPS comprises 23 historical populations, 17 winter-run populations and six summer-run populations. Nine populations are at very high risk, 7 populations are at high risk, 6 populations are at moderate risk, and 1 population is at low risk. The majority of winter-run steelhead populations in this DPS continue to persist at low abundances. Hatchery interactions remain a concern in select basins, but the overall situation is somewhat improved compared to prior reviews. Summer-run steelhead populations were similarly stable, but at low abundance levels. The decline in the Wind River summer-run population is a source of concern, given that this population has been considered one of the healthiest of the summer-runs; however, the most recent abundance estimates suggest that the decline was a single year aberration. Passage programs in the Cowlitz and Lewis basins have the potential to provide considerable improvements in abundance and spatial structure, but have not produced	• 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

				self-sustaining populations to date. Even with modest improvements in the status of several winter-run DIPs, none of the populations appear to be at fully viable status, and similarly none of the MPGs meet the criteria for viability.	
Columbia River chum salmon	Threatened 06/28/2005 (70 FR 37160)	NMFS 2013	NWFSC 2015	Overall, the status of most chum salmon populations is unchanged from the baseline VSP scores estimated in the recovery plan. A total of 3 of 17 populations are at or near their recovery viability goals, although under the recovery plan scenario these populations have very low recovery goals of 0. The remaining populations generally require a higher level of viability and most require substantial improvements to reach their viability goals. Even with the improvements observed during the last five years, the majority of populations in this ESU remain at a high or very high risk category and considerable progress remains to be made to achieve the recovery goals.	• 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
Upper Willamette River Chinook salmon	Threatened 06/28/2005 (70 FR 37160)	ODFW and NMFS 2011	NWFSC 2015	This ESU comprises seven populations. Five populations are at very high risk, one population is at moderate risk (Clackamas River) and one population is at low risk (McKenzie River). Consideration of data collected since the last status review in 2010 indicates the fraction of hatchery origin fish in all populations remains high (even in Clackamas and McKenzie populations). The proportion of natural origin spawners improved in the North and South Santiam basins, but is still well below identified recovery goals. Abundance levels for five of the seven populations remain well below their recovery goals. Of these, the Calapooia River may be functionally extinct and the Molalla River remains critically	• Degraded freshwater habitat • Degraded water quality • Increased disease incidence • Altered stream flows • Reduced access to spawning and rearing habitats • Altered food web due to reduced inputs of microdetritus • Predation by native and non-native species, including hatchery fish • Competition related to introduced salmon and steelhead • Altered population traits due to fisheries and bycatch

				low. Abundances in the North and South Santiam rivers have risen since the 2010 review, but still range only in the high hundreds of fish. The Clackamas and McKenzie populations have previously been viewed as natural population strongholds, but have both experienced declines in abundance despite having access to much of their historical spawning habitat. Overall, populations appear to be at either moderate or high risk, there has been likely little net change in the VSP score for the ESU since the last review, so the ESU remains at moderate risk.	
Upper Willamette River steelhead	Threatened 01/05/2006 (71 FR 834)	ODFW and NMFS 2011	NWFSC 2015	This DPS has four demographically independent populations. Three populations are at low risk and one population is at moderate risk. Declines in abundance noted in the last status review continued through the period from 2010-2015. While rates of decline appear moderate, the DPS continues to demonstrate the overall low abundance pattern that was of concern during the last status review. The causes of these declines are not well understood, although much accessible habitat is degraded and under continued development pressure. The elimination of winter-run hatchery release in the basin reduces hatchery threats, but non-native summer steelhead hatchery releases are still a concern for species diversity and a source of competition for the DPS. While the collective risk to the persistence of the DPS has not changed significantly in recent years, continued declines and potential negative impacts from climate change may cause increased risk in the near future.	• 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	NWFSC 2015	This ESU comprises 56 populations including 21 independent and 35 dependent populations. The last status review indicated a moderate risk of extinction. Significant improvements in hatchery and harvest practices have been made for this ESU. Most recently, spatial structure conditions have improved in terms of spawner and juvenile distribution in watersheds; none of the geographic area or strata within the ESU appear to have considerably lower abundance or productivity. The ability of the ESU to survive another prolonged period of poor marine survival remains in question.	• 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. 2015	This ESU comprises 31 independent, 9 independent, and 5 ephemeral populations all grouped into 7 diversity strata. Of the 31 independent populations, 24 are at high risk of extinction and 6 are at moderate risk of extinction. The extinction risk of an ESU depends upon the extinction risk of its constituent independent populations; because the population abundance of most independent populations are below their depensation threshold, the SONCC coho salmon ESU is at high risk of extinction and is not viable	• 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	NMFS 2016b	This DPS historically comprised 42 independent populations of winter-run steelhead (19 functionally independent and 23 potentially independent), and up to 10 independent populations (all functionally independent) of summer-run steelhead, with more than 65 dependent populations of winter-run steelhead in small coastal watersheds, and Eel river tributaries. Many populations are considered to be extant. Significant gaps in information exist for the Lower Interior and North Mountain Interior	• Logging and road construction • estuarine alteration • dams and barriers • climate change • urbanization and agriculture • gravel mining • alien species • hatcheries

				diversity strata. All winter-run populations are currently well below viability targets, with most at 5-13% of these goals. Mixed population trends arise depending on time series length; thus, there is no strong evidence to indicate conditions for winter-run populations have worsened appreciably since the last status review. Summer-run populations are of concern. While one run is near the viability target, others are very small or there is a lack of data. Overall, available information for winter- and summer-run populations do not suggest an appreciable increase or decrease in extinction risk since the last status review.	
California Coastal Chinook salmon	Threatened 09/16/1999 (64 FR 50394)	NMFS 2016a	Williams et al. 2016	This ESU historically supported 16 Independent populations of fall-run Chinook salmon (11 Functionally Independent and five potentially Independent), six populations of spring-run Chinook salmon, and an unknown number of dependent populations. Based on the data available, eight of the 16 populations were classified as data deficient, one population was classified as being at a Moderate/High risk of extirpation, and six populations were classified as being at a High risk of extirpation. There has been a mix in population trends, with some population escapement numbers increasing and others decreasing. Overall, there is a lack of compelling evidence to suggest that the status of these populations has improved or deteriorated appreciably since the previous status review.	• dams and other barriers • logging • agriculture • ranching • fisheries • hatcheries
Central California Coast steelhead	Threatened 8/18/1997 (62 FR 43937)	NMFS 2016a	NMFS 2016c	Both adult and juvenile abundance data are limited for this DPS. It was historically comprised of 37 independent populations (11 functionally independent and 26 potentially independent) and perhaps 30 or	• Central California Coast steelhead

				more dependent populations of winter-run steelhead. Most of the coastal populations are assumed to be extant with other populations (Coastal San Francisco Bay and Interior San Francisco Bay) likely at high risk of extirpation. While data availability for this DPS remains poor, there is little new evidence to suggest that the extinction risk for this DPS has changed appreciably in either direction since the last status review.	
Central Valley spring-run Chinook salmon	Threatened 09/16/1999 (64 FR 50394)	NMFS 2014a	Williams et al. 2016	This ESU historically supported 18 or 19 Independent populations, with some smaller dependent populations, and four diversity groups. Only three populations are extant (Mill, Deer, and Butte creeks on the upper Sacramento River) which only represent one diversity group (Northern Sierra Nevada). Spatial diversity is increasing with presence (at low numbers in some cases) in all diversity groups. Recolonization of the Battle Creek population with increasing abundance of the Clear Creek population is benefiting ESU viability. The reappearance of phenotypic spring-run to the San Joaquin River tributaries may be the beginning of natural recolonization processes in once extirpated rivers. Active reintroduction efforts on the Yuba and San Joaquin rivers show promise. The ESU is trending positively towards achieving at least two populations in each of the four historical diversity groups necessary for recovery.	• Central Valley spring-run Chinook salmon
California Central Valley steelhead	Threatened 3/19/1998 (63 FR 13347)	NMFS 2014a	Williams et al. 2016	Steelhead are present throughout most of the watersheds in the Central Valley, but often in low numbers, especially in the San Joaquin River tributaries. The status of this DPS appears to have changed little since the 2011 status review stating the DPS was in danger of extinction. There is still a paucity	• California Central Valley steelhead

				of data on the status of wild populations. There are some encouraging signs of increased returns over the last few years. However, the catch of unmarked (wild) steelhead at Chipps Island is still less than 5 percent of the total smolt catch, which indicates natural production of steelhead throughout the Central Valley remains at very low levels. Despite a positive trend on Clear Creek and encouraging signs from Mill Creek, all other concerns raised in the previous status review remain.	
South-Central California Coast steelhead	Threatened 8/18/1997 (62 FR 43937)	NMFS 2013b	NMFS 2016d	Currently, nearly half of this DPS reside in the Carmel River. Most other streams and rivers have small populations that can be stochastically driven to extirpation. The ability to fully assess the status of individual populations and the DPS as whole has been limited. There is little new evidence to indicate that the status of the S-CCC steelhead DPS has changed appreciably since the last status review, though the Carmel River runs have shown a long term decline. Threats to the DPS identified during initial listing have remained largely unchanged, though some fish passage barriers have been removed. Threats to this DPS are likely to exacerbate the factors affecting the continued existence of the DPS. S-CCC steelhead recovery will require reducing threats, maintaining interconnected populations across their native range, and preserving the diversity of life history strategies.	• 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 eulachon	Threatened 03/18/2010 (75 FR 13012)	NMFS 2017c	Gustafson et al. 2016	The Southern DPS of eulachon includes all naturally-spawned populations that occur in rivers south of the Nass River in British Columbia to the Mad River in California. Sub populations for this species include the Fraser River, Columbia River, British	• 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.

				Columbia and the Klamath River. In the early 1990s, there was an abrupt decline in the abundance of eulachon returning to the Columbia River. Despite a brief period of improved returns in 2001-2003, the returns and associated commercial landings eventually declined to the low levels observed in the mid-1990s. Although eulachon abundance in monitored rivers has generally improved, especially in the 2013-2015 return years, recent poor ocean conditions and the likelihood that these conditions will persist into the near future suggest that population declines may be widespread in the upcoming return years	• Climate-induced change to freshwater habitats • Bycatch of eulachon in commercial fisheries • Adverse effects related to dams and water diversions • Water quality • Shoreline construction • Over harvest • Predation
Southern DPS of green sturgeon	Threatened 04/07/2006 (71 FR 17757)	NMFS 2018b	NMFS 2015b	The Sacramento River contains the only known green sturgeon spawning population in this DPS. The current estimate of spawning adult abundance is between 824-1,872 individuals. 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. Within the nearshore marine environment, tagging and fisheries data indicate that Northern and Southern DPS green sturgeon prefer marine waters of less than a depth of 110 meters.	• Reduction of its spawning area to a single known population • Lack of water quantity • Poor water quality • Poaching
Southern resident killer whale	Endangered 11/18/2005 (70 FR 69903)	NMFS 2008	Ford 2013	The Southern Resident killer whale DPS is composed of a single population that ranges as far south as central California and as far north as southeast Alaska. The estimated effective size of the population (based on the number of breeding individuals under ideal genetic conditions) is very small — <30 whales, or about 1/3 of the current population size. The small effective	• Quantity and quality of prey • Exposure to toxic chemicals • Disturbance from sound and vessels • Risk from oil spills

	population size, the absence of gene flow from other populations, and documented breeding within pods may elevate the risk from inbreeding and other issues associated with genetic deterioration. As of July 1, 2013, there were 26 whales in J pod, 19 whales in K pod and 37 whales in L pod, for a total of 82 whales. Estimates for the historical abundance of Southern Resident killer whales range from 140 whales (based on public display removals to 400 whales, as used in population viability analysis scenarios.	

Species-specific status information is discussed in more detail below. The natural abundance numbers presented should be viewed with caution, however, as they only address one of several juvenile life stages. Moreover, deriving any juvenile abundance estimate 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.).

Puget Sound Chinook salmon

Listed Hatchery Juvenile Releases – Twenty-six artificial propagation programs are part of the species and are also listed (79 FR 20802; Table 3). Juvenile listed hatchery PS Chinook salmon abundance estimates come from the annual hatchery production goals. Hatchery production varies annually due to several factors including funding, equipment 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 from Table 3 is 43,568,630 adipose-fin-clipped and non-clipped juvenile Chinook salmon.

Table 3. Expected 2020 Puget Sound Chinook salmon hatchery releases (WDFW 2018).

Subbasin	Artificial propagation program	Brood year	Run Timing	Clipped Adipose Fin	Intact Adipose Fin
Deschutes	Tumwater Falls	2018	Fall	3,800,000	-
Dungeness-Elwha	Dungeness	2018	Spring	-	50,000
	Elwha	2017	Fall	-	200,000
		2018	Fall	250,000	2,250,000
	Gray Wolf River	2018	Spring	-	50,000
	Hurd Creek	2018	Spring	-	50,000
	Upper Dungeness Pond	2018	Spring	-	50,000
Duwamish	Icy Creek	2017	Fall	300,000	-
	Palmer	2018	Fall	-	1,000,000
	Soos Creek	2018	Fall	3,000,000	200,000
Hood Canal	Hood Canal Schools	2018	Fall	-	500
	Hoodsport	2017	Fall	120,000	-
		2018	Fall	3,000,000	-
Kitsap	Bernie Gobin	2017	Spring	40,000	-
		2018	Fall	-	200,000
			Summer	2,300,000	100,000
	Garrison	2018	Fall	850,000	-
	George Adams	2018	Fall	3,375,000	425,000
	Gorst Creek	2018	Fall	730,000	-
	Grovers Creek	2018	Fall	1,250,000	-
	Hupp Springs	2018	Spring	-	400,000
	Lummi Sea Ponds	2018	Fall	500,000	-

Subbasin	Artificial propagation program	Brood year	Run Timing	Clipped Adipose Fin	Intact Adipose Fin
	Minter Creek	2018	Fall	1,250,000	-
Lake Washington	Salmon in the Schools	2018	Fall	-	540
	Issaquah	2018	Fall	2,000,000	-
Nisqually	Clear Creek	2018	Fall	3,300,000	200,000
	Kalama Creek	2018	Fall	600,000	-
	Nisqually MS	2018	Fall	-	90
Nooksack	Kendall Creek	2018	Spring	800,000	-
	Skookum Creek	2018	Spring	-	1,000,000
Puyallup	Clarks Creek	2018	Fall	400,000	-
	Voights Creek	2018	Fall	1,600,000	-
	White River	2017	Spring	-	55,000
		2018	Spring	-	340,000
San Juan Islands	Glenwood Springs	2018	Fall	725,000	-
Skokomish	McKernan	2018	Fall	-	100,000
Skykomish	Wallace River	2017	Summer	500,000	-
		2018	Summer	800,000	200,000
Stillaguamish	Brenner	2018	Fall	-	200,000
	Whitehorse Pond	2018	Summer	220,000	-
Strait of Georgia	Samish	2018	Fall	3,800,000	200,000
Upper Skagit	Marblemount	2018	Spring	387,500	200,000
			Summer	200,000	-
Total Annual Release Number				36,297,500	7,271,130

Adult spawners and expected outmigration – The average abundance (2013-2017) for PS Chinook salmon populations is 37,941 adult spawners (22,398 natural-origin and 15,543 hatchery-origin spawners; Table 4). Natural-origin spawners range from 18 (in the South Fork Nooksack River population) to 9,505 fish (in the Upper Skagit population). No populations are meeting minimum viability abundance targets, and only three of 22 populations average greater than 20 percent of the minimum viability abundance target for natural-origin spawner abundance (all of which are in the Skagit River watershed).

Table 4. Average abundance estimates for PS Chinook salmon natural- and hatchery-origin spawners 2012-2016 (unpublished data, Mindy Rowse, NWFSC, April 10, 2019).

Population Name	Natural-origin Spawners[a]	Hatchery-origin Spawners[a]	% Hatchery Origin	Minimum Viability Abundance[b]	Expected Number of Outmigrants[c]
Strait of Georgia MPG					
NF Nooksack River[d]	181	945	83.95%	16,000	90,009
SF Nooksack River[d]	18	15	45.04%	9,100	2,597
Strait of Juan de Fuca MPG					
Elwha River	130	2,156	94.30%	15,100	182,895
Dungeness River	189	213	52.91%	4,700	32,163
Hood Canal MPG					
Skokomish River	224	1,158	83.82%	12,800	110,505
Mid-Hood Canal	165	117	41.55%	11,000	22,589
Whidbey Basin MPG					

Population Name	Natural-origin Spawners[a]	Hatchery-origin Spawners[a]	% Hatchery Origin	Minimum Viability Abundance[b]	Expected Number of Outmigrants[c]
Skykomish River	2,001	1,466	42.29%	17,000	277,348
Snoqualmie River	881	219	19.93%	17,000	87,978
NF Stillaguamish River	385	291	43.04%	17,000	54,137
SF Stillaguamish River	42	29	40.57%	15,000	5,676
Upper Skagit River	9,505	120	1.25%	17,000	770,047
Lower Skagit River	2,207	13	0.60%	16,000	177,643
Upper Sauk River	1,106	5	0.46%	3,000	88,899
Lower Sauk River	559	3	0.59%	5,600	44,984
Suiattle River	590	5	0.77%	600	47,582
Cascade River	205	7	3.12%	1,200	16,937
Central / South Sound MPG					
Sammamish River	125	885	87.64%	10,500	80,823
Cedar River	883	440	33.26%	11,500	105,864
Duwamish/Green River	1,120	4,171	78.83%	17,000	423,326
Puyallup River	565	1,240	68.72%	17,000	144,384
White River	569	1,438	71.64%	14,200	160,622
Nisqually River	747	606	44.81%	13,000	108,281
ESU Average	22,398	15,543	40.97%		3,035,288

[a] Five-year geometric mean of post-fishery spawners (2013-2017).
[b] Ford 2011
[c] Expected number of outmigrants=Total spawners*40% proportion of females*2,000 eggs per female*10% survival rate from egg to outmigrant
[d] 2012-2016 five year geometric mean (2017 data not available).

Juvenile PS Chinook salmon abundance estimates come from escapement data, the percentage of females in the population, and fecundity. 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 percent of escapement. By applying a conservative fecundity estimate (2,000 eggs/female) to the expected female escapement (both natural-origin and hatchery-origin spawners – 15,543 females), the ESU is estimated to produce approximately 30.4 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 percent, which corresponds with those reported by Healey (1991). With an estimated survival rate of 10 percent, the ESU should produce roughly 3.04 million natural-origin outmigrants annually.

Puget Sound Steelhead

Listed Hatchery Juvenile Releases – Six artificial propagation programs were listed as part of the DPS (79 FR 20802; Table 5). For 2020, 222,500 hatchery steelhead are expected to be released throughout the range of the PS steelhead DPS (WDFW 2018).

Table 5. Expected 2020 Puget Sound steelhead listed hatchery releases (WDFW 2018).

Subbasin	Artificial propagation program	Brood year	Run Timing	Clipped Adipose Fin	Intact Adipose Fin
Dungeness/Elwha	Dungeness	2018	Winter	10,000	-
	Hurd Creek	2018	Winter	-	34,500
Duwamish/Green	Flaming Geyser	2018	Winter	-	15,000
	Icy Creek	2018	Summer	50,000	-
			Winter	-	28,000
	Soos Creek	2018	Summer	50,000	-
Puyallup	White River	2018	Winter	-	35,000
Total Annual Release Number				110,000	112,500

Adult spawners and expected outmigration – The average abundance (2012-2016) for the PS steelhead DPS is 19,313 adult spawners (natural-origin and hatchery-production combined). Juvenile PS steelhead abundance estimates is calculated from the escapement data (Table 6). For the species, 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 (9,657 females), 33.80 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 2.20 million natural-origin outmigrants annually.

Table 6. Abundance of PS steelhead spawner escapements (natural-origin and hatchery-production combined) from 2012-2016 (pers. comm., A. Marshall, WDFW, July 13, 2017; WDFW Steelhead - General Information Page).

Demographically Independent Populations	Spawners	Expected Number of Outmigrants[b]
Central and South Puget Sound MPG		
Cedar River	3	391
Green River	977	111,179
Nisqually River	759	86,323
N. Lake WA/Lake Sammamish	-	-
Puyallup/Carbon River	603	68,646
White River	629	71,638
Hood Canal and Strait of Juan de Fuca MPG		
Dungeness River[c]	26	2,984
East Hood Canal Tribs.	89	10,120
Elwha River	878	99,954
Sequim/Discovery Bay Tribs.	19	2,186
Skokomish River	862	98,066
South Hood Canal Tribs.	73	8,304
Strait of Juan de Fuca Tribs.	173	19,697
West Hood Canal Tribs.	122	13,858

Demographically Independent Populations	Spawners	Expected Number of Outmigrants[b]
North Cascades MPG		
Nooksack River	1,790	203,631
Pilchuck River	868	98,709
Samish River/ Bellingham Bay Tribs.	977	111,167
Skagit River	8,038	914,353
Snohomish/Skykomish Rivers	1,053	119,762
Snoqualmie River	824	93,772
Stillaguamish River	476	54,170
Tolt River	70	7,988
TOTAL	19,313	2,196,901

[a] Geometric mean of post fishery spawners.
[b] Expected number of outmigrants=Total spawners*50% proportion of females*3,500 eggs per female*6.5% survival rate from egg to outmigrant.
[c] Spawner estimates for 2009-2013

Hood Canal Summer-run Chum Salmon

Listed Hatchery Juvenile Releases – Four artificial propagation programs were listed as part of the ESU (79 FR 20802); however, only one program is currently active (Table 7). The combined hatchery production goal for listed HCS chum salmon from Table 7 is 150,000 unmarked juvenile chum salmon.

Table 7. Expected 2020 Hood Canal summer-run juvenile chum salmon hatchery releases (WDFW 2018).

Subbasin	Artificial propagation program	Brood year	Run Timing	Clipped Adipose Fin	Intact Adipose Fin
Hood Canal	LLTK - Lilliwaup	2018	Summer	-	150,000
Total Annual Release Number				-	150,000

Adult spawners and expected outmigration – The current average run size of 26,598 adult spawners (25,146 natural-origin and 1,452 hatchery-origin spawners; Table 8) is largely the result of aggressive reintroduction and supplementation programs throughout the ESU. In the Strait of Juan de Fuca population, the annual natural-origin spawners returns for Jimmycomelately Creek dipped to a single fish in 1999 and again in 2002 (unpublished data, Mindy Rowse, NWFSC, Feb 2, 2017). From 2015 to 2019, Jimmycomelately Creek averaged 1,288 natural-origin spawners. Salmon and Snow Creeks have improved substantially. Natural-origin spawner abundance was 130 fish in 1999, whereas the average for Salmon and Snow creeks were 1,836 and 311, respectively, for the 2015-2019 period.

Table 8. Abundance of natural-origin and hatchery-origin HCS chum salmon spawners in escapements 2013-2017 (unpublished data, Mindy Rowse, NWFSC, Apr 12, 2019).

Population Name	Natural-origin Spawners[a]	Hatchery-origin Spawners[a]	% Hatchery Origin	Expected Number of Outmigrants[c]
Strait of Juan de Fuca Population				
Jimmycomelately Creek	1,288	0	0.00%	188,313
Salmon Creek	1,836	0	0.00%	268,531
Snow Creek	311	0	0.00%	45,541
Chimacum Creek	902	0	0.00%	131,971
Population Average[d]	4,337	0	0.00%	634,355
Hood Canal Population				
Big Quilcene River	6,437	0	0.00%	941,450
Little Quilcene River	122	0	0.00%	17,795
Big Beef Creek	10	0	0.00%	1,532
Dosewallips River	2,021	0	0.00%	295,524
Duckabush River	3,172	0	0.00%	463,856
Hamma Hamma River	2,944	10	0.34%	432,056
Anderson Creek	3	0	0.00%	376
Dewatto River	95	0	0.00%	13,947
Lilliwaup Creek	857	1,141	57.10%	292,159
Skokomish River	205	299	59.36%	73,777
Tahuya River	2,789	2	0.07%	408,166
Union River	2,154	0	0.00%	314,960
Population Average[d]	20,809	1,452	6.52%	3,255,599
ESU Average	25,146	1,452	5.46%	3,889,955

[a] Five-year geometric mean of post fishery natural-origin spawners (2015-2019).
[b] Five-year geometric mean of post fishery hatchery-origin spawners (2015-2019).
[c] Expected number of outmigrants=Total spawners*45% proportion of females*2,500 eggs per female*13% survival rate from egg to outmigrant.
[d] Averages are calculated as the geometric mean of the annual totals (2015-2019).

Escapement data, the percentage of females in the population, and fecundity can estimate juvenile HCS chum salmon abundance. ESU fecundity estimates average 2,500 eggs per female, and the proportion of female spawners is approximately 45 percent of escapement in most populations (WDFW/PNPTT 2000). By applying fecundity estimates to the expected escapement of females (both natural-origin and hatchery-origin spawners – 11,969 females), the ESU is estimated to produce approximately 29.9 million eggs annually. For HCS chum salmon, freshwater mortality rates are high with no more than 13 percent of the eggs expected to survive to the juvenile migrant stage (Quinn 2005). With an estimated survival rate of 13 percent, the ESU should produce roughly 3.89 million natural-origin outmigrants annually.

Upper Columbia River Steelhead

Listed Hatchery Juvenile Releases and Natural Juvenile Abundance – Six artificial propagation programs were listed as part of the DPS (79 FR 20802). From 2015-2019, the geometric means for the releases from these hatcheries are 687,567 LHAC and 138,601 LHIA UCR steelhead annually (Zabel 2015, 2017a, 2017b, 2018, 2020). To estimate abundance of natural juvenile UCR steelhead, we calculate the geometric means for outmigrating smolts over the past five years (2015-2019) by using annual abundance estimates provided by the NWFSC (Zabel 2015, 2017a, 2017b, 2018, 2020). For natural-origin juvenile UCR steelhead, an estimated average of 199,380 juveniles outmigrated over the last five years.

Adult Abundance – To calculate the abundance figures for adult spawners (natural and hatchery), we calculate the geometric means of the last five years of adult returns as measured by dam counts. This is part of the tracking done for the Federal Columbia River Power System's Adaptive Management and Implementation Plan (AMIP 2019). The five-year geometric means (2015-2019) for UCR steelhead are 1,931 natural-origin; 5,309 LHAC, and 1,163 LHIA adults. The AMIP figures represent natural returns only. We calculate the hatchery returns by taking the wild return numbers and expanding them by the fractions of the wild vs. hatchery constituents found in the NWFSC outmigration estimate memos (above).

Middle Columbia River Steelhead

Listed Hatchery Juvenile Releases and Natural Juvenile Abundance – Seven artificial propagation programs were listed as part of the DPS (79 FR 20802). From 2015-2019, the geometric means for the releases from these hatcheries are 444,973 LHAC and 110,469 LHIA MCR steelhead annually (Zabel 2015, 2017a, 2017b, 2018, 2020). To estimate abundance of natural juvenile MCR steelhead, we calculate the geometric means for outmigrating smolts over the past five years (2015-2019) by using annual abundance estimates provided by the NWFSC (Zabel 2015, 2017a, 2017b, 2018, 2020). For natural-origin juvenile MCR steelhead, an estimated average of 407,697 juveniles outmigrated over the last five years.

Adult Abundance – To calculate the abundance figures for adult spawners (natural and hatchery), we calculate the geometric means of the last five years of adult returns as measured by dam counts. This is part of the tracking done for the Federal Columbia River Power System's Adaptive Management and Implementation Plan (AMIP 2019). The five-year geometric means (2015-2019) for MCR steelhead are 5,052 natural-origin; 448 LHAC, and 112 LHIA adults. The AMIP figures represent natural returns only. We calculate the hatchery returns by taking the wild return numbers and expanding them by the fractions of the wild vs. hatchery constituents found in the NWFSC outmigration estimate memos (above).

Snake River Spring/Summer-run Chinook salmon

Listed Hatchery Juvenile Releases and Natural Juvenile Abundance – 11 artificial propagation programs were listed as part of the DPS (79 FR 20802). From 2014-2018, the geometric means for the releases from these hatcheries are 4,760,250 LHAC and 868,679 LHIA spr/sum Chinook annually (Zabel 2014, 2015, 2017a, 2017b, 2018). To estimate abundance of natural juvenile spr/sum Chinook, we calculate the geometric means for outmigrating smolts over the past five years for which we have data (2014-2018) by using annual abundance estimates provided by the NWFSC (Zabel 2014, 2015, 2017a, 2017b, 2018). For natural-origin juvenile spr/sum Chinook, an estimated average of 1,296,641 juveniles outmigrated over the five most recent years for which we have data.

Adult Abundance – To calculate the abundance figures for adult spawners (natural and hatchery), we calculate the geometric means of the last five years of adult returns as measured by dam counts. This is part of the tracking done for the Federal Columbia River Power System's Adaptive Management and Implementation Plan (AMIP 2018). The five-year geometric means (2014-2018) for SnkR spr/sum-run Chinook salmon are 12,798 natural-origin; 2,387 LHAC, and 421 LHIA adults. The AMIP figures represent natural returns only. We calculate the hatchery returns by taking the wild return numbers and expanding them by the fractions of the wild vs. hatchery constituents found in the NWFSC outmigration estimate memos (above).

Snake River Fall-run Chinook salmon.

Listed Hatchery Juvenile Releases and Natural Juvenile Abundance – four artificial propagation programs were listed as part of the DPS (79 FR 20802). From 2015-2019, the geometric means for the releases from these hatcheries are 2,483,713 LHAC and 2,862,418 LHIA SnkR fall Chinook annually (Zabel 2015, 2017a, 2017b, 2018, 2020). To estimate abundance of natural juvenile SnkR fall Chinook, we calculate the geometric means for outmigrating smolts over the past five years (2015-2019) by using annual abundance estimates provided by the NWFSC (Zabel 2015, 2017a, 2017b, 2018, 2020). For natural-origin juvenile SnkR fall Chinook, an estimated average of 692,819 juveniles outmigrated over the last five years.
Adult Abundance – To calculate the abundance figures for adult spawners (natural and hatchery), we calculate the geometric means of the last five years of adult returns as measured by dam counts. This is part of the tracking done for the Federal Columbia River Power System's Adaptive Management and Implementation Plan (AMIP 2020). The five-year geometric means (2015-2019) for SnkR fall Chinook salmon are 10,337 natural-origin; 12,508 LHAC, and 13,551 LHIA adults. The AMIP figures represent natural returns only. We calculate the hatchery returns by taking the wild return numbers and expanding them by the fractions of the wild vs. hatchery constituents found in the NWFSC outmigration estimate memos (above).

Snake River Basin Steelhead

Listed Hatchery Juvenile Releases and Natural Juvenile Abundance – six artificial propagation programs were listed as part of the DPS (79 FR 20802). From 2015-2019, the geometric means for the releases from these hatcheries are 3,300,152 LHAC and 705,490 LHIA SnkR basin steelhead annually (Zabel 2015, 2017a, 2017b, 2018, 2020). To estimate abundance of natural juvenile SnkR basin steelhead, we calculate the geometric means for outmigrating smolts over the past five years (2015-2019) by using annual abundance estimates provided by the NWFSC (Zabel 2015, 2017a, 2017b, 2018, 2020). For natural-origin juvenile SnkR basin steelhead, an estimated average of 798,341 juveniles outmigrated over the last five years.
Adult Abundance – To calculate the abundance figures for adult spawners (natural and hatchery), we calculate the geometric means of the last five years of adult returns as measured by dam counts. This is part of the tracking done for the Federal Columbia River Power System's Adaptive Management and Implementation Plan (AMIP 2018). The five-year geometric means (2014-2018) for SnkR basin steelhead are 10, 547 natural-origin; 79,510 LHAC, and 16,137 LHIA adults. The AMIP figures represent natural returns only. We calculate the hatchery returns by taking the wild return numbers and expanding them by the fractions of the wild vs. hatchery constituents found in the NWFSC outmigration estimate memos (above).

Lower Columbia River Chinook salmon

Listed Hatchery Juvenile Releases and Natural Juvenile Abundance – This ESU includes 15 ESA-listed artificial propagation programs (79 FR 20802). From 2015-2019, the geometric means for the releases from these hatcheries are 31,353,395 LHAC and 962,458 LHIA LCR Chinook salmon smolts (Zabel 2015, 2017a, 2017b, 2018, 2020). To estimate abundance of juvenile LCR Chinook salmon, we calculate the geometric mean for outmigrating smolts over the past five years (2015-2019) by using annual abundance estimates provided by the NWFSC (Zabel 2014, 2015, 2017a, 2017b, 2018). For juvenile natural-origin LCR Chinook salmon, an estimated average of 11,745,027 juvenile salmon outmigrated over the last five years.
Adult Abundance – The average abundance for LCR Chinook salmon populations is 68,061 adult spawners (29,469 natural-origin and 38,594 hatchery-origin spawners; Table 9).

Table 9. Average abundance estimates for LCR Chinook salmon natural- and hatchery-origin spawners (ODFW Corvallis Research Laboratory - Oregon Adult Salmonid Inventory & Sampling Project; WDFW Chinook - General Information Page).

Population Name	Years	Natural-origin Spawners[a]	Hatchery-origin Spawners[a]	% Hatchery Origin
Coastal Stratum – Fall run				
Youngs Bay	2012-2014	233	5,606	96.01%
Grays/Chinook	2010-2014	100	357	78.12%
Big Creek	2012-2014	32	1,510	97.92%
Elochoman/Skamokowa	2010-2014	116	580	83.33%
Clatskanie	2012-2014	98	3,193	97.02%
Mill/Abernathy/Germany	2010-2014	92	805	89.74%
Cascade Stratum – Fall run				
Lower Cowlitz	2010-2013	723	196	21.33%
Upper Cowlitz	2010-2013	2,873	961	25.07%
Toutle	2010-2014	3,305	5,400	62.03%
Coweeman	2010-2014	385	963	71.44%
Kalama	2010-2014	803	8,892	91.72%
Lewis	2010-2014	2,178	943	30.21%
Washougal	2010-2014	192	116	37.66%
Clackamas	2012-2014	1,272	2,955	69.91%
Sandy	2012-2014	1,207	320	20.96%
Columbia Gorge Stratum – Fall run				
Lower Gorge	2003-2007	146	-	-
Upper Gorge	2010-2012	200	327	62.05%
White Salmon	2010-2014	829	246	22.88%
Cascade Stratum – Late fall run				
North Fork Lewis	2010-2014	12,330	0	0.00%
Cascade Stratum – Spring run				
Upper Cowlitz/Cispus	2010-2014	279	3,614	92.83%

Population Name	Years	Natural-origin Spawners[a]	Hatchery-origin Spawners[a]	% Hatchery Origin
Kalama	2011-2014	115	-	-
North Fork Lewis	2010-2014	217	0	0.00%
Sandy	2010-2014	1,731	1,470	45.92%
Gorge Stratum – Spring run				
White Salmon	2013-2014	13	140	91.50%
ESU Average		29,469	38,594	56.70%

Lower Columbia River Coho Salmon

Listed Hatchery Juvenile Releases and Natural Juvenile Abundance – The LCR coho salmon ESU includes 21 artificial propagation programs (79 FR 20802). From 2015-2019, the geometric means for the releases from these hatcheries are 7,287,647 LHAC and 249,784 LHIA LCR coho salmon smolts annually (Zabel 2015, 2017a, 2017b, 2018, 2020). To estimate abundance of juvenile LCR coho salmon, we calculate the geometric mean for outmigrating smolts over the past five years (2015-2019) by using annual abundance estimates provided by the NWFSC (Zabel 2015, 2017a, 2017b, 2018, 2020). For juvenile natural-origin LCR coho salmon, an estimated average of 661,468 juvenile salmon outmigrated over the last five years.

Adult Abundance – The average abundance for LCR coho salmon populations is 38,657 adult spawners (29,866 natural-origin and 8,791 hatchery-origin spawners; Table 10).

Table 10. Average abundance estimates for LCR coho salmon natural- and hatchery-origin spawners (Lewis et al. 2009, 2010, 2011, 2012, 2014; Sounhein et al. 2014, 2015, 2016, 2017, 2018; WDFW Conservation - Coho salmon webpage).

Population Name	Years	Natural-origin Spawners	Hatchery-origin Spawners	% Hatchery Origin
Coastal Stratum				
Grays/Chinook	2013-2017	284	429	60.14%
Elochoman/Skamokowa	2013-2017	587	306	34.22%
Mill/Abernathy/Germany	2013-2017	733	73	9.05%
Youngs Bay	2008-2012	79	121	60.61%
Big Creek	2008-2012	349	171	32.86%
Clatskanie	2013-2017	614	81	11.71%
Scappoose	2013-2017	811	3	0.39%
Cascade Stratum				
Lower Cowlitz	2013-2017	4,502	668	12.92%
Upper Cowlitz/Cispus	2013-2017	5,245	478	8.36%
Titlton	2013-2017	3,039	3,193	51.24%
SF Toutle	2013-2017	1,711	472	21.63%
NF Toutle	2013-2017	1,039	789	43.15%
Coweeman	2013-2017	2,032	309	13.21%
Kalama	2013-2017	33	172	83.96%
NF Lewis	2013-2017	520	151	22.55%

Population Name	Years	Natural-origin Spawners	Hatchery-origin Spawners	% Hatchery Origin
EF Lewis	2013-2017	835	283	25.29%
Salmon Creek	2013-2017	1,465	44	2.91%
Washougal	2013-2017	219	416	65.52%
Clackamas	2013-2017	3,762	319	7.82%
Sandy	2013-2017	1,315	25	1.87%
Gorge Stratum				
Lower Gorge	2012-2016	576	142	19.75%
Upper Gorge/White Salmon	2013-2017	47	13	21.12%
Hood	2012-2016	68	133	66.15%
ESU Average		29,866	8,791	22.74%

Lower Columbia River Steelhead

Listed Hatchery Juvenile Releases and Natural Juvenile Abundance – Seven artificial propagation programs were listed as part of this DPS (79 FR 20802). From 2015-2019, the geometric means for the releases from these hatcheries are 1,197,156 LHAC and 9,138 LHIA LCR steelhead annually (Zabel 2015, 2017a, 2017b, 2018, 2020). To estimate abundance of juvenile natural LCR steelhead, we calculate the geometric mean for outmigrating smolts over the past five years (2015-2019) by using annual abundance estimates provided by the NWFSC (Zabel 2015, 2017a, 2017b, 2018, 2020). For juvenile natural-origin LCR steelhead, an estimated average of 352,146 juvenile steelhead outmigrated over the last five years.
Adult Abundance – The average abundance for LCR coho salmon populations is 35,217 adult spawners (12,920 natural-origin and 22,297 hatchery-origin spawners; Table 11).

Table 11. Average abundance estimates for LCR steelhead natural- and hatchery-origin spawners (ODFW Corvallis Research Laboratory - Oregon Adult Salmonid Inventory & Sampling Project; WDFW Chinook - General Information Page).

Population Name	Years	Natural-origin Spawners[a]	Hatchery-origin Spawners[a]	% Hatchery Origin
Cascade Stratum – Winter run				
Lower Cowlitz	2009	0	4,559	100.00%
Upper Cowlitz/Cispus	2010-2014	438	51	10.43%
Tilton	2010-2013	279	0	0.00%
South Fork Toutle	2010-2014	501	7	1.38%
North Fork Toutle	2010-2014	387	121	23.82%
Coweeman	2010-2014	296	166	35.93%
Kalama	2011-2015	475	455	48.92%
North Fork Lewis	2007-2011	129	2,126	94.28%
East Fork Lewis	2010-2014	364	0	0.00%
Washougal	2010-2014	167	195	53.87%
Clackamas	2014-2015	3,607	1,876	34.21%
Sandy	2013-2015	3,810	284	6.94%

Population Name	Years	Natural-origin Spawners[a]	Hatchery-origin Spawners[a]	% Hatchery Origin
Cascade Stratum – Summer run				
Kalama	2011-2015	127	499	79.71%
North Fork Lewis	2009	0	10,508	100.00%
East Fork Lewis	2011-2015	760	168	18.10%
Washougal	2012-2015	102	621	85.89%
Gorge Stratum – Winter run				
Upper Gorge	2010-2014	36	0	0.00%
Hood	2003-2007	438	380	46.45%
Gorge Stratum – Summer run				
Wind	2010-2014	763	42	5.22%
Hood	2003-2007	241	239	49.79%
DPS Average		12,920	22,297	63.31%

Columbia River Chum Salmon

Listed Hatchery Juvenile Releases and Natural Juvenile Abundance – Two artificial propagation programs were listed as part of the ESU (79 FR 20802). All the fish produced in these hatcheries have intact adipose fins. From 2015-2019, the geometric means for the releases from these hatcheries are 01,503 LHIA CR chum salmon smolts (Zabel 2015, 2017a, 2017b, 2018, 2020). To estimate abundance of juvenile CR chum salmon, we calculate the geometric mean for outmigrating smolts over the past five years (2015-2019) by using annual abundance estimates provided by the NWFSC (Zabel 2015, 2017a, 2017b, 2018, 2020). For juvenile natural-origin CR chum salmon is juvenile salmon, an estimated average of 6,626,218 outmigrated over the last five years.

Adult Abundance – The average abundance for CR chum salmon populations is 11,070 adult spawners (10,644 natural-origin and 426 hatchery-origin spawners; Table 12).

Table 12. Average abundance estimates for CR chum salmon natural- and hatchery-origin spawners (ODFW Corvallis Research Laboratory - Oregon Adult Salmonid Inventory & Sampling Project; WDFW Chinook - General Information Page).

Population Name	Years	Natural-origin Spawners[a]	Hatchery-origin Spawners[a]	% Hatchery Origin
Coastal Ecological Zone				
Grays/Chinook	2010-2014	6,604	421	5.99%
Elochoman/Skamania	2002-2004	122	-	-
Mill/Abernathy/Germany	2002-2004	40	-	-
Cascade Ecological Zone				
Lewis River	2011-2013	36	-	-
Washougal River	2010-2014	2,440	-	-
Columbia Gorge Ecological Zone				
Lower Gorge tributaries	2010-2014	1,600	5	0.31%
Upper Gorge tributaries	2010-2014	106	-	-

Population Name	Years	Natural-origin Spawners[a]	Hatchery-origin Spawners[a]	% Hatchery Origin
ESU Average		10,644	426	3.85%

Upper Willamette River Chinook salmon

Listed Hatchery Juvenile Releases – This ESU includes spring-run Chinook salmon from six artificial propagation programs (79 FR 20802). From 2015-2019, the geometric means for the releases from these hatcheries are 4,709,045 LHAC and 157 LHIA UWR Chinook salmon smolts annually (Zabel 2015, 2017a, 2017b, 2018, 2020). To estimate abundance of juvenile UWR Chinook salmon, we calculate the geometric mean for outmigrating smolts over the past five years (2015-2019) by using annual abundance estimates provided by the NWFSC (Zabel 2014, 2015, 2017a, 2017b, 2018). For juvenile natural-origin UWR Chinook salmon, and estimated average of 1,211,863 juvenile salmon outmigrated over the last five years.
Adult spawners and expected outmigration – The average (2013-2017) abundance of UWR Chinook salmon is 41,679 adult spawners (10,203 natural-origin and 31,476 hatchery-origin spawners; Table 13).

Table 13. Adult UWR spring-run Chinook salmon abundance (ODFW and WDFW 2014, 2015, 2016, 2017, 2018).

Year	Natural-origin Spawners	Hatchery-origin Spawners	Total Spawner Abundance[a]
2013	11,182	24,532	35,714
2014	7,758	29,523	37,281
2015	11,973	49,561	61,534
2016	10,588	27,679	38,267
2017	10,054	31,096	41,150
ESU Average[b]	10,203	31,476	41,679

a Sum of Natural + Hatchery escapement to Willamette Falls fish ladder and the Clackamas River

b Five-year geometric mean of post-fishery spawners (2013-2017)

Upper Willamette River Steelhead

Listed Hatchery Juvenile Releases – There are no listed hatchery programs for this DPS. To estimate abundance of natural juvenile UWR steelhead, we calculate the geometric mean for outmigrating smolts over the past five years (2015-2019) by using annual abundance estimates provided by the NWFSC (Zabel 2015, 2017a, 2017b, 2018, 2020). For juvenile natural-origin UWR steelhead, an estimated average of 140,396 juveniles outmigrated over the last five years.
Adult Abundance – The average abundance for UWR steelhead populations is 2,912 adult natural-origin spawners (Table 14).

Table 14. Five-year geometric mean for adult UWR winter-run steelhead abundance from 2013/2014 through 2017/2018 (ODFW - Lower Willamette Fisheries and Willamette Falls Fish Counts).

Year	Natural Escapement
2013-2014	5,349
2014-2015	4,508
2015-2016	5,778
2016-2017	822
2017-2018	1,829
DPS Average	2,912

Oregon Coast Coho Salmon

Listed Hatchery Juvenile Releases – The OC coho salmon ESU includes one artificial propagation programs – Cow Creek Hatchery Program (Oregon Department of Fish and Wildlife Stock #18) (79 FR 20802). The hatchery production goal is 60,000 adipose-fin-clipped yearling OC coho salmon (ODFW 2017).

Adult spawners and expected outmigration – The average abundance for OC coho salmon populations is 94,879 adult spawners (94,320 natural-origin and 559 hatchery-origin spawners; Table 15).

Table 15. Average abundance estimates for OC coho salmon natural- and hatchery-origin spawners (Sounhein et al. 2014, 2015, 2016, 2017, 2018).

Population Name	Natural-origin Spawners[a]	Hatchery-origin Spawners[a]	% Hatchery Origin	Expected Number of Outmigrantsb
North Coast Stratum				
Necanicum River	1,139	5	0.42%	80,063
Nehalem River	7,073	11	0.16%	495,889
Tillamook Bay	4,771	19	0.39%	335,290
Nestucca River	2,320	2	0.09%	162,547
North Coast Dependents	602	3	0.49%	42,350
Mid-Coast Stratum				
Salmon River	924	9	0.98%	65,352
Siletz River	5,534	2	0.04%	387,545
Yaquina River	4,585	2	0.05%	321,141
Beaver Creek	1,634	1	0.09%	114,493
Alsea River	8,627	0	0.00%	603,904
Siuslaw River	12,994	0	0.00%	909,584
Mid Coast Dependents	1,190	7	0.56%	83,747
Lakes Stratum				
Siltcoos Lake	2,362	0	0.00%	165,333
Tahkenitch Lake	1,356	2	0.13%	95,077
Tenmile Lake	2,909	0	0.00%	203,660
Umpqua Stratum				
Lower Umpqua River	8,755	2	0.02%	612,987
Middle Umpqua River	3,080	0	0.00%	215,578

Population Name	Natural-origin Spawners[a]	Hatchery-origin Spawners[a]	% Hatchery Origin	Expected Number of Outmigrantsb
North Umpqua River	2,320	191	7.59%	175,760
South Umpqua River	3,683	299	7.52%	278,743
Mid-South Coast Stratum				
Coos River	6,320	0	0.00%	442,407
Coquille River	10,781	3	0.03%	754,870
Floras Creek	1,154	0	0.00%	80,785
Sixes River	200	0	0.00%	14,029
Mid-South Coast Dependents	5	1	16.36%	428
ESU Average	94,320	559	0.59%	6,641,564

[a] Five-year geometric mean of post-fishery spawners (2013-2017).
[b] Expected number of outmigrants=Total spawners*50% proportion of females*2,000 eggs per female*7% survival rate from egg to outmigrant.

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. The five-year geometric mean from 2013 through 2017 is estimated at 94,879 spawners (Table 15). 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 47,440 females returning (roughly half of 94,879) to this ESU, one may expect approximately 94.88 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 6.64 million juvenile coho salmon are produced annually by the Oregon Coast ESU.

Southern Oregon/Northern California Coast Coho Salmon

Listed Hatchery Juvenile Releases – Three artificial propagation programs were listed as part of the ESU (79 FR 20802). Hatchery releases from these hatcheries average 200,000 LHAC and 575,000 LHIA SONCC coho salmon juveniles annually (ODFW 2011, CHSRG 2012).
Adult spawners and expected outmigration – The average abundance for SONCC coho salmon populations is 19,990 adult spawners (9,065 natural-origin and 10,934 hatchery-origin spawners; Table 16).

Table 16. Estimates of the natural-origin and hatchery-produced adult coho salmon returning to the Rogue, Trinity, and Klamath rivers (ODFW Corvallis Research Laboratory - Oregon Adult Salmonid Inventory & Sampling Project, Kier et al 2015, CDFW 2012).

YEAR	Rogue River		Trinity River		Klamath River		
	Hatchery	Natural	Hatchery	Natural	Shasta River[a]	Scott River[a]	Salmon River
2008	158	414	3,851	944	30	62	
2009	518	2,566	2,439	542	9	81	
2010	753	3,073	2,863	658	44	927	

2011	1,156	3,917	9,009	1,178	62	355	
2012	1,423	5,440	8,662	1,761		201	
2013	1,999	11,210	11,177	4,097			
2014	829	2,409	8,712	917			
Average [b]	1,417	6,353	9,517	2,258	38	357	50 [c]

[a] Hatchery proportion unknown, but assumed to be low.
[b] 3-year average of most recent years of data.
[c] Annual returns of adults are likely less than 50 per year (NMFS 2014b).

While we currently lack data on naturally-produced juvenile coho salmon production, it is possible to make rough estimates of juvenile abundance from adult return data. Quinn (2005) published estimates for salmonids in which average fecundity for coho salmon is 2,878 eggs per female. By applying the average fecundity of 2,878 eggs per female to the estimated 9,995 females returning (half of the average total number of spawners), approximately 28.8 million eggs may be expected 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 approximate that this ESU produces about 2,013,593 juvenile SONCC coho salmon outmigrants annually.

Northern California Steelhead

The DPS includes all naturally spawned populations of steelhead in rivers and streams from Redwood Creek (Humboldt County) south to the Gualala River (Mendocino County). Extant summer-run populations are found in Redwood Creek, Mad River, Eel River (Middle Fork), and Mattole River. The Northern California Coast steelhead DPS begins at the Russian River and extends south to Aptos Creek. This leaves several *O. mykiss* populations in small watersheds between the Gualala and Russian rivers that are not currently assigned to either DPS. The NC steelhead DPS is comprised of both winter- and summer-run steelhead populations (Table 17).

Table 17. Historical NC steelhead Independent Populations (NMFS 2011).

Population Groups	Run	Populations
Northern Coastal	Summer	Mad River (lower), Mattole River, Redwood Creek (lower), South Fork Eel River
	Winter	Humboldt Bay, Little River, Mattole River, Redwood Creek (lower), South Fork Eel River
Lower Interior	Winter	Woodman Creek, Chamise Creek, Tomki Creek, Outlet Creek
Northern Mountain Interior	Summer	Mad River (upper), Redwood Creek (upper), Upper Mid-mainstem Van Duzen Creek
	Winter	Larabee Creek, Middle Fork Eel River, North Fork Eel River, Redwood Creek (upper), Van Duzen Creek
North-Central Coastal	Winter	Big River, Caspar Creek, Noyo River, Ten Mile River, Usal Creek, Wages Creek
Central Coastal	Winter	Garcia River, Gualala River, Navarro River

*Abundance and Productivity***.** Short- and long-term trends have been calculated for a few rivers in this DPS (Table 18). Abundance trends for Little River have been significantly negative with the annual abundance having not been above 20 during the past decade (Gallagher and Wright 2009, 2011, and 2012, Williams et al. 2011, Gallagher et al. 2013). In Redwood Creek, annual dive surveys have occurred since 1981. Williams et al. (2011) stated at the time the 16-year trend was positive ($p = 0.029$); however, the critically low abundance overshadowed the trend. For the Upper Eel River, abundance data are gathered from the Van Arsdale Fish Station. The short-term trend for the upper Eel River is positive, but there were no significant trends for the other three rivers; Freshwater Creek, South Fork (SF) Noyo River, and Gualala River (Williams et al. 2011). The most recent status review found that for many winter-run populations, while long-term trends have been negative run sizes of natural-origin steelhead have stabilized or are increasing. Summer-run populations continue to be of significant concern, and overall available data do not suggest an appreciable change in extinction risk since the 2011 status review despite the fact that most populations remain below viability targets (NMFS 2016e).

Table 18. Short- and Long-term Trends in NC steelhead Abundance Based on Partial Population Estimates and Population Indices. Trends in Bold are Significantly Different from 0 at α=0.05 (Williams et al. 2011).

Stratum	Population (run)	Short-term Trend (95 percent CI)	Long-term Trend (95 percent CI)
Northern Coastal	Humboldt Bay Freshwater Creek (winter)	-0.046 (-0.245, 0.153)	-
	Little River (winter)	-0.231 (-0.418, -0.043)	
	Redwood Creek (summer)	0.093 (0.011, 0.175)	-0.012 (-0.054, 0.029)
North Mountain-Interior	Upper Eel River (winter)	0.062 (0.001, 0.123)	-
North-Central Coastal	Noyo River SF Noyo River (winter)	0.004 (-0.115, 0.123)	-
Central Coast	Gualala River Wheatfield Fork (winter)	0.000 (-0.361, 0.361)	-

From available surveys, we estimate that the NC steelhead DPS has an annual abundance of 7,221 adults (Table 19).

Table 19. Geometric Mean Abundances of NC steelhead Spawners by Population (Gallagher and Wright 2009, 2011, and 2012; Gallagher et al. 2013, Mattole Salmon Group 2011, Duffy 2011, Counts at Van Arsdale Fisheries Station (http://www.pottervalleywater.org/files/VAFS_fish_counts.csv), Harris and Thompson 2014, De Haven 2010, Metheny and Duffy 2014, Ricker et al. 2014, additional unpublished data provided by the NMFS SWFSC)

Stratum	Waterbody	Run	Years	Abundance	Expected Number of Outmigrants[a]
Northern Coastal	Elk Creek	Winter	2011, 2014	13	1,479

Stratum	Waterbody	Run	Years	Abundance	Expected Number of Outmigrants[a]
	Little River	Winter	2010-2014	10	1,138
	Mattole River	Winter	2012-2013	558	63,473
	Mattole River	Summer	2011-2015	92	10,465
	Redwood Creek	Winter	2010-2013	610	69,388
	Redwood Creek	Summer	2010-2014	7	796
	Prairie Creek	Winter	2007, 2008, 2010-2012	22	2,503
	Humboldt Bay	Winter	2011-2014	52	5,915
	Freshwater Creek	Winter	2010-2014	102	11,603
North Mountain-Interior	Eel River	Winter	2011-2015	389	44,249
	South Fork Eel River	Winter	2011-2014	574	65,293
	Van Duzen River	Summer	2011-2015	115	13,081
	Middle Fork Eel River	Summer	2010-2014	796	90,545
North-Central Coastal	Big River	Winter	2010-2014	465	52,894
	Caspar Creek	Winter	2010-2014	31	3,526
	Cottoneva Creek	Winter	2010, 2012, 2014	83	9,441
	Hare Creek	Winter	2010-2014	2	228
	Juan Creek	Winter	2012	39	4,436
	Noyo River	Winter	2010-2014	442	50,278
	SF Noyo River	Winter	2010-2014	79	8,986
	Pudding Creek	Winter	2010-2014	34	3,868
	Ten Mile River	Winter	2010-2014	382	43,453
	Usal Creek	Winter	2010-2013	54	6,143
	Wages Creek	Winter	2010, 2011, 2014	55	6,256
Central Coastal	Albion River	Winter	2010-2014	45	5,119
	Big Salmon Creek	Winter	2012-2013	84	9,555
	Brush Creek	Winter	2010-2014	6	683
	Garcia River	Winter	2010-2014	340	38,675
	Gualala River	Winter	2006-2010	1,066	121,258
	Navarro River	Winter	2010-2014	332	37,765
	North Fork Navarro River	Winter	2013-2014	342	38,903
Total				7,221	821,389

[a]Expected number of outmigrants=Total spawners*50 percent proportion of females*3,500 eggs per female*6.5 percent survival rate from egg to outmigrant

Both adult and juvenile abundance data are limited for this DPS. 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 (Table 19). For the species, 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 – 3,610 females), 12.6 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 821,389 natural outmigrants annually. There are not currently hatchery NC steelhead included in this DPS.

California Coastal Chinook salmon

Listed Hatchery Juvenile Releases – There are no listed hatchery programs for this ESU.
Adult spawners and expected outmigration – Although there is limited population-level estimates of abundance for CC Chinook salmon populations, Table 20 summarizes the information that is available for the major watersheds in the ESU. Based on this limited information, the current average run size for CC Chinook salmon ESU is 7,034 adults.

Table 20. Average abundance for CC Chinook salmon natural-origin spawners (Metheny and Duffy 2014, PFMC 2013, Ricker et al. 2014, Mattole Salmon Group 2011, Potter Valley Irrigation District - Van Arsdale Fish Counts webpage, Sonoma Water - Chinook salmon in the Russian River webpage).

Population	Years	Spawners	Expected Number of Outmigrants[ab]
Redwood Creek	2009-2013	1,745	317,067
Mad River	2010-2015	71	12,900
Freshwater Creek	2010-2015	6	1,090
Eel River mainstem	2010-2015	1,198	217,677
Eel River (Tomki Creek)	2010-2015	70	12,719
Eel River (Sproul Creek)	2010-2015	103	18,715
Mattole River	2007-2009, 2012, 2013	648	117,742
Russian River	2009 - 2014	3,137	569,993
Ten Mile River	2009 - 2014	6	1,090
Noyo River	2009 - 2014	14	2,544
Big River	2009 - 2014	13	2,362
Albion River	2009 - 2014	15	2,726
Navarro River	2009 - 2014	3	545
Garcia River	2009 - 2014	5	909
ESU Average		7,034	1,278,078

[a] Expected number of outmigrants=Total spawners*50 percent proportion of females*3,634 eggs per female*10 percent survival rate from egg to outmigrant.

[b] Based upon number of natural-origin spawners.

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 escapement data, the percentage of females in the population, and fecundity. Average fecundity for female CC Chinook salmon is not available. 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 an average fecundity of 3,634 eggs per female to the estimated 3,517 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 1,278,078 natural outmigrants annually.

Central Valley Spring-run Chinook salmon

Listed Hatchery Juvenile Releases – The Feather River Hatchery is the only ESA-listed hatchery for the CVS Chinook salmon (79 FR 20802). From 1999-2009, the hatchery has released, on average, 2,169,329 CVS Chinook salmon smolts (all adipose-clipped) (California HSRG 2012). **Adult spawners and expected outmigration** – The average abundance[2] (2013-2017) for CVS Chinook salmon populations is 6,000 adult spawners (3,727 natural-origin and 2,273 hatchery-origin spawners; Table 21). Historic spawning habitat on the Feather River is blocked by Oroville Dam, so all CVS Chinook salmon are returned to the hatchery (Williams et al. 2016; CDFW 2019).

Table 21. Average abundance estimates for CVS Chinook salmon natural- and hatchery-origin spawners 2013-2017 (CDFW 2018).

Population Name	Natural-origin Spawners[a]	Hatchery-origin Spawners[a]	% Hatchery Origin	Expected Number of Outmigrants[b]
Southern Cascades Stratum				
Battle Creek	191	0	0%	39,761
Mill Creek	302	0	0%	62,807
Deer Creek	409	0	0%	85,049
Butte Creek	2,750	0	0%	572,056
Big Chico Creek	0	0	0%	0
Antelope Creek	3	0	0%	598
Coastal Range Stratum				
Clear Creek	73	0	0%	15,143
Cottonwood / Beegum creeks	0.3	0	0%	60
Northern Sierra Stratum				
Feather River	0	2,273	100%	-
ESU Average	3,727	2,273	37.9%	775,474

[a] Geometric mean (2013-2017) of post-fishery spawners.

[2] Average abundance calculations are the geometric mean. The geometric mean of a collection of positive data is defined as the nth root of the product of all the members of the data set, where n is the number of members. Salmonid abundance data tend to be skewed by the presence of outliers (observations considerably higher or lower than most of the data). For skewed data, the geometric mean is a more stable statistic than the arithmetic mean.

[b] Expected number of outmigrants=Total spawners*50% proportion of females*4,131 eggs per female*10% survival rate from egg to outmigrant.

The CDFG (1998) published estimates in which average fecundity of spring-run Chinook salmon is 4,161 eggs per female. By applying the average fecundity of 4,161 eggs per female to the estimated 1,862 females returning (half of the most recent five-year average of spawners), and applying an estimated survival rate from egg to smolt of 10 percent, the Sacramento River basin portion of the ESU could produce roughly 775 thousand natural outmigrants annually.

California Central Valley Steelhead

Abundance and Productivity. Historic CCV steelhead run sizes are difficult to estimate given the paucity of data, but may have approached one to two million adults annually (McEwan 2001). By the early 1960s the steelhead run size had declined to about 40,000 adults (McEwan 2001). Hallock et al. (1961) estimated an average of 20,540 adult steelhead through the 1960s in the Sacramento River upstream of the Feather River. Steelhead counts at the Red Bluff Diversion Dam (RBDD) declined from an average of 11,187 for the period from 1967 to 1977, to an average of approximately 2,000 through the early 1990's, with an estimated total annual run size for the entire Sacramento-San Joaquin system, based on RBDD counts, to be no more than 10,000 adults (McEwan and Jackson 1996, McEwan 2001). Steelhead escapement surveys at RBDD ended in 1993 due to changes in dam operations, and comprehensive steelhead population monitoring has not taken place in the Central Valley until recently, despite 100 percent marking of hatchery steelhead smolts since 1998. Efforts are underway to improve this deficiency, and initial results of an adult escapement monitoring plan should be available by the time of the next status review.

Table 22. Abundance geometric means for adult CCV steelhead natural- and hatchery-origin spawners (CHSRG 2012, Hannon and Deason 2005, Teubert et al. 2011, additional unpublished data provided by the NMFS SWFSC)

Population	Years	Natural-origin Spawners	Hatchery-origin Spawners	Expected Number of Outmigrants[ab]
American River	2011-2015	208	1,068	145,145
Antelope Creek	2007	140	0	15,925
Battle Creek	2010-2014	410	1,563	224,429
Bear Creek	2008-2009	119	0	13,536
Cottonwood Creek	2008-2009	27	0	3,071
Clear Creek	2011-2015	463	0	52,666
Cow Creek	2008-2009	2	0	228
Feather River	2011-2015	41	1,092	128,879

Mill Creek	2010-2015	166	0	18,883
Mokelumne River	2006-2010	110	133	27,641
Total		1,686	3,856	630,403

[a] Expected number of outmigrants=Total spawners*50 percent proportion of females*3,500 eggs per female*6.5 percent survival rate from egg to outmigrant

[b] Based upon number of natural-origin spawners

Historic CCV steelhead abundance is unknown. In the mid-1960's, the California Department of Fish and Game (CDFG) (now CDFW) estimated CCV steelhead abundance at 26,750 fish (CDFG 1965). The CDFG estimate, however, is just a midpoint number in the CCV steelhead's abundance decline—at the point the estimate was made, there had already been a century of commercial harvest, dam construction, and urbanization.

An estimated 100,000 to 300,000 naturally produced juvenile steelhead are estimated to leave the Central Valley annually, based on rough calculations from sporadic catches in trawl gear (Good et al. 2005). The Mossdale trawls on the San Joaquin River conducted annually by CDFW and USFWS capture steelhead smolts, although usually in very small numbers. These steelhead recoveries, which represent migrants from the Stanislaus, Tuolumne, and Merced rivers, suggest that the productivity of CCV steelhead in these tributaries is very low. In addition, the Chipps Island midwater trawl dataset from the USFWS provides information on the trend (Williams et al. 2011).

In contrast to the data from Chipps Island and the Central Valley Project and State Water Project fish collection facilities, some populations of wild CCV steelhead appear to be improving (Clear Creek) while others (Battle Creek) appear to be better able to tolerate the recent poor ocean conditions and dry hydrology in the Central Valley compared to hatchery produced fish (NMFS 2011). Since 2003, fish returning to the Coleman NFH have been identified as wild (adipose fin intact) or hatchery produced (adipose-clipped). Returns of wild fish to the hatchery have remained fairly steady at 200-300 fish per year, but represent a small fraction of the overall hatchery returns. Numbers of hatchery origin fish returning to the hatchery have fluctuated much more widely; ranging from 624 to 2,968 fish per year.

Both adult and juvenile abundance data are limited for this DPS. 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. Juvenile CCV steelhead abundance estimates come from the escapement data (Table 22). For the species, 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 hatchery- and natural-origin spawners – 2,771 females), 9.7 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 630,403 naturally produced outmigrants annually. In addition, hatchery managers could produce approximately 1.6 million listed hatchery juvenile CCV steelhead each year (Table 23).

Table 23. Expected Annual CCV steelhead Hatchery Releases (CHSRG 2012).

Artificial propagation program	Clipped Adipose Fin
Nimbus Hatchery (American River)	439,490
Feather River Hatchery (Feather River)	273,398
Coleman NFH (Battle Creek)	715,712
Mokelumne River Hatchery (Mokelumne River)	172,053
Total Annual Release Number	1,600,653

Central California Coast Steelhead

The CCC steelhead DPS includes winter-run steelhead populations from the Russian River (Sonoma County) south to Aptos Creek (Santa Cruz County) inclusive and eastward to Chipps Island (confluence of the Sacramento and San Joaquin rivers) and including all drainages of San Francisco, San Pablo, and Suisun bays (Table 24).

Table 24. Historical CCC steelhead Populations (NMFS 2011).

Diversity Strata	Populations
North Coastal	Austin Creek, Salmon Creek, Walker Creek, Lagunitas Creek, Green Valley Creek
Interior	Dry Creek, Maacama Creek, Mark West Creek, Upper Russian River
Santa Cruz Mountains	Aptos Creek, Pescadero Creek, Pilarcitos Creek, San Lorenzo River, San Gregorio Creek, Scott Creek, Soquel Creek, Waddell Creek
Coastal San Francisco Bay	Corte Madera Creek, Guadalupe River, Miller Creek, Novato Creek, San Francisquito Creek
Interior San Francisco Bay	Alameda Creek, Coyote Creek, Napa River, Petaluma River, San Leandro Creek, San Lorenzo Creek

Table 25. Approximate annual releases of hatchery CCC steelhead (J. Jahn, pers. comm., July 2, 2013).

Artificial propagation program	Adipose Fin-Clipped
Scott Creek/Kingfisher Flat Hatchery	3,220
San Lorenzo River	19,125
Don Clausen Fish Hatchery	380,338
Coyote Valley Fish Facility	246,208
Total Annual Release Number	648,891

*Abundance and Productivity***.** Historic CCC steelhead abundance is unknown. In the mid-1960's, CDFG estimated CCC steelhead abundance at 94,000 fish (CDFG 1965). The CDFG estimate, however, is just a midpoint number in the CCC steelhead's abundance decline—at the point the estimate was made, there had already been a century of commercial harvest and urbanization. Current CCC steelhead abundance is still not well known. Multiple short-term studies using different methodologies have occurred over the past decade.

Data for both adult and juvenile abundance are limited for this DPS. 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. Juvenile CCC steelhead abundance estimates come from the escapement data (Table 26). All returnees to the hatcheries do not contribute to the natural population and are not used in this calculation. For the species, 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 – 1,094 females), 3.8 million eggs are expected to be produced annually. In addition, hatchery managers could produce 648,841 listed hatchery juvenile CCC steelhead each year (Table 26). With an estimated survival rate of 6.5 percent (Ward and Slaney 1993), the DPS should produce roughly 248,771 natural outmigrants annually (Table 26).

Table 26. Geometric Mean Abundances of CCC steelhead Spawners Escapements by Population (Ettlinger et al. 2012, Jankovitz 2013, Source: http://www.marinwater.org/DocumentCenter/View/200/Walker-Creek-Salmon-Monitoring-Program-Reports-and-References-March-2010?bidId=, Natural abundance: Manning and Martini-Lamb (ed.) 2012; Hatchery abundance source: http://www.scwa.ca.gov/files/docs/projects/rrifr/Final_BO_Report_2011_2012.pdf, Source: http://scceh.com/LinkClick.aspx?fileticket=dRW_AUu1EoUpercent3D&tabid=1772, Atkinson 2010, Williams et al. 2011, Koehler and Blank 2012, additional unpublished data provided by the NMFS SWFSC).

			Abundance		
Stratum	Waterbody	Years	Natural Origin	Hatchery Origin	Expected Number of Outmigrantsab
Northern Coastal	Austin Creek	2010-2012	63	-	7,166
	Lagunitas Creek	2009-2013	71	-	8,076
	Pine Gulch Creek	2010-2014	37		4,209
	Redwood Creek	2010-2014	18		2,048
	Walker Creek	2007-2010	29	-	3,299
Interior	Dry Creek	2011-2012	33	-	3,754
	Russian River	2008-2012	230	3,451	26,163
Santa Cruz Mountains	Aptos Creek	2007-2011	249	-	28,324
	Pescadero	2013-2015	361	-	41,064
	Gazos Creek	2013-2015	30	-	3,413
	Waddell Creek	2013-2014	73	-	8,304
	San Gregorio Creek	2014-2015	135	-	15,356
	San Lorenzo River	2013-2015	423	319	48,116
	San Pedro Creek	2013	38		4,323
	San Vicente Creek	2013-2015	35		3,981

			Abundance		
Stratum	Waterbody	Years	Natural Origin	Hatchery Origin	Expected Number of Outmigrantsab
	Scott Creek	2011-2015	120	96	13,650
	Soquel Creek	2007-2011	230	-	26,163
Central Coastal	Napa River	2009-2012	12	-	1,365
		Totals	2,187	3,866	248,771

[a]Expected number of outmigrants=Total spawners*50 percent proportion of females*3,500 eggs per female*6.5 percent survival rate from egg to outmigrant
[b]Based upon natural-origin spawner numbers

Good et al. (2005) concluded that due to past declines, threats to genetic integrity, and available abundance data the CCC steelhead DPS was not presently in danger of extinction but was likely to become so in the future. While data indicated that CCC steelhead remain present in the Santa Cruz mountains, reducing overall extinction risk of the DPS, subsequent reviews of DPS viability (Williams et al. 2011, NMFS 2016e) have concluded there was not sufficient information to indicate any change in DPS viability, although they acknowledge high levels of uncertainty surrounding most populations (NMFS 2016e). This indicates the DPS may not be viable in the long term. DPS populations that historically provided enough steelhead strays to support dependent populations may no longer be able to do so, placing dependent populations at increased risk of extirpation. However, because CCC steelhead have maintained a wide distribution throughout the DPS, roughly approximating the known historical distribution, CCC steelhead likely possess a resilience that is likely to slow their decline relative to other salmonid species in worse condition (*e.g.*, CCC coho salmon).

Current abundance trend data for the CCC steelhead remains extremely limited. Only the Scott Creek population provides enough of a time series to examine trends, and this population is influenced by hatchery origin fish. Natural-origin spawners have experienced a significant downward trend (slope = -0.220; p = 0.036) (Williams et al. 2011). Since we only have trend information on Scott Creek, trends for the majority of the DPS is unknown although most of the populations are presumed to be extant.

South-Central California Coast Steelhead

S-CCC steelhead occupy rivers from the Pajaro River (Santa Cruz County, California), inclusive, south to, but not including, the Santa Maria River (San Luis Obispo County, California) (Table 27). Most rivers in this DPS drain from the San Lucia Mountain range, the southernmost section of the California Coast Ranges. Many stream and rive mouths in this area are seasonally closed by sand berms that form during the low water flows of summer. The climate is drier than for the more northern DPSs with vegetation ranging from coniferous forest to chaparral and coastal scrub.

Table 27. Historical S-CCC steelhead Populations (NMFS 2012).

Population Groups	Populations (north to south)
Interior Coast Range	Pajaro River, Gabilan Creek, Arroyo Seco, Upper Salinas Basin

Population Groups	Populations (north to south)
Carmel River Basin	Carmel River
Big Sur Coast	San Jose Creek, Malpaso Creek, Garrapata Creek, Rocky Creek, Bixby Creek, Little Sur River, Big Sur River, Partington Creek, Big Creek, Vicente Creek, Limekiln Creek, Mill Creek, Prewitt Creek, Plaskett Creek, Willow Creek (Monterey Co.), Alder Creek, Villa Creek (Monterey Co.), Salmon Creek
San Luis Obispo Terrace	Carpoforo Creek, Arroyo de la Cruz, Little Pico Creek, Pico Creek, San Simeon Creek, Santa Rosa Creek, Villa Creek (SLO Co.), Cayucos Creek, Old Creek, Toro Creek, Morro Creek, Chorro Creek, Los Osos Creek, Islay Creek, Coon Creek, Diablo Canyon, San Luis Obispo Creek, Pismo Creek, Arroyo Grande Creek

*Abundance and Productivity***.** Historic S-CCC steelhead abundance is unknown. In the mid-1960s, CDFG estimated S-CCC steelhead abundance at 17,750 fish (CDFG 1965). The CDFG estimate, however, is just a midpoint number in the S-CCC steelhead's abundance decline—at the point the estimate was made, there had already been a century of commercial harvest and coastal development. Current S-CCC steelhead abundance is still not well known. Multiple short-term studies using different methodologies have occurred over the past decade.

Table 28. Geometric Mean Abundances of S-CCC steelhead Spawners from 2001-2012 Escapements by Population.

Stratum	Waterbody	Years	Abundance	Expected Number of Outmigrants[a]
Interior Coast Range	Pajaro River[b]	2007-2011	35	3,981
	Salinas River[c]	2011-2013	21	2,389
Carmel River Basin	Carmel River[d]	2009-2013	318	36,173
Big Sur Coast	Big Sur River[e]	2010	11	1,251
	Garrapata Creek[f]	2005	17	1,934
San Luis Obispo Terrace	Arroyo Grande Creek[g]	2006	18	2,048
	Chorro Creek[h]	2001	2	228
	Coon Creek[i]	2006	3	341
	Los Osos Creek[h]	2001	23	2,616
	San Simeon Creek[j]	2005	4	455
	Santa Rosa Creek[k]	2002-2006	243	27,641
Total			695	79,057

[a]Expected number of outmigrants=Total spawners*50 percent proportion of females*3,500 eggs per female*6.5 percent survival rate from egg to outmigrant
[b]Source: http://scceh.com/LinkClick.aspx?fileticket=dRW_AUu1EoUpercent3D&tabid=1772
[c]Kraft et al. 2013
[d]Sources: http://www.mpwmd.dst.ca.us/fishcounter/fishcounter.htm and http://www.mpwmd.dst.ca.us/wrd/lospadres/lospadres.htm.
[e]Allen and Riley 2012
[f]Garrapata Creek Watershed Council 2006

[g]Source: http://www.coastalrcd.org/zone1-1a/Fisheriespercent20Studies/AG_Steelhead_Report_Draft-small.pdf
[h]Source: http://www.coastalrcd.org/images/cms/files/MBpercent20Steelheadpercent20Abundpercent20andpercent20Distpercent20Report.pdf
[i]City of San Luis Obispo 2006
[j]Baglivio 2012
[k]Stillwater Sciences et al. 2012

Both adult and juvenile abundance data are limited for this DPS. While we currently lack data on naturally-produced juvenile S-CCC steelhead, it is possible to make rough estimates of juvenile abundance from the available adult return data. The estimated average adult run size is 695 (Table 28). Juvenile S-CCC steelhead abundance estimates come from the escapement data. For the species, 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 – 348 females), 1.2 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 79,057 natural outmigrants annually (Table 28).

The natural abundance number should be viewed with caution, however, as it only addresses one of several juvenile life stages. Moreover, deriving any juvenile abundance estimate is complicated by a host of variables, including the facts that: (1) the available data are not inclusive of 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.).

The Carmel River contains the biggest spawning run of the DPS (Williams et al. 2011). Two dams and reservoirs (Los Padres and San Clemente) are built in the drainage and are monitored for fish abundance. In 2013, the San Clemente dam has begun to be removed, and when completed the Carmel River will be rerouted. While improving steelhead habitat, this will remove one of the few locations where steelhead are monitored within the DPS. The Santa Rosa Creek has the second most abundant run for the DPS, but it is poorly studied. Overall, this steelhead DPS is too data poor for abundance to statistically test abundance trends.

Southern Eulachon

For most S eulachon DPS spawning runs, abundance is unknown with the exception of the Columbia and Fraser River spawning runs. Beginning in 1995, the Canada's Department of Fisheries and Oceans (DFO) started annual surveys in the Fraser River. These surveys consisted of estimating larval density, measuring river discharge, and using estimates of relative fecundity to determine spawning biomass (Hay et al. 2002). Beginning in 2011, Oregon Department of Fish and Wildlife (ODFW) and Washington Department of Fish and Wildlife (WDFW) began instituting similar monitoring in the Columbia River. From 2014 through 2018, the eulachon spawner population estimate for the Fraser River is 2,608,909 adults and for the Columbia River 16,188,081 adults (Table 29). The combined spawner estimate from the Columbia and Fraser rivers is 18.80 million eulachon.

Table 29. Southern DPS eulachon spawning estimates for the lower Fraser River (British Columbia, Canada) and Columbia River (Oregon/Washington states, USA).

Year	Fraser River		Columbia River	
	Biomass estimate (metric tons)[a]	Estimated spawner population[ab]	Biomass estimate (metric tons)[c]	Estimated spawner population[bc]
2011	31	765,445	723	17,860,400
2012	120	2,963,013	810	20,008,600
2013	100	2,469,177	1,845	45,546,700
2014	66	1,629,657	3,412	84,243,100
2015	317	7,827,292	2,330	57,525,700
2016	44	1,086,438	877	21,654,800
2017	35	864,212	330	8,148,600
2018	408	10,074,243	53	1,300,000
2014-2018[d]	106	2,608,009	656	16,188,081

[a] Data from unpublished data, R. Gustafson, NWFSC, September 17, 2017 and Canada Department of Fisheries and Ocean - Fraser River Eulachon Egg/larval Abundance Surveys

[b] Estimated population numbers are calculated as 11.2 eulachon per pound.

[c] Langness 2018

[d] Five-year geometric mean of mean eulachon biomass estimates (2014-2018).

Southern Green Sturgeon

Green sturgeon are composed of two DPSs with two geographically distinct spawning locations. The northern DPS (not listed under the ESA) 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 spawn in rivers south of the Eel River which is now restricted to the Sacramento River. Since 2010, Dual Frequency Identification Sonar (DIDSON) surveys of aggregating sites in the upper Sacramento River for S green sturgeon have been conducted. Annually, green sturgeon adults were monitored with tagged individuals showing a mean spawning periodicity was 3.69 years (Mora et al. 2018). Results from these surveys for S green sturgeon resulted in an estimate of 4,387 juveniles (freshwater stage, less than 60 cm length, and one to three years of age), 11,055 sub-adults (3-20 years and 60-165 cm length), and 2,106 adults (greater than 165 cm in length and older than 20 years) (Table 30; Mora et al. 2018).

Table 30. Six-year geometric mean (2010-2015) abundance estimate of S green sturgeon (Mora et al. 2018).

Lifestage	Estimate	95% Confidence Interval	
		Low	High
Juvenile	4,387	2,595	6,179
Sub-adult	11,055	6,540	15,571
Adult	2,106	1,246	2,966

Lifestage	Estimate	95% Confidence Interval	
		Low	High
ESU abundancea	17,548	12,614	22,482

2.2.3 Status of the 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' 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.

For southern DPS green sturgeon, a team similar to the CHARTs — a critical habitat review team (CHRT) — identified and analyzed the conservation value of particular areas occupied by southern green sturgeon, and unoccupied areas necessary to ensure the conservation of the species (USDC 2009). The CHRT did not identify those particular areas using HUC nomenclature, but did provide geographic place names for those areas, including the names of freshwater rivers, the bypasses, the Sacramento-San Joaquin Delta, coastal bays and estuaries, and coastal marine areas (within 110 m depth) extending from the California/Mexico border north to Monterey Bay, California, and from the Alaska/Canada border northwest to the Bering Strait; and certain coastal bays and estuaries in California, Oregon, and Washington.

For southern DPS eulachon, critical habitat includes portions of 16 rivers and streams in California, Oregon, and Washington (USDC 2011). We designated all of these areas as migration and spawning habitat for this species.

A summary of the status of critical habitats, considered in this opinion, is provided in Table 31, below.

Table 31. 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
PS Chinook salmon	9/02/05 70 FR 52630	Critical habitat for PS 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 PS 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..
PS steelhead	2/24/16 81 FR 9252	Critical habitat for PS steelhead includes 2,031 stream miles. Nearshore and offshore marine waters were not designated for this species. There are 66 watersheds within the range of this DPS. Nine watersheds received a low conservation value rating, 16 received a medium rating, and 41 received a high rating to the DPS.
Hood Canal summer-run chum	9/02/05 70 FR 52630	Critical habitat for Hood Canal summer-run 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.
Upper Columbia River steelhead	9/02/05 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 PCEs 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.
Snake River spring/summer-run Chinook salmon	10/25/99 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	10/25/99 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

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
		reservoirs of the Federal Columbia River Power System.
Snake River basin steelhead	9/02/05 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.
Middle Columbia River steelhead	9/02/05 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 PCEs 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.
Columbia River chum salmon	9/02/05 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 PCEs 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.
Lower Columbia River Chinook salmon	9/02/05 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 PCEs 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	2/24/16 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 PCEs 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	9/02/05 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 PCEs 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.
Upper Willamette River Chinook salmon	9/02/05 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 PCEs 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	9/02/05 70 FR 52630	Critical habitat encompasses seven subbasins in Oregon containing 34 occupied watersheds, as well as the lower Willamette/Columbia River

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
		rearing/migration corridor. Most HUC5 watersheds with PCEs 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	2/11/08 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 2016). 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 California Coast coho salmon	5/5/99 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 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
California Coastal Chinook salmon	9/2/05 70 FR 52488	Critical habitat includes all river reaches and estuarine areas accessible to listed Chinook salmon from Redwood Creek (Humboldt County, California) to the Russian River (Sonoma County, California), inclusive. Excluded are areas above specific dams or above longstanding, naturally impassable barriers (i.e., natural waterfalls in existence for at least several hundred years). Our assessment of the condition of CC Chinook critical habitat shows PCEs for spawning and rearing habitat in the two major rivers within this ESU—the Eel River and the Russian River—to be severely degraded by the persistence of highly turbid flows during the winter and spring, persisting even at low flows. The persistence is considered to be primarily a result of flows released from Scott Dam on the Eel River and Coyote Valley Dam on the Russian River (Beach 1996, USACE 1982, Ritter and Brown 1971). Migration and rearing habitat PCEs in the Eel River (both riverine and estuarine) are degraded by diminished flows resulting from water storage in Lake Pillsbury (Scott Dam) and by interbasin diversions to the Russian River through the Potter Valley Project tunnel. Rearing habitat PCEs of the Russian River, both riverine and estuarine, are considered to be degraded as a result of land use patterns changing the channel configuration limiting available habitat, and a program of keeping the Russian River estuary breached open to the ocean throughout the year. Within the smaller coastal streams of the ESU which support populations of Chinook, the status of critical habitat PCEs for rearing, spawning, and migration are considered degraded to a lesser extent.

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
Northern California Steelhead	9/2/05 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. 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, received a high conservation value rating. NC steelhead inhabit coastal river basins from Redwood Creek south to, and including, the Gualala River. Major watersheds include Redwood Creek, Mad River, Eel River, and several smaller coastal watersheds southward to the Gualala River. Steelhead from both summer and winter run types are found.
Central California Coast Steelhead	9/2/05 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. There are 46 watersheds within the range of this DPS. Fourteen watersheds received a low rating, 13 received a medium rating, and 19 received a high rating of conservation value to the DPS. CCC steelhead inhabit coastal river basins from the Russian River southward to, and including, Aptos Creek as well as naturally spawned populations from the San Francisco/San Pablo bays west of the Sacramento/San Joaquin Delta.
Central Valley Spring-run Chinook salmon	9/2/05 70 FR 52488	There are approximately 1,373 miles of stream habitats and 427 square miles of estuary habitats designated as critical habitat for CVS Chinook salmon. NMFS determined that marine areas did not warrant consideration as critical habitat for this ESU. There are 37 watersheds within the range of this ESU. Seven watersheds received a low rating, three received a medium rating, and 27 received a high rating of 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.
California Central Valley Steelhead	9/2/05 70 FR 52488	There are approximately 2,308 miles of stream habitats and 254 square miles of estuary habitats designated as critical habitat for CV steelhead. NMFS determined that marine areas did not warrant consideration as critical habitat for this DPS. 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.
South-Central California Coast Steelhead	9/2/05 70 FR 52488	There are approximately 1,249 miles of stream habitats and three square miles of estuary habitats designated as critical habitat for SCCC steelhead. NMFS determined that marine areas did not warrant consideration as critical habitat for this DPS. There are 30 watersheds within the range of this DPS. Six watersheds received a low rating, 11 received a medium rating, and 13 received a high rating of conservation value to the DPS. Morro Bay, an estuarine habitat, is used as rearing and migratory habitat for spawning and rearing steelhead. SCCC 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.
Southern DPS of green sturgeon	10/09/09 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,

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
		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 CHRT identified several activities that threaten the PCEs 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).
Southern DPS of eulachon	10/20/11 76 FR 65324	Critical habitat for eulachon includes portions of 16 rivers and streams in California, Oregon, and Washington. All of these areas are designated as migration and spawning habitat for this species. In Oregon, we designated 24.2 miles of the lower Umpqua River, 12.4 miles of the lower Sandy River, and 0.2 miles of Tenmile Creek. We also designated the mainstem Columbia River from the mouth to the base of Bonneville Dam, a distance of 143.2 miles. Dams and water diversions are moderate threats to eulachon in the Columbia and Klamath rivers where hydropower generation and flood control are major activities. Degraded water quality is common in some areas occupied by southern DPS eulachon. In the Columbia and Klamath river basins, large-scale impoundment of water has increased winter water temperatures, potentially altering the water temperature during eulachon spawning periods. Numerous chemical contaminants are also present in spawning rivers, but the exact effect these compounds have on spawning and egg development is unknown. Dredging is a low to moderate threat to eulachon in the Columbia River. Dredging during eulachon spawning would be particularly detrimental.
Southern resident killer whale	11/29/06 71 FR 69054	Critical habitat consists of three specific marine areas of inland waters of Washington: 1) the Summer Core Area in Haro Strait and waters around the San Juan Islands; 2) Puget Sound; and 3) the Strait of Juan de Fuca. These areas comprise approximately 2,560 square miles of marine habitat. Based on the natural history of the Southern Residents and their habitat needs, NMFS identified three PCEs, or physical or biological features, essential for the conservation of Southern Residents: 1) Water quality to support growth and development; 2) prey species of sufficient quantity, quality, and availability to support individual growth, reproduction and development, as well as overall population growth; and 3) passage conditions to allow for migration, resting, and foraging Water quality in Puget Sound, in general, is degraded. Some pollutants in Puget Sound persist and build up in marine organisms including Southern Residents and their prey resources, despite bans in the 1970s of some harmful substances and cleanup efforts. The primary concern for direct effects on whales from water quality is oil spills, although oil spills can also have long-lasting impacts on other habitat features In regards to passage, human activities can interfere with movements of the whales and impact their passage. In particular, vessels may present obstacles to whales' passage,

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
		causing the whales to swim further and change direction more often, which can increase energy expenditure for whales and impacts foraging behavior. Reduced prey abundance, particularly Chinook salmon, is also a concern for critical habitat.

2.3 Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). As the Programs describe, the research actions will occur throughout much of Washington, Idaho, Oregon, and California. Because the proposed activities are so wide-ranging, the action area for this opinion potentially includes the majorities of all the listed species' ranges (including a great many stream reaches to be randomly chosen from year to year) and therefore we cannot describe the action area in more detail.

The specific areas for each project are detailed in the individual project descriptions. In all cases, individual research activities would take place on very small sites. For example, researchers may anchor a rotary screw trap in the stream channel, deploy seines and nets covering tens of feet of stream, or wade a few hundred feet of stream while backpack electrofishing. The proposed actions have very little potential to affect the water, substrate, and adjacent riparian zones of estuarine and riverine reaches, and no potential to affect nearshore marine habitats. Most of the proposed research activities would take place in designated critical habitat.

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) have had on the various listed species' survival and recovery. It is also the result of the effects that climate change has had in the region (see Section 2.2.1 for discussion). Because the total action area under consideration covers a large percentage of the listed species' ranges (see Section 2.3), the effects of these past activities on the species themselves (i.e., on their abundance, productivity, etc.) are described in a general way in the species and critical habitat status sections that precede this section (see Section 2.2).

2.4.1 Factors Limiting Recovery

The best scientific information presently available demonstrates that a multitude of factors, past, present, and some ongoing, have contributed to the decline of west coast salmonids. NMFS' status reviews, Technical Recovery Team publications, and recovery plans for the listed species considered in this opinion identify several factors that have caused them to decline, as well as those that prevent them from recovering (many of which are the same). These factors are generally associated with (a) habitat degradation caused by human development (including hydropower development); (b) recreational, commercial, and tribal salmonid harvest; and (c) hatchery practices. More information on the limiting factors for individual species can be found in Table 2 (above) and in the most recent status reports (NWFSC 2015; SWFSC 2015).

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 area. The listed species are still experiencing the impact of a variety of past and ongoing Federal, state, and private activities in the action area and that impact is expressed in the limiting factors described above and in Table 2—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.

2.4.2 Research Effects

Although not identified as a factor for decline or a threat preventing recovery, scientific research and monitoring activities have the potential to affect the species' survival and recovery by killing listed salmonids. For the year 2020, NMFS has issued numerous section 10(a)(1)(A) scientific research permits and a section 4(d) Tribal Plan Limit authorization allowing lethal and non-lethal take of listed species (Table 32).

Table 32. Total Expected Take of Salmon and Steelhead for Scientific Research and Monitoring in 2020.

	Origin	Adults Handled	Adults Killed	Juveniles Handled	Juveniles Killed
PS Chinook	Natural	865	35	196,466	2,835
	Listed Hatchery Intact Adipose	846	12	64,899	737
	Listed Hatchery Adipose Clip	1,414	47	146,072	2,160
PS Steelhead	Natural	304	10	36,569	624
	Listed Hatchery Intact Adipose	5	0	1,727	24
	Listed Hatchery Adipose Clip	32	5	1,802	58
HCS Chum	Natural	23	3	6,381	86
	Listed Hatchery Intact Adipose	0	0	80	2
SR fall Chinook	Natural	237	6	788	36
	Listed Hatchery Intact Adipose	200	2	122	2
	Listed Hatchery Adipose Clip	232	6	540	29

	Origin	Adults Handled	Adults Killed	Juveniles Handled	Juveniles Killed
SR s/s Chinook	Natural	2,618	16	398,108	3,762
	Listed Hatchery Intact Adipose	778	7	44,155	402
	Listed Hatchery Adipose Clip	1,975	12	76,457	846
SR steelhead	Natural	7,595	94	136,569	1,653
	Listed Hatchery Intact Adipose	2,253	30	33,659	350
	Listed Hatchery Adipose Clip	2,381	31	75,395	805
UCR Steelhead	Natural	263	2	46,353	939
	Listed Hatchery Intact Adipose	94	2	3,418	88
	Listed Hatchery Adipose Clip	217	4	11,334	252
MCR Steelhead	Natural	212	2	52,944	1,081
	Listed Hatchery Intact Adipose	0	0	3	0
	Listed Hatchery Adipose Clip	23	0	581	19
CR Chum	Natural	30	1	2,200	42
	Listed Hatchery Intact Adipose	1	0	17	0
	Listed Hatchery Adipose Clip	0	0	10	0
LCR Chinook	Natural	113	3	15,078	314
	Listed Hatchery Intact Adipose	12	0	183	6
	Listed Hatchery Adipose Clip	128	2	2,123	39
LCR Coho	Natural	660	6	11,573	229
	Listed Hatchery Intact Adipose	31	0	175	3
	Listed Hatchery Adipose Clip	494	8	2,140	44
LCR steelhead	Natural	1,077	11	9,787	309
	Listed Hatchery Intact Adipose	0	0	3	0
	Listed Hatchery Adipose Clip	84	2	920	33
UWR Chinook	Natural	60	1	8,652	241
	Listed Hatchery Intact Adipose	0	0	24	0
	Listed Hatchery Adipose Clip	65	1	2,791	89
UWR Steelhead	Natural	22	0	1,819	55
OC Coho	Natural	644	10	2,516	84
	Listed Hatchery Adipose Clip	11	0	185	7
SONCC Coho	Natural	47	0	69,865	1,266
	Listed Hatchery Intact Adipose	28	0	8,793	84
	Listed Hatchery Adipose Clip	25	0	141	8

	Origin	Adults Handled	Adults Killed	Juveniles Handled	Juveniles Killed
CC Chinook	Natural	293	6	60,660	1,334
NC steelhead	Natural	408	4	115,425	2,323
CCC steelhead	Natural	2,703	42	228,494	4,828
	Listed Hatchery Intact Adipose	0	0	6,200	124
	Listed Hatchery Adipose Clip	492	10	12,881	274
CV Chinook	Natural	656	24	403,099	11,957
	Listed Hatchery Adipose Clip	474	13	8,217	113
CCV steelhead	Natural	2,316	78	48,013	1,455
	Listed Hatchery Adipose Clip	1,856	43	23,114	849
SCCC steelhead	Natural	200	6	30,820	689
Green sturgeon	Natural	211	10	1,696	113
Eulachon	Natural	2,981	1,905	540	456

Actual take levels associated with these activities are almost certain to be a good deal lower than the permitted levels. There are two reasons for this. First, most researchers do not handle or kill the full number of outmigrants (or adults) they are allowed. Our research tracking system reveals that researchers, on average, end up taking only about 21percent of the number of fish they request and the actual mortality is only about 12 percent of what they request. Second, the estimates of mortality for each proposed study are purposefully inflated to account for potential accidental deaths and it is therefore very likely that fewer fish—especially juveniles—would be killed during any given research project than the researchers are allotted, in some cases many fewer.

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 activities are found in the state submittals (CDFW 2019, IDFG 2019, ODFW 2019, and WDFW 2019). In general, the activities would be capturing fish (e.g., traps, nets, hook and line, or backpack electrofishing) and sampling them. 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. None of the activities will measurably affect any habitat PCE listed earlier. Moreover, the proposed activities are all of short duration. Therefore, NMFS concludes that the proposed activities are not likely to have an adverse impact on any designated critical habitat.

2.5.2 Effects on Species

As discussed above, the proposed research activities will have no measurable effects on the listed salmonids' habitat. The actions are therefore not likely to jeopardize any of the listed salmonids by reducing the ability of that habitat 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. The state fisheries agencies submittals (CDFW 2019, IDFG 2019, ODFW 2019, and WDFW 2019) include NMFS' uniform, pre-established set of mitigation measures. These measures are incorporated (where relevant) into every research project approval as part of the conditions to which a researcher must adhere.

Observing/Harassing

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.

Capturing/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.

Harassment caused by capturing, handling, and releasing fish generally leads to stress and other sub-lethal effects that are difficult to assess in terms of their impact on individuals, populations, and species (Sharpe et al. 1998). Handling of fish may cause stress, injury, or death, which typically are due to overdoses of anesthetic, differences in water temperatures between the river and holding buckets, depleted dissolved oxygen in holding buckets, holding fish out of the water, and physical trauma. 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 fairly rapidly from handling.

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. (2005) reported that spring Chinook salmon had lower delayed mortality rates when captured in tangle nets (92 percent survival) versus gill nets (50 percent survival), relative to a control group. Vander Haegen et al. (2005) emphasized that, to minimize both immediate and delayed mortality, researchers must employ best practices including using short nets with short soak times, and removing fish from the net carefully and promptly after capture. As with other types of capture, fish stress increases rapidly if the water temperature exceeds 18 ºC or dissolved oxygen is below saturation.

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, Snyder 1995, 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 percent 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.

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 percent 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.

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 percent 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 percent (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 percent. Natural bait had slightly higher mortality (5.6 percent) than did artificial lures (3.8 percent), and barbed hooks (7.3 percent) had higher mortality than barbless hooks (2.9 percent). Hooton (1987) concluded that catching and releasing adult steelhead was an effective mechanism for maintaining angling opportunity without negatively impacting 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 percent of harvested summer and winter steelhead in Washington streams were hooked in critical areas (tongue, esophagus, gills, eye). The highest percentage (17.8 percent) 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 percent 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 percent when using bait versus 4.9 and 3.8 percent for lures and flies, respectively. Schisler and Bergersen (1996) reported average mortality of trout caught on passively fished bait to be higher (32 percent) than mortality from actively fished bait (21 percent). Mortality of fish caught on artificial flies was only 3.9 percent. 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 percent.

Most studies have found a notable difference in the mortality of fish associated with using barbed versus barbless hooks (Huhn and Arlinghuas 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 in Willamette River fisheries of 8.6 percent (Schroeder et al. 2000), which is similar to a mortality of 7.6 percent 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 percent (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 percent in Lindsay et al. (2004)) compared to fish hooked in the gills or esophagus (81.6 and 67.3 percent). 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 (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 Alex (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.

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 percent 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.

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.

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 percent 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.

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.

Sacrifice/Intentional Mortality

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 juveniles, are forever removed from the gene pool; 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-spawning adults has the greatest potential to affect the listed species. Because of this, NMFS rarely allows it to happen. 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.

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 the Action

For each species that we consider in this opinion, we report average annual abundance by life stage and origin. For life stage we estimate abundance of juveniles (smolts or parr) and adults. For origin we estimate abundance of natural-origin fish, ESA-listed hatchery-origin fish with the adipose fin clipped ("listed hatchery adipose clipped," or LHAC), and ESA-listed hatchery-origin fish with an intact adipose fin ("listed hatchery intact adipose," or LHIA). These estimates are derived from various sources including some of the research projects included in the Programs.

In conducting the following analyses, we have tied the effects of the Programs to their impacts on the listed species. Due to the nature of the Program (i.e., it includes broadly distributed research projects throughout California, Oregon, Washington and Idaho) is such that the take cannot reliably be assigned to any population or group of populations. Therefore, the effects of the Programs are measured in terms of how they are expected to affect each listed unit at the species scale, rather than at the population scale.

Puget Sound Chinook salmon

The specific projects and related take estimates are described in detail in the WDFW submittal (WDFW 2019) and that document is incorporated in full herein. The WDFW would conduct, oversee, or coordinate 15 projects that could take PS Chinook salmon. The majority of planned research (11 out of 15 projects) involves activities that are not intended to kill listed salmon. However, any fish handling carries an inherent potential for causing or promoting stress, disease, injury, or death of the specimen. We have summarized the total proposed take in Table 33.

Table 33. Summary of proposed take of PS Chinook salmon.

Life Stage	Origin	Take Action	Requested Take	Requested Mortality
Juvenile	Natural	Capture/Handle/Release Fish	99,427	562
Juvenile	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	179,475	1,981
Juvenile	Natural	Intentional (Directed) Mortality	1,626	1,626
Juvenile	Listed Hatchery Intact Adipose	Capture/Handle/Release Fish	931	5
Juvenile	Listed Hatchery Intact Adipose	Capture/Mark, Tag, Sample Tissue/Release Live Animal	23,000	340
Juvenile	Listed Hatchery Intact Adipose	Intentional (Directed) Mortality	290	290

Life Stage	Origin	Take Action	Requested Take	Requested Mortality
Juvenile	Listed Hatchery Adipose Clip	Capture/Handle/Release Fish	122,001	1,134
Juvenile	Listed Hatchery Adipose Clip	Capture/Mark, Tag, Sample Tissue/Release Live Animal	3,835	67
Juvenile	Listed Hatchery Adipose Clip	Intentional (Directed) Mortality	910	910
Adult	Natural	Capture/Handle/Release Fish	125	0
Adult	Listed Hatchery Intact Adipose	Capture/Handle/Release Fish	101	0
Adult	Listed Hatchery Adipose Clip	Capture/Handle/Release Fish	113	0
Spawned Adult/ Carcass	Natural	Capture/Handle/Release Fish	10	0
Spawned Adult/ Carcass	Natural	Observe/Sample Tissue Dead Animal	2,170	0
Spawned Adult/ Carcass	Listed Hatchery Intact Adipose	Observe/Sample Tissue Dead Animal	780	0
Spawned Adult/ Carcass	Listed Hatchery Adipose Clip	Observe/Sample Tissue Dead Animal	1,180	0

Researchers, when submitting their applications, estimated the number of juvenile and adult PS Chinook salmon that may be handled and killed during the year. Additionally, to account for the dynamic and potentially increasing scope of research that may annually affect listed PS Chinook, we increased the requested take and requested mortality in this evaluation by 10 percent (Table 34). Although it is difficult to anticipate how much more research may be requested, NMFS believes this 10 percent would be sufficient to include any changes or additions. The table below compares the total requested take, plus the 10 percent buffer, to the species' estimated abundance. Activities that would take spawned adult/carcass Chinook salmon are not expected to affect the species' abundance, productivity, distribution, or diversity, therefore, we do not include them in the table below.

Table 34. Total requested take, plus the 10 percent buffer, compared to the estimated abundance of PS Chinook salmon.

Life Stage	Origin	Total Take plus 10%	Percent of ESU Handled*	Requested Mortality plus 10%	Percent of ESU killed*
Juvenile	Natural	308,581	10%	4,586	0.2%
Juvenile	Listed Hatchery Intact Adipose	26,643	0.4%	699	0.01%
Juvenile	Listed hatchery adipose clipped	139,421	0.4%	2,322	0.006%
Adult	Natural	138	0.6%	0	0%
Adult	Listed Hatchery Intact Adipose	111		0	
Adult	Listed hatchery adipose clipped	124	2%	0	0%

*We do not have separate abundance estimates for the two types of adult listed hatchery fish.

In total, WDFW may capture, handle, and release up to 308,581 and kill no more than two-tenths of a percent of the expected abundance of naturally produced juvenile PS Chinook salmon. WDFW may also capture and variously handle, mark, tag, tissue sample, and release up to 138 naturally-produced adult PS Chinook salmon throughout the Puget Sound. The researchers do not anticipate any mortality of adult PS Chinook salmon.

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the effects of the proposed action considered herein are best seen in the context of the fish that may be killed. When compared to the abundance of the ESU (Percent of ESU), the potential mortality levels are very low: a maximum of two-tenths of a percent may be killed from any component of the species. Furthermore, the effects from all of the proposed research would be spread out over most of the major tributaries of the Puget Sound basin. Thus, no population is likely to experience a disproportionate amount of these losses. Therefore, the research would likely have only a very small impact on abundance, a similarly small impact on productivity, and no measurable effect on spatial structure or diversity.

It is very likely that the effects of the program at the population and ESU level will be much lower than what we have evaluated. To account for year to year variation in species abundance, researchers factor in a modest overestimate of take. Our research tracking system reveals that for the past 10 years researchers, on average, ended up taking 24 percent of the number of fish they requested and the actual mortality was only 14 percent of requested.

An effect of the research that cannot be quantified is how it would help benefit and conserve the species. The largest of WDFW's projects in the Puget Sound basin accounts for 44 percent of the take of PS Chinook salmon. This project is part of WDFW's IMW program. The premise of the IMW project is that the complex relationships controlling salmon response to habitat conditions can best be understood by concentrating monitoring and research efforts at a few locations. Focusing efforts on a few locations allows enough data on an ecosystem's physical and biological attributes of systems to be collected that becomes possible to evaluate effects of restoration treatments on salmon production and that information, in turn, may be used to design and refine further recovery actions. We expect the research actions to generate lasting benefits to conservation of the listed fish. The majority of the projects in the Programs focus on monitoring and evaluating actions recommended for the conservation of the listed species. Full details about the programs can be found in the state fishery agency submittals.

Puget Sound Steelhead

The specific projects and related take estimates are described in detail in WDFW's submittal (WDFW 2019) and that document is incorporated in full herein. The WDFW would conduct, oversee, or coordinate 20 projects that could affect PS steelhead. The majority of planned research (17 out of 20 projects) involves activities that are not intended to kill listed steelhead. However, any fish handling carries an inherent potential for causing or promoting stress, disease, injury, or death of the specimen. We have summarized the total proposed take in Table 35.

Table 35. Summary of proposed take of PS Steelhead.

Life Stage	Origin	Take Action	Requested Take	Requested Mortality
Juvenile	Natural	Capture/Handle/Release Fish	11,882	154
Juvenile	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	15,195	198
Juvenile	Natural	Intentional (Directed) Mortality	400	400
Juvenile	Listed Hatchery Intact Adipose	Capture/Handle/Release Fish	616	9
Juvenile	Listed Hatchery Adipose Clip	Capture/Handle/Release Fish	3,145	41
Adult	Natural	Capture/Handle/Release Fish	77	1
Adult	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	1,475	26
Adult	Listed Hatchery Intact Adipose	Capture/Mark, Tag, Sample Tissue/Release Live Animal	15	0
Spawned Adult/ Carcass	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	17	0

Researchers, when submitting their applications, estimated the number of juvenile and adult PS steelhead that may be handled and killed during the year. Additionally, to account for the dynamic and potentially increasing scope of research that may annually affect listed PS steelhead, the requested take and requested mortality in this evaluation were increased by 10 percent (Table 36). Although it is difficult to anticipate how much more research may be requested, NMFS believes this 10 percent would be sufficient to include any changes or additions. The table below compares the total requested take, plus the 10 percent buffer, to the species' estimated abundance. Activities that would take spawned adult/carcass steelhead are not expected to affect the species' abundance, productivity, distribution, or diversity, therefore, we do not include them in the table below.

Table 36. Total requested take, plus the 10 percent buffer, compared to the estimated abundance of PS Steelhead.

Life Stage	Origin	Total Take plus 10%	Percent of ESU Handled	Requested Mortality plus 10%	Percent of ESU killed
Juvenile	Natural	30,225	1%	827	0.04%
Juvenile	Listed Hatchery Intact Adipose	678	0.6%	10	0.009%
Juvenile	Listed Hatchery Adipose Clipped	3,460	3%	45	0.04%
Adult	Natural	1,707	9%	30	0.2%
Adult	Listed Hatchery Intact Adipose	17		0	

In total, WDFW may capture, handle, and release up to 30,225 naturally produced juvenile steelhead and kill no more than four-hundredths of a percent of the expected abundance of naturally produced juvenile steelhead. WDFW may also capture and variously handle, mark, tag, tissue sample, and release up to 1,707 naturally-produced adult PS steelhead throughout the Puget Sound. The majority (89 percent) of the adult fish would be captured with hook and line. The researchers expect the mortality to be less than two percent of the requested take and at most two-tenths of a percent of the DPS for naturally produced adult steelhead.

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the effects of the proposed action considered herein are best seen in the context of the fish that may be killed. When compared to the abundance of the DPS (Percent of DPS), the potential mortality levels are very low. Furthermore, the effects from all of the proposed research would be spread out over various channels and tributaries of the Puget Sound basin. Thus, no population is likely to experience a disproportionate amount of these losses. Therefore, the research would likely have only a very small impact on abundance, a similarly small impact on productivity, and no measurable effect on spatial structure or diversity.

It is very likely that the effects of the program will be much lower than what we have evaluated. To account for year to year variation in species abundance, researchers factor in a modest overestimate of take. Our research tracking system reveals that for the past 10 years researchers, on average, ended up taking 20 percent of the PS steelhead they requested and the actual mortality was only seven percent of requested.

An effect of the research that cannot be quantified is how it would help benefit and conserve the species. We expect the research actions to generate lasting benefits to conservation of the listed fish (see above examples). The majority of the projects in the Programs focus on monitoring and evaluating actions recommended for the conservation of the listed species. Full details about the programs can be found in the state fishery agency submittals.

Hood Canal Summer-run Chum Salmon

The specific projects and related take estimates are described in detail in WDFW's submittal (WDFW 2019) and those records are incorporated in full herein. The WDFW would conduct, oversee, or coordinate eight projects that could take listed HCS chum salmon. None of planned research involves activities intended to kill listed chum salmon. However, any fish handling carries an inherent potential for causing or promoting stress, disease, injury, or death of the specimen. We have summarized the total proposed take in Table 37.

Table 37. Summary of proposed take of HCS chum salmon.

Life Stage	Origin	Take Action	Requested Take	Requested Mortality
Juvenile	Natural	Capture/Handle/Release Fish	633,974	1,941
Juvenile	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	22,300	252
Juvenile	Listed Hatchery Intact Adipose	Capture/Handle/Release Fish	50	1

Life Stage	Origin	Take Action	Requested Take	Requested Mortality
Adult	Natural	Capture/Handle/Release Fish	1,300	14
Adult	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	500	8
Spawned Adult/ Carcass	Natural	Observe/Sample Tissue Dead Animal	200	0

Researchers, when submitting their applications, estimated the number of juvenile and adult HCS chum salmon that may be handled and killed during the year. Additionally, to account for the dynamic and potentially increasing scope of research that may annually affect listed HCS chum, we increased the requested take and requested mortality in this evaluation by 10 percent (Table 38). Although it is difficult to anticipate how much more research may be requested, NMFS believes this 10 percent would be sufficient to include any changes or additions. The table below compares the total requested take, plus the 10 percent buffer, to the species' estimated abundance. Activities that would take spawned adult/carcass chum salmon are not expected to affect the species' abundance, productivity, distribution, or diversity, therefore, we do not include them in the table below.

Table 38. Total requested take, plus the 10 percent buffer, compared to the estimated abundance of HCS chum salmon.

Life Stage	Origin	Total Take plus 10%	Percent of ESU Handled	Requested Mortality plus 10%	Percent of ESU killed
Juvenile	Natural	721,901	19%	2,412	0.06%
Juvenile	Listed Hatchery Intact Adipose	55	0.04%	1	0.0007%
Adult	Natural	1,980	8%	24	0.1%

Two research projects (Salmon/Snow Creeks Summer Chum Population Monitoring and the Big Beef Creek Adult Escapement study) account for 99 percent of the take of both juvenile and adult chum salmon. The projects may variously capture, handle, mark, tag, tissue sample up to 19 percent of the expected abundance of adult summer-run chum salmon. The projects would take fish from both HCS chum salmon populations, so neither population is likely to experience a disproportionate amount of the effects. Our understanding of the summer-run chum's status—and hence our ability to manage their conservation—depends to a large degree on the research carried out in these two projects. The HCS chum abundance data collected by these two projects is essential for monitoring the status and trends of the species. A small number of fish (one-tenth of a percent of the expected number of naturally produced adults and six-hundredths of a percent of naturally produced juveniles) may die as an unintended result of the research. The impact on this population is therefore small even in the worst case scenario, but it is most likely to be even smaller in actuality. That is, if the past may be used as an indicator, in the last four years, the annual reports from this project indicate that the actual take and mortality are typically 39 percent and 26 percent respectively of what is requested for these projects.

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the effects of the proposed action considered herein are best seen in the context of the fish that may be killed. When compared to the abundance of the ESU (Percent of ESU), the potential mortality levels are very low (a maximum of one-tenth of a percent for juveniles and adults). Furthermore, the effects from all of the proposed research would be spread out over the entirety of the ESU, so no population is likely to experience a disproportionate amount of these losses. Therefore, the research would likely have only a very small impact on abundance, a similarly small impact on productivity, and no measurable effect on spatial structure or diversity.

It is very likely that the effects of the program will be much lower than what we have evaluated. To account for year to year variation in species abundance, researchers factor in a modest overestimate of take. Our research tracking system reveals that for the past 10 years researchers, on average, ended up taking 30 percent of the HCS chum they requested and the actual mortality was only 16 percent of requested. Furthermore, some of the chum salmon that are captured may belong to the non-listed fall-run chum salmon ESU. The summer and fall run populations overlap and it is often difficult to distinguish them. Hence, we are making a very conservative estimate of the effects of the research program on HCS chum salmon.

An effect of the research that cannot be quantified is how it would help benefit and conserve the species. We expect the research actions to generate lasting benefits to conservation of the listed fish. The majority of the projects in the Programs focus on monitoring and evaluating actions recommended for the conservation of the listed species. The best example of this would be the two projects discussed above which are essential to our status and trends monitoring, as well as planning for recovery actions. Full details about the projects can be found in the state fishery agency submittals.

Upper Columbia River Steelhead

The one project (Aquatic Monitoring to Assess Flow Restoration Impacts) that may take UCR steelhead is described in detail in the WDFW's submittal (WDFW 2019) and that document is incorporated in full herein. The WDFW would conduct one project that could take listed UCR steelhead. The planned research is not intended to kill listed steelhead. However, any fish handling carries an inherent potential for causing or promoting stress, disease, injury, or death of the specimen. We have summarized the total proposed take in Table 39.

Table 39. Summary of proposed take of UCR steelhead.

Life Stage	Origin	Take Action	Requested Take	Requested Mortality
Juvenile	Natural	Capture/Handle/Release Fish	800	12

Researchers, when submitting their applications, estimated the number of juvenile UCR steelhead that may be handled and killed during the year. Additionally, to account for the dynamic and potentially increasing scope of research that may annually affect listed UCR steelhead, the requested take and requested mortality in this evaluation were increased by 10 percent (Table 40). Although it is difficult to anticipate how much more research may be requested, NMFS believes this 10 percent would be sufficient to include any changes or additions. The table below compares the total requested take, plus the 10 percent buffer, to the species' estimated abundance.

Table 40. Total requested take, plus the 10 percent buffer, compared to the estimated abundance of UCR steelhead.

Life Stage	Origin	Total Take plus 10%	Percent of ESU Handled*	Requested Mortality plus 10%	Percent of ESU killed
Juvenile	Natural	880	0.4%	13	0.007%

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the effects of the proposed action considered herein are best seen in the context of the fish that may be killed. When compared to the abundance of the DPS (Percent of DPS), the potential mortality level of seven-thousandths of a percent is very low. Furthermore, the effects from the proposed research would be spread out over various channels and tributaries of the upper Columbia River basin. Thus, no population is likely to experience a disproportionate amount of these losses. Therefore, the research would likely have only a very small impact on abundance, a similarly small impact on productivity, and no measurable effect on spatial structure or diversity.

An effect of the research that cannot be quantified is how it would help benefit and conserve the species. WDFW's Aquatic Monitoring to Assess Flow Restoration Impacts project monitors the effectiveness of the Washington Department of Ecology's water-rights purchases and leases. WDFW has designed survey methodologies to monitor the effects of on fish, amphibians, and invertebrates. We expect the research actions to generate lasting benefits to conservation of the listed fish. Full details about the project can be found in the state fishery agency submittal.

Middle Columbia River Steelhead

The specific projects and related take estimates are described in detail in two of the state fishery agency submittals (ODFW 2019 and WDFW 2019) and those documents are incorporated in full herein. The two agencies would conduct, oversee, or coordinate 14 projects that could take listed MCR steelhead. The majority of planned research (12 out of 14 projects) involves activities that are not intended to kill listed steelhead. However, any fish handling carries an inherent potential for causing or promoting stress, disease, injury, or death of the specimen. We have summarized the total proposed take in Table 41.

Table 41. Summary of proposed take of MCR steelhead.

Life Stage	Origin	Take Action	Requested Take	Requested Mortality
Juvenile	Natural	Capture/Handle/Release Fish	12,760	252
Juvenile	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	38,850	678
Juvenile	Natural	Intentional (Directed) Mortality	236	236
Juvenile	Natural	Observe/Harass	3,000	10

Life Stage	Origin	Take Action	Requested Take	Requested Mortality
Juvenile	Listed Hatchery Intact Adipose	Capture/Handle/Release Fish	40	2
Juvenile	Listed Hatchery Intact Adipose	Capture/Mark, Tag, Sample Tissue/Release Live Animal	250	5
Juvenile	Listed Hatchery Adipose Clip	Capture/Handle/Release Fish	40	2
Juvenile	Listed Hatchery Adipose Clip	Capture/Mark, Tag, Sample Tissue/Release Live Animal	250	5
Adult	Natural	Capture/Handle/Release Fish	4	2
Adult	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	1,140	10
Adult	Natural	Observe/Harass	285	0
Adult	Listed Hatchery Intact Adipose	Capture/Mark, Tag, Sample Tissue/Release Live Animal	35	1
Adult	Listed Hatchery Adipose Clip	Capture/Mark, Tag, Sample Tissue/Release Live Animal	825	9
Spawned Adult/ Carcass	Natural	Capture/Handle/Release Fish	10	0
Spawned Adult/ Carcass	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	155	10
Spawned Adult/ Carcass	Listed Hatchery Intact Adipose	Capture/Mark, Tag, Sample Tissue/Release Live Animal	20	1
Spawned Adult/ Carcass	Listed Hatchery Adipose Clip	Capture/Mark, Tag, Sample Tissue/Release Live Animal	12	1

Researchers, when submitting their applications, estimated the number of juvenile and adult MCR steelhead that may be handled and killed during the year. Additionally, to account for the dynamic and potentially increasing scope of research that may annually affect listed MCR steelhead, the requested take and requested mortality in this evaluation were increased by 10 percent (Table 42). Although it is difficult to anticipate how much more research may be requested, NMFS believes this 10 percent would be sufficient to include any changes or additions. The table below compares the total requested take, plus the 10 percent buffer, to the species' estimated abundance. Activities that would observe/harass steelhead or take spawned adult/carcass steelhead are not expected to affect the species' abundance, productivity, distribution, or diversity, therefore, we do not include them in the table below.

Table 42. Total requested take, plus the 10 percent buffer, compared to the estimated abundance of MCR steelhead.

Life Stage	Origin	Total Take plus 10%	Percent of ESU Handled*	Requested Mortality plus 10%	Percent of ESU killed
Juvenile	Natural	57,031	14%	1,283	0.3%
Juvenile	Listed Hatchery Intact Adipose	319	0.3%	8	0.007%
Juvenile	Listed Hatchery Adipose Clip	319	0.07%	8	0.002%

Life Stage	Origin	Total Take plus 10%	Percent of ESU Handled*	Requested Mortality plus 10%	Percent of ESU killed
Adult	Natural	1,258	25%	13	0.3%
Adult	Listed Hatchery Intact Adipose	39	34%	1	1%
Adult	Listed Hatchery Adipose Clip	908	203%	10	2%

*We do not have separate abundance estimates for the two types of adult listed hatchery fish.

In total, researchers may variously capture, handle, mark, tag, tissue sample and release up to 57,031 naturally produced juvenile steelhead and kill up to 1,283 (a two percent mortality rate). The majority of the requested nonlethal take of juvenile steelhead (74 percent) would be captured with screw traps and fyke nets/traps. Our records from the past nine years indicate that mortality rates for screw and fyke traps are typically less than one percent. Researchers deploy screw traps and fyke traps from late winter through early summer to capture juvenile salmon and steelhead during their annual outmigration. Managers use the data collected from screw traps to derive estimates of outmigration abundance.

Researchers may also variously capture, handle, mark, tag, tissue sample and release up to 1,258 naturally produced adults. WDFW and ODFW submitted six projects that would take adult steelhead. The research projects are designed to monitor the status and trends of steelhead, study the effects of hatchery fish spawning in the wild, and monitor habitat restoration and the effects it may have on abundance and productivity. All of these projects are important for the survival and recovery of the species. We use trends in abundance and productivity to measure the status of the species and the effects of various recovery efforts. The research would take place in seven different subbasins and the effects would therefore be spread out over all the DPS's populations. Researchers intend to release all naturally produced adult steelhead alive. However, a small number of the naturally produced adult fish (three-tenths of a percent) may die as an unintended result of the research. These same projects may unintentionally kill up to two percent of the abundance of adult listed hatchery steelhead. Some of the adipose clipped steelhead are likely to be from non-listed hatchery programs, but unidentifiable as such.

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the effects of the proposed action considered herein are best seen in the context of the fish that may be killed. When compared to the abundance of the DPS (Percent of DPS), the potential mortality levels are low (a maximum of four-tenths of a percent for naturally produced juveniles and adults). These effects would be spread out over various channels and tributaries of the middle Columbia River basin. Thus, no population is likely to experience a disproportionate amount of these losses. Therefore, the research would likely have only a very small impact on abundance, a similarly small impact on productivity, and no measurable effect on spatial structure or diversity.

It is very likely that the effects of the program will be much lower than what we have evaluated. To account for year to year variation in species abundance, researchers factor in a modest overestimate of take. Our research tracking system reveals that for the past 10 years researchers, on average, ended up taking 30 percent of the MCR steelhead they requested and the actual mortality was only 18 percent of requested.

An effect of the research that cannot be quantified is how it would help benefit and conserve the species. We expect the research actions to generate lasting benefits to conservation of the listed fish (see above example). The majority of the projects in the Programs focus on monitoring and evaluating actions recommended for the conservation of the listed species. Full details about the programs can be found in the state fishery agency submittals.

Snake River Fall Chinook salmon

The specific projects and related take estimates are described in detail in the Oregon and Washington state fishery agency submittals (IDFG 2019, ODFW 2019, and WDFW 2019) and those records are incorporated in full herein. The three agencies would conduct, oversee, or coordinate six projects that could take listed SR fall Chinook salmon. Most of the captured juvenile fish would be variously marked, tagged, or tissue sampled and released, whereas most of the adult fish would be briefly handled and released. One of the proposed research activities would intentionally kill three juvenile naturally produced SR fall Chinook salmon, but the majority of the proposed work would involve activities that are not intended to harm listed fish. However, any fish handling carries an inherent potential for causing or promoting stress, disease, injury, or death of the specimen. We have summarized the total proposed take in Table 43.

Table 43. Summary of proposed take of SR Fall Chinook salmon.

Life Stage	Origin	Take Action	Requested Take	Requested Mortality
Juvenile	Natural	Capture/Handle/Release Fish	1,125	28
Juvenile	Natural	Intentional (Directed) Mortality	3	3
Juvenile	Listed Hatchery Intact Adipose	Capture/Handle/Release Fish	195	5
Juvenile	Listed Hatchery Adipose Clip	Capture/Handle/Release Fish	270	8
Adult	Natural	Capture/Handle/Release Fish	16	1
Adult	Listed Hatchery Intact Adipose	Capture/Handle/Release Fish	12	0
Adult	Listed Hatchery Adipose Clip	Capture/Handle/Release Fish	12	0
Spawned Adult/ Carcass	Natural	Capture/Handle/Release Fish	5	0

Researchers, when submitting their applications, estimated the number of juvenile and adult SR fall Chinook salmon that may be handled and killed during the year. Additionally, to account for the dynamic and potentially increasing scope of research that may annually affect listed SR fall Chinook, we increased the requested take and requested mortality in this evaluation by 10 percent (Table 44). Although it is difficult to anticipate how much more research may be requested, NMFS believes this 10 percent buffer would be sufficient to include any changes or additions. The table below compares the total requested take, plus the 10 percent buffer, to the species' estimated abundance.

Table 44. Total requested take, plus the 10 percent buffer, compared to the estimated abundance of SR fall Chinook salmon.

Life Stage	Origin	Total Take plus 10%	Percent of ESU Handled*	Requested Mortality plus 10%	Percent of ESU killed*
Juvenile	Natural	1,241	0.2%	34	0.005%
Juvenile	Listed Hatchery Intact Adipose	215	0.007%	6	0.0002%
Juvenile	Listed Hatchery Adipose Clip	297	0.01%	9	0.0004%
Adult	Natural	18	0.2%	1	0.01%
Adult	Listed Hatchery Intact Adipose	13	0.1%	0	0%
Adult	Listed Hatchery Adipose Clip	13	0.09%	0	0%

*We do not have separate abundance estimates for the two types of adult listed hatchery fish.

In total, researchers may capture, handle, and release up to 1,241 and kill no more than five-thousandths of a percent of the expected abundance of naturally produced juvenile SR fall Chinook salmon. Researchers may also capture and variously handle, mark, tag, tissue sample, and release up to 18 naturally-produced adult SR fall Chinook salmon throughout the various waterways of the ESU. The researchers expect the mortality to be no more than one-hundredths of a percent of the abundance of naturally produced adult SR fall Chinook salmon.

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the effects of the proposed action considered herein are best seen in the context of the fish that may be killed. When compared to the abundance of the ESU (Percent of ESU), the potential mortality levels are very low in all cases, with the maximum mortality for any category being a few hundredths of a percent. And because SR fall Chinook are considered to have only one population, the mortalities would affect that population just as displayed above and would not therefore have variable effects across the species' geography. Thus, the research would have only a very small impact on abundance, a similarly small impact on productivity, and no measurable effect on spatial structure or diversity.

It is very likely that the effects of the program will be much lower than what we have evaluated. To account for year to year variation in species abundance, researchers factor in a modest overestimate of take. Our research tracking system reveals that for the past 10 years researchers, on average, ended up taking four percent of the number of fish they requested and the actual mortality was only two percent of requested.

An effect of the research that cannot be quantified is how it would help benefit and conserve the species. We expect the research actions to generate lasting benefits to conservation of the listed fish. The majority of the projects in the Programs focus on monitoring and evaluating actions recommended for the conservation of the listed species. For example, in the Stock Assessment in the Snake Basin project WDFW collects information about the status and trends of Snake River salmon and steelhead. The information is needed for management and recovery plans for the species. Full details about the programs can be found in the state fishery agency submittals.

Snake River Spring/Summer Chinook salmon

The specific projects and related take estimates are described in detail in the state fishery agency submittals (IDFG 2019, ODFW 2019, and WDFW 2019) and those records are incorporated in full herein. The three agencies would conduct, oversee, or coordinate 24 projects that could take listed SR spr/sum Chinook salmon. Most of the captured juvenile fish would be handled briefly and released, whereas most of the adult fish would be variously marked, tagged, or tissue sampled and released. One of the proposed research activities would intentionally kill three juvenile naturally produced SR spr/sum Chinook, but the vast majority of the proposed work involves activities that are not intended to harm listed fish at all. However, any fish handling carries an inherent potential for causing or promoting stress, disease, injury, or death of the specimen. We have summarized the total proposed take in Table 45.

Table 45. Summary of proposed take of SR spr/sum Chinook salmon.

Life Stage	Origin	Take Action	Requested Take	Requested Mortality
Juvenile	Natural	Capture/Handle/Release Fish	257,823	2,181
Juvenile	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	74,845	777
Juvenile	Natural	Intentional (Directed) Mortality	3	3
Juvenile	Natural	Observe/Harass	1,430	0
Juvenile	Natural	Observe/Sample Tissue Dead Animal	20	0
Juvenile	Listed Hatchery Intact Adipose	Capture/Handle/Release Fish	1,520	18
Juvenile	Listed Hatchery Adipose Clip	Capture/Handle/Release Fish	7,338	144
Juvenile	Listed Hatchery Adipose Clip	Observe/Harass	10	0
Adult	Natural	Capture/Handle/Release Fish	29	2
Adult	Natural	Observe/Sample Tissue Dead Animal	1	0
Adult	Listed Hatchery Intact Adipose	Capture/Handle/Release Fish	7	0
Adult	Listed Hatchery Adipose Clip	Capture/Handle/Release Fish	24	0
Spawned Adult/ Carcass	Natural	Observe/Sample Tissue Dead Animal	4,085	0
Spawned Adult/ Carcass	Listed Hatchery Intact Adipose	Observe/Sample Tissue Dead Animal	785	0
Spawned Adult/ Carcass	Listed Hatchery Adipose Clip	Observe/Sample Tissue Dead Animal	885	0

Researchers, when submitting their applications, estimated the number of juvenile and adult SR spr/sum Chinook salmon that may be handled and killed during the year. Additionally, to account for the dynamic and potentially increasing scope of research that may annually affect listed SR spr/sum Chinook salmon, we increased the requested take and requested mortality in this evaluation by 10 percent (Table 46). Although it is difficult to anticipate how much more research may be requested, NMFS believes this 10 percent would be sufficient to include any changes or additions. The table below compares the total requested take, plus the 10 percent buffer, to the species' estimated abundance. Activities that would take spawned adult/carcass Chinook salmon are not expected to affect the species' abundance, productivity, distribution, or diversity, therefore, we do not include them in the table below.

Table 46. Total requested take, plus the 10 percent buffer, compared to the estimated abundance of SR spr/sum Chinook salmon.

Life Stage	Origin	Total Requested Take plus 10%	Percent of ESU Handled*	Requested Mortality plus 10%	Percent of ESU killed*
Juvenile	Natural	365,938	36%	3,257	0.3%
Juvenile	Listed Hatchery Intact Adipose	1,672	0.2%	20	0.003%
Juvenile	Listed Hatchery Adipose Clip	8,072	0.2%	158	0.004%
Adult	Natural	32	0.2%	2	0.02%
Adult	Listed Hatchery Intact Adipose	8	2%	0	0%
Adult	Listed Hatchery Adipose Clip	26	1%	0	0%

*We do not have separate abundance estimates for the two types of adult listed hatchery fish.

With 10 percent added to the requested take, the state fisheries agencies programs may variously capture, handle, mark, tag, tissue sample, and release up to 365,938 naturally produced juveniles, the great majority of which (93 percent) would be captured in rotary screw traps. Researchers deploy screw traps from late winter through early summer and use them to capture outmigrating juvenile salmon and steelhead. Researchers use the data collected from screw traps to derive estimates of outmigration abundance. Our records from the past nine years indicate that mortality rates for screw traps are typically less than one percent.

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the effects of the proposed action considered herein are best seen in the context of the fish that may be killed. When compared to the abundance of the ESU (Percent of ESU), the potential mortality levels are very low: a maximum of three-tenths of a percent may be killed from any component of the species. Furthermore, the effects from all of the proposed research would be spread out over most of the major tributaries in the Snake River basin. Thus, no population is likely to experience a disproportionate amount of these losses. Therefore, the research would likely have only a very small impact on abundance, a similarly small impact on productivity, and no measurable effect on spatial structure or diversity.

It is very likely that the effects of the program will be much lower than what we have evaluated.

To account for year to year variation in species abundance, researchers factor in a modest overestimate of take. Our research tracking system reveals that for the past 10 years researchers, on average, ended up taking 33 percent of the number of fish they requested and the actual mortality was only 25 percent of requested.

An effect of the research that cannot be quantified is how it would help benefit and conserve the species. We expect the research actions to generate lasting benefits to conservation of the listed fish. The majority of the projects in the Programs focus on monitoring and evaluating actions recommended for the conservation of the listed species. Many of the projects are also essential for monitoring the status and trends of the species. For example, two projects together account for nearly 93 percent of the total take of naturally produced juvenile SR spr/sum Chinook. These two projects monitor the status and trends of SR spr/sum Chinook and help to direct management and recovery actions for the species. Full details about the projects can be found in the state fishery agency submittals.

Snake River Steelhead

The specific projects and related take estimates are described in detail in each of the state fishery agency submittals (IDFG 2019, ODFW 2019, and WDFW 2019) and those records are incorporated in full herein. The three agencies would conduct, oversee, or coordinate 25 projects that could take listed SR steelhead. Most of the captured juvenile fish would be handled briefly and released, whereas most of the adult fish would be variously marked, tagged, or tissue sampled and released. One of the proposed research activities would intentionally kill three juvenile naturally produced SR steelhead, but the vast majority of the proposed work involves activities that are not intended to harm listed fish at all. However, any fish handling carries an inherent potential for causing or promoting stress, disease, injury, or death of the specimen. We have summarized the total proposed take in Table 47.

Table 47. Summary of proposed take of SR steelhead.

Life Stage	Origin	Take Action	Requested Take	Requested Mortality
Juvenile	Natural	Capture/Handle/Release Fish	72,831	979
Juvenile	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	66,920	698
Juvenile	Natural	Intentional (Directed) Mortality	3	3
Juvenile	Natural	Observe/Harass	1,015	0
Juvenile	Natural	Observe/Sample Tissue Dead Animal	25	0
Juvenile	Listed Hatchery Intact Adipose	Capture/Handle/Release Fish	195	7
Juvenile	Listed Hatchery Adipose Clip	Capture/Handle/Release Fish	2,940	61
Juvenile	Listed Hatchery Adipose Clip	Capture/Mark, Tag, Sample Tissue/Release Live Animal	100	2
Juvenile	Listed Hatchery Adipose Clip	Observe/Harass	75	0

Life Stage	Origin	Take Action	Requested Take	Requested Mortality
Adult	Natural	Capture/Handle/Release Fish	58	2
Adult	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	1,280	19
Adult	Natural	Observe/Sample Tissue Dead Animal	1	0
Adult	Listed Hatchery Intact Adipose	Capture/Mark, Tag, Sample Tissue/Release Live Animal	160	7
Adult	Listed Hatchery Adipose Clip	Capture/Handle/Release Fish	152	1
Adult	Listed Hatchery Adipose Clip	Capture/Mark, Tag, Sample Tissue/Release Live Animal	345	12
Spawned Adult/ Carcass	Natural	Capture/Handle/Release Fish	52	2
Spawned Adult/ Carcass	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	626	7
Spawned Adult/ Carcass	Natural	Observe/Sample Tissue Dead Animal	85	0

Researchers, when submitting their applications, estimated the number of juvenile and adult SR steelhead that may be handled and killed during the year. Additionally, to account for the dynamic and potentially increasing scope of research that may annually affect listed SR steelhead, the requested take and requested mortality in this evaluation were increased by 10 percent (Table 48). Although it is difficult to anticipate how much more research may be requested, NMFS believes this 10 percent would be sufficient to include any changes or additions. The table below compares the total requested take, plus the 10 percent buffer, to the species' estimated abundance. Activities that would observe/harass steelhead or take spawned adult/carcass steelhead are not expected to affect the species' abundance, productivity, distribution, or diversity, therefore, we do not include them in the table below.

Table 48. Total requested take, plus the 10 percent buffer, compared to the estimated abundance of SR steelhead.

Life Stage	Origin	Total Take plus 10%	Percent of ESU Handled*	Requested Mortality plus 10%	Percent of ESU killed*
Juvenile	Natural	153,729	19%	1,848	0.2%
Juvenile	Listed Hatchery Intact Adipose	215	0.03%	8	0.001%
Juvenile	Listed Hatchery Adipose Clip	3,344	0.1%	69	0.002%
Adult	Natural	1,472	14%	23	0.2%
Adult	Listed Hatchery Intact Adipose	176	1%	8	0.05%
Adult	Listed Hatchery Adipose Clip	547	0.7%	14	0.02%

*We do not have separate abundance estimates for the two types of adult listed hatchery fish.

With 10 percent added to the requested take, the state fisheries agencies programs may variously capture, handle, mark, tag, tissue sample and release up to 153,729 naturally produced juveniles, about 99 percent of which would be captured in rotary screw traps. Researchers deploy screw traps from late winter through early summer to capture juvenile salmon and steelhead during their annual outmigration. Researchers use the data collected from screw traps to derive estimates of outmigration abundance. Our records from the past nine years indicate that mortality rates for screw traps are typically less than one percent of the fish captured.

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the effects of the proposed action considered herein are best seen in the context of the fish that may be killed. When compared to the abundance of the DPS (Percent of DPS), the potential mortality levels are low (a maximum of two-tenths of a percent for juveniles and adults). These effects would be spread out over various channels and tributaries of the Snake River basin. Therefore, the research would likely have only a very small impact on abundance, a similarly small impact on productivity, and no measurable effect on spatial structure or diversity.

It is very likely that the effects of the program will be much lower than what we have evaluated. To account for year to year variation in species abundance, researchers factor in a modest overestimate of take. Our research tracking system reveals that for the past 10 years researchers, on average, ended up taking 28 percent of the SR steelhead they requested and the actual mortality was only nine percent of requested.

An effect of the research that cannot be quantified is how it would help benefit and conserve the species. For example, the Idaho Steelhead Monitoring and Evaluation project is designed to estimate freshwater production of naturally-produced salmonids, estimate survival rates of hatchery-reared salmonids from release to emigration, and determine emigration timing of wild and hatchery salmonids. These data are vital to assessing the health of naturally-produced stocks and their freshwater habitat. We expect the research actions to generate lasting benefits to conservation of the listed fish. The majority of the projects in the Programs focus on monitoring and evaluating actions recommended for the conservation of the listed species. Full details about the projects can be found in the state fishery agency submittals.

Columbia River Chum Salmon

The specific projects and related take estimates are described in detail in two of the state fishery agency submittals (ODFW 2019 and WDFW 2019) and those records are incorporated in full herein. The two agencies would conduct, oversee, or coordinate 12 projects that could take listed CR chum salmon. The majority of planned research (11 out of 12 projects) involves activities that are not intended to kill listed chum salmon. However, any fish handling carries an inherent potential for causing or promoting stress, disease, injury, or death of the specimen. We have summarized the total proposed take in Table 49.

Table 49. Summary of proposed take of CR chum salmon.

Life Stage	Origin	Take Action	Requested Take	Requested Mortality
Juvenile	Natural	Capture/Handle/Release Fish	13,595	170
Juvenile	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	20,000	200

Life Stage	Origin	Take Action	Requested Take	Requested Mortality
Juvenile	Natural	Intentional (Directed) Mortality	12	12
Juvenile	Listed Hatchery Intact Adipose	Capture/Handle/Release Fish	500	5
Adult	Natural	Capture/Handle/Release Fish	5	1

Researchers, when submitting their applications, estimated the number of juvenile and adult CR chum salmon that may be handled and killed during the year. Additionally, to account for the dynamic and potentially increasing scope of research that may annually affect listed CR Chum, we increased the requested take and requested mortality in this evaluation by 10 percent (Table 50). Although it is difficult to anticipate how much more research may be requested, NMFS believes this 10 percent would be sufficient to include any changes or additions. The table below compares the total requested take, plus the 10 percent buffer, to the species' estimated abundance.

Table 50. Total requested take, plus the 10 percent buffer, compared to the estimated abundance of CR chum salmon.

Life Stage	Origin	Total Take plus 10%	Percent of ESU Handled*	Requested Mortality plus 10%	Percent of ESU killed
Juvenile	Natural	36,968	0.6%	420	0.006%
Juvenile	Listed Hatchery Intact Adipose	550	0.09%	6	0.0009%
Adult	Natural	6	0.05%	1	0.01%

In total, researchers may capture, handle, and release up to 36,968 and kill no more than 420 or six-thousandths of a percent of the expected abundance of naturally produced juvenile CR chum salmon. Researchers would also capture up to six adult naturally produced CR chum salmon and may kill no more than one.

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the effects of the proposed action considered herein are best seen in the context of the fish that may be killed. When compared to the abundance of the ESU (Percent of ESU), the potential mortality levels are very low: a maximum of one-hundredth of a percent may be killed from any component of the species. Furthermore, the effects from all of the proposed research would be spread out over nearly all the tributaries to the Columbia River that contain chum salmon. Thus, no population is likely to experience a disproportionate amount of these losses. Therefore, the research would likely have only a very small impact on abundance (a maximum loss of one-hundredth of a percent), a similarly small impact on productivity, and no measurable effect on spatial structure or diversity.

It is very likely that the effects of the program will be much lower than what we have evaluated. To account for year to year variation in species abundance, researchers factor in a modest overestimate of take. Our research tracking system reveals that for the past 10 years researchers, on average, ended up taking 39 percent of the CR chum they requested and the actual mortality was only 13 percent of requested.

An effect of the research that cannot be quantified is how it would help benefit and conserve the species. For example, the two largest projects are designed to estimate freshwater production of naturally-produced salmonids, estimate survival rates of hatchery-reared salmonids from release to emigration, and determine emigration timing of wild and hatchery salmonids. These data are vital to assessing the health of naturally-produced stocks and their freshwater habitat. We expect the research actions to generate lasting benefits to conservation of the listed fish. The majority of the projects in the Programs focus on monitoring and evaluating actions recommended for the conservation of the listed species. Full details about the projects can be found in the state fishery agency submittals.

Lower Columbia River Chinook salmon

The specific projects and related take estimates are described in detail in the state fishery agency submittals (ODFW 2019 and WDFW 2019) and those records are incorporated in full herein. The two agencies would conduct, oversee, or coordinate 25 projects that could take listed LCR Chinook salmon. The majority of the proposed research (22 out of 25 projects) would involve activities that are not intended to harm listed fish. However, any fish handling carries an inherent potential for causing or promoting stress, disease, injury, or death of the specimen. We have summarized the total proposed take in Table 51.

Table 51. Summary of proposed take of LCR Chinook salmon.

Life Stage	Origin	Take Action	Requested Take	Requested Mortality
Juvenile	Natural	Capture/Handle/Release Fish	267,750	2,403
Juvenile	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	416,923	6,720
Juvenile	Natural	Intentional (Directed) Mortality	73	73
Juvenile	Natural	Observe/Harass	850	0
Juvenile	Listed Hatchery Intact Adipose	Capture/Handle/Release Fish	120	4
Juvenile	Listed Hatchery Adipose Clip	Capture/Handle/Release Fish	345	8
Juvenile	Listed Hatchery Adipose Clip	Capture/Mark, Tag, Sample Tissue/Release Live Animal	46,740	885
Adult	Natural	Capture/Handle/Release Fish	61	3
Adult	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	120	2
Adult	Natural	Observe/Harass	200	0
Adult	Listed Hatchery Intact Adipose	Observe/Harass	5	0
Adult	Listed Hatchery Adipose Clip	Observe/Harass	400	0
Spawned Adult/ Carcass	Natural	Capture/Handle/Release Fish	20	0

Researchers, when submitting their applications, estimated the number of juvenile and adult LCR Chinook salmon that may be handled and killed during the year. Additionally, to account for the dynamic and potentially increasing scope of research that may annually affect listed LCR Chinook salmon, we increased the requested take and requested mortality in this evaluation by 10 percent (Table 52). Although it is difficult to anticipate how much more research may be requested, NMFS believes this 10 percent would be sufficient to include any changes or additions. The table below compares the total requested take, plus the 10 percent buffer, to the species' estimated abundance. Activities that would observe/harass LCR Chinook salmon or take spawned adult/carcass LCR Chinook salmon are not expected to affect the species' abundance, productivity, distribution, or diversity, therefore, we do not include them in the table below.

Table 52. Total requested take, plus the 10 percent buffer, compared to the estimated abundance of LCR Chinook salmon.

Life Stage	Origin	Total Take plus 10%	Percent of ESU Handled*	Requested Mortality plus 10%	Percent of ESU killed
Juvenile	Natural	753,221	6%	10,116	0.09%
Juvenile	Listed Hatchery Intact Adipose	132	0.01%	4	0.0005%
Juvenile	Listed Hatchery Adipose Clip	51,794	0.2%	982	0.003%
Adult	Natural	199	0.7%	6	0.02%

*We do not have separate abundance estimates for the two types of adult listed hatchery fish.

The majority (99 percent) of the naturally produced juvenile LCR Chinook would be captured with screw traps and beach seines. Our records from the past 10 years indicate that mortality rates for screw traps are typically less than one percent and beach seines less than two percent. Researchers deploy screw traps from late winter through early summer to capture juvenile salmon and steelhead during their annual outmigration. Beach seines are used throughout the year and are more effective in deep water habitats. Managers use the data collected from screw traps and beach seines to derive estimates of outmigration abundance.

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the effects of the proposed action considered herein are best seen in the context of the fish that may be killed. When compared to the abundance at the population and ESU scales (Percent of Population/ESU), the potential mortality levels are very low: a maximum of nine-hundredths of a percent may be killed from any component of the species. Therefore, the research would likely amount to only a very small impact on the species' abundance and productivity. In addition, because the take is concentrated in two populations there could be some very small (and currently unmeasurable) effects on spatial structure and diversity.

It is very likely that the effects of the program will be much lower than what we have evaluated. To account for year to year variation in species abundance, researchers factor in a modest overestimate of take. Our research tracking system reveals that for the past 10 years researchers, on average, ended up taking 13 percent of the LCR Chinook they requested and the actual mortality was only 18 percent of requested.

An effect of the research that cannot be quantified is how it would help benefit and conserve the species. We expect the research actions to generate lasting benefits to conservation of the listed fish. The majority of the projects in the Programs are essential for monitoring the status and trends of the species. Other projects focus on monitoring and evaluating actions recommended for the conservation of the listed species. For example, for one project WDFW is studying the influence of hatchery fish on naturally produced fish and the effectiveness of restoration actions in the Mill/Abernathy/Germany population of LCR Chinook. The project is a joint effort of the Washington Departments of Fish and Wildlife and Ecology, NOAA Fisheries, the Environmental Protection Agency, Lower Elwha Klallam Tribe and Weyerhaeuser Company and is financially supported by the Washington Salmon Recovery Funding Board. The premise of the project is that the complex relationships controlling salmon response to habitat conditions can best be understood by concentrating monitoring and research efforts at a few locations. Focusing efforts on a few locations allows enough data on an ecosystem's physical and biological attributes of systems to be collected that becomes possible to evaluate effects of restoration treatments on salmon production and that information, in turn, may be used to design and refine further recovery actions. Full details about the programs can be found in the state fishery agency submittals.

Lower Columbia River Coho Salmon

The specific projects and related take estimates are described in detail in two of the state fishery agency submittals (ODFW 2019 and WDFW 2019) and those documents are incorporated in full herein. The two agencies would conduct, oversee, or coordinate 27 projects that could take listed LCR coho salmon. The majority of planned research (25 out of 27 projects) involves activities that are not intended to kill listed coho salmon. However, any fish handling carries an inherent potential for causing or promoting stress, disease, injury, or death of the specimen. We have summarized the total proposed take in Table 53.

Table 53. Summary of proposed take of LCR coho salmon.

Life Stage	Origin	Take Action	Requested Take	Requested Mortality
Juvenile	Natural	Capture/Handle/Release Fish	80,059	937
Juvenile	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	73,203	1,034
Juvenile	Natural	Intentional (Directed) Mortality	52	52
Juvenile	Natural	Observe/Harass	8,750	0
Juvenile	Listed Hatchery Intact Adipose	Capture/Handle/Release Fish	350	4
Juvenile	Listed Hatchery Adipose Clip	Capture/Handle/Release Fish	10,570	110
Juvenile	Listed Hatchery Adipose Clip	Capture/Mark, Tag, Sample Tissue/Release Live Animal	36,180	724
Juvenile	Listed Hatchery Adipose Clip	Intentional (Directed) Mortality	10	10
Adult	Natural	Capture/Handle/Release Fish	165	3
Adult	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	525	4

Life Stage	Origin	Take Action	Requested Take	Requested Mortality
Adult	Natural	Observe/Harass	100	0
Adult	Listed Hatchery Adipose Clip	Capture/Mark, Tag, Sample Tissue/Release Live Animal	75	1
Adult	Listed Hatchery Adipose Clip	Observe/Harass	200	0
Spawned Adult/ Carcass	Natural	Capture/Handle/Release Fish	15	0

Researchers, when submitting their applications, estimated the number of juvenile and adult LCR coho salmon that may be handled and killed during the year. Additionally, to account for the dynamic and potentially increasing scope of research that may annually affect listed LCR coho, we increased the requested take and requested mortality in this evaluation by 10 percent (Table 54). Although it is difficult to anticipate how much more research may be requested, NMFS believes this 10 percent would be sufficient to include any changes or additions. The table below compares the total requested take, plus the 10 percent buffer, to the species' estimated abundance. Activities that would observe/harass coho salmon or take spawned adult/carcass coho salmon are not expected to affect the species' abundance, productivity, distribution, or diversity, therefore, we do not include them in the table below.

Table 54. Total requested take, plus the 10 percent buffer, compared to the estimated abundance of LCR coho salmon.

Life Stage	Origin	Total Take plus 10%	Percent of ESU Handled*	Requested Mortality plus 10%	Percent of ESU killed*
Juvenile	Natural	168,645	25%	2,225	0.3%
Juvenile	Listed Hatchery Intact Adipose	385	0.2%	4	0.002%
Juvenile	Listed Hatchery Adipose Clip	51,436	0.7%	928	0.01%
Adult	Natural	759	3%	8	0.03%
Adult	Listed Hatchery Adipose Clip	83	0.9%	1	0.01%

* We do not have separate abundance estimates for adipose clipped and intact adipose adult hatchery salmonids.

In total, researchers may capture, handle, and release up to 168,645 naturally produced juvenile fish and kill no more than three-hundredths of a percent of the expected abundance of naturally produced juvenile LCR coho salmon. Researchers may also capture, handle, and release up to 759 naturally produced adult LCR coho salmon and kill no more than three-hundredths of a percent of the species estimated abundance.

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the effects of the proposed action considered herein are best seen in the context of the fish that may be killed. When compared to the abundance of the ESU (Percent of ESU), the potential mortality levels are low (a maximum of three-tenths of a percent for naturally produced juveniles and three-hundredths of a percent for naturally produced adults). Furthermore, the effects from all of the proposed research would be spread out over most of the tributaries of the Columbia River that contain coho. Thus, no population is likely to experience a disproportionate amount of these losses. Therefore, the research would likely have only a very small impact on abundance, a similarly small impact on productivity, and no measurable effect on spatial structure or diversity.

It is very likely that the effects of the program will be much lower than what we have evaluated. To account for year-to-year variation in species abundance, researchers factor in a modest overestimate of take. Our research tracking system reveals that for the past 10 years researchers, on average, ended up taking 22 percent of the LCR coho they requested and the actual mortality was only 10 percent of requested.

An effect of the research that cannot be quantified is how it would help benefit and conserve the species. One of the larger projects, the Cedar Creek Juvenile Salmonid Trapping, is designed to estimate juvenile salmonid production in the Cedar Creek watershed using mark and recapture methods. Co-managers use the information in the annual coho population estimates for the Washington portion of the Lower Columbia River ESU. We expect this and other research actions to generate lasting benefits to conservation of the listed fish. The majority of the projects in the Programs focus on monitoring and evaluating actions recommended for the conservation of the listed species. Full details about the projects can be found in the state fishery agency submittals.

Lower Columbia River Steelhead

The specific projects and related take estimates are described in detail in two of the state fishery agency submittals (ODFW 2019 and WDFW 2019) and those documents are incorporated in full herein. The two agencies would conduct, oversee, or coordinate 19 projects that could take listed LCR steelhead. The majority of planned research (17 out of 19 projects) involves activities that are not intended to kill listed steelhead. However, any fish handling carries an inherent potential for causing or promoting stress, disease, injury, or death of the specimen. We have summarized the total proposed take in Table 55.

Table 55. Summary of proposed take of LCR steelhead.

Life Stage	Origin	Take Action	Requested Take	Requested Mortality
Juvenile	Natural	Capture/Handle/Release Fish	17,765	246
Juvenile	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	35,620	389
Juvenile	Natural	Intentional (Directed) Mortality	133	133
Juvenile	Natural	Observe/Harass	1,350	0
Juvenile	Listed Hatchery Adipose Clip	Capture/Handle/Release Fish	2,050	21
Juvenile	Listed Hatchery Adipose Clip	Capture/Mark, Tag, Sample Tissue/Release Live Animal	34,410	485
Adult	Natural	Capture/Handle/Release Fish	30	0

Life Stage	Origin	Take Action	Requested Take	Requested Mortality
Adult	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	1,565	17
Adult	Natural	Observe/Harass	100	0
Adult	Listed Hatchery Adipose Clip	Observe/Harass	100	0
Spawned Adult/ Carcass	Natural	Capture/Handle/Release Fish	45	4
Spawned Adult/ Carcass	Listed Hatchery Adipose Clip	Capture/Handle/Release Fish	35	4

Researchers, when submitting their applications, estimated the number of juvenile and adult LCR steelhead that may be handled and killed during the year. Additionally, to account for the dynamic and potentially increasing scope of research that may annually affect listed LCR steelhead, we increased the requested take and requested mortality in this evaluation by 10 percent (Table 56). Although it is difficult to anticipate how much more research may be requested, NMFS believes this 10 percent would be sufficient to include any changes or additions. The table below compares the total requested take, plus the 10 percent buffer, to the species' estimated abundance. Activities that would observe/harass steelhead or take spawned adult/carcass steelhead are not expected to affect the species' abundance, productivity, distribution, or diversity, therefore, we do not include them in the table below.

Table 56. Total requested take, plus the 10 percent buffer, compared to the estimated abundance of LCR steelhead.

Life Stage	Origin	Total Take plus 10%	Percent of ESU Handled*	Requested Mortality plus 10%	Percent of ESU killed
Juvenile	Natural	58,870	17%	845	0.2%
Juvenile	Listed Hatchery Intact Adipose	40,106	3%	557	0.05%
Adult	Natural	1,755	14%	19	0.1%

Researchers may variously capture, handle, mark, tag, tissue sample and release up to 58,870 naturally produced smolts and kill no more than two-tenths of a percent of them (including the intentional mortalities). The majority (92 percent) of the requested nonlethal take of juvenile steelhead would be captured with screw traps and beach seines. Our records from the past 10 years indicate that mortality rates for screw traps are typically less than 1 percent and beach seines less than two percent. Researchers deploy screw traps from late winter through early summer to capture juvenile salmon and steelhead during their annual outmigration. Beach seines are used throughout the year and are more effective in deep water habitats. Managers use the data collected from screw traps and beach seines to derive estimates of outmigration abundance.

Researchers may variously capture, handle, mark, tag, tissue sample and release up to 1,755 naturally produced adults. Researchers would use hook and line, beach seines, fish ladders, and weirs to capture adult steelhead from nine populations. WDFW and ODFW submitted five projects that would take adult steelhead. These five projects are designed to monitor steelhead status and trends. The projects would count returning adults, take tissue samples to determine the origin of the fish, and tag a portion of the fish. Researchers would use tags to monitor the movements of fish and validate the population estimates. All of these projects are important for the survival and recovery of the species. We use trends in abundance and productivity to measure the status of the species and the effects of various recovery efforts. Researchers intend to release all naturally produced adult steelhead alive. However, a small number of fish (one percent of the requested numbers, one-tenth of a percent of the DPS) may die as an unintended result of the research.

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the effects of the proposed action considered herein are best seen in the context of the fish that may be killed. When compared to the abundance of the DPS (Percent of DPS), the potential mortality levels are very low (as stated above). These effects would be spread out over various channels and tributaries of the lower Columbia River basin. Thus, no population is likely to experience a disproportionate amount of these losses. Therefore, there would be a very small impact on abundance, no measurable impact on productivity, spatial structure, or diversity.

It is very likely that the effects of the program will be much lower than what we have evaluated. To account for year to year variation in species abundance, researchers factor in a modest overestimate of take. Our research tracking system reveals that for the past 10 years researchers, on average, ended up taking 24 percent of the LCR steelhead they requested and the actual mortality was only 26 percent of requested.

An effect of the research that cannot be quantified is how it would help benefit and conserve the species. We expect the research actions to generate lasting benefits to conservation of the listed fish (see the examples above). The majority of the projects in the Programs focus on monitoring and evaluating actions recommended for the conservation of the listed species. Full details about the programs can be found in the state fishery agency submittals.

Upper Willamette River Chinook salmon

The specific projects and related take estimates are described in detail in the ODFW submittal (ODFW 2019) and those records are incorporated in full herein. The ODFW would conduct, oversee, or coordinate 22 projects that could take listed UWR Chinook salmon. The majority of planned research (20 out of 22 projects) involves activities that are not intended to kill listed steelhead. However, any fish handling carries an inherent potential for causing or promoting stress, disease, injury, or death of the specimen. We have summarized the total proposed take in Table 57.

Table 57. Summary of proposed take of UWR Chinook salmon.

Life Stage	Origin	Take Action	Requested Take	Requested Mortality
Juvenile	Natural	Capture/Handle/Release Fish	12,735	225
Juvenile	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	21,150	182
Juvenile	Natural	Intentional (Directed) Mortality	24	24

Life Stage	Origin	Take Action	Requested Take	Requested Mortality
Juvenile	Natural	Observe/Harass	300	0
Juvenile	Listed Hatchery Intact Adipose	Capture/Handle/Release Fish	20	1
Juvenile	Listed Hatchery Intact Adipose	Observe/Harass	40	0
Juvenile	Listed Hatchery Adipose Clip	Capture/Handle/Release Fish	6,435	114
Juvenile	Listed Hatchery Adipose Clip	Observe/Harass	210	0
Adult	Natural	Capture/Handle/Release Fish	127	1
Adult	Natural	Observe/Harass	30	0
Adult	Listed Hatchery Adipose Clip	Capture/Handle/Release Fish	77	2
Adult	Listed Hatchery Adipose Clip	Observe/Harass	110	0
Spawned Adult/ Carcass	Natural	Capture/Handle/Release Fish	10	0

Researchers, when submitting their applications, estimated the number of juvenile and adult UWR Chinook salmon that may be handled and killed during the year. Additionally, to account for the dynamic and potentially increasing scope of research that may annually affect listed SR fall Chinook, we increased the requested take and requested mortality by 10 percent (Table 58). Although it is difficult to anticipate how much more research may be requested, NMFS believes this 10 percent would be sufficient to include any changes or additions. The table below compares the total requested take, plus the 10 percent buffer, to the species' estimated abundance. Activities that would observe/harass UWR Chinook salmon or take spawned adult/carcass UWR Chinook salmon are not expected to affect the species' abundance, productivity, distribution, or diversity, therefore, we do not include them in the table below.

Table 58. Total requested take, plus the 10 percent buffer, compared to the estimated abundance of UWR Chinook salmon.

Life Stage	Origin	Total Take plus 10%	Percent of ESU Handled*	Requested Mortality plus 10%	Percent of ESU killed
Juvenile	Natural	37,300	3%	474	0.04%
Juvenile	Listed Hatchery Intact Adipose	22	0.5%	1	0.03%
Juvenile	Listed Hatchery Adipose Clip	7,079	0.2%	125	0.003%
Adult	Natural	140	1%	1	0.01%
Adult	Listed Hatchery Adipose Clip	85	0.3%	2	0.007%

Researchers may variously capture, handle, mark, tag, tissue sample and release up to 37,300 naturally produced juveniles and kill no more than one-tenth of a percent of them (including the intentional mortalities). The majority (72 percent) of the requested nonlethal take of juvenile Chinook would be captured with screw traps and beach seines. Our records from the past 10 years indicate that mortality rates for screw traps are typically less than one percent and beach seines less than two percent. Researchers deploy screw traps from late winter through early summer to capture juvenile salmon and steelhead during their annual outmigration. Beach seines are used throughout the year and are more effective in deep water habitats. Managers use the data collected from screw traps and beach seines to derive estimates of outmigration abundance.

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the effects of the proposed action considered herein are best seen in the context of the fish that may be killed. When compared to the abundance of the ESU (Percent of ESU), the potential mortality levels are very low: a maximum of four-hundredths of a percent may be killed from any component of the species. Furthermore, the effects from all of the proposed research would be spread out over most of the tributaries to the Willamette River basin. Thus, no population is likely to experience a disproportionate amount of these losses. Therefore, the research would likely have only a very small impact on abundance, a similarly small impact on productivity, and no measurable effect on spatial structure or diversity.

It is very likely that the effects of the program will be much lower than what we have evaluated. To account for year to year variation in species abundance, researchers factor in a modest overestimate of take. Our research tracking system reveals that for the past 10 years researchers, on average, ended up taking 28 percent of the number of fish they requested and the actual mortality was only 18 percent of requested.

An effect of the research that cannot be quantified is how it would help benefit and conserve the species. More than half of the requested take of UWR Chinook salmon are from ODFW's Spring Chinook salmon in the Willamette River project. The purpose of ODFW's project is to study temporal and spatial use patterns by life stage and identify the habitat/environmental attributes of high use areas. Study results will be used to help identify priority recovery actions and will provide a basis for implementing the Upper Willamette spring Chinook Recovery Plan. We expect these and other research actions to generate lasting benefits to conservation of the listed fish. The majority of the projects in the Programs focus on monitoring and evaluating actions recommended for the conservation of the listed species. Full details about the programs can be found in the state fishery agency submittals.

Upper Willamette River Steelhead

The specific projects and related take estimates are described in detail in the ODFW's submittal (ODFW 2019) and that document is incorporated in full herein. The ODFW would conduct, oversee, or coordinate 19 projects that could take listed UWR steelhead. One of the research projects would intentionally kill juvenile two UWR steelhead, but the great majority of the proposed work would involve activities that do not intend to harm listed fish. However, any fish handling carries an inherent potential for causing or promoting stress, disease, injury, or death of the specimen. We have summarized the total proposed take in Table 59.

Table 59. Summary of proposed take of UWR Steelhead.

Life Stage	Origin	Take Action	Requested Take	Requested Mortality
Juvenile	Natural	Capture/Handle/Release Fish	6,590	127
Juvenile	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	3,070	43
Juvenile	Natural	Intentional (Directed) Mortality	2	2
Juvenile	Natural	Observe/Harass	1,505	0
Adult	Natural	Capture/Handle/Release Fish	105	1
Adult	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	80	1
Adult	Natural	Observe/Harass	5	0

Researchers, when submitting their applications, estimated the number of juvenile and adult UWR steelhead that may be handled and killed during the year. Additionally, to account for the dynamic and potentially increasing scope of research that may annually affect listed UWR steelhead, the requested take and requested mortality in this evaluation were increased by 10 percent (Table 60). Although it is difficult to anticipate how much more research may be requested, NMFS believes this 10 percent would be sufficient to include any changes or additions. The table below compares the total requested take, plus the 10 percent buffer, to the species' estimated abundance. Activities that would observe/harass steelhead are not expected to affect the species' abundance, productivity, distribution, or diversity; therefore, we do not include them in the table below.

Table 60. Total requested take, plus the 10 percent buffer, compared to the estimated abundance of UWR Steelhead.

Life Stage	Origin	Total Take plus 10%	Percent of ESU Handled	Requested Mortality plus 10%	Percent of ESU killed
Juvenile	Natural	10,628	8%	189	0.1%
Adult	Natural	204	7%	2	0.08%

In total, researchers may capture, handle, and release up to 10,628 naturally produced juvenile UWR steelhead and kill no more than two percent of them. Researchers may also capture, handle, and release up to 204 naturally produced adult UWR steelhead and kill no more than two percent of them.

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the effects of the proposed action considered herein are best seen in the context of the fish that may be killed. When compared to the abundance of the DPS (Percent of DPS), the potential mortality levels are very low (a maximum of one-tenth of a percent for naturally produced juveniles and adults). These effects would be spread out over various channels and tributaries of the Upper Willamette River basin. Thus, no population is likely to experience a disproportionate amount of these losses. Therefore, the research would likely have only a very small impact on abundance, a similarly small impact on productivity, and no measurable effect on spatial structure or diversity.

It is very likely that the effects of the program will be much lower than what we have evaluated.

To account for year to year variation in species abundance, researchers factor in a modest overestimate of take. Our research tracking system reveals that for the past 10 years researchers, on average, ended up taking two percent of the UWR steelhead they requested and the actual mortality was only one percent of requested.

An effect of the research that cannot be quantified is how it would help benefit and conserve the species. More than half of the requested take is from three projects. The first two projects are evaluating the distribution and population status of fish species in two of ODFW's districts (one project per district). The third project is the Willamette National Forest Identification of Fish Distribution and Population Monitoring. We expect these research projects (and the others submitted by ODFW) to generate lasting benefits to conservation of the listed fish. The majority of the projects in the Programs focus on monitoring and evaluating actions recommended for the conservation of the listed species. Full details about the projects can be found in the state fishery agency submittals.

Oregon Coast Coho Salmon

The specific projects and related take estimates are described in detail in ODFW's submittal (ODFW 2019) and that document is incorporated in full herein. The ODFW would conduct, oversee, or coordinate 40 projects that could take OC coho salmon. One of the research projects would intentionally kill juvenile two OC coho salmon, but the great majority of the proposed work would involve activities that do not intend to harm listed fish. However, any fish handling carries an inherent potential for causing or promoting stress, disease, injury, or death of the specimen. We have summarized the total proposed take in Table 61.

Table 61. Summary of proposed take of OC coho salmon.

Life Stage	Origin	Take Action	Requested Take	Requested Mortality
Juvenile	Natural	Capture/Handle/Release Fish	355,000	8,620
Juvenile	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	123,401	2,158
Juvenile	Natural	Intentional (Directed) Mortality	10	10
Juvenile	Natural	Observe/Harass	151,100	0
Juvenile	Natural	Captive animals (research, enhancement, public display)	120	12
Juvenile	Listed Hatchery Adipose Clip	Capture/Handle/Release Fish	90	3
Adult	Natural	Capture/Handle/Release Fish	630	12
Adult	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	5,650	72
Adult	Natural	Observe/Harass	15,950	0
Adult	Listed Hatchery Adipose Clip	Capture/Handle/Release Fish	5	0
Adult	Listed Hatchery Adipose Clip	Observe/Harass	200	0

Life Stage	Origin	Take Action	Requested Take	Requested Mortality
Spawned Adult/ Carcass	Natural	Observe/Sample Tissue Dead Animal	50	0

Researchers, when submitting their applications, estimated the number of juvenile and adult OC coho salmon that may be handled and killed during the year. Additionally, to account for the dynamic and potentially increasing scope of research that may annually affect listed OC coho, we increased the requested take and requested mortality in this evaluation by 10 percent (Table 62). Although it is difficult to anticipate how much more research may be requested, NMFS believes this 10 percent would be sufficient to include any changes or additions. The table below compares the total requested take, plus the 10 percent buffer, to the species' estimated abundance. Activities that would observe/harass coho or take spawned adult/carcass coho salmon are not expected to affect the species' abundance, productivity, distribution, or diversity, therefore, we do not include them in the table below.

Table 62. Total requested take, plus the 10 percent buffer, compared to the estimated abundance of OC coho salmon.

Life Stage	Origin	Total Take plus 10%	Percent of ESU Handled	Requested Mortality plus 10%	Percent of ESU killed
Juvenile	Natural	526,384	8%	11,880	0.2%
Juvenile	Listed Hatchery Adipose Clip	99	0.2%	3	0.006%
Adult	Natural	6,908	7%	92	0.1%
Adult	Listed Hatchery Adipose Clip	6	1%	0	0%

One of the research projects in ODFW's research program accounts for more than half of the take of smolts and adults. In 1997, as part of the Oregon Plan for Salmon and Watersheds, ODFW began monitoring survival and downstream migration of salmonids in coastal basins. The purpose of the Oregon Plan is to restore native fish populations and the aquatic systems that support them to productive and sustainable levels that will provide substantial environmental, cultural, and economic benefits. For nearly 20 years, the project has been capturing and variously handling, tagging, and tissue sampling coho from six OC coho populations. The information gathered from the project has been critical to our understanding of the species' survival and abundance.

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the effects of the proposed action considered herein are best seen in the context of the fish that may be killed. When compared to the abundance of the ESU (Percent of ESU), the potential mortality levels are very low (a maximum of two-tenths of a percent for naturally produced juveniles). Furthermore, the effects from all of the proposed research would be spread out over most of the streams that contain coho on the Oregon Coast. Thus, no population is likely to experience a disproportionate amount of these losses. Therefore, the research would likely have only a very small impact on abundance, a similarly small impact on productivity, and no measurable effect on spatial structure or diversity.

It is very likely that the effects of the program will be much lower than what we have evaluated. To account for year to year variation in species abundance, researchers factor in a modest overestimate of take. Our research tracking system reveals that for the past 10 years researchers, on average, ended up taking 28 percent of the number of fish they requested and the actual mortality was only 11 percent of requested.

An effect of the research that cannot be quantified is how it would help benefit and conserve the species. We expect the research actions to generate lasting benefits to conservation of the listed fish (see the examples above). The majority of the projects in the Programs focus on monitoring and evaluating actions recommended for the conservation of the listed species. Full details about the programs can be found in the state fishery agency submittals.

Southern Oregon/Northern California Coasts Coho Salmon

The specific projects and related take estimates are described in detail in two of the state agencies' submittals (ODFW 2019 and CDFW 2019) and those documents are incorporated in full herein. The state agencies would conduct, oversee, or coordinate 43 projects that could take SONCC coho salmon. None of the planned research would intentionally kill listed coho salmon. However, any fish handling carries an inherent potential for causing or promoting stress, disease, injury, or death of the specimen. We have summarized the total proposed take in Table 63.

Table 63. Summary of proposed take of SONCC coho salmon.

Life Stage	Origin	Take Action	Requested Take	Requested Mortality
Juvenile	Natural	Capture/Handle/Release Fish	52,792	663
Juvenile	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	51,655	588
Juvenile	Natural	Intentional (Directed) Mortality	9	9
Juvenile	Natural	Observe/Harass	59,602	0
Juvenile	Listed Hatchery Intact Adipose	Capture/Handle/Release Fish	30	3
Juvenile	Listed Hatchery Intact Adipose	Intentional (Directed) Mortality	125	125
Juvenile	Listed Hatchery Adipose Clip	Capture/Handle/Release Fish	1,280	20
Adult	Natural	Capture/Handle/Release Fish	587	7
Adult	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	820	4
Adult	Natural	Observe/Harass	9,732	0
Adult	Natural	Observe/Sample Tissue Dead Animal	27	0
Adult	Listed Hatchery Intact Adipose	Capture/Handle/Release Fish	3	0

Life Stage	Origin	Take Action	Requested Take	Requested Mortality
Adult	Listed Hatchery Intact Adipose	Capture/Mark, Tag, Sample Tissue/Release Live Animal	1,570	3
Adult	Listed Hatchery Intact Adipose	Observe/Harass	470	0
Adult	Listed Hatchery Intact Adipose	Observe/Sample Tissue Dead Animal	5	0
Adult	Listed Hatchery Adipose Clip	Capture/Handle/Release Fish	523	6
Spawned Adult/ Carcass	Natural	Observe/Sample Tissue Dead Animal	1,845	0
Spawned Adult/ Carcass	Listed Hatchery Intact Adipose	Observe/Sample Tissue Dead Animal	205	0

Researchers, when submitting their applications, estimated the number of juvenile and adult SONCC coho salmon that may be handled and killed during the year. Additionally, to account for the dynamic and potentially increasing scope of research that may annually affect listed SONCC coho, we increased the requested take and requested mortality in this evaluation by 10 percent (Table 64). Although it is difficult to anticipate how much more research may be requested, NMFS believes this 10 percent would be sufficient to include any changes or additions. The table below compares the total requested take, plus the 10 percent buffer, to the species' estimated abundance. Activities that would observe/harass coho salmon are not expected to affect the species' abundance, productivity, distribution, or diversity, therefore, we do not include them in the table below.

Table 64. Total requested take, plus the 10 percent buffer, compared to the estimated abundance of SONCC coho salmon.

Life Stage	Origin	Total Take plus 10%	Percent of ESU Handled*	Requested Mortality plus 10%	Percent of ESU killed*
Juvenile	Natural	114,902	6%	1,386	0.07%
Juvenile	Listed Hatchery Intact Adipose	171	0.03%	141	0.02%
Juvenile	Listed hatchery adipose clipped	1,408	0.7%	22	0.01%
Adult	Natural	1,548	17%	12	0.1%
Adult	Listed Hatchery Intact Adipose	1,730	21%	3	0.09%
Adult	Listed hatchery adipose clipped	575		7	

* We do not have separate abundance estimates for adipose clipped and intact adipose adult hatchery salmonids.

The proposed research projects may capture, handle, and release up to 17 percent of the expected abundance of naturally produced adult coho. The majority (79 percent) of the adult coho take is for two projects. The first project is the Huntley Park beach seine project on the Rogue River in Oregon. The second project is the Trinity River run-size and escapement estimate in California. These two projects are the primary sources of abundance information; the data derived from the projects is used to inform many management decisions throughout the species range. Mortality is expected to be no more than eight-tenths of a percent of the number of naturally produced adult coho captured, handled, and released.

The proposed research projects may also take up to 21 percent of the abundance of adult listed hatchery coho. However, many of these fish are likely to be unlisted hatchery coho. There are both listed and unlisted coho hatchery stocks with more fish produced in the unlisted hatchery stock programs. The state agencies do not identify the origin of the hatchery fish. Regardless, we consider the adipose fin-clipped listed hatchery fish to be surplus to conservation and recovery needs and therefore there are no take prohibitions for these fish (70 FR 37160).

The state agencies may also capture, handle, and release up to six percent of the expected abundance of naturally produced juvenile coho salmon. Mortality is expected to be no more than one percent of the number of juvenile coho captured.

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the effects of the proposed action considered herein are best seen in the context of the fish that may be killed. When compared to the abundance of the ESU (Percent of ESU), the potential mortality levels are very low (a maximum of one-tenth of a percent for naturally produced juveniles and adults). Effects on juvenile fish would be spread out over various channels and tributaries the ESU inhabits in Oregon and California. Thus, no population is likely to experience a disproportionate amount of these losses. Therefore, the research would likely have only a very small impact on abundance, a similarly small impact on productivity, and no measurable effect on spatial structure or diversity.

It is very likely that the effects of the program will be much lower than what we have evaluated. To account for year-to-year variation in species abundance, researchers factor in a modest overestimate of take. Our research tracking system reveals that for the past 10 years researchers, on average, ended up taking 24 percent of the SONCC coho they requested and the actual mortality was only 11 percent of requested.

An effect of the research that cannot be quantified is how it would help benefit and conserve the species. We expect the research actions to generate lasting benefits to conservation of the listed fish (see above example). The majority of the projects in the Programs focus on monitoring and evaluating actions recommended for the conservation of the listed species. Full details about the programs can be found in the state fishery agency submittals.

California Coastal Chinook salmon

The specific projects and related take estimates are described in detail in CDFW's submittal (CDFW 2019) and that document is incorporated in full herein. The CDFW would conduct, oversee, or coordinate 16 projects that could take CC Chinook salmon. The proposed research involves activities that are not intended to harm or kill listed fish at all. However, any fish handling carries an inherent potential for causing or promoting stress, disease, injury, or death of the specimen. We have summarized the total proposed take in Table 65.

Table 65. Summary of proposed take of CC Chinook salmon.

Life Stage	Origin	Take Action	Requested Take	Requested Mortality
Juvenile	Natural	Capture/Handle/Release Fish	190,295	1,889
Juvenile	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	26,855	286
Juvenile	Natural	Observe/Harass	9,190	0
Adult	Natural	Capture/Handle/Release Fish	5	0
Adult	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	210	4
Adult	Natural	Observe/Sample Tissue Dead Animal	2	0
Adult	Natural	Observe/Harass	46,396	0
Spawned Adult/ Carcass	Natural	Observe/Sample Tissue Dead Animal	920	0

Researchers, when submitting their applications, estimated the number of juvenile and adult CC Chinook salmon that may be handled and killed during the year. Additionally, to account for the dynamic and potentially increasing scope of research that may annually affect listed CC Chinook, we increased the requested take and requested mortality in this evaluation by 10 percent (Table 66). Although it is difficult to anticipate how much more research may be requested, NMFS believes this 10 percent would be sufficient to include any changes or additions. The table below compares the total requested take, plus the 10 percent buffer, to the species' estimated abundance. Activities that would observe/harass Chinook salmon, or sample dead fish, are not expected to affect the species' abundance, productivity, distribution, or diversity, therefore, we do not include them in the table below.

Table 66. Total requested take, plus the 10 percent buffer, compared to the estimated abundance of CC Chinook salmon.

Life Stage	Origin	Total Take plus 10%	Percent of ESU Handled	Requested Mortality plus 10%	Percent of ESU killed
Juvenile	Natural	238,865	19%	2,393	0.2%
Adult	Natural	237	3%	4	0.06%

The research projects proposed by CDFW may variously capture, handle, mark, tag, tissue sample, and release up to 19 percent of the expected abundance of naturally produced juvenile Chinook salmon. The majority (86 percent) of the take of juvenile Chinook is from two screw traps in the Redwood Creek Watershed. The research is designed to determine abundance of downstream migrating juvenile Chinook salmon, coho salmon, steelhead trout, and cutthroat trout using mark/recapture techniques. Researchers recapture fish in the second screw trap and use the numbers of recaptured fish to determine abundance. Although a portion of the juvenile Chinook salmon in this project would be marked and tissue sampled, the vast majority (88 percent) of the fish would only be handled and released. Of all the capture methods employed by researchers, screw traps are one of the most efficient and have some of the lowest mortality rates. The average mortality rate reported by researchers using screw traps to capture juvenile CC Chinook is two-tenths of a percent (2014-2018).

Researchers may also capture and variously handle, mark, tag, tissue sample and release 237 adult CC Chinook salmon with only one anticipated mortality. Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the effects of the proposed action considered herein are best seen in the context of the fish that may be killed. When compared to the abundance of the ESU (Percent of ESU), the potential mortality levels are very low (a maximum of two-tenths of a percent for naturally produced juveniles and six-hundredths of a percent for adults). Furthermore, the effects from all of the proposed research would be spread out over most of the major tributaries of the ESU. Thus, no population is likely to experience a disproportionate amount of these losses. Therefore, the research would likely have only a very small impact on abundance, a similarly small impact on productivity, and no measurable effect on spatial structure or diversity.

It is very likely that the effects of the program will be much lower than what we have evaluated. To account for year to year variation in species abundance, researchers factor in a modest overestimate of take. Our research tracking system reveals that for the past five years researchers, on average, ended up taking 53 percent of the CC Chinook they requested and the actual mortality was only 10 percent of requested.

An effect of the research that cannot be quantified is how it would help benefit and conserve the species. We expect the research actions to generate lasting benefits to conservation of the listed fish (see above example). The majority of the projects in CDFW’s Program focus on monitoring and evaluating actions recommended for the conservation of the listed species. Full details about the program can be found in the state fishery agency submittal.

Northern California Steelhead

The specific projects and related take estimates are described in detail in CDFW’s submittal (CDFW 2019) and that document is incorporated in full herein. The CDFW would conduct, oversee, or coordinate 16 projects that could take NC steelhead. The proposed research involves activities that are not intended to harm or kill listed fish at all. However, any fish handling carries an inherent potential for causing or promoting stress, disease, injury, or death of the specimen. We have summarized the total proposed take in Table 67.

Table 67. Summary of proposed take of NC steelhead.

Life Stage	Origin	Take Action	Requested Take	Requested Mortality
Juvenile	Natural	Capture/Handle/Release Fish	98,255	830
Juvenile	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	13,805	148
Juvenile	Natural	Observe/Harass	17,050	0
Adult	Natural	Capture/Handle/Release Fish	80	1

Life Stage	Origin	Take Action	Requested Take	Requested Mortality
Adult	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	395	11
Adult	Natural	Observe/Sample Tissue Dead Animal	3	0
Adult	Natural	Observe/Harass	18,149	0
Spawned Adult/Carcass	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	5	0
Spawned Adult/Carcass	Natural	Observe/Sample Tissue Dead Animal	192	0

Researchers, when submitting their applications, estimated the number of juvenile and adult NC steelhead that may be handled and killed during the year. Additionally, to account for the dynamic and potentially increasing scope of research that may annually affect listed NC steelhead, we increased the requested take and requested mortality in this evaluation by 10 percent (Table 68). Although it is difficult to anticipate how much more research may be requested, NMFS believes this 10 percent would be sufficient to include any changes or additions. The table below compares the total requested take, plus the 10 percent buffer, to the species' estimated abundance. Activities that would observe/harass steelhead, or sample dead fish, are not expected to affect the species' abundance, productivity, distribution, or diversity, therefore, we do not include them in the table below.

Table 68. Total requested take, plus the 10 percent buffer, compared to the estimated abundance of NC steelhead.

Life Stage	Origin	Total Take plus 10%	Percent of ESU Handled	Requested Mortality plus 10%	Percent of ESU killed
Juvenile	Natural	123,266	15%	1,076	0.1%
Adult	Natural	523	7%	13	0.2%

The research projects proposed by CDFW may variously capture, handle, mark, tag, tissue sample, and release up to 15 percent of the expected abundance of naturally produced juvenile steelhead. The majority (84 percent) of the take of juvenile steelhead is from two screw traps in the Redwood Creek Watershed. The research is designed to determine abundance of downstream migrating juvenile Chinook salmon, coho salmon, steelhead trout, and cutthroat trout using mark/recapture techniques. Researchers recapture fish in the second screw trap and use the numbers of recaptured fish to determine abundance. Although a portion of the juvenile steelhead in this project would be marked and tissue sampled, the vast majority (88 percent) of the fish would only be handled and released. Of all the capture methods employed by researchers, screw traps are one of the most efficient and have some of the lowest mortality rates. The average mortality rate reported by researchers using screw traps to capture juvenile NC steelhead is four-tenths of a percent (2014-2018).

Researchers may also capture and variously handle, mark, tag, tissue sample and release 523 adult steelhead with only 13 anticipated mortalities. Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the effects of the proposed action considered herein are best seen in the context of the fish that may be killed. When compared to the abundance of the ESU (Percent of ESU), the potential mortality levels are very low (a maximum of one-tenth of a percent for naturally produced juveniles and two-tenths of a percent for adults). Furthermore, the effects from all of the proposed research would be spread out over most of the major tributaries of the ESU. Thus, no population is likely to experience a disproportionate amount of these losses. Therefore, the research would likely have only a very small impact on abundance, a similarly small impact on productivity, and no measurable effect on spatial structure or diversity.

It is very likely that the effects of the program will be much lower than what we have evaluated. To account for year to year variation in species abundance, researchers factor in a modest overestimate of take. Our research tracking system reveals that for the past five years researchers, on average, ended up taking 35 percent of the NC steelhead they requested and the actual mortality was only 12 percent of requested.

An effect of the research that cannot be quantified is how it would help benefit and conserve the species. We expect the research actions to generate lasting benefits to conservation of the listed fish (see above example). The majority of the projects in CDFW’s Program focus on monitoring and evaluating actions recommended for the conservation of the listed species. Full details about the program can be found in the state fishery agency submittal.

Central California Coast Steelhead

The specific projects and related take estimates are described in detail in CDFW’s submittal (CDFW 2019) and that document is incorporated in full herein. The CDFW would conduct, oversee, or coordinate 12 projects that could take CCC steelhead. The proposed research involves activities that are not intended to harm or kill listed fish at all. However, any fish handling carries an inherent potential for causing or promoting stress, disease, injury, or death of the specimen. We have summarized the total proposed take in Table 69.

Table 69. Summary of proposed take of CCC steelhead.

Life Stage	Origin	Take Action	Requested Take	Requested Mortality
Juvenile	Natural	Capture/Handle/Release Fish	7,440	136
Juvenile	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	3,120	55
Juvenile	Natural	Observe/Harass	2,310	0
Adult	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	30	1
Adult	Natural	Observe/Sample Tissue Dead Animal	13	0
Adult	Natural	Observe/Harass	270	0
Spawned Adult/ Carcass	Natural	Observe/Sample Tissue Dead Animal	102	0

Researchers, when submitting their applications, estimated the number of juvenile and adult CCC steelhead that may be handled and killed during the year. Additionally, to account for the dynamic and potentially increasing scope of research that may annually affect listed CCC steelhead, we increased the requested take and requested mortality in this evaluation by 10 percent (Table 70). Although it is difficult to anticipate how much more research may be requested, NMFS believes this 10 percent would be sufficient to include any changes or additions. The table below compares the total requested take, plus the 10 percent buffer, to the species' estimated abundance. Activities that would observe/harass steelhead, or sample dead fish, are not expected to affect the species' abundance, productivity, distribution, or diversity, therefore, we do not include them in the table below.

Table 70. Total requested take, plus the 10 percent buffer, compared to the estimated abundance of CCC steelhead.

Life Stage	Origin	Total Take plus 10%	Percent of ESU Handled	Requested Mortality plus 10%	Percent of ESU killed
Juvenile	Natural	11,616	5%	210	0.08%
Adult	Natural	35	2%	1	0.05%

Researchers may variously capture, handle, mark, tag, tissue sample, and release up to 11,616 juvenile steelhead and kill, at most, two percent of those fish. Researchers may also capture and variously handle, mark, tag, tissue sample and release 35 adult steelhead and kill no more than one of them. Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the effects of the proposed action considered herein are best seen in the context of the fish that may be killed. When compared to the abundance of the DPS (Percent of DPS), the potential mortality levels are very low (a maximum of eight-hundredths of a percent for naturally produced juveniles). Furthermore, the effects from all of the proposed research would be spread out over most of the major tributaries of the DPS. Thus, no population is likely to experience a disproportionate amount of these losses. Therefore, the research would likely have only a very small impact on abundance, a similarly small impact on productivity, and no measurable effect on spatial structure or diversity.

It is very likely that the effects of the program will be much lower than what we have evaluated. To account for year-to-year variation in species abundance, researchers factor in a modest overestimate of take. Our research tracking system reveals that for the past five years researchers, on average, ended up taking 11 percent of the CCC steelhead they requested and the actual mortality was only four percent of requested.

An effect of the research that cannot be quantified is how it would help benefit and conserve the species. We expect the research actions to generate lasting benefits to conservation of the listed fish (see above example). The majority of the projects in CDFW's Program focus on monitoring and evaluating actions recommended for the conservation of the listed species. Full details about the program can be found in the state fishery agency submittal.

Central Valley Spring-run Chinook salmon

The specific projects and related take estimates are described in detail in CDFW's submittal (CDFW 2019) and that document is incorporated in full herein. The CDFW would conduct, oversee, or coordinate 33 projects that could take CVS Chinook. The majority of planned research (31 out of 33 projects) involves activities that are not intended to kill listed Chinook. However, any fish handling carries an inherent potential for causing or promoting stress, disease, injury, or death of the specimen. We have summarized the total proposed take in Table 71.

Table 71. Summary of proposed take of CVS Chinook.

Life Stage	Origin	Take Action	Requested Take	Requested Mortality
Juvenile	Natural	Capture/Handle/Release Fish	417,400	4,271
Juvenile	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	10,600	104
Juvenile	Natural	Intentional (Directed) Mortality	100	100
Juvenile	Natural	Observe/Harass	33,245	0
Juvenile	Listed Hatchery Adipose Clip	Capture/Handle/Release Fish	8,950	111
Juvenile	Listed Hatchery Adipose Clip	Capture/Mark, Tag, Sample Tissue/Release Live Animal	380	7
Juvenile	Listed Hatchery Adipose Clip	Intentional (Directed) Mortality	160	160
Juvenile	Listed Hatchery Adipose Clip	Observe/Harass	1,475	0
Adult	Natural	Capture/Handle/Release Fish	48	2
Adult	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	50	1
Adult	Natural	Observe/Harass	54,455	0
Adult	Listed Hatchery Adipose Clip	Capture/Handle/Release Fish	32	1
Adult	Listed Hatchery Adipose Clip	Capture/Mark, Tag, Sample Tissue/Release Live Animal	145	2
Adult	Listed Hatchery Adipose Clip	Observe/Harass	7,457	0
Spawned Adult/ Carcass	Natural	Observe/Sample Tissue Dead Animal	4,700	0
Spawned Adult/ Carcass	Natural	Observe/Harass	19,250	0
Spawned Adult/ Carcass	Listed Hatchery Adipose Clip	Observe/Sample Tissue Dead Animal	7,195	0

Researchers, when submitting their applications, estimated the number of juvenile and adult CVS Chinook that may be handled and killed during the year. Additionally, to account for the dynamic and potentially increasing scope of research that may annually affect listed CVS

Chinook, we increased the requested take and requested mortality in this evaluation by 10 percent (Table 72). Although it is difficult to anticipate how much more research may be requested, NMFS believes this 10 percent would be sufficient to include any changes or additions. The table below compares the total requested take, plus the 10 percent buffer, to the species' estimated abundance. Activities that would observe/harass Chinook, or sample dead fish, are not expected to affect the species' abundance, productivity, distribution, or diversity, therefore, we do not include them in the table below.

Table 72. Total requested take, plus the 10 percent buffer, compared to the estimated abundance of CVS Chinook.

Life Stage	Origin	Total Take plus 10%	Percent of ESU Handled	Requested Mortality plus 10%	Percent of ESU killed
Juvenile	Natural	470,910	61%	4,923	0.6%
Juvenile	Listed Hatchery Adipose Clip	10,439	0.5%	306	0.01%
Adult	Natural	108	3%	3	0.09%
Adult	Listed Hatchery Adipose Clip	195	9%	3	0.1%

The research projects proposed by CDFW may variously capture, handle, mark, tag, tissue sample, and release up to 61 percent of the expected abundance of naturally produced juvenile Chinook salmon. The majority (98 percent) of the take of juvenile steelhead is from screw traps in seven different locations throughout five basins of the Central California Valley. The research projects are designed to determine abundance of downstream migrating juvenile salmonids using mark/recapture techniques. Researchers recapture fish in the second screw trap and use the numbers of recaptured fish to determine abundance. Although a portion of the juvenile Chinook salmon in these projects would be marked and tissue sampled, the vast majority (98 percent) of the fish would only be handled and released. Of all the capture methods employed by researchers, screw traps are one of the most efficient and have some of the lowest mortality rates. The average mortality rate reported by researchers using screw traps to capture juvenile CVS Chinook salmon is eight-tenths of a percent (2014-2018).

Researchers may also capture and variously handle, mark, tag, tissue sample and release 108 naturally produced and 195 adipose clipped hatchery adult Chinook salmon with no more than three mortalities for each.

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the effects of the proposed action considered herein are best seen in the context of the fish that may be killed. When compared to the abundance of the ESU (Percent of ESU), the potential mortality levels are very low (a maximum of six-tenths of a percent for naturally produced juveniles). Furthermore, the effects from all of the proposed research would be spread out over most of the major tributaries of the ESU. Thus, no population is likely to experience a disproportionate amount of these losses. Therefore, the research would likely have only a very small impact on abundance, a similarly small impact on productivity, and no measurable effect on spatial structure or diversity.

It is very likely that the effects of the program will be much lower than what we have evaluated. To account for year-to-year variation in species abundance, researchers factor in a modest overestimate of take. Our research tracking system reveals that for the past five years researchers, on average, ended up taking 17 percent of the naturally produced CVS Chinook they requested and the actual mortality was only 18 percent of requested.

An effect of the research that cannot be quantified is how it would help benefit and conserve the species. We expect the research actions to generate lasting benefits to conservation of the listed fish (see above example). The majority of the projects in CDFW's Program focus on monitoring and evaluating actions recommended for the conservation of the listed species. Full details about the program can be found in the state fishery agency submittal.

California Central Valley Steelhead

The specific projects and related take estimates are described in detail in CDFW's submittal (CDFW 2019) and that document is incorporated in full herein. The CDFW would conduct, oversee, or coordinate 37 projects that could take CCV steelhead. The proposed research involves activities that are not intended to harm or kill listed fish at all. However, any fish handling carries an inherent potential for causing or promoting stress, disease, injury, or death of the specimen. We have summarized the total proposed take in Table 73.

Table 73. Summary of proposed take of CCV steelhead.

Life Stage	Origin	Take Action	Requested Take	Requested Mortality
Juvenile	Natural	Capture/Handle/Release Fish	6,353	112
Juvenile	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	10,885	162
Juvenile	Natural	Intentional (Directed) Mortality	25	25
Juvenile	Natural	Observe/Harass	72,545	0
Juvenile	Listed Hatchery Adipose Clip	Capture/Handle/Release Fish	1,486	21
Juvenile	Listed Hatchery Adipose Clip	Capture/Mark, Tag, Sample Tissue/Release Live Animal	921	20
Juvenile	Listed Hatchery Adipose Clip	Intentional (Directed) Mortality	200	200
Juvenile	Listed Hatchery Adipose Clip	Observe/Harass	1,030	0
Adult	Natural	Capture/Handle/Release Fish	227	5
Adult	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	1,351	13
Adult	Natural	Observe/Harass	6,817	0
Adult	Listed Hatchery Adipose Clip	Capture/Handle/Release Fish	143	2
Adult	Listed Hatchery Adipose Clip	Capture/Mark, Tag, Sample Tissue/Release Live Animal	229	7

Life Stage	Origin	Take Action	Requested Take	Requested Mortality
Adult	Listed Hatchery Adipose Clip	Observe/Harass	3,570	0
Spawned Adult/Carcass	Natural	Observe/Sample Tissue Dead Animal	367	0
Spawned Adult/Carcass	Listed Hatchery Adipose Clip	Observe/Sample Tissue Dead Animal	77	0

Researchers, when submitting their applications, estimated the number of juvenile and adult CCV steelhead that may be handled and killed during the year. Additionally, to account for the dynamic and potentially increasing scope of research that may annually affect listed CCV steelhead, we increased the requested take and requested mortality in this evaluation by 10 percent (Table 74). Although it is difficult to anticipate how much more research may be requested, NMFS believes this 10 percent would be sufficient to include any changes or additions. The table below compares the total requested take, plus the 10 percent buffer, to the species' estimated abundance. Activities that would observe/harass steelhead, or sample dead fish, are not expected to affect the species' abundance, productivity, distribution, or diversity, therefore, we do not include them in the table below.

Table 74. Total requested take, plus the 10 percent buffer, compared to the estimated abundance of CCV steelhead.

Life Stage	Origin	Total Take plus 10%	Percent of ESU Handled	Requested Mortality plus 10%	Percent of ESU killed
Juvenile	Natural	18,989	3%	329	0.05%
Juvenile	LHAC	2,868	0.2%	265	0.02%
Adult	Natural	1,736	103%	20	1%
Adult	LHAC	409	11%	10	0.3%

Researchers may variously capture, handle, mark, tag, tissue sample, and release up to 18,989 naturally produced juvenile steelhead and kill, at most, two percent of those fish. Researchers may also capture and variously handle, mark, tag, tissue sample and release up to 1,736 naturally produced adult steelhead and kill, at most, one percent of those fish. The effects of this research would be dispersed throughout the DPS; researcher targeting adult steelhead would take place in seven different basins of the California central valley.

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the effects of the proposed action considered herein are best seen in the context of the fish that may be killed. When compared to the abundance of the DPS (Percent of DPS), the potential mortality levels are very low (a maximum of five-hundredths of a percent for naturally produced juveniles and one percent for adults). Furthermore, the effects from all of the proposed research would be spread out over most of the major tributaries of the DPS. Thus, no population is likely to experience a disproportionate amount of these losses. Therefore, the research would likely have only a very small impact on abundance, a similarly small impact on productivity, and no measurable effect on spatial structure or diversity.

It is very likely that the effects of the program will be much lower than what we have evaluated. To account for year-to-year variation in species abundance, researchers factor in a modest overestimate of take. Our research tracking system reveals that for the past five years researchers, on average, ended up taking nine percent of the naturally produced juvenile CCV steelhead they requested and the actual mortality was only seven percent of requested. Our research tracking system also reveals that for the same time period researchers, on average, ended up taking 16 percent of the naturally produced adult CCV steelhead they requested and the actual mortality was only four percent of requested.

An effect of the research that cannot be quantified is how it would help benefit and conserve the species. We expect the research actions to generate lasting benefits to conservation of the listed fish (see above example). The majority of the projects in CDFW's Program focus on monitoring and evaluating actions recommended for the conservation of the listed species. Full details about the program can be found in the state fishery agency submittal.

South-Central California Coast Steelhead

The specific projects and related take estimates are described in detail in CDFW's submittal (CDFW 2019) and that document is incorporated in full herein. The CDFW would conduct, oversee, or coordinate nine projects that could take SCCC steelhead. The proposed research involves activities that are not intended to harm or kill listed fish at all. However, any fish handling carries an inherent potential for causing or promoting stress, disease, injury, or death of the specimen. We have summarized the total proposed take in Table 75.

Table 75. Summary of proposed take of SCCC steelhead.

Life Stage	Origin	Take Action	Requested Take	Requested Mortality
Juvenile	Natural	Capture/Handle/Release Fish	6,200	77
Juvenile	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	5,325	73
Juvenile	Natural	Observe/Harass	3,395	0
Adult	Natural	Capture/Handle/Release Fish	712	2
Adult	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	175	2
Adult	Natural	Observe/Harass	693	0
Spawned Adult/Carcass	Natural	Observe/Sample Tissue Dead Animal	85	0
Spawned Adult/Carcass	Natural	Observe/Harass	7	0
Spawned Adult/Carcass	Natural	Collect, Sample, and Transport Live Animal	10	0

Researchers, when submitting their applications, estimated the number of juvenile and adult SCCC steelhead that may be handled and killed during the year. Additionally, to account for the dynamic and potentially increasing scope of research that may annually affect listed SCCC steelhead, we increased the requested take and requested mortality in this evaluation by 10 percent (Table 76). Although it is difficult to anticipate how much more research may be requested, NMFS believes this 10 percent would be sufficient to include any changes or additions. The table below compares the total requested take, plus the 10 percent buffer, to the species' estimated abundance. Activities that would observe/harass steelhead, or sample dead fish, are not expected to affect the species' abundance, productivity, distribution, or diversity, therefore, we do not include them in the table below.

Table 76. Total requested take, plus the 10 percent buffer, compared to the estimated abundance of SCCC steelhead.

Life Stage	Origin	Total Take plus 10%	Percent of ESU Handled	Requested Mortality plus 10%	Percent of ESU killed
Juvenile	Natural	12,678	16%	165	0.2%
Adult	Natural	976	140%	4	0.6%

Researchers may variously capture, handle, mark, tag, tissue sample, and release up to 12,678 juvenile steelhead and kill, at most, one percent of those fish. The majority of these fish (45 percent) would be captured from the Carmel River during summer-time low flows and held temporarily in an artificial stream channel adjacent to the river. Efforts are underway to restore stream flows in the Carmel River, and in the interim this program will help to ensure that adequate numbers of juvenile steelhead survive through the summer. Researchers may also capture and variously handle, mark, tag, tissue sample and release up to 976 adult steelhead with no anticipated mortalities.

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the effects of the proposed action considered herein are best seen in the context of the fish that may be killed. When compared to the abundance of the DPS (Percent of DPS), the potential mortality levels are very low (a maximum of two-tenths of a percent for juveniles and six-tenths of a percent for adults). Furthermore, the effects from all of the proposed research would be spread out over most of the major tributaries of the DPS. Thus, no population is likely to experience a disproportionate amount of these losses. Therefore, the research would likely have only a very small impact on abundance, a similarly small impact on productivity, and no measurable effect on spatial structure or diversity.

It is very likely that the effects of the program will be much lower than what we have evaluated. To account for year-to-year variation in species abundance, researchers factor in a modest overestimate of take. Our research tracking system reveals that for the past five years researchers, on average, ended up taking 11 percent of the SCCC steelhead they requested and the actual mortality was only three percent of requested.

An effect of the research that cannot be quantified is how it would help benefit and conserve the species. We expect the research actions to generate lasting benefits to conservation of the listed fish (see above example). The majority of the projects in CDFW's Program focus on monitoring and evaluating actions recommended for the conservation of the listed species. Full details about the program can be found in the state fishery agency submittal.

Green Sturgeon

The specific projects and related take estimates are described in detail in the CDFW, ODFW, and WDFW submittals (CDFW 2019, ODFW 2019, and WDFW 2019) and in individual project applications; those records are incorporated in full herein. The agencies would conduct, oversee, or coordinate 22 projects that could take listed green sturgeon. The proposed research involves activities that are not intended to harm juveniles or adults, except for a small amount of intentional mortality of eggs. Any fish handling carries an inherent potential for causing or promoting stress, disease, injury, or death of the specimen. We have summarized the total proposed take in Table 77.

Table 77. Summary of requested take of green sturgeon by take action for the 2020 Program.

Life Stage	Take Action	Requested Take	Requested Mortality
Egg	Intentional (Directed) Mortality	560	0
Larvae	Capture/Handle/Release Fish	160	33
Juvenile	Capture/Handle/Release Fish	53	2
Juvenile	Observe/Harass	29	0
Adult	Capture/Handle/Release Fish	31	1
Adult	Capture/Mark, Tag, Sample Tissue/Release Live Animal	320	6
Adult	Observe/Harass	579	0

Researchers, when submitting their applications, estimated the number of green sturgeon that may be handled and killed during the year. Additionally, to account for the dynamic and potentially increasing scope of research that may annually affect listed green sturgeon, we increased the requested take and requested mortality in this evaluation by 10 percent (Table 78). Although it is difficult to anticipate how much more research may be requested, NMFS believes this 10 percent buffer would be sufficient to include any changes or additions. The table below compares the total requested take, plus the 10 percent buffer, to the species' estimated abundance. Activities that would observe/harass sturgeon are not expected to affect the species' abundance, productivity, distribution, or diversity; therefore, we do not include them in the table below.

Table 78. Summary of total proposed take of green sturgeon for the 2020 Program.

Life Stage	Requested Take plus 10%	Percent of DPS Handled	Requested Mortality plus 10%	Percent of ESU Killed
Egg	616	See discussion	616	See discussion
Larvae	176	See discussion	36	See discussion

Life Stage	Requested Take plus 10%	Percent of DPS Handled	Requested Mortality plus 10%	Percent of ESU Killed
Juvenile	58	0.4%	2	0.01%
Adult	386	18%	8	0.4%

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the effects of the proposed action considered herein are best seen in the context of the fish that may be killed. The 2020 Program may kill up to 616 eggs and 36 larvae. The annual abundance of green sturgeon eggs and larvae is currently unknown due to a lack of knowledge of the survival rate of early life history stages of green sturgeon. However, given an annual adult estimate of 2,106 individuals, and a mean green sturgeon fecundity of 142,000 (Van Eenennaam et al. 2001), it can be safely assumed that 616 egg mortalities and 36 larval mortalities would represent a very small fraction of the annual abundance of those life stages for the DPS.

Researchers would capture juvenile and adult green sturgeon and variously mark, tag, or tissue sample the fish before releasing them (Table 50). Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the effects of the proposed action considered herein are best seen in the context of the fish that may be killed. When compared to the abundance of the DPS (Percent of DPS), the potential mortality levels are very low (a maximum of one-hundredth of a percent for juveniles and four-tenths of a percent for adults). Furthermore, the effects from all of the proposed research would be spread out over most of the major tributaries of the DPS. Thus, no portion of the DPS is likely to experience a disproportionate amount of these losses. Therefore, the research would likely have only a very small impact on abundance, a similarly small impact on productivity, and no measurable effect on spatial structure or diversity.

An effect of the research that cannot be quantified is how it would help benefit and conserve the species. We expect the research actions to generate lasting benefits to conservation of the listed fish. The majority of the projects in the 2020 Program focus on monitoring and evaluating actions recommended for the conservation of the listed species, and some projects are beginning to monitor population abundance and trends.

Eulachon

The specific projects and their effects on eulachon are described in detail in three of the state fishery agency submittals (CDFW 2019, ODFW 2019, and WDFW 2019) and those documents are incorporated in full herein. The three agencies would conduct 24 projects that could take eulachon. None of the planned research involves activities that are intended to kill eulachon. However, any fish handling carries an inherent potential for causing or promoting stress, disease, injury, or death of the specimen. For 2020, the research programs may take up to 1,884 adult eulachon and kill no more than 80. The projects may also take 1,100 post spawn adult eulachon. Activities that would take post spawn eulachon are not expected to affect the species' abundance, productivity, distribution, or diversity, therefore, we do not include them in our analysis of effects.

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the effects of the proposed action considered herein are best seen in the context of the fish that may be killed. When compared to a DPS abundance of roughly 18 million eulachon, the death of 80 adult eulachon represents a negligible loss (four ten-thousands of a percent) of that total. That’s about two out of every one million fish. Furthermore, the effects from all of the proposed research would be spread out over various river systems in California, Oregon, and Washington. Thus, no population is likely to experience a disproportionate amount of these losses. Therefore, the research would likely have only a very small impact on abundance, a similarly small impact on productivity, and no measurable effect on spatial structure or diversity.

An effect of the research that cannot be quantified is how it would help benefit and conserve the species. Several of the projects that may take eulachon are assessing habitat conditions and monitoring restoration activities. We expect the research actions to generate lasting benefits to conservation of all listed fish species. The majority of the projects in the Programs focus on monitoring and evaluating actions recommended for the conservation of the listed species. Full details about the programs can be found in the state fishery agency submittals.

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 402.02 402.17(a)). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action area’s future environmental conditions caused by global climate change that are properly part of the environmental baseline versus cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the environmental baseline (Section 2.4).

Because the action area falls 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.

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.[3] 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 2.2.2). The result of that review was that salmon take—particularly associated with research, monitoring, and habitat restoration—is likely to continue to increase in the region for the foreseeable future. However, as noted above, all actions falling in those categories would also have to undergo consultation (like that in this opinion) before they are allowed to proceed.

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

2.6.1 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

[3] NOAA Fisheries – West Coast Region - 2016 Status Reviews of Listed Salmon & Steelhead

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.

2.6.2 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.[4] 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,[5] 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).[6] And, though Eastern Washington has also seen some population increase, it has largely been restricted to the population centers rather than the rural areas.[7] 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.

2.6.3 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%

[4] Idaho State Journal June 2, 2013 "Idaho's rural population continues to shrink"

[5] Portland State University "Annual Oregon Population Report"

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

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

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.

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.

2.6.4 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.

2.7 Integration and Synthesis

2.7.1 Critical Habitat

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

2.7.2 Salmon and Steelhead

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.

The assessments are also made in consideration of the other research that has been authorized and that may affect the various listed species (Table 32). The reasons we integrate the proposed take in the permits considered here with the take from other 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 sections therefore add the take proposed by CDFW, IDFG, ODFW, and WDFW to the research take that has already been authorized in the region and then compare those totals to the estimated annual abundance of each species under consideration.

Puget Sound Chinook salmon

When combined with scientific research and monitoring permits already approved (see section 2.4 Environmental Baseline), the total authorized take would be as much as 16 percent of the estimated abundance of naturally produced juvenile PS Chinook salmon and four percent for naturally produced adult PS Chinook salmon (Table 79).

Table 79. Total expected take of PS Chinook salmon for scientific research and monitoring already approved for 2020 plus the actions covered in this Biological Opinion.

Life Stage	Origin	Requested take plus the baseline	Percent of abundance*	Requested mortality plus the baseline	Percent of abundance*
Juvenile	Natural	499,326	16%	10,466	0.3%
Juvenile	Listed Hatchery Intact Adipose	89,492	1%	3,003	0.04%
Juvenile	Listed hatchery adipose clipped	283,761	0.8%	12,228	0.03%
Adult	Natural	987	4%	33	0.1%
Adult	Listed Hatchery Intact Adipose	947	16%	11	0.5%
Adult	Listed hatchery adipose clipped	1,522		70	

* We do not have separate abundance estimates for adipose clipped and intact adipose adult hatchery salmonids.

The majority of fish handled subsequently recover shortly after handling with no adverse physiological, behavioral, or reproductive effects (no more than two percent of the total requested take of naturally produced Chinook is lethal). So, the effect of all actions we consider here is the potential mortality, and when requested take is combined with the baseline, the potential mortality would equal no more than three-tenths of a percent for naturally produced juveniles and one-tenth of a percent of the abundance for naturally produced adults. Thus, the projected total lethal take for all research and monitoring activities represent only fractions of a percent of the species' total abundance. And the activities contemplated in this opinion represent less than half of that already small number.

In addition, the true numbers of fish that would actually be taken would almost certainly be smaller than the amounts authorized. First, we develop conservative estimates of juvenile abundance, as described in Section 2.2 above. Second, as noted repeatedly in the effects section, the researchers generally request more take than they estimate will actually occur and, to that requested amount of take, we add a 10 percent buffer. It is therefore very likely that researchers will take fewer fish than estimated. Our research tracking system for the 4(d) Limit 7 program reveals that on average researches only take about 37 percent of the naturally produced PS Chinook they request and the actual (reported) mortality is only 42 percent of requested mortality.

Third, many of the fish that may be affected will be in the smolt stage, but others definitely will not be. These latter would simply be described as "juveniles," which means they may actually be yearlings, parr, or even fry: life stages represented by many more individuals than reach the smolt stage—perhaps as much as an order of magnitude more. Therefore, we derived the percentages by (a) overestimating the number of adult and juvenile fish likely to be taken, (b) conservatively estimating the actual number of juveniles and adults, and (c) treating each juvenile fish as part of the same year class. Thus, the actual numbers of fish likely to be killed represent fractions of the numbers stated above. Still, if even the worst case were to occur and the researchers were to take the maximum estimated number of fish, the effects of the losses would be very small, and because they would be spread out over the species' entire range, they would be restricted to reductions in the species' total abundance and productivity (that is, the effects on structure and diversity would be unmeasurably small and not assignable to any individual population). Moreover, to some degree, the small reductions in abundance and productivity would be offset by the information to be gained—information that in most cases would be directly used to protect salmon and steelhead and promote their recovery.

Puget Sound Steelhead

When combined with scientific research and monitoring permits already approved (see section 2.4 Environmental Baseline), the total authorized take would be as much as three percent of the estimated abundance of naturally produced juvenile PS steelhead and 10 percent for naturally produced adult PS steelhead (Table 80).

Table 80. Total expected take of PS steelhead for scientific research and monitoring already approved for 2020 plus the actions covered in this Biological Opinion.

Life Stage	Origin	Requested take plus the baseline	Percent of abundance*	Requested mortality plus the baseline	Percent of abundance*
Juvenile	Natural	63,826	3%	1,395	0.06%

Life Stage	Origin	Requested take plus the baseline	Percent of abundance*	Requested mortality plus the baseline	Percent of abundance*
Juvenile	Listed Hatchery Intact Adipose	1,895	2%	32	0.03%
Juvenile	Listed Hatchery Adipose Clipped	4,400	4%	86	0.08%
Adult	Natural	2,005	10%	39	0.2%
Adult	Listed Hatchery Intact Adipose	22		0	

*We do not have separate abundance estimates for naturally produced and hatchery adult steelhead.

The majority of fish handled subsequently recover shortly after handling with no adverse physiological, behavioral, or reproductive effects (no more than two percent of the total requested take of naturally produced steelhead is lethal). So, the effect of all actions we consider here is the potential mortality, and when requested take is combined with the baseline, the potential mortality would be no more than two-tenths of a percent of the abundance for naturally produced adults or juveniles. Thus, the projected total lethal take for all research and monitoring activities represent only fractions of a percent of the species' total abundance.

In addition, the true numbers of fish that would actually be taken would almost certainly be smaller than the amounts authorized. First, we develop conservative estimates of juvenile abundance, as described in Section 2.2 above. Second, as noted repeatedly in the effects section, the researchers generally request more take than they estimate will actually occur and, to that requested amount of take, we add a 10 percent buffer. It is therefore very likely that researchers will take fewer fish than estimated. Our research tracking system for the 4(d) Limit 7 program reveals that on average researches only take about 26 percent of the naturally produced PS steelhead they request and the actual (reported) mortality is only eight percent of requested mortality.

Third, many of the fish that may be affected will be in the smolt stage, but others definitely will not be. These latter would simply be described as "juveniles," which means they may actually be yearlings, parr, or even fry: life stages represented by many more individuals than reach the smolt stage—perhaps as much as an order of magnitude more. Therefore, we derived the percentages by (a) overestimating the number of adult and juvenile fish likely to be taken, (b) conservatively estimating the actual number of juveniles and adults, and (c) treating each juvenile fish as part of the same year class. Thus, the actual numbers of fish likely to be killed represent fractions of the numbers stated above. Still, if even the worst case were to occur and the researchers were to take the maximum estimated number of fish, the effects of the losses would be very small, and because they would be spread out over the species' entire range, they would be restricted to reductions in the species' total abundance and productivity (that is, the effects on structure and diversity would be unmeasurably small and not assignable to any individual population). Moreover, to some degree, the small reductions in abundance and productivity would be offset by the information to be gained—information that in most cases would be directly used to protect salmon and steelhead and promote their recovery.

Hood Canal Summer-run Chum Salmon

When combined with scientific research and monitoring permits already approved (see section 2.4 Environmental Baseline), the total authorized take would be as much as 19 percent of the estimated abundance of naturally produced juvenile HCS chum salmon and eight percent for naturally produced adult HCS chum salmon (Table 81).

Table 81. Total expected take of HCS chum salmon for scientific research and monitoring already approved for 2020 plus the actions covered in this Biological Opinion.

Life Stage	Origin	Requested take plus the baseline	Percent of abundance	Requested mortality plus the baseline	Percent of abundance
Juvenile	Natural	726,682	19%	2,529	0.07%
Juvenile	Listed Hatchery Intact Adipose	135	0.09%	3	0.002%
Adult	Natural	2,002	8%	27	0.1%

The majority of fish handled subsequently recover shortly after handling with no adverse physiological, behavioral, or reproductive effects (no more than four-tenths of a percent of the total requested take of chum is lethal). So, the effect of all actions we consider here is the potential mortality, and when requested take is combined with the baseline, the potential mortality would equal no more than one-tenth of a percent of the abundance for naturally produced adults or juveniles. Thus, the projected total lethal take for all research and monitoring activities represents only fractions of a percent of the species' total abundance.

In addition, the true numbers of fish that would actually be taken would almost certainly be smaller than the amounts authorized. First, we develop conservative estimates of juvenile abundance, as described in Section 2.2 above. Second, as noted repeatedly in the effects section, the researchers generally request more take than they estimate will actually occur and, to that requested amount of take, we add a 10 percent buffer. It is therefore very likely that researchers will take fewer fish than estimated. Our research tracking system for the 4(d) Limit 7 program reveals that on average researches only take about 67 percent of the naturally produced HCS chum salmon they request and the actual (reported) mortality is only 15 percent of requested mortality. Therefore, we derived the percentages by overestimating the number of adult and juvenile fish likely to be taken and conservatively estimating the actual number of juveniles and adults. Thus, the actual numbers of fish likely to be killed represent fractions of the numbers stated above. Still, if even the worst case were to occur and the researchers were to take the maximum estimated number of fish, the effects of the losses would be very small, and because they would be spread out over the species' entire range, they would be restricted to reductions in the species' total abundance and productivity (that is, the effects on structure and diversity would be unmeasurably small and not assignable to any individual population). Moreover, to some degree, the small reductions in abundance and productivity would be offset by the information to be gained—information that in most cases would be directly used to protect salmon and steelhead and promote their recovery.

Upper Columbia River Steelhead

When combined with scientific research and monitoring permits already approved (see section 2.4 Environmental Baseline), the total authorized take would be 24 percent of the estimated abundance of naturally produced juvenile UCR steelhead (Table 82).

Table 82. Total expected take of UCR steelhead for scientific research and monitoring already approved for 2020 plus the actions covered in this Biological Opinion.

Life Stage	Origin	Requested take plus the baseline	Percent of abundance	Requested mortality plus the baseline	Percent of abundance
Juvenile	Natural	47,233	24%	963	0.5%

The majority of fish handled subsequently recover shortly after handling with no long-term ill effects. So, the effect of all actions we consider here is the potential mortality, and when requested take is combined with the baseline, the potential mortality would equal no more than half a percent of the abundance for juveniles. Thus, the projected total lethal take for all research and monitoring activities represent only fractions of a percent of the species' total abundance. And the activities contemplated in this opinion represent only fractions of those already small numbers.

In addition, the true numbers of fish that would actually be taken would almost certainly be smaller than the amounts authorized. First, we develop conservative estimates of juvenile abundance, as described in Section 2.2 above. Second, as noted repeatedly in the effects section, the researchers generally request more take than they estimate will actually occur and, to that requested amount of take, we add a 10 percent buffer. It is therefore very likely that researchers will take fewer fish than estimated. Our research tracking system for the 4(d) Limit 7 program reveals that the actual (reported) mortality for juvenile UCR steelhead is only one percent of requested mortality. Third, many of the fish that may be affected will be in the smolt stage, but others definitely will not be. These latter would simply be described as "juveniles," which means they may actually be yearlings, parr, or even fry: life stages represented by multiple spawning years and many more individuals than reach the smolt stage—perhaps as much as an order of magnitude more. Therefore, we derived the percentages by (a) overestimating the number of juvenile fish likely to be taken, (b) conservatively estimating the actual number of juveniles, and (c) treating each juvenile fish as part of the same year class. Thus, the actual numbers of fish likely to be killed represent fractions of the numbers stated above. Still, if even the worst case were to occur and the researchers were to take the maximum estimated number of fish, the effects of the losses would be very small, and because they would be spread out over the species' entire range, they would be restricted to reductions in the species' total abundance and productivity (that is, the effects on structure and diversity would be unmeasurably small and not assignable to any individual population). Moreover, to some degree, the small reductions in abundance and productivity would be offset by the information to be gained—information that in most cases would be directly used to protect salmon and steelhead and promote their recovery.

Middle Columbia River Steelhead

When combined with scientific research and monitoring permits already approved (see section

2.4 Environmental Baseline), the total authorized take would be as much as 27 percent for naturally produced juveniles and 29 percent for adults (Table 83).

Table 83. Total expected take of MCR steelhead for scientific research and monitoring already approved for 2020 plus the actions covered in this Biological Opinion.

Life Stage	Origin	Requested take plus the baseline	Percent of abundance*	Requested mortality plus the baseline	Percent of abundance*
Juvenile	Natural	109,975	27%	2,394	0.6%
Juvenile	Listed Hatchery Intact Adipose	322	0.3%	8	0.007%
Juvenile	Listed Hatchery Adipose Clip	900	0.2%	43	0.01%
Adult	Natural	1,470	29%	15	0.3%
Adult	Listed Hatchery Intact Adipose	39	34%	1	1%
Adult	Listed Hatchery Adipose Clip	931	208%	10	2%

* We do not have separate abundance estimates for adipose clipped and intact adipose adult hatchery salmonids.

The majority of fish handled subsequently recover shortly after handling with no adverse physiological, behavioral, or reproductive effects (no more than two percent of the total requested take of naturally produced fish is lethal). So, the effect of all actions we consider here is the potential mortality, and when requested take is combined with the baseline, the potential mortality would be no more than six-tenths of a percent of the abundance of naturally produced juvenile and adult steelhead. The potential mortality for listed hatchery fish would equal no more than one percent for adults or juveniles. Intact adipose fin listed hatchery fish are produced for conservation purposes, however adipose clipped hatchery fish are considered to be surplus to recovery needs. Thus, the projected total lethal take for all research and monitoring activities represent only fractions of a percent of the species' total abundance. And the activities contemplated in this opinion represent only fractions of those already small numbers.

In addition, the true numbers of fish that would actually be taken would almost certainly be smaller than the amounts authorized. First, we develop conservative estimates of juvenile abundance, as described in Section 2.2 above. Second, as noted repeatedly in the effects section, the researchers generally request more take than they estimate will actually occur and, to that requested amount of take, we add a 10 percent buffer. It is therefore very likely that researchers will take fewer fish than estimated. Our research tracking system for the 4(d) Limit 7 program reveals that on average researches only take about 29 percent of the naturally produced juvenile MCR steelhead they request and the actual (reported) mortality is only 13 percent of requested mortality. For naturally produced adult MCR steelhead, researchers only take about 29 percent of the fish they request and the actual (reported) mortality is only 13 percent of requested mortality.

Third, many of the fish that may be affected will be in the smolt stage, but others definitely will not be. These latter would simply be described as "juveniles," which means they may actually be yearlings, parr, or even fry: life stages represented by multiple spawning years and many more individuals than reach the smolt stage—perhaps as much as an order of magnitude more.

Therefore, we derived the percentages by (a) overestimating the number of adult and juvenile fish likely to be taken, (b) conservatively estimating the actual number of juveniles and adults, and (c) treating each juvenile fish as part of the same year class. Thus, the actual numbers of fish likely to be killed represent fractions of the numbers stated above. Still, if even the worst case were to occur and the researchers were to take the maximum estimated number of fish, the effects of the losses would be very small, and because they would be spread out over the species' entire range, they would be restricted to reductions in the species' total abundance and productivity (that is, the effects on structure and diversity would be unmeasurably small and not assignable to any individual population). Moreover, to some degree, the small reductions in abundance and productivity would be offset by the information to be gained—information that in most cases would be directly used to protect salmon and steelhead and promote their recovery.

SR Fall Chinook salmon

When combined with scientific research and monitoring permits already approved (see section 2.4 Environmental Baseline), the total authorized take would be as much as three-tenths of a percent of the estimated abundance of naturally produced juvenile SR fall Chinook salmon and two percent for naturally produced adult SR fall Chinook salmon (Table 84).

Table 84. Total expected take of SR fall Chinook salmon for scientific research and monitoring already approved for 2020 plus the actions covered in this Biological Opinion.

Life Stage	Origin	Requested take plus the baseline	Percent of abundance*	Requested mortality plus the baseline	Percent of abundance*
Juvenile	Natural	2,029	0.3%	112	0.02%
Juvenile	Listed Hatchery Intact Adipose	337	0.01%	35	0.001%
Juvenile	Listed hatchery adipose clipped	837	0.03%	139	0.006%
Adult	Natural	255	2%	7	0.07%
Adult	Listed Hatchery Intact Adipose	213	2%	2	0.01%
Adult	Listed hatchery adipose clipped	245	2%	6	0.04%

* We do not have separate abundance estimates for adipose clipped and intact adipose adult hatchery salmonids.

The majority of fish handled subsequently recover shortly after handling with no adverse physiological, behavioral, or reproductive effects (no more than five percent of the total requested take of Chinook is lethal). So, the effect of all actions we consider here is the potential mortality, and when requested take is combined with the baseline, the potential mortality would equal no more than seven-hundredths of a percent of the abundance for any life stage or origin. Thus, the projected total lethal take for all research and monitoring activities represents only fractions of a percent of the species' total abundance, and the activities contemplated in this opinion represent only fractions of those already small numbers.

In addition, the true numbers of fish that would actually be taken would almost certainly be smaller than the amounts authorized. First, we develop conservative estimates of juvenile abundance, as described in Section 2.2 above. Second, as noted repeatedly in the effects section, the researchers generally request more take than they estimate will actually occur and, to that requested amount of take, we add a 10 percent buffer. It is therefore very likely that researchers will take fewer fish than estimated. Our research tracking system for the 4(d) Limit 7 program reveals that on average researches only take about nine percent of the naturally produced SR fall Chinook they request and the actual (reported) mortality is only three percent of requested mortality. This would mean that the actual effect is likely to be fractions of the numbers stated in the table above.

Third, many of the juvenile fish that may be affected will be in the smolt stage, but others definitely will not be. These latter would simply be described as “juveniles,” which means they may actually be parr or fry: life stages represented by many more individuals than reach the smolt stage—perhaps as much as an order of magnitude more. Therefore, we derived the already small percentages by (a) conservatively estimating the actual number of juveniles, (b) overestimating the number of fish likely to be killed (both juvenile and adult), and (c) treating each dead juvenile fish as part of the same year class. Thus, the actual numbers of fish likely to be killed represent fractions of the numbers stated above. Still, if even the worst case were to occur and the researchers were to take the maximum estimated number of fish, the effects of the losses would be very small, they would be restricted to reductions in abundance and productivity (because the species has only one population), and to some degree they would be offset by the information to be gained—information that in most cases would be directly used to protect salmon and steelhead or promote their recovery.

SR spr/sum Chinook salmon

When combined with scientific research and monitoring permits already approved (see section 2.4 Environmental Baseline), the total authorized take would be as much as 76 percent of the estimated abundance of naturally produced juvenile SR spr/sum Chinook salmon and 21 percent for naturally produced adult SR spr/sum Chinook salmon (Table 85).

Table 85. Total expected take of SR spr/sum Chinook salmon for scientific research and monitoring already approved for 2020 plus the actions covered in this Biological Opinion.

Life Stage	Origin	Requested take plus the baseline	Percent of abundance*	Requested mortality plus the baseline	Percent of abundance*
Juvenile	Natural	764,046	76%	7,190	0.7%
Juvenile	Listed Hatchery Intact Adipose	45,827	6%	424	0.05%
Juvenile	Listed hatchery adipose clipped	84,529	2%	1,189	0.03%
Adult	Natural	2,650	21%	18	0.1%
Adult	Listed Hatchery Intact Adipose	786	187%	7	2%
Adult	Listed hatchery adipose clipped	2,001	84%	12	0.5%

* We do not have separate abundance estimates for adipose clipped and intact adipose adult hatchery salmonids.

The majority of fish handled subsequently recover shortly after handling with no adverse physiological, behavioral, or reproductive effects (only seven-tenths of a percent of the total requested take of Chinook is lethal). So, the effect of all actions we consider here is the potential mortality, and when requested take is combined with the baseline, the potential mortality would equal a maximum of seven-tenths of a percent of the abundance for naturally produced fish. Thus, the projected total lethal take for all research and monitoring activities represent only fractions of a percent of the species' total abundance.

In addition, the true numbers of fish that would actually be taken would almost certainly be smaller than the amounts authorized. First, we develop conservative estimates of juvenile abundance, as described in Section 2.2 above. Second, as noted repeatedly in the effects section, the researchers generally request more take than they estimate will actually occur and, to that requested amount of take, we add a 10 percent buffer. It is therefore very likely that researchers will take fewer fish than estimated. Our research tracking system reveals that for the past five years researchers, on average, ended up taking 57 percent of the number of adult fish they requested and the actual mortality was only four percent of requested. For juvenile fish, researchers have only taken 52 percent of the number of fish they requested and the actual mortality was only 13 percent of requested.

Third, many of the fish that may be affected will be in the smolt stage, but others definitely will not be. These latter would simply be described as "juveniles," which means they may actually be yearlings, parr, or even fry: life stages represented by multiple spawning years and many more individuals than reach the smolt stage—perhaps as much as an order of magnitude more. Therefore, we derived the percentages by (a) overestimating the number of adult and juvenile fish likely to be taken, (b) conservatively estimating the actual number of juveniles and adults, and (c) treating each juvenile fish as part of the same year class. Thus, the actual numbers of fish likely to be killed represent fractions of the numbers stated above. Still, if even the worst case were to occur and the researchers were to take the maximum estimated number of fish, the effects of the losses would be very small, and because they would be spread out over the species' entire range, they would be restricted to reductions in the species' total abundance and productivity (that is, the effects on structure and diversity would be unmeasurably small and not assignable to any individual population). Moreover, to some degree, the small reductions in abundance and productivity would be offset by the information to be gained—information that in most cases would be directly used to protect salmon and steelhead and promote their recovery.

Snake River Steelhead

When combined with scientific research and monitoring permits already approved (see section 2.4 Environmental Baseline), the total authorized take would be as much as 36 percent of the estimated abundance of naturally produced juvenile SR steelhead and 86 percent for naturally produced adult SR steelhead (Table 86).

Table 86. Total expected take of SR steelhead for scientific research and monitoring already approved for plus the actions covered in this Biological Opinion.

Life Stage	Origin	Requested take plus the baseline	Percent of abundance*	Requested mortality plus the baseline	Percent of abundance*
Juvenile	Natural	290,298	36%	3,670	0.5%
Juvenile	Listed Hatchery Intact Adipose	33,874	5%	367	0.05%
Juvenile	Listed hatchery adipose clipped	78,739	2%	909	0.03%
Adult	Natural	9,067	86%	117	1%
Adult	Listed Hatchery Intact Adipose	2,429	15%	38	0.2%
Adult	Listed hatchery adipose clipped	2,928	4%	45	0.06%

* We do not have separate abundance estimates for adipose clipped and intact adipose adult hatchery salmonids.

The majority of fish handled subsequently recover shortly after handling with no adverse physiological, behavioral, or reproductive effects (no more than one percent of the total requested take of naturally produced steelhead is lethal). So, the effect of all actions we consider here is the potential mortality, and when requested take is combined with the baseline, the potential mortality would equal no more than one percent of the abundance for naturally produced adults or juveniles. Thus, the projected total lethal take for all research and monitoring activities represent only a small fraction of the species' total abundance. And the activities contemplated in this opinion represent less than half of that already small number.

In addition, the true numbers of fish that would actually be taken would almost certainly be smaller than the amounts authorized. First, we develop conservative estimates of juvenile abundance, as described in Section 2.2 above. Second, as noted repeatedly in the effects section, the researchers generally request more take than they estimate will actually occur and, to that requested amount of take, we add a 10 percent buffer. It is therefore very likely that researchers will take fewer fish than estimated. Our research tracking system reveals that for the past 10 years researchers, on average, ended up taking 34 percent of the SR steelhead they requested and the actual mortality was only 14 percent of requested.

Third, many of the fish that may be affected will be in the smolt stage, but others definitely will not be. These latter would simply be described as "juveniles," which means they may actually be yearlings, parr, or even fry: life stages represented by multiple spawning years and many more individuals than reach the smolt stage—perhaps as much as an order of magnitude more. Therefore, we derived the percentages by (a) overestimating the number of adult and juvenile fish likely to be taken, (b) conservatively estimating the actual number of juveniles and adults, and (c) treating each juvenile fish as part of the same year class. Thus, the actual numbers of fish likely to be killed represent fractions of the numbers stated above. Still, if even the worst case were to occur and the researchers were to take the maximum estimated number of fish, the effects of the losses would be very small, and because they would be spread out over the species' entire range, they would be restricted to reductions in the species' total abundance and productivity (that is, the effects on structure and diversity would be unmeasurably small and not assignable to any individual population). Moreover, to some degree, the small reductions in abundance and productivity would be offset by the information to be gained—information that in most cases would be directly used to protect salmon and steelhead and promote their recovery.

Columbia River Chum Salmon

When combined with scientific research and monitoring permits already approved (see section 2.4 Environmental Baseline), the total take would be as much as six-tenths of a percent of the estimated abundance of juvenile naturally produced CR chum salmon and three-tenths of a percent for adults (Table 87).

Table 87. Total expected take of CR chum salmon for scientific research and monitoring already approved for 2020 plus the actions covered in this Biological Opinion.

Life Stage	Origin	Requested take plus the baseline	Percent of abundance	Requested mortality plus the baseline	Percent of abundance
Juvenile	Natural	39,168	0.6%	498	0.008%
Juvenile	Listed Hatchery Intact Adipose	567	0.09%	18	0.003%
Adult	Natural	36	0.3%	2	0.02%

The majority of fish handled subsequently recover shortly after handling with no adverse physiological, behavioral, or reproductive effects (no more than one percent of the total requested take is lethal). So, the effect of all actions we consider here is the potential mortality, and when requested take is combined with the baseline, the potential mortality would equal no more than two-hundredths of a percent of the abundance for any life stage or origin. Thus, the projected total lethal take for all research and monitoring activities represent only fractions of a percent of the species' total abundance. And the activities contemplated in this opinion represent less than half of that already small number.

In addition, the true numbers of fish that would actually be taken would almost certainly be smaller than the amounts authorized. First, we develop conservative estimates of juvenile abundance, as described in Section 2.2 above. Second, as noted repeatedly in the effects section, the researchers generally request more take than they estimate will actually occur and, to that requested amount of take, we add a 10 percent buffer. It is therefore very likely that researchers will take fewer fish than estimated. Our research tracking system reveals that for the past 10 years researchers, on average, ended up taking 33 percent of the CR chum they requested and the actual mortality was only 14 percent of requested. Therefore, we derived the percentages by overestimating the number of adult and juvenile fish likely to be taken and conservatively estimating the actual number of juveniles and adults. Thus, the actual numbers of fish likely to be killed represent fractions of the numbers stated above. Still, if even the worst case were to occur and the researchers were to take the maximum estimated number of fish, the effects of the losses would be very small, and because they would be spread out over the species' entire range, they would be restricted to reductions in the species' total abundance and productivity (that is, the effects on structure and diversity would be unmeasurably small and not assignable to any individual population). Moreover, to some degree, the small reductions in abundance and productivity would be offset by the information to be gained—information that in most cases would be directly used to protect salmon and steelhead and promote their recovery.

Lower Columbia River Chinook salmon

When combined with scientific research and monitoring permits already approved (see section 2.4 Environmental Baseline), the total authorized take would be seven percent of the estimated abundance of naturally produced juvenile LCR Chinook salmon and one percent of adults (Table 88).

Table 88. Total expected take of LCR Chinook salmon for scientific research and monitoring already approved for 2020 plus the actions covered in this Biological Opinion.

Life Stage	Origin	Requested take plus the baseline	Percent of abundance*	Requested mortality plus the baseline	Percent of abundance*
Juvenile	Natural	768,299	7%	10,589	0.09%
Juvenile	List Hatchery Intact Adipose	315	0.03%	36	0.004%
Juvenile	Listed Hatchery Adipose Clipped	53,917	0.2%	1,566	0.005%
Adult	Natural	312	1%	9	0.03%

* We do not have separate abundance estimates for adipose clipped and intact adipose adult hatchery salmonids.

The majority of fish handled subsequently recover shortly after handling with no adverse physiological, behavioral, or reproductive effects (only one percent of the total requested take of naturally produced fish is lethal). So, the effect of all actions we consider here is the potential mortality, and when the requested take is combined with the baseline, the potential mortality would equal no more than nine-hundredths of a percent of the abundance of any life stage or origin. Thus, the projected total lethal take for all research and monitoring activities represents only fractions of a percent of the species' total abundance.

In addition, the true numbers of fish that would actually be taken would almost certainly be smaller than the amounts authorized. First, we develop conservative estimates of juvenile abundance, as described in Section 2.2 above. Second, as noted repeatedly in the effects section, the researchers generally request more take than they estimate will actually occur and, to that requested amount of take, we add a 10 percent buffer. It is therefore very likely that researchers will take fewer fish than estimated. Our research tracking system reveals that for the past 10 years researchers, on average, ended up taking 30 percent of the LCR Chinook they requested and the actual mortality was only 23 percent of requested.

Third, many of the fish that may be affected will be in the smolt stage, but others definitely will not be. These latter would simply be described as "juveniles," which means they may actually be yearlings, parr, or even fry: life stages represented by many more individuals than reach the smolt stage—perhaps as much as an order of magnitude more. Therefore, we derived the percentages by (a) overestimating the number of adult and juvenile fish likely to be taken, (b) conservatively estimating the actual number of juveniles and adults, and (c) treating each juvenile fish as part of the same year class. Thus, the actual numbers of fish likely to be killed represent fractions of the numbers stated above. Still, if even the worst case were to occur and the researchers were to take the maximum estimated number of fish, the effects of the losses would be very small, and because they would be spread out over the species' entire range, they would be restricted to reductions in the species' total abundance and productivity (that is, the effects on structure and diversity would be unmeasurably small and not assignable to any individual population). Moreover, to some degree, the small reductions in abundance and productivity would be offset by the information to be gained—information that in most cases would be directly used to protect salmon and steelhead and promote their recovery.

Lower Columbia River Coho Salmon

When combined with scientific research and monitoring permits already approved (see section 2.4 Environmental Baseline), the total take would be 27 percent of the estimated abundance of naturally produced juvenile LCR coho salmon and five percent of adults (Table 89).

Table 89. Total expected take of LCR coho salmon for scientific research and monitoring already approved for 2020 plus the actions covered in this Biological Opinion.

Life Stage	Origin	Requested take plus the baseline	Percent of abundance*	Requested mortality plus the baseline	Percent of abundance*
Juvenile	Natural	180,218	27%	2,559	0.4%
Juvenile	List Hatchery Intact Adipose	560	0.2%	112	0.04%
Juvenile	Listed Hatchery Adipose Clipped	53,576	0.7%	1,857	0.03%
Adult	Natural	1,419	5%	14	0.05%
Adult	Listed Hatchery Adipose Clipped	577	7%	9	0.1%

* We do not have separate abundance estimates for adipose clipped and intact adipose adult hatchery salmonids.

The majority of fish handled subsequently recover shortly after handling with no adverse physiological, behavioral, or reproductive effects (no more than one percent of the total requested take is lethal). So, the effect of all actions we consider here is the potential mortality, and when requested take is combined with the baseline, the potential mortality would equal no more than four-tenths of a percent of the abundance for juveniles or adults. Thus, the projected total lethal take for all research and monitoring activities represent only fractions of a percent of the species' total abundance.

In addition, the true numbers of fish that would actually be taken would almost certainly be smaller than the amounts authorized. First, we develop conservative estimates of juvenile abundance, as described in Section 2.2 above. Second, as noted repeatedly in the effects section, the researchers generally request more take than they estimate will actually occur and, to that requested amount of take, we add a 10 percent buffer. It is therefore very likely that researchers will take fewer fish than estimated. Our research tracking system reveals that for the past 10 years researchers, on average, ended up taking 28 percent of the LCR coho they requested and the actual mortality was only 11 percent of requested.

Third, many of the fish that may be affected will be in the smolt stage, but others definitely will not be. These latter would simply be described as "juveniles," which means they may actually be yearlings, parr, or even fry: life stages represented by multiple spawning years and many more individuals than reach the smolt stage—perhaps as much as an order of magnitude more. Therefore, we derived the percentages by (a) overestimating the number of adult and juvenile fish likely to be taken, (b) conservatively estimating the actual number of juveniles and adults, and (c) treating each juvenile fish as part of the same year class. Thus, the actual numbers of fish likely to be killed represent fractions of the numbers stated above. Still, if even the worst case were to occur and the researchers were to take the maximum estimated number of fish, the effects of the losses would be very small, and because they would be spread out over the species' entire range, they would be restricted to reductions in the species' total abundance and productivity (that is, the effects on structure and diversity would be unmeasurably small and not assignable to any individual population). Moreover, to some degree, the small reductions in abundance and productivity would be offset by the information to be gained—information that in most cases would be directly used to protect salmon and steelhead and promote their recovery.

Lower Columbia River Steelhead

When combined with scientific research and monitoring permits already approved (see section 2.4 Environmental Baseline), the total take would be 19 percent of the estimated abundance of naturally produced juvenile LCR coho salmon and 22 percent of adults (Table 90).

Table 90. Total expected take of LCR steelhead for scientific research and monitoring already approved for 2020 plus the actions covered in this Biological Opinion.

Life Stage	Origin	Requested take plus the baseline	Percent of abundance	Requested mortality plus the baseline	Percent of abundance
Juvenile	Natural	68,657	19%	1,183	0.3%
Juvenile	Listed Hatchery Adipose Clipped	41,026	3%	619	0.05%
Adult	Natural	2,832	22%	30	0.2%

The majority of fish handled subsequently recover shortly after handling with no adverse physiological, behavioral, or reproductive effects (no more than two percent of the total requested take of naturally produced fish is lethal). So, the effect of all actions we consider here is the potential mortality, and when requested take is combined with the baseline, the potential mortality would equal no more than three-tenths of a percent of the abundance for adults or juveniles. Thus, the projected total lethal take for all research and monitoring activities represent only fractions of a percent of the species' total abundance.

In addition, the true numbers of fish that would actually be taken would almost certainly be smaller than the amounts authorized. First, we develop conservative estimates of juvenile abundance, as described in Section 2.2 above. Second, as noted repeatedly in the effects section, the researchers generally request more take than they estimate will actually occur and, to that requested amount of take, we add a 10 percent buffer. It is therefore very likely that researchers will take fewer fish than estimated. Our research tracking system reveals that for the past 10 years researchers, on average, ended up taking 26 percent of the LCR steelhead they requested and the actual mortality was only 11 percent of requested.

Third, many of the fish that may be affected will be in the smolt stage, but others definitely will not be. These latter would simply be described as “juveniles,” which means they may actually be yearlings, parr, or even fry: life stages represented by multiple spawning years and many more individuals than reach the smolt stage—perhaps as much as an order of magnitude more. Therefore, we derived the percentages by (a) overestimating the number of adult and juvenile fish likely to be taken, (b) conservatively estimating the actual number of juveniles and adults, and (c) treating each juvenile fish as part of the same year class. Thus, the actual numbers of fish likely to be killed represent fractions of the numbers stated above. Still, if even the worst case were to occur and the researchers were to take the maximum estimated number of fish, the effects of the losses would be very small, and because they would be spread out over the species’ entire range, they would be restricted to reductions in the species’ total abundance and productivity (that is, the effects on structure and diversity would be unmeasurably small and not assignable to any individual population). Moreover, to some degree, the small reductions in abundance and productivity would be offset by the information to be gained—information that in most cases would be directly used to protect salmon and steelhead and promote their recovery.

Researchers may also handle both naturally produced and listed hatchery post-spawn adults. As many as 136 naturally produced post-spawn adults may be taken in 2020. Although steelhead may spawn more than once, repeat spawning is relatively uncommon and repeat spawners are predominately female (Busby et al. 1996). For those spawned adults that are still alive survival is relatively low and these fish have already contributed to the next generation. Therefore, any deaths of post-spawn fish during handling are not considered to be a result of the research, nor, is the research targeting the post-spawn fish expected to have any effect on the species’ abundance, productivity, diversity, or spatial structure.

Upper Willamette River Chinook salmon

When combined with scientific research and monitoring permits already approved (see section 2.4 Environmental Baseline), the total take would range from two-tenths of a percent to three percent of estimated species abundance (Table 91).

Table 91. Total expected take of UWR Chinook salmon for scientific research and monitoring already approved for 2020 plus the actions covered in this Biological Opinion.

Life Stage	Origin	Requested take plus the baseline	Percent of abundance	Requested mortality plus the baseline	Percent of abundance
Juvenile	Natural	45,952	4%	727	0.06%
Juvenile	Listed Hatchery Intact Adipose	46	1%	3	0.07%
Juvenile	Listed Hatchery Adipose Clipped	9,870	0.2%	300	0.006%
Adult	Natural	200	2%	2	0.02%
Adult	Listed Hatchery Adipose Clipped	150	0.5%	3	0.01%

The majority of fish handled subsequently recover shortly after handling with no adverse physiological, behavioral, or reproductive effects (two percent of the total requested take of naturally produced fish is lethal). So, the effect of all actions we consider here is the potential mortality, and when requested take is combined with the baseline, the potential mortality would equal no more than seven-hundredths of a percent of the abundance for any life stage or origin. Thus, the projected total lethal take for all research and monitoring activities represent only fractions of a percent of the species' total abundance.

In addition, the true numbers of fish that would actually be taken would almost certainly be smaller than the amounts authorized. First, we develop conservative estimates of juvenile abundance, as described in Section 2.2 above. Second, as noted repeatedly in the effects section, the researchers generally request more take than they estimate will actually occur and, to that requested amount of take, we add a 10 percent buffer. It is therefore very likely that researchers will take fewer fish than estimated. Our research tracking system reveals that for the past 10 years researchers, on average, ended up taking 14 percent of the UWR steelhead they requested and the actual mortality was only one percent of requested.

Third, many of the fish that may be affected will be in the smolt stage, but others definitely will not be. These latter would simply be described as "juveniles," which means they may actually be yearlings, parr, or even fry: life stages represented by many more individuals than reach the smolt stage—perhaps as much as an order of magnitude more. Therefore, we derived the percentages by (a) overestimating the number of adult and juvenile fish likely to be taken, (b) conservatively estimating the actual number of juveniles and adults, and (c) treating each juvenile fish as part of the same year class. Thus, the actual numbers of fish likely to be killed represent fractions of the numbers stated above. Still, if even the worst case were to occur and the researchers were to take the maximum estimated number of fish, the effects of the losses would be very small, and because they would be spread out over the species' entire range, they would be restricted to reductions in the species' total abundance and productivity (that is, the effects on structure and diversity would be unmeasurably small and not assignable to any individual population). Moreover, to some degree, the small reductions in abundance and productivity would be offset by the information to be gained—information that in most cases would be directly used to protect salmon and steelhead and promote their recovery.

Upper Willamette River Steelhead

When combined with scientific research and monitoring permits already approved (see section 2.4 Environmental Baseline), the total take would be no more than nine percent of estimated species abundance (Table 92).

Table 92. Total expected take of UWR steelhead for scientific research and monitoring already approved for 2020 plus the actions covered in this Biological Opinion.

Life Stage	Origin	Requested take plus the baseline	Percent of abundance	Requested mortality plus the baseline	Percent of abundance
Juvenile	Natural	12,447	9%	248	0.2%

Life Stage	Origin	Requested take plus the baseline	Percent of abundance	Requested mortality plus the baseline	Percent of abundance
Adult	Natural	226	8%	2	0.08%

The majority of fish handled subsequently recover shortly after handling with no adverse physiological, behavioral, or reproductive effects (no more than two percent of the total requested take of naturally produced fish is lethal). So, the effect of all actions we consider here is potential mortality, and when requested take is combined with the baseline, the potential mortality would be no more than two-tenths of a percent of the abundance for adults or juveniles. Thus, the projected total lethal take for all research and monitoring activities represent only fractions of a percent of the species' total abundance.

In addition, the true numbers of fish that would actually be taken would almost certainly be smaller than the amounts authorized. First, we develop conservative estimates of juvenile abundance, as described in Section 2.2 above. Second, as noted repeatedly in the effects section, the researchers generally request more take than they estimate will actually occur and, to that requested amount of take, we add a 10 percent buffer. It is therefore very likely that researchers will take fewer fish than estimated. Our research tracking system reveals that for the past 10 years researchers, on average, ended up taking 14 percent of the UWR steelhead they requested and the actual mortality was only one percent of requested.

Third, many of the fish that may be affected will be in the smolt stage, but others definitely will not be. These latter would simply be described as "juveniles," which means they may actually be yearlings, parr, or even fry: life stages represented by multiple spawning years and many more individuals than reach the smolt stage—perhaps as much as an order of magnitude more. Therefore, we derived the percentages by (a) overestimating the number of adult and juvenile fish likely to be taken, (b) conservatively estimating the actual number of juveniles and adults, and (c) treating each juvenile fish as part of the same year class. Thus, the actual numbers of fish likely to be killed represent fractions of the numbers stated above. Still, if even the worst case were to occur and the researchers were to take the maximum estimated number of fish, the effects of the losses would be very small, and because they would be spread out over the species' entire range, they would be restricted to reductions in the species' total abundance and productivity (that is, the effects on structure and diversity would be unmeasurably small and not assignable to any individual population). Moreover, to some degree, the small reductions in abundance and productivity would be offset by the information to be gained—information that in most cases would be directly used to protect salmon and steelhead and promote their recovery.

Oregon Coast Coho Salmon

When combined with scientific research and monitoring permits already approved (see section 2.4 Environmental Baseline), the total take would range from half a percent to eight percent of estimated species abundance (Table 93).

Table 93. Total expected take of OC coho salmon for scientific research and monitoring already approved for 2020 plus the actions covered in this Biological Opinion.

Life Stage	Origin	Requested take plus the baseline	Percent of abundance	Requested mortality plus the baseline	Percent of abundance
Juvenile	Natural	528,900	8%	12,066	0.2%
Juvenile	Listed Hatchery Adipose Clipped	284	0.5%	20	0.03%
Adult	Natural	7,552	8%	102	0.1%
Adult	Listed Hatchery Adipose Clipped	17	3%	0	0%

The majority of fish handled subsequently recover shortly after handling with no adverse physiological, behavioral, or reproductive effects (only two percent of the total requested take is lethal). So, the effect of all actions we consider here is the potential mortality, and when requested take is combined with the baseline, the potential mortality would equal no more than two-tenths of a percent of the abundance for adults or juveniles. Thus, the projected total lethal take for all research and monitoring activities represent only fractions of a percent of the species' total abundance.

In addition, the true numbers of fish that would actually be taken would almost certainly be smaller than the amounts authorized. First, we develop conservative estimates of juvenile abundance, as described in Section 2.2 above. Second, as noted repeatedly in the effects section, the researchers generally request more take than they estimate will actually occur and, to that requested amount of take, we add a 10 percent buffer. It is therefore very likely that researchers will take fewer fish than estimated. Our research tracking system reveals that for the past 10 years researchers, on average, ended up taking 28 percent of the number of fish they requested and the actual mortality was only 13 percent of requested.

Third, many of the fish that may be affected will be in the smolt stage, but others definitely will not be. These latter would simply be described as "juveniles," which means they may actually be yearlings, parr, or even fry: life stages represented by multiple spawning years and many more individuals than reach the smolt stage—perhaps as much as an order of magnitude more. Therefore, we derived the percentages by (a) overestimating the number of adult and juvenile fish likely to be taken, (b) conservatively estimating the actual number of juveniles and adults, and (c) treating each juvenile fish as part of the same year class. Thus, the actual numbers of fish likely to be killed represent fractions of the numbers stated above. Still, if even the worst case were to occur and the researchers were to take the maximum estimated number of fish, the effects of the losses would be very small, and because they would be spread out over the species' entire range, they would be restricted to reductions in the species' total abundance and productivity (that is, the effects on structure and diversity would be unmeasurably small and not assignable to any individual population). Moreover, to some degree, the small reductions in abundance and productivity would be offset by the information to be gained—information that in most cases would be directly used to protect salmon and steelhead and promote their recovery.

Southern Oregon/Northern California Coast Coho Salmon

When combined with scientific research and monitoring permits already approved (see section

2.4 Environmental Baseline), the total take could be as much as 18 percent of the abundance of naturally produced adult and juvenile SONCC coho salmon (Table 94).

Table 94. Total expected take of SONCC coho salmon for scientific research and monitoring already approved for 2020 plus the actions covered in this Biological Opinion.

Life Stage	Origin	Requested take plus the baseline	Percent of abundance*	Requested mortality plus the baseline	Percent of abundance*
Juvenile	Natural	184,767	9%	2,712	0.1%
Juvenile	Listed Hatchery Intact Adipose	8,964	2%	653	0.1%
Juvenile	Listed Hatchery Adipose Clipped	1,549	0.8%	51	0.03%
Adult	Natural	1,595	18%	25	0.3%
Adult	Listed Hatchery Intact Adipose	1,758		16	
Adult	Listed Hatchery Adipose Clipped	600	22%	10	0.2%

* We do not have separate abundance estimates for adipose clipped and intact adipose adult hatchery salmonids.

The majority of fish handled subsequently recover shortly after handling with no adverse physiological, behavioral, or reproductive effects (no more than two percent of the total requested take is lethal). So, the effect of all actions we consider here is the potential mortality, and when requested take is combined with the baseline, the potential mortality would equal no more than three-tenths of a percent of the abundance for naturally produced adults or juveniles. Thus, the projected total lethal take for all research and monitoring activities represent only fractions of a percent of the species' total abundance of naturally produced fish. The potential mortality for listed hatchery fish would equal no more than two-tenths of a percent. Adipose clipped hatchery fish are considered to be surplus to recovery needs.

In addition, the true numbers of fish that would actually be taken would almost certainly be smaller than the amounts authorized. First, we develop conservative estimates of juvenile abundance, as described in Section 2.2 above. Second, as noted repeatedly in the effects section, the researchers generally request more take than they estimate will actually occur and, to that requested amount of take, we add a 10 percent buffer. It is therefore very likely that researchers will take fewer fish than estimated. Our research tracking system reveals that for the past 10 years researchers, on average, ended up taking six percent of the SONCC coho they requested and the actual mortality was only three percent of requested.

Third, many of the fish that may be affected will be in the smolt stage, but others definitely will not be. These latter would simply be described as "juveniles," which means they may actually be yearlings, parr, or even fry: life stages represented by multiple spawning years and many more individuals than reach the smolt stage—perhaps as much as an order of magnitude more. Therefore, we derived the percentages by (a) overestimating the number of adult and juvenile fish likely to be taken, (b) conservatively estimating the actual number of juveniles and adults, and (c) treating each juvenile fish as part of the same year class. Thus, the actual numbers of fish likely to be killed represent fractions of the numbers stated above. Still, if even the worst case were to occur and the researchers were to take the maximum estimated number of fish, the effects of the losses would be very small, and because they would be spread out over the species' entire range, they would be restricted to reductions in the species' total abundance and productivity (that is, the effects on structure and diversity would be unmeasurably small and not assignable to any individual population). Moreover, to some degree, the small reductions in abundance and productivity would be offset by the information to be gained—information that in most cases would be directly used to protect salmon and steelhead and promote their recovery.

California Coastal Chinook salmon

When combined with scientific research and monitoring permits already approved (see section 2.4 Environmental Baseline), the total capture take would range from eight to 23 percent of estimated species abundance—depending on the age class (Table 95).

Table 95. Total expected take of CC Chinook salmon for scientific research and monitoring already approved for 2020 plus the actions covered in this biological opinion.

Life Stage	Origin	Requested take plus the baseline	Percent of abundance	Requested mortality plus the baseline	Percent of abundance
Juvenile	Natural	299,525	23%	3,880	0.3%
Adult	Natural	530	8%	36	0.5%

The majority of fish handled subsequently recover shortly after handling with no adverse physiological, behavioral, or reproductive effects (no more than one percent of the total requested take is lethal). So, the effect of all actions we consider here is the potential mortality, and when requested take is combined with the baseline, the potential mortality would equal only three-tenths of a percent of the estimated abundance of natural-origin juveniles and half a percent of natural-origin adult estimated abundance. Thus, the projected total lethal take for all research and monitoring activities represents only fractions of a percent of the species' total abundance, and the activities contemplated in this opinion represent only fractions of those already small numbers.

In addition, the true numbers of fish that would actually be taken would most likely be smaller than the amounts authorized. First, we develop conservative estimates of juvenile abundance, as described in Section 2.2 above. Second, as noted repeatedly in the effects section, the researchers generally request more take than they estimate will actually occur and, to that requested amount of take, we add a 10 percent buffer. It is therefore very likely that researchers will take fewer fish than estimated. Our research tracking system reveals that for the past five years researchers, on average, ended up taking 42 percent of the CC Chinook they requested and the actual mortality was only 27 percent of requested. This would mean that the actual effect is likely to be lower than the numbers stated in the table above.

Third, many of the fish that may be affected will be in the smolt stage, but others definitely will not be. These latter would simply be described as "juveniles," which means they may actually be yearlings, parr, or even fry: life stages represented by multiple spawning years and many more individuals than reach the smolt stage—perhaps as much as an order of magnitude more. Therefore, we derived the percentages by (a) overestimating the number of adult and juvenile fish likely to be taken, (b) conservatively estimating the actual number of juveniles and adults, and (c) treating each juvenile fish as part of the same year class. Thus, the actual numbers of fish likely to be killed represent fractions of the numbers stated above. Still, if even the worst case were to occur and the researchers were to take the maximum estimated number of fish, the effects of the losses would be very small, and because they would be spread out over the species' entire range, they would be restricted to reductions in the species' total abundance and productivity (that is, the effects on structure and diversity would be unmeasurably small and not assignable to any individual population). Moreover, to some degree, the small reductions in abundance and productivity would be offset by the information to be gained—information that in most cases would be directly used to protect salmon and steelhead and promote their recovery.

Northern California Steelhead

When combined with scientific research and monitoring permits already approved (see section 2.4 Environmental Baseline), the total capture take would be no more than 29 percent of estimated species abundance (Table 96).

Table 96. Total expected take of NC steelhead for scientific research and monitoring already approved for 2020 plus the actions covered in this biological opinion.

Life Stage	Origin	Requested take plus the baseline	Percent of abundance	Requested mortality plus the baseline	Percent of abundance
Juvenile	Natural	238,691	29%	3,882	0.5%
Adult	Natural	931	13%	24	0.3%

The majority of fish handled subsequently recover shortly after handling with no adverse physiological, behavioral, or reproductive effects (no more than two percent of the total requested take is lethal). So, the effect of all actions we consider here is the potential mortality, and when requested take is combined with the baseline, the potential mortality would equal half a percent of the estimated abundance of natural-origin juveniles and only three-tenths of a percent of natural-origin adult estimated abundance. Thus, the projected total lethal take for all research and monitoring activities represents only a small percent of the species' total abundance.

In addition, the true numbers of fish that would actually be taken would almost certainly be smaller than the amounts authorized. First, we develop conservative estimates of juvenile abundance, as described in Section 2.2 above. Second, as noted repeatedly in the effects section, the researchers generally request more take than they estimate will actually occur and, to that requested amount of take, we add a 10 percent buffer. It is therefore very likely that researchers will take fewer fish than estimated. Our research tracking system reveals that for the past five years researchers, on average, ended up taking 47 percent of the NC steelhead they requested and the actual mortality was only 15 percent of requested. This would mean that the actual effect is likely to be fractions of the numbers stated in the table above.

Third, many of the juvenile fish that may be affected will be in the smolt stage, but others definitely will not be. These latter would simply be described as “juveniles,” which means they may actually be parr or fry: life stages represented by many more individuals than reach the smolt stage—perhaps as much as an order of magnitude more. Therefore, we derived the already small percentages by (a) conservatively estimating the actual number of juveniles, (b) overestimating the number of fish likely to be killed (both juvenile and adult), and (c) treating each dead juvenile fish as part of the same year class. Thus, the actual numbers of fish likely to be killed represent fractions of the numbers stated above. Still, if even the worst case were to occur and the researchers were to take the maximum estimated number of fish, the effects of the losses would be very small, and because they would be spread out over the species’ entire range, they would be restricted to reductions in the species’ total abundance and productivity (that is, the effects on structure and diversity would be unmeasurably small and not assignable to any individual population). Moreover, to some degree, the small reductions in abundance and productivity would be offset by the information to be gained—information that in most cases would be directly used to protect salmon and steelhead and promote their recovery.

Central California Coast Steelhead

When combined with scientific research and monitoring permits already approved (see section 2.4 Environmental Baseline), the total capture take would be more than the estimated species abundance (Table 97).

Table 97. Total expected take of CCC steelhead for scientific research and monitoring already approved for 2020 plus the actions covered in this biological opinion.

Life Stage	Origin	Requested take plus the baseline	Percent of abundance	Requested mortality plus the baseline	Percent of abundance
Juvenile	Natural	240,110	97%	5,390	2%
Adult	Natural	2,736	125%	50	2%

The majority of fish handled subsequently recover shortly after handling with no adverse physiological, behavioral, or reproductive effects (no more than two percent of the total requested take of steelhead is lethal). So, the effect of all actions we consider here is the potential mortality, and when requested take is combined with the baseline, the potential mortality would be no more than two percent of the estimated abundance of natural-origin juveniles and adults. The abundance estimate is not inclusive of all populations in the DPS and is therefore lower than the actual DPS abundance. Thus, the projected total lethal take for all research and monitoring activities represents only a small percent of the species’ total abundance.

In addition, the true numbers of fish that would actually be taken would almost certainly be smaller than the amounts authorized. First, we develop conservative estimates of juvenile abundance, as described in Section 2.2 above. Second, as noted repeatedly in the effects section, the researchers generally request more take than they estimate will actually occur and, to that requested amount of take, we add a 10 percent buffer. It is therefore very likely that researchers will take fewer fish than estimated. Our research tracking system reveals that for the past five years researchers, on average, ended up taking 15 percent of the CCC steelhead they requested and the actual mortality was only seven percent of requested. This would mean that the actual effect is likely to be fractions of the numbers stated in the table above.

Third, many of the juvenile fish that may be affected will be in the smolt stage, but others definitely will not be. These latter would simply be described as "juveniles," which means they may actually be parr or fry: life stages represented by many more individuals than reach the smolt stage—perhaps as much as an order of magnitude more. Therefore, we derived the already small percentages by (a) conservatively estimating the actual number of juveniles, (b) overestimating the number of fish likely to be killed (both juvenile and adult), and (c) treating each dead juvenile fish as part of the same year class. Thus, the actual numbers of fish likely to be killed represent fractions of the numbers stated above. Still, if even the worst case were to occur and the researchers were to take the maximum estimated number of fish, the effects of the losses would be very small, and because they would be spread out over the species' entire range, they would be restricted to reductions in the species' total abundance and productivity (that is, the effects on structure and diversity would be unmeasurably small and not assignable to any individual population). Moreover, to some degree, the small reductions in abundance and productivity would be offset by the information to be gained—information that in most cases would be directly used to protect salmon and steelhead and promote their recovery.

Central Valley Spring-run Chinook salmon

When combined with scientific research and monitoring permits already approved (see section 2.4 Environmental Baseline), for the Sacramento River basin the total capture take would range from 20 to well over 100 percent of the estimated abundance of naturally produced juvenile and adult CVS Chinook salmon (Table 98).

Table 98. Total expected take of CVS Chinook salmon for scientific research and monitoring already approved for 2020 plus the actions covered in this biological opinion.

Life Stage	Origin	Requested take plus the baseline	Percent of abundance	Requested mortality plus the baseline	Percent of abundance
Juvenile	Natural	874,009	113%	17,059	2%
Juvenile	Listed Hatchery Adipose Clipped	18,656	0.9%	3,010	0.1%
Adult	Natural	764	20%	30	0.8%
Adult	Listed Hatchery Adipose Clipped	669	29%	59	3%

The majority of fish handled subsequently recover shortly after handling with no adverse physiological, behavioral, or reproductive effects (less than two percent of the total requested take is lethal). So, the effect of all actions we consider here is the potential mortality, and when requested take is combined with the baseline, the potential mortality would equal no more than two percent of the estimated abundance of natural-origin juveniles and adults. When the effect of the Programs is added to the baseline for adipose clipped listed hatchery CVS Chinook salmon, the potential mortality would equal one-tenth of a percent for juveniles and three percent for adults. We consider adipose clipped listed hatchery fish to be surplus to recovery needs. Thus, the projected total lethal take for all research and monitoring activities represents only a small percent of the species' total abundance.

In addition, the true numbers of fish that would actually be taken would almost certainly be smaller than the amounts authorized. First, we develop conservative estimates of juvenile abundance, as described in Section 2.2 above. Second, as noted repeatedly in the effects section, the researchers generally request more take than they estimate will actually occur and, to that requested amount of take, we add a 10 percent buffer. It is therefore very likely that researchers will take fewer fish than estimated. Our research tracking system reveals that for the past five years researchers, on average, ended up taking 23 percent of the naturally produced CVS Chinook they requested and the actual mortality was only 17 percent of requested. This would mean that the actual effect is likely to be fractions of the numbers stated in the table above.

Third, many of the juvenile fish that may be affected will be in the smolt stage, but others definitely will not be. These latter would simply be described as "juveniles," which means they may actually be parr or fry: life stages represented by many more individuals than reach the smolt stage—perhaps as much as an order of magnitude more. Therefore, we derived the already small percentages by (a) conservatively estimating the actual number of juveniles, (b) overestimating the number of fish likely to be killed (both juvenile and adult), and (c) treating each dead juvenile fish as part of the same year class. Thus, the actual numbers of fish likely to be killed represent fractions of the numbers stated above. Still, if even the worst case were to occur and the researchers were to take the maximum estimated number of fish, the effects of the losses would be very small, and because they would be spread out over the species' entire range, they would be restricted to reductions in the species' total abundance and productivity (that is, the effects on structure and diversity would be unmeasurably small and not assignable to any individual population). Moreover, to some degree, the small reductions in abundance and productivity would be offset by the information to be gained—information that in most cases would be directly used to protect salmon and steelhead and promote their recovery.

California Central Valley Steelhead

When combined with scientific research and monitoring permits already approved (see section 2.4 Environmental Baseline), the total capture take would range from 11 to well over 200 percent of estimated abundance of naturally produced CCV steelhead—depending on the age class (Table 99). The number of adult steelhead that may be captured is much higher than the estimated abundance for the species. However, our estimated abundance is likely to be much lower than actual abundance and the effects of research would likewise be lower than what we have calculated. Current abundance data for CCV steelhead is limited to returns to hatcheries and redd surveys conducted on a few rivers. The hatchery data is the most reliable, as redd surveys for steelhead are often made difficult by high flows and turbid water usually present during the winter-spring spawning period. However, the hatchery data represents only a partial count. For example, the Feather River abundance estimate only includes those steelhead that entered the hatchery fish ladder at the upstream end of anadromous distribution. Many more adult steelhead spawn in the river and never enter the fish ladder.

Table 99. Total expected take of CCV steelhead for scientific research and monitoring already

approved for 2020 plus the actions covered in this biological opinion.

Life Stage	Origin	Requested take plus the baseline	Percent of abundance	Requested mortality plus the baseline	Percent of abundance
Juvenile	Natural	67,002	11%	2,088	0.3%
Juvenile	Listed Hatchery Adipose Clipped	25,982	2%	1,691	0.1%
Adult	Natural	4,052	240%	102	6%
Adult	Listed Hatchery Adipose Clipped	2,265	59%	108	3%

The majority of fish handled subsequently recover shortly after handling with no adverse physiological, behavioral, or reproductive effects (no more than four percent of the total requested take is lethal). So, the effect of all actions we consider here is the potential mortality, and when requested take is combined with the baseline, the potential mortality would equal three-tenths of a percent of the estimated abundance of natural-origin juveniles and six percent of natural-origin adult estimated abundance. However, as stated above, we believe our abundance estimates are much lower than the actual abundance of the species. Thus, the projected total lethal take for all research and monitoring activities represents only a small percent of the species' total abundance.

In addition, the true numbers of fish that would actually be taken would almost certainly be smaller than the amounts authorized. First, we develop conservative estimates of juvenile abundance, as described in Section 2.2 above. Second, as noted repeatedly in the effects section, the researchers generally request more take than they estimate will actually occur and, to that requested amount of take, we add a 10 percent buffer. It is therefore very likely that researchers will take fewer fish than estimated. Our research tracking system reveals that for the past five years researchers, on average, ended up taking nine percent of the naturally produced juvenile CCV steelhead they requested and the actual mortality was only seven percent of requested. Our research tracking system also reveals that for the same time period researchers, on average, ended up taking 14 percent of the naturally produced adult CCV steelhead they requested and the actual mortality was only four-tenths of a percent of requested. This would mean that the actual effect is likely to be fractions of the numbers stated in the table above.

Third, many of the juvenile fish that may be affected will be in the smolt stage, but others definitely will not be. These latter would simply be described as "juveniles," which means they may actually be parr or fry: life stages represented by many more individuals than reach the smolt stage—perhaps as much as an order of magnitude more. Therefore, we derived the already small percentages by (a) conservatively estimating the actual number of juveniles, (b) overestimating the number of fish likely to be killed (both juvenile and adult), and (c) treating each dead juvenile fish as part of the same year class. Thus, the actual numbers of fish likely to be killed represent fractions of the numbers stated above. Still, if even the worst case were to occur and the researchers were to take the maximum estimated number of fish, the effects of the losses would be very small, and because they would be spread out over the species' entire range, they would be restricted to reductions in the species' total abundance and productivity (that is, the effects on structure and diversity would be unmeasurably small and not assignable to any individual population). Moreover, to some degree, the small reductions in abundance and productivity would be offset by the information to be gained—information that in most cases would be directly used to protect salmon and steelhead and promote their recovery.

South-Central California Coast Steelhead

When combined with scientific research and monitoring permits already approved (see section 2.4 Environmental Baseline), the total capture take would range from 55 to well over 100 percent of estimated species abundance—depending on the component and age class (Table 100). The number of fish that may be captured is high relative to the estimated abundance of the species. However, our estimated abundance is likely to be much lower than actual abundance and the effects of research would likewise be lower than what we have calculated. Our knowledge of current SCCC steelhead abundance is based largely on multiple short-term studies some of which are more than ten years old.

Table 100. Total expected take of SCCC steelhead for scientific research and monitoring already approved for 2020 plus the actions covered in this biological opinion.

Life Stage	Origin	Requested take plus the baseline	Percent of abundance	Requested mortality plus the baseline	Percent of abundance
Juvenile	Natural	43,498	55%	1,154	1%
Adult	Natural	1,176	169%	10	1%

The majority of fish handled subsequently recover shortly after handling with no adverse physiological, behavioral, or reproductive effects (no more than three percent of the total requested take is lethal). So, the effect of all actions we consider here is the potential mortality, and when requested take is combined with the baseline, the potential mortality would equal only one percent of the estimated abundance of natural-origin juvenile and adult steelhead. The abundance estimate is not inclusive of all populations in the DPS and is therefore lower than the actual DPS abundance. Thus, the projected total lethal take for all research and monitoring activities represents only a very small percent of the species' total abundance.

In addition, the true numbers of fish that would actually be taken would almost certainly be smaller than the amounts authorized. First, we develop conservative estimates of juvenile abundance, as described in Section 2.2 above. Second, as noted repeatedly in the effects section, the researchers generally request more take than they estimate will actually occur and, to that requested amount of take, we add a 10 percent buffer. It is therefore very likely that researchers will take fewer fish than estimated. Our research tracking system reveals that for the past five years researchers, on average, ended up taking eight percent of the SCCC steelhead they requested and the actual mortality was only three percent of requested. This would mean that the actual effect is likely to be fractions of the numbers stated in the table above.

Third, many of the juvenile fish that may be affected will be in the smolt stage, but others definitely will not be. These latter would simply be described as "juveniles," which means they may actually be parr or fry: life stages represented by many more individuals than reach the smolt stage—perhaps as much as an order of magnitude more. Therefore, we derived the already small percentages by (a) conservatively estimating the actual number of juveniles, (b) overestimating the number of fish likely to be killed (both juvenile and adult), and (c) treating each dead juvenile fish as part of the same year class. Thus, the actual numbers of fish likely to be killed represent fractions of the numbers stated above. Still, if even the worst case were to occur and the researchers were to take the maximum estimated number of fish, the effects of the losses would be very small, and because they would be spread out over the species' entire range, they would be restricted to reductions in the species' total abundance and productivity (that is, the effects on structure and diversity would be unmeasurably small and not assignable to any individual population). Moreover, to some degree, the small reductions in abundance and productivity would be offset by the information to be gained—information that in most cases would be directly used to protect salmon and steelhead and promote their recovery.

2.7.3 Summary for Salmon and Steelhead

The majority (at least 99 percent) of the naturally produced and listed hatchery juvenile fish that would be captured, handled, tissue sampled, etc., during the course of the proposed research are expected to survive with no long-term ill effects. Thirteen projects, out of a total of 209, have requested to intentionally kill naturally produced and listed hatchery juvenile salmonids. These projects combined would intentionally kill fish from 16 of the 22 listed salmon ESUs and steelhead DPSs included in this evaluation. There are no requests to intentionally kill HCS chum salmon, UCR steelhead, CC Chinook salmon, NC steelhead, CCC steelhead, or SCCC steelhead.

The proposed amount of juvenile salmon and steelhead that may be killed is very small in comparison to the expected outmigration of each species. In no case would it be more than two percent of the estimated outmigration of naturally produced fish. Such losses would have little effect on abundance, a similarly small effect on productivity, and effectively unmeasurably small effects on diversity and distribution. Nonetheless, actual takes are almost certainly smaller than the amounts in the Tables 79 through 100. First, we develop conservative estimates of juvenile abundance, as described in Section 2.2 above. Second, as noted repeatedly in the effects section, the researchers generally request more take than they estimate will actually occur and, to that requested amount of take, we add a 10 percent buffer. It is therefore very likely that researchers will kill fewer fish than estimated. Third, many of the fish we have counted as smolts would actually be pre-smolts. These pre-smolts may be yearlings, parr, or fry: life stages represented by multiple spawning years and many more individuals than reach the smolt stage—perhaps as much as an order of magnitude more. Therefore, we derived the already small percentages by (a) conservatively estimating the actual number of juveniles and adults, (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 and adult salmonids the research is likely to kill are nearly certain to be smaller than the stated figures. Still, if even the worst case were to occur and the researchers were to take the maximum estimated number of fish, the effects of the losses would be very small, they would be restricted to reductions in abundance and productivity and, to some degree, they would be offset by the information to be gained—information that in most cases would be directly used to protect salmon and steelhead or promote their recovery.

The majority (at least 99 percent) of the naturally produced and hatchery propagated adult fish that would be captured, handled, tissue sampled, etc., during the course of the proposed research are expected to survive with no long-term physiological, behavioral, or reproductive effects. The proposed amount of naturally produced and listed hatchery adult salmon and steelhead that may be killed is a very small fraction of the expected returns. In all but two cases (CCC and CCV steelhead), the expected mortality plus the baseline would it be no more than several tenths of a percent of the average or forecasted annual return of naturally produced fish. And as we stated above, we believe the actual effect on CCC (2%) and CCV (6%) steelhead to be much lower than what we calculated. Such losses to threatened salmon and steelhead would have little effect on abundance, a similarly small effect on productivity, and effectively unmeasurably small effects on diversity and distribution. Moreover, most of projects that may take adult salmon or steelhead generally don't actually expect to kill any adults at all (100 out of 123). Thus, the estimates for lethal take are very conservative: the request for lethal take is often made simply to ensure that the research can go forward should something go awry and an adult is killed. Over the past five years, the actual take of adult salmon and steelhead (both nonlethal and lethal) reported for the states' research programs was always less than requested. Our research tracking system reveals that on average for the past 12 years researchers take about 21 percent of the numbers of naturally produced adult salmonids they request and only kill about 12 percent of requested. Furthermore, the effects on all species would be distributed throughout each listed unit as a whole, and much of the information generated from the research would be used to improve listed salmonid survival in the future.

2.7.4 Sturgeon and Eulachon

The effects on sturgeon and eulachon are detailed in the previous pages and those effects have individually been shown to be minimal. When that minimal effect is added to the previously allotted research take (see section 2.4 Environmental Baseline) the end result is still a very small degree of effect (Table 101).

Table 101. Total expected take of sturgeon and eulachon for scientific research and monitoring in projects that have already been permitted/authorized plus the actions covered in this Biological Opinion.

Species	Life Stage	Requested take plus the baseline	Percent of abundance	Requested mortality plus the baseline	Percent of abundance
Sturgeon	Egg	1,966	See discussion	1,966	See discussion
Sturgeon	Larvae	11,191	See discussion	1,051	See discussion
Sturgeon	Juvenile	1,749	11%	115	0.7%
Sturgeon	Adult	597	28%	18	0.8%
Eulachon	Adult	4,617	0.02%	1,982	0.01%

The majority of juvenile and adult sturgeon handled subsequently recover shortly after handling with no long-term physiological, behavioral, or reproductive effects (no more than seven percent of the total take is lethal). Therefore, the effects of the proposed action considered herein are best seen in the context of the fish that may be killed. When combined with the baseline, research authorizations may kill up to 1,966 eggs and 1,051 larvae. The annual abundance of green sturgeon eggs and larvae is currently unknown due to a lack of knowledge of the survival rate of early life history stages of green sturgeon. However, given an annual spawning run estimate of 292 individuals, and a mean green sturgeon fecundity of 142,000 (Van Eenennaam et al. 2001), it can be safely assumed that the egg and larvae mortalities would represent a small fraction of the annual abundance of those life stages for the DPS.

When requested take of juvenile and adult sturgeon is combined with the baseline, the potential mortality would equal no more than eight-tenths of a percent of the estimated abundance of either juvenile or adult sturgeon. Thus, the projected total lethal take for all research and monitoring activities represents only a very small percent of the species' total abundance.

Some of the eulachon captured by the proposed research activities are expected to recover shortly after handling with no long-term physiological, behavioral, or reproductive effects. Therefore, effects of the proposed action considered herein are best seen in the context of the fish that may be killed. When requested mortality is combined with the baseline, the loss of these fish is one-hundredth of a percent of abundance. Thus, the projected total loss for all research and monitoring activities represent only fractions of a percent of the species' total abundance. And the activities contemplated in this opinion represent only fractions of those already small numbers.

Even if the worst case were to occur and the researchers were to kill the maximum estimated number of green sturgeon or eulachon, the effects of the losses would be very small, they would restricted to reductions in abundance and productivity and, to some degree, they would be offset by the information to be gained—information that in most cases would be directly used to protect sturgeon and eulachon or promote their recovery.

2.7.5 Summary

As noted in the sections on species status, 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 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 fish 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. In doing this, we have shown that while the proposed research activities will in fact have a small negative effect on each of the species' abundance and productivity, the actions, even in total, are unlikely to have a measurable effect on the species' other biological requirements. In all cases, even the effect on abundance will be minimal, the activity has not been identified as a threat, and the research is designed to benefit the species' survival in the long term.

The majority of the research proposed for 2020 in the Programs involves fish handling that is not intended to kill listed fish. However, handling does have the potential to cause stress, disease, injury or other sub-lethal effects, and even mortality in some instances. Agency researchers will use techniques generally accepted in their profession (e.g., anesthetics), when handling and sampling fish. To reduce risks to listed fish, all researchers are required by the terms and conditions of Limit 7 to follow established state and Federal guidelines such as NMFS Electrofishing Guidelines (NMFS 2000). Based on extensive prior experience with the techniques the agencies will use—and past reviews of similar activities by these agencies and their stated minimization and mitigation measures—only a very small percentage of the listed fish proposed to be handled are likely to be killed. Some of the research activities (14 out of 209 projects) do call for sacrificing some listed fish, but those fish will make up a small fraction of the overall research take.

It is not possible to know the exact adult and juvenile abundance for the various species during the coming year. For some of the species abundance estimates are updated each year, but for other species abundance data may be somewhat older. Each year's estimates are based on updated, revised information; they are produced with the best data available. Although these numbers are often very accurate, they must be considered estimates. Researchers also estimate the numbers of fish they expect to take during the coming year (displayed above and detailed in the agency's submittals). Further, researchers are required to submit reports at the end of the year detailing how many fish were actually taken. In nearly all cases in the 19 years this program has been running, the actual numbers of adult and juvenile fish taken have been much less than the requested numbers. If this trend continues, and we believe from experience that it will, it is very likely that the numbers of adults and juveniles taken in 2020 will be much smaller than the amounts proposed.

Also, the projects will not be concentrated in one stream, watershed, or marine area—or even a few—but rather will be distributed throughout each of the listed species' ranges. The number of mortalities for any single population will therefore be very small. The mortalities will only cause minor reductions in abundance and productivity and will not affect any species' spatial structure or diversity. In no case will the activities affect any species to the point of appreciably reducing its ability to survive and recover in the wild. Furthermore, the effects of the research on listed species, to some degree, would be offset by the information to be gained—information that in most cases would be directly used to protect listed species or promote their recovery.

In addition, NMFS' 4(d) rules are designed to encourage activities and programs that will conserve listed species. If programs are consistent with the rules' limits, ESA take prohibitions do not apply to those programs. As discussed in the Evaluation/Determination Document, the states' Programs are consistent with the 4(d) rules and will sufficiently conserve the listed species. Thus, the ESA take prohibitions do not apply to the Programs, nor do they apply to any Federal Action associated with the Programs.

One further consideration is that a great number of the activities contained in the section 10 and 4(d) research programs are expressly designed for the purpose of monitoring various species' statuses—an activity that the ESA specifically requires. According to ESA section 4(c)(2), we must review a species' status every five years after it is listed; the majority of the take associated with the research program goes directly toward fulfilling that goal. Therefore, though no individual activity is specifically mandated, much of the program's overall effect is actually to further purpose and intent of the ESA.

2.8 Conclusion

After reviewing the current status of the listed species, the environmental baseline within the action area, the effects of the proposed action, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of PS Chinook salmon, PS steelhead, HCS chum salmon, UCR steelhead, MCR steelhead, SR fall Chinook salmon, SR spr/sum Chinook salmon, SR steelhead, CR chum salmon, LCR Chinook salmon, LCR coho salmon, LCR steelhead, UWR Chinook salmon, UWR steelhead, OC coho salmon, SONCC coho salmon, CC Chinook salmon, NC steelhead, CCC steelhead, CVS Chinook salmon, CCV steelhead, SCCC steelhead, southern DPS eulachon, southern DPS green sturgeon, or to destroy or adversely modify any designated critical habitat.

2.9 Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harass" is further defined by interim guidance as any act which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering. "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 incidental take statement.

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. The actions are considered to be direct take rather than incidental take because in every case their actual purpose is to take the animals while carrying out a lawfully permitted activity. Thus, the take cannot be considered "incidental" under the definition give above. Nonetheless, one of the purposes of an incidental take statement is to lay out the amount or extent of take beyond which individuals carrying out an action cannot go without being in possible violation of section 9 of the ESA. That purpose is fulfilled here by the amounts of direct take laid out in the effects section above (2.5). Those amounts—displayed in the various species effects analysis sections—constitute hard limits on both the amount and extent of take the permit holders would be allowed in a given year. This concept is also reflected in the reinitiation clause just below.

2.10 Reinitiation of Consultation

This concludes formal consultation on the “Evaluation and Determination of Research Programs Submitted for Consideration Under the Endangered Species Act Section 4(d) Rule’s Scientific Research Limit [50 CFR 223.203(b)(7)] and Scientific Research and Monitoring Exemptions [50 CFR 223.210(c)(1)].”

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" Determinations

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.

2.11.1 Southern Resident Whales Determination

The Southern Resident killer whale DPS was listed as endangered on February 16, 2006 (70 FR 69903) and a recovery plan was completed in 2008 (NMFS 2008). A 5-year review under the ESA completed in 2016 concluded that Southern Residents should remain listed as endangered and includes recent information on the population, threats, and new research results and publications (NMFS 2016b). Because NMFS determined the action is not likely to adversely affect SKRWs, this document does not provide detailed discussion of environmental baseline or cumulative effects for the SRKW portion of the action area.

Several factors identified in the final recovery plan for Southern Resident killer whales may be limiting 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 Southern Residents, all of the threats identified are potential limiting factors in their population dynamics (NMFS 2008).

Southern Resident killer whales 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. 2017). During the spring, summer, and fall months, the whales 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. In recent years, several sightings and acoustic detections of Southern Residents have been obtained off the Washington and Oregon coasts in the winter and spring (Hanson et al. 2010; Hanson et al. 2013, NWFSC unpubl. data). Satellite-linked tag deployments have also provided more data on the Southern Resident killer whale movements in the winter indicating that K and L pods use the coastal waters along Washington, Oregon, and California during non-summer months.

Southern Resident killer whales 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. Southern Residents are the subject of ongoing research, including direct observation, scale and tissue sampling of prey remains, and fecal sampling. Scale and tissue sampling from May to September 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). Recently, Ford et al. (2016) confirmed the importance of Chinook salmon to the Southern Residents 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 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 primarily contributors of the whale's diet (NWFSC unpubl. data).

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. Preliminary 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 (80% of prey remains and 67% of fecal samples were Chinook salmon), with a smaller number of steelhead, chum salmon, and halibut (NWFSC unpubl. data). 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 (NWFSC unpubl. data).

At the time of the last status review in 2016 there were 83 Southern Resident killer whales left in the population (NMFS 2016f). Recent estimates based on a July 2019 survey indicate Southern Residents now total approximately 73 individuals (22 in J pod, 17 in K pod, and 34 in L pod, CWR 2019). 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 from that work, the data now suggests a downward trend in population growth projected over the next 50 years. As the model projects out over a longer time frame (50 years) there is increased uncertainty around the estimates, however, if all of the parameters in the model remain the same the overall trend shows a decline in later years. To explore potential demographic projections, Lacy et al. (2017) constructed a population viability assessment that considered sublethal effects and the cumulative impacts of threats (contaminants, acoustic disturbance, and prey abundance). 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 Southern Resident killer whales indirectly by reducing availability of their primary prey, Chinook salmon. As described in the effects analysis for salmonids, approximately 53,791 juvenile and 431 adult salmonids, including 28,777 juvenile and 83 adult Chinook may be killed during proposed research activities (Table 102). Still, as the effects analysis illustrated, the proposed research as a whole is expected to have only very small effects on salmonid abundance and productivity and no appreciable effect on diversity or distribution. Further, the adult salmonids that may be killed during the course of the research activities would not affect the whales' prey base because they would be taken after they have returned to freshwater and would therefore no longer be available as prey for the whales.

Table 102 Summary of Proposed Incidental and Intentional Mortality of Salmon and Steelhead from Scientific Research Projects in the 2020 State Research Programs.

Species	ESU/DPS	Adult	Juvenile
Chinook salmon	Puget Sound	0	6,918
Chinook salmon	Snake River fall-run	5	60
Chinook salmon	Snake River spring/summer-run	10	3,148
Chinook salmon	Lower Columbia River	10	10,961
Chinook salmon	Upper Willamette River	51	660
Chinook salmon	California Coastal	2	2,335
Chinook salmon	Central Valley spring-run	5	4,695
Total		83	28,777
Chum salmon	Columbia River	6	389
Chum salmon	Hood Canal summer-run	22	2,194
Total		28	2,583

Species	ESU/DPS	Adult	Juvenile
Coho salmon	Lower Columbia River	13	2,876
Coho salmon	Oregon Coast	85	11,154
Coho salmon	Southern Oregon/Northern California Coast	20	1,377
Total		118	15,407
Steelhead	Puget Sound	26	752
Steelhead	Upper Columbia River	0	12
Steelhead	Middle Columbia River	26	1,149
Steelhead	Snake River Basin	51	1,767
Steelhead	Lower Columbia River	22	1,253
Steelhead	Upper Willamette River	7	140
Steelhead	Northern California	6	979
Steelhead	Central California Coast	1	207
Steelhead	South-Central California Coast	7	234
Steelhead	California Central Valley	56	531
Total		202	7,024

Take of juvenile salmonids could affect prey availability to the whales in future years throughout their range, including designated critical habitat in inland waters of Washington. The average smolt to adult ratio from coded wire tag returns is no more than half a percent for hatchery Chinook in the Columbia Basin (http://www.cbr.washington.edu/cwtSAR/). Average smolt to adult survival of naturally produced Chinook in the Columbia Basin is one percent (Schaller et al. 2007). For Puget Sound, average survival of both naturally produced and hatchery Chinook is also one percent. If one percent of the 28,777 juvenile Chinook salmon taken by research activities were to survive to adulthood this would translate to the effective loss of no more than 288 adult Chinook salmon from a variety of runs along the West Coast across a three to five year period after the research activities occurred (i.e., by the time these juveniles would have grown to be adults and available prey of killer whales).

However, the estimated mortality of Chinook is likely to be much smaller than stated. Our estimates of lethal take for most of the proposed studies are purposefully inflated to account for potential accidental deaths and it is therefore very likely that fewer fish will be killed by the research than stated. In fact, our research tracking system reveals that on average researchers have only killed five percent of the allotted lethal take of Chinook salmon. Therefore, we derived the already small number of adults by overestimating the number of fish likely to be killed. Thus, the actual reduction in prey available to the whales is undoubtedly smaller than the stated figures.

Given the total quantity of prey available to killer whales throughout their range, this reduction in prey is extremely small, and although measurable is not anticipated to be different than zero by multiple decimal places (based on NMFS previous analysis of the effects of salmon harvest on Southern Residents; e.g., NMFS 2008c). Because the reduction is so small, there is also a very low probability that any of the juvenile Chinook salmon killed by the research activities would have later (in three to five years' time) been intercepted by the killer whales across their vast range in the absence of the research activities. Therefore, the anticipated take of salmonids associated with the proposed actions would result in an insignificant reduction in adult equivalent prey resources for killer whales.

Given these circumstances, and the fact that we anticipate no direct interaction between the researchers and the killer whales, NMFS finds that potential adverse effects of the proposed research on Southern Resident killer whales are insignificant and determines that the proposed action may affect, but is not likely to adversely affect killer whales.

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 our EFH assessment and the descriptions of EFH for Pacific coast salmon (PFMC 2014) contained in the fishery management plans developed by the Pacific Fishery Management Council 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. 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 upon. 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

As required by section 305(b)(4)(B) of the MSA, the Federal agency must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation from NMFS. Given that there are no conservation recommendations, there is no statutory response requirement.

3.5 Supplemental Consultation

The action agency must reinitiate EFH consultation with 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 the 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 consultation are the applicants and funding/action agencies listed on the first page. Individual copies were made available to the applicants. The document will be available within two weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. The format and naming adheres to conventional standards for style.

This ESA section 7 consultation on the authorization of the state research programs 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 MSA implementation, if applicable, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

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5.1 State Fishery Agency Submittals

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Idaho Department of Fish and Game (IDFG). 2019. Letter from Lance Hebdon, Anadromous Fishery Manager, Idaho Department of Fish and Game conveying the state's research Program for consideration under the NMFS 4(d) research limit, to Gary Rule, NMFS, December 3, 2019.

Oregon Department of Fish and Wildlife (ODFW). 2019. Letter from Ed Bowles, Fish Division Administrator, Oregon Department of Fish and Wildlife conveying the state's research Program for consideration under the NMFS 4(d) rules, to Gary Rule, NMFS, December 13, 2019.

Washington Department of Fish and Wildlife (WDFW). 2019. Letter from Val Tribble, ESA Response Unit, Washington Department of Fish and Wildlife conveying the state's research Program for consideration under the NMFS 4(d) research limit, to Gary Rule, NMFS, December 17, 2019.

5.2 Federal Register Notices

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December 28, 1993 (58 FR 68543). Final Rule. Endangered and Threatened Species: Designated Critical Habitat for Snake River Sockeye Salmon, Snake River Spring/summer Chinook salmon, and Snake River Fall Chinook salmon.

July 18, 1997 (62 FR 38479). Interim Rule: Endangered and Threatened Species; Final Rule Governing Take of the Threatened Southern Oregon/Northern California Coast Evolutionarily Significant Unit (ESU) of Coho Salmon.

August 18, 1997 (62 FR 43937). Final Rule: Endangered and Threatened Species: Listing of Several Evolutionarily Significant Units (ESUs) of West Coast Steelhead.

March 25, 1999 (64 FR 14508). Final Rule: Endangered and Threatened Species; Threatened Status for Two ESUs of Chum Salmon in Washington and Oregon.

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.

October 25, 1999 (64 FR 57399). Final Rule: Designated Critical Habitat: Revision of Critical Habitat for Snake River Spring/Summer Chinook salmon.

February 16, 2000 (65 FR 7764). Final Rule: Designated Critical Habitat: Central California Coast and Southern Oregon/Northern California Coasts Coho Salmon.

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Critical Habitat for the Oregon Coast Evolutionarily Significant Unit of Coho Salmon.
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August 15, 2011 (76 FR 50448). Notice of Availability of 5-year Reviews. Endangered and Threatened Species; 5-Year Reviews for 17 Evolutionarily Significant Units and Distinct Population Segments of Pacific Salmon and Steelhead.
April 14, 2014 (79 FR 20802). Final Rule to Revise the Code of Federal Regulations for Species Under the Jurisdiction of the National Marine Fisheries Service
February 24, 2016 (81 FR 9252). Final Rule: Endangered and Threatened Species; Designation of Critical Habitat for Lower Columbia River Coho Salmon and Puget Sound Steelhead.

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