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National Marine Fisheries Service Endangered Species Act (ESA) Section 7 Consultation and Magnuson–Stevens Act Essential Fish Habitat (EFH) Consultation

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-2020-03293
Administrative Record Number: 151422WCR2020PR00243

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		Is Action Likely to		Is Action Likely To
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
Middle 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
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 steelhead (*O. mykiss*)	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?
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 Valley spring-run Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	No
California Central Valley steelhead (*O. mykiss*)	Threatened	Yes	No	No
Central California Coast steelhead (*O. mykiss*)	Threatened	Yes	No	No
South-Central California Coast steelhead (*O. mykiss*)	Threatened	Yes	No	No
Southern Distinct Population Segment of North American green sturgeon (*Acipenser medirostris*)	Threatened	Yes	No	No
Southern Distinct Population Segment of Pacific eulachon (*Thaleichthys pacificus*)	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: [signature]

FOR Barry A. Thom
Regional Administrator

Date: April 15, 2021 (Expires on: December 31, 2021)

Table of Contents

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
USFWS – 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
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
SONCC – 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

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. It constitutes our review of 204 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). 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 November 25, 2020, the IDFG submitted their Program, which contains 14 projects in Idaho. On December 8, 2020, the ODFW submitted their Program, which contains 71 projects in Oregon. On December 4, 2020, the WDFW submitted their Program, which contains 33 projects in Washington. On January 5, 2021, the CDFW submitted their Program, which contains 86 projects in California. Upon receipt of the final request, we initiated consultation on January 5, 2021.

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
CDFW	86	9	1/05/2021
IDFG	14	3	11/25/2020

State Agency	Number of Projects in Program	Number of Listed Species Included in Program	Date the Program was Submitted to NMFS
ODFW	71	14	12/08/2020
WDFW	33	14	12/04/2020

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 204 projects that would affect 24 threatened fish species in Idaho, Oregon, Washington, and California. We did not receive proposals for any projects that might affect Ozette Lake sockeye salmon (*O. nerka*).

Because they 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" Determination 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.

On July 10, 2000, NMFS adopted a rule prohibiting the take of 14 groups of salmon and steelhead listed as threatened under the ESA (65 FR 42422, 50 CFR 223.203). NMFS adopted the take rule under section 4(d) of the ESA (salmon and steelhead 4(d) rule). The rule applies the prohibitions of section 9(a)(1) 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," provided that the Program complies with the four factors specified in the rule (see Part IV of the Evaluation and Determination document) and is authorized in writing by NMFS' West Coast Regional Administrator. Under the rule, states are required to submit a new Program each year. The Programs that NMFS authorizes are exempt from the prohibitions of section 9(a)(1) for one year—at the end of which annual reports documenting research-related take for the past year must be submitted to NMFS.

On June 28, 2005, January 5, 2006, February 11, 2008, and September 25, 2008 NMFS issued final listing determinations and protective regulations for 26 threatened and endangered salmon and steelhead species (70 FR 37160, 71 FR 834, 73 FR 7816, 73 FR 55451). The protective regulations extended the 4(d) rule to all threatened salmonid species considered in this evaluation. The protective regulations apply the prohibitions of section 9(a)(1) of the ESA to threatened 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 prohibitions for the threatened Southern Distinct Population Segment (sDPS) of North American green sturgeon (75 FR 30714, 50 CFR 223.210). The rule applies the prohibitions of section 9(a)(1) 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 Part IV of the Evaluation and Determination document). Under the rule, states are required to submit a new Program each year. The programs that NMFS authorizes are exempt from the prohibitions of section 9(a)(1) for one year—at the end of which reports documenting each project's take must be submitted to NMFS.

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.

1.3 Proposed Federal Action

"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). 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 the effects of other activities that are interrelated or interdependent with the proposed action. "Interrelated actions" are those that are part of a larger action and depend on the larger action for their justification. "Interdependent actions" are those that have no independent utility apart from the action under consideration (50 CFR 402.02). In this instance, we found no actions that are interrelated to or interdependent with the proposed Federal actions.

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 April 7, 2021, Evaluation/Determination Document. The 4(d) research exception would apply to the Programs for one year (through December 31, 2021), 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 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, each Federal agency must ensure that its actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, Federal action agencies consult with NMFS and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provide an opinion stating how the agency's actions would affect listed species and their critical habitats. If incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an ITS that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

This opinion constitutes formal consultation and an analysis of effects solely for the evolutionarily significant units (ESUs) and distinct population segments (DPSs) that are the subject of this opinion.[1] Herein, the NMFS determined that the proposed action of authorizing the four state Programs:

- 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,

[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."

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

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

The critical habitat designations for many of the species considered here use the term primary constituent element (PCE) or essential features. The 2016 critical habitat regulations (50 CFR 424.12) replaced this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a ''destruction or adverse modification'' analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

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

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

- Evaluate the rangewide status of the species and critical habitat expected to be adversely affected by the proposed action.
- Evaluate the environmental baseline of the species and critical habitat.
- Evaluate the effects of the proposed action on species and their habitat using an exposure-response approach.
- Evaluate cumulative effects.
- In the integration and synthesis, add the effects of the action and cumulative effects to the environmental baseline, and, in light of the status of the species and critical habitat,

analyze whether the proposed action is likely to: (1) directly or indirectly reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species, or (2) directly or indirectly result in an alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species.

- If necessary, suggest a reasonable and prudent alternative to the proposed action.

2.2 Rangewide Status of the Species and Critical Habitat

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

Climate Change

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

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

Overall, about one-third of the current cold-water salmonid habitat in the Pacific Northwest is likely to exceed key water temperature thresholds by the end of this century (Mantua et al. 2009). Higher temperatures will reduce the quality of available salmonid habitat for most freshwater life stages (ISAB 2007). Reduced flows will make it more difficult for migrating fish to pass physical and thermal obstructions, limiting their access to available habitat (Mantua et al. 2010; Isaak et al. 2012). Temperature increases shift timing of key life cycle events for salmonids and species forming the base of their aquatic foodwebs (Crozier et al. 2011, Tillmann and Siemann 2011, Winder and Schindler 2004). Higher stream temperatures will also cause decreases in dissolved oxygen and may also cause earlier onset of stratification and reduced mixing between layers in lakes and reservoirs, which can also result in reduced oxygen (Meyer et al. 1999, Winder and Schindler 2004, Raymondi et al. 2013). Higher temperatures are likely to cause several species to become more susceptible to parasites, disease, and higher predation rates (Crozier et al. 2008; Wainwright and Weitkamp 2013; Raymondi et al. 2013).
As more basins become rain-dominated and prone to more severe winter storms, higher winter stream flows may increase the risk that winter or spring floods in sensitive watersheds will damage spawning redds and wash away incubating eggs (Goode et al. 2013). Earlier peak stream flows will also alter migration timing for salmon smolts, and may flush some young salmon and steelhead from rivers to estuaries before they are physically mature, increasing stress and reducing smolt survival (McMahon and Hartman 1989; Lawson et al. 2004).
In addition to changes in freshwater conditions, predicted changes for coastal waters in the Pacific Northwest as a result of climate change include increasing surface water temperature, increasing but highly variable acidity, and increasing storm frequency and magnitude (Mote et al. 2014). Elevated ocean temperatures already documented for the Pacific Northwest are highly likely to continue during the next century, with sea surface temperature projected to increase by 1.0-3.7ºC (1.8-6.7ºF) by the end of the century (IPCC 2014). Habitat loss, shifts in species' ranges and abundances, and altered marine food webs could have substantial consequences to anadromous, coastal, and marine species in the Pacific Northwest (Tillmann and Siemann 2011, Reeder et al. 2013).

In California, average summer air temperatures are expected to increase according to modeling of climate change impacts (Lindley et al. 2007). Heat waves are expected to occur more often, and heat wave temperatures are likely to be higher (Hayhoe et al. 2004). Total precipitation in California may decline; critically dry years may increase (Lindley et al. 2007, Schneider 2007). Events of both extreme precipitation and intense aridity are projected for California, increasing climactic volatility throughout the state (Swain et al. 2018). Snow pack is a major contributor to stored and distributed water in the state (Diffenbaugh et al. 2015), but this important water source is becoming increasingly threatened. The Sierra Nevada snow pack is likely to decrease by as much as 70 to 90 percent by the end of this century under the highest emission scenarios modeled (Luers et al. 2006). California wildfires are expected to increase in frequency and magnitude, with 77% more area burned by 2099 under a high emission scenario model (Westerling 2018). Vegetative cover may also change, with decreases in evergreen conifer forest and increases in grasslands and mixed evergreen forests. The likely change in amount of rainfall in Northern and Central Coastal California streams under various warming scenarios is less certain, although as noted above, total rainfall across the state is expected to decline.

For the California North Coast, some models show large increases in precipitation (75 to 200 percent) while other models show decreases of 15 to 30 percent (Hayhoe et al. 2004). Many of these changes are likely to further degrade salmonid habitat by, for example, reducing stream flows during the summer and raising summer water temperatures (Williams et al. 2016). Estuaries may also experience changes detrimental to salmonids and green sturgeon. Estuarine productivity is likely to change based on alterations to freshwater flows, nutrient cycling, and sedimentation (Scavia et al. 2002). In marine environments, ecosystems and habitats important to subadult and adult green sturgeon and salmonids are likely to experience changes in temperatures, circulation and chemistry, and food supplies (Feely et al. 2004, Brewer 2008, Osgood 2008, Turley 2008), which would be expected to negatively affect marine growth and survival of listed fish. The projections described above are for the mid- to late-21st Century. In shorter time frames, climate conditions not caused by the human addition of carbon dioxide to the atmosphere are more likely to predominate (Cox and Stephenson 2007, Smith et al. 2007).

Moreover, as atmospheric carbon emissions increase, increasing levels of carbon are absorbed by the oceans, changing the pH of the water. Acidification also affects sensitive estuary habitats, where organic matter and nutrient inputs further reduce pH and produce conditions more corrosive than those in offshore waters (Feely et al. 2012, Sunda and Cai 2012). Global sea levels are expected to continue rising throughout this century, reaching likely predicted increases of 10-32 inches by 2081-2100 (IPCC 2014). These changes will likely result in increased erosion and more frequent and severe coastal flooding, and shifts in the composition of nearshore habitats (Tillmann and Siemann 2011, Reeder et al. 2013). Estuarine-dependent salmonids such as chum and Chinook salmon are predicted to be impacted by significant reductions in rearing habitat in some Pacific Northwest coastal areas (Glick et al. 2007). Historically, warm periods in the coastal Pacific Ocean have coincided with relatively low abundances of salmon and steelhead, while cooler ocean periods have coincided with relatively high abundances, and therefore these species are predicted to fare poorly in warming ocean conditions (Scheuerell and Williams 2005; Zabel et al. 2006). This is supported by the recent observation that anomalously warm sea surface temperatures off the coast of Washington from 2013 to 2016 resulted in poor coho and Chinook salmon body condition for juveniles caught in those waters (NWFSC 2015). Changes to estuarine and coastal conditions, as well as the timing of seasonal shifts in these habitats, have the potential to affect a wide range of listed aquatic species (Tillmann and Siemann 2011, Reeder et al. 2013).

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

2.2.1 Status of the Species

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

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

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

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

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

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

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

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

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Puget Sound Chinook salmon	Threatened 06/28/2005 (70 FR 37160)	SSDC 2007 NMFS 2006	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 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.	• Continued destruction and modification of habitat • Widespread declines in adult abundance despite significant reductions in harvest • Threats to diversity posed by use of two hatchery steelhead stocks • Declining diversity in the DPS, including the uncertain but weak status of summer-run fish • A reduction in spatial structure • Reduced habitat quality • Urbanization • Dikes, hardening of banks with riprap, and channelization

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
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 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	• 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

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
				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 productivity in several populations relative to prior reviews, those changes have not been sufficient to warrant a change in ESU status.	• Degraded freshwater habitat • Effects related to the hydropower system in the mainstem Columbia River, • Altered flows and degraded water quality • Harvest-related effects • Predation
Snake River fall-run Chinook salmon	Threatened 06/28/2005 (70 FR 37160)	NMFS 2017a	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	• Degraded floodplain connectivity and function • Harvest-related effects • Loss of access to historical habitat above Hells Canyon and other Snake River dams

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
				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.	• 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 natural spawning areas near major hatchery release sites within individual populations.	• 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

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Lower Columbia River Chinook salmon	Threatened 06/28/2005 (70 FR 37160)	NMFS 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.	• Reduced access to spawning and rearing habitat • Hatchery-related effects • Harvest-related effects on fall Chinook salmon • An altered flow regime and Columbia River plume • Reduced access to off-channel rearing habitat • Reduced productivity resulting from sediment and nutrient-related changes in the estuary • Contaminant
Lower Columbia River coho salmon	Threatened 06/28/2005 (70 FR 37160)	NMFS 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 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	• Degraded estuarine and near-shore marine habitat • Fish passage barriers • Degraded freshwater habitat: Hatchery-related effects • Harvest-related effects • An altered flow regime and Columbia River plume • Reduced access to off-channel rearing habitat in the lower Columbia River • Reduced productivity resulting from sediment and nutrient-related changes in the estuary • Juvenile fish wake strandings • Contaminants

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
				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 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.	• Degraded estuarine and nearshore marine habitat • Degraded freshwater habitat • Reduced access to spawning and rearing habitat • Avian and marine mammal predation • Hatchery-related effects • An altered flow regime and Columbia River plume • Reduced access to off-channel rearing habitat in the lower Columbia River • Reduced productivity resulting from sediment and nutrient-related changes in the estuary • Juvenile fish wake strandings • Contaminants
Columbia River chum salmon	Threatened 06/28/2005	NMFS 2013	NWFSC 2015	Overall, the status of most chum salmon populations is unchanged from the baseline VSP	• Degraded estuarine and nearshore marine habitat

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
	(70 FR 37160)			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 freshwater habitat • Degraded stream flow as a result of hydropower and water supply operations • Reduced water quality • Current or potential predation • An altered flow regime and Columbia River plume • Reduced access to off-channel rearing habitat in the lower Columbia River • Reduced productivity resulting from sediment and nutrient-related changes in the estuary • Juvenile fish wake strandings • Contaminants
Upper Willamette River Chinook salmon	Threatened 06/28/2005 (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 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	• Degraded freshwater habitat • Degraded water quality • Increased disease incidence • Altered stream flows • Reduced access to spawning and rearing habitats • Altered food web due to reduced inputs of microdetritus • Predation by native and non-native species, including hatchery fish • Competition related to introduced salmon and steelhead • Altered population traits due to fisheries and bycatch

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
				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	• 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

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
				another prolonged period of poor marine survival remains in question.	
Southern Oregon/ Northern California Coastal coho salmon	Threatened 06/28/2005 (70 FR 37160)	NMFS 2014b	Williams et al. 2016	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 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	• Dams and other barriers to migration • Logging • Agriculture • Ranching • Fishery-related effects • Hatchery-related effects

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
				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.	• Logging and road construction altering substrate composition, increasing sediment load, and reducing riparian cover • Estuarine alteration resulting in lost complexity and habitat from draining and diking • Dams and barriers diminishing downstream habitats through altered flow regimes and gravel recruitment • Climate change • Urbanization and agriculture degrading water quality from urban pollution and agricultural runoff • Gravel mining creating barriers to migration, stranding of adults, and promoting spawning in poor locations • Alien species (i.e. Sacramento Pikeminnow) • Small hatchery production without monitoring the effects of hatchery releases on wild spawners
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	• Dams block access to 90 percent of historic spawning and summer holding areas along with altering river flow regimes and temperatures. • Diversions • Urbanization and rural development • Logging • Grazing • Agriculture • Mining – historic hydraulic mining from the California Gold Rush era. • Estuarine modified and degraded, thus reducing developmental opportunities for juvenile salmon • Fisheries

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
				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.	• Hatcheries • 'Natural' factors (e.g. ocean conditions)
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 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.	• Major dams • Water diversions • Barriers • Levees and bank protection • Dredging and sediment disposal • Mining • Contaminants • Alien species • Fishery-related effects • Hatchery-related effects
Central California Coast 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 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	• Dams and other barriers to migration • Stream habitat degradation • Estuarine habitat degradation • Hatchery-related effects

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
				appreciably in either direction since the last status review.	
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 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

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Southern DPS of eulachon	Threatened 03/18/2010 (75 FR 13012)	NMFS 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 Columbia and the Klamath River. In the early 1990s, there was an abrupt decline in the abundance of eulachon returning to the Columbia River. Despite a brief period of improved returns in 2001-2003, the returns and associated commercial landings eventually declined to the low levels observed in the mid-1990s. Although eulachon abundance in monitored rivers has generally improved, especially in the 2013-2015 return years, recent poor ocean conditions and the likelihood that these conditions will persist into the near future suggest that population declines may be widespread in the upcoming return years	• Changes in ocean conditions due to climate change, particularly in the southern portion of the species' range where ocean warming trends may be the most pronounced and may alter prey, spawning, and rearing success. • Climate-induced change to freshwater habitats • Bycatch of eulachon in commercial fisheries • Adverse effects related to dams and water diversions • Water quality • Shoreline construction • Over harvest • Predation

Species-specific status information is discussed in more detail below. The 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 2). 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 54,843,130 adipose-fin-clipped and non-clipped juvenile Chinook salmon.

Table 3. Expected 2021 Puget Sound Chinook salmon hatchery releases (WDFW 2020).

Subbasin	Artificial propagation program	Brood year	Run Timing	Clipped Adipose Fin	Intact Adipose Fin
Deschutes	Tumwater Falls	2020	Fall	3,800,000	-
Dungeness-Elwha	Dungeness	2020	Spring	-	50,000
	Elwha	2019	Fall	-	200,000
		2020	Fall	250,000	2,250,000
	Gray Wolf River	2020	Spring	-	50,000
	Hurd Creek	2020	Spring	-	50,000
	Upper Dungeness Pond	2020	Spring	-	50,000
Duwamish	Icy Creek	2019	Fall	300,000	-
	Palmer	2020	Fall	2,000,000	-
	Soos Creek	2020	Fall	3,000,000	1,200,000
Hood Canal					
	Hoodsport	2019	Fall	120,000	-
		2020	Fall	3,000,000	-
Kitsap	Bernie Gobin	2019	Spring	40,000	-
		2020	Fall	-	200,000
			Summer	4,300,000	100,000
	Garrison	2020	Fall	950,000	-
	George Adams	2020	Fall	3,375,000	425,000
	Gorst Creek	2020	Fall	1,530,000	-
	Grovers Creek	2020	Fall	450,000	-
	Hupp Springs	2020	Spring	-	500,000
	Lummi Sea Ponds	2020	Fall	950,000	-
	Minter Creek	2020	Fall	1,650,000	-
Lake Washington	Salmon in the Schools	2020	Fall	-	540
	Issaquah	2020	Fall	3,000,000	-
Nisqually	Clear Creek	2020	Fall	3,300,000	200,000
	Kalama Creek	2020	Fall	600,000	-

Subbasin	Artificial propagation program	Brood year	Run Timing	Clipped Adipose Fin	Intact Adipose Fin
	Nisqually MS	2020	Fall	-	90
Nooksack	Kendall Creek	2020	Spring	1,300,000	-
	Skookum Creek	2020	Spring	-	1,000,000
Puyallup	Clarks Creek	2020	Fall	1,020,000	-
	Narrows Marina Pens	2020	Fall	30,000	-
	Voights Creek	2020	Fall	1,600,000	-
	White River	2019	Spring	-	55,000
		2020	Spring	-	340,000
	Wilkeson Creek	2020	Fall	400,000	-
San Juan Islands	Glenwood Springs	2020	Fall	800,000	-
Skokomish	McKernan	2020	Fall	-	100,000
Skykomish	Wallace River	2019	Summer	600,000	-
		2020	Summer	2,000,000	200,000
Stillaguamish	Brenner	2020	Fall	200,000	-
	Whitehorse Pond	2020	Summer	220,000	-
Strait of Georgia	Samish	2020	Fall	5,000,000	200,000
	Whatcom Creek	2020	Fall	500,000	-
Upper Skagit	Marblemount	2019	Spring	300,000	100,000
		2020	Spring	587,500	200,000
			Summer	200,000	-
Total Annual Release Number				**47,372,500**	**7,470,630**

Adult spawners and expected outmigration – The current abundance for PS Chinook salmon populations is 39,546 adult spawners (21,486 natural-origin and 18,060 hatchery-origin spawners; Table 4). Natural-origin spawners range from 34 (in the South Fork Nooksack River population) to 9,032 fish (in the Upper Skagit population). No populations are meeting their minimum viability abundance targets, and only three of 22 populations average greater than 20% of the minimum viability abundance target for natural-origin spawner abundance (all of which are in the Skagit River watershed).

Table 4. Five-year geometric mean abundance estimates for PS Chinook salmon natural- and hatchery-origin spawners (unpublished data, Mindy Rowse, NWFSC, July 14, 2020).

Population Name	Years	Natural-origin Spawners	Hatchery-origin Spawners	% Hatchery Origin	Minimum Viability Abundance[a]	Expected Number of Outmigrants[b]
Strait of Georgia MPG						
NF Nooksack River	2013-2017	143	1,234	89.60%	16,000	110,136
SF Nooksack River	2015-2019	34	54	61.42%	9,100	7,080
Strait of Juan de Fuca MPG						
Elwha River	2014-2018	122	2,561	95.44%	15,100	214,650
Dungeness River	2014-2018	81	270	76.92%	4,700	28,071
Hood Canal MPG						
Skokomish River	2014-2018	202	1,335	86.85%	12,800	122,923
Mid-Hood Canal	2014-2018	149	27	15.25%	11,000	14,032
Whidbey Basin MPG						
Skykomish River	2015-2019	1,680	1,005	37.43%	17,000	214,855
Snoqualmie River	2015-2019	816	265	24.51%	17,000	86,426
NF Stillaguamish River	2015-2019	289	369	56.07%	17,000	52,648
SF Stillaguamish River	2015-2019	36	41	53.64%	15,000	6,162
Upper Skagit River	2014-2018	9,032	715	7.33%	17,000	779,779
Lower Skagit River	2014-2018	1,989	105	5.02%	16,000	167,531
Upper Sauk River	2014-2018	1,202	6	0.48%	3,000	96,596

Population Name	Years	Natural-origin Spawners	Hatchery-origin Spawners	% Hatchery Origin	Minimum Viability Abundance[a]	Expected Number of Outmigrants[b]
Lower Sauk River	2014-2018	513	6	1.23%	5,600	41,552
Suiattle River	2014-2018	591	8	1.39%	600	47,960
Cascade River	2014-2018	186	8	4.01%	1,200	15,519
Central / South Sound MPG						
Sammamish River	2015-2019	122	716	85.46%	10,500	67,067
Cedar River	2015-2019	857	331	27.86%	11,500	95,056
Duwamish/Green River	2015-2019	1,682	4,105	70.94%	17,000	462,952
Puyallup River	2015-2019	557	1,236	68.96%	17,000	143,421
White River	2015-2019	492	2,902	85.49%	14,200	271,554
Nisqually River	2014-2018	710	761	51.73%	13,000	117,680
ESU Average		**21,486**	**18,060**	**45.67%**		**3,163,652**

[a] Ford 2011

[b] Expected number of outmigrants=Total spawners*40% proportion of females*2,000 eggs per female*10% survival rate from egg to outmigrant

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% of escapement. By applying a conservative fecundity estimate (2,000 eggs/female) to the expected female escapement (both natural-origin and hatchery-origin spawners – 15,818 females), the ESU is estimated to produce approximately 31.6 million eggs annually. Smolt trap studies have researched egg to migrant juvenile Chinook salmon survival rates in the following Puget Sound tributaries: Skagit River, North Fork Stillaguamish River, South Fork Stillaguamish River, Bear Creek, Cedar River, and Green River (Beamer et al. 2000; Seiler et al. 2002, 2004, 2005; Volkhardt et al. 2005; Griffith et al. 2004). The average survival rate in these studies was 10%, which corresponds with those reported by Healey (1991). With an estimated survival rate of 10%, the ESU should produce roughly 3.16 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 2021, 222,500 hatchery steelhead are expected to be released throughout the range of the PS steelhead DPS (WDFW 2020).

Table 5. Expected 2021 Puget Sound steelhead listed hatchery releases (WDFW 2020).

Subbasin	Artificial propagation program	Brood year	Run Timing	Clipped Adipose Fin	Intact Adipose Fin
Dungeness/Elwha	Dungeness	2020	Winter	10,000	-
	Hurd Creek	2021	Winter	-	34,500
Duwamish/Green	Flaming Geyser	2020	Winter	-	15,000
	Icy Creek	2020	Summer	50,000	-
			Winter	-	28,000
	Soos Creek	2020	Summer	50,000	-
Puyallup	White River	2020	Winter	-	35,000
Total Annual Release Number				**110,000**	**112,500**

Adult spawners and expected outmigration – The current abundance for the PS steelhead DPS is 19,456 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 (9,728 females), 34.05 million eggs are expected to be produced annually. With an estimated survival rate of 6.5% (Ward and Slaney 1993), the DPS should produce roughly 2.21 million natural-origin outmigrants annually.

Table 6. Five-year geometric mean abundance estimates for PS steelhead spawner escapements (natural-origin and hatchery-production combined) (data accessed on June 30, 2020 from WDFW Steelhead - General Information Page).

Demographically Independent Populations	Years	Spawners	Expected Number of Outmigrants[a]
Central and South Puget Sound MPG			
Cedar River	2015-2019	3	340
Green River	2015-2019	1,262	143,532
Nisqually River	2015-2019	1,368	155,563
N. Lake WA/Lake Sammamish	-	0	-
Puyallup/Carbon River	2015-2019	953	108,425
White River	2014-2018	649	73,791
Hood Canal and Strait of Juan de Fuca MPG			
Dungeness River	2009-2014	26	-
East Hood Canal Tribs.	2014-2018	75	8,510
Elwha River	2014-2018	1,232	140,193
Sequim/Discovery Bay Tribs.	2013-2017	22	2,474
Skokomish River	2014-2018	877	99,702
South Hood Canal Tribs.	2014-2018	64	7,330
Strait of Juan de Fuca Tribs.	2014-2018	107	12,191
West Hood Canal Tribs.	2014-2018	142	16,206
North Cascades MPG			
Nooksack River	2014-2018	1,822	207,205
Pilchuck River	2015-2019	634	72,096
Samish River/ Bellingham Bay Tribs.	2012-2016	977	111,167
Skagit River	2014-2018	7,527	856,175
Snohomish/Skykomish Rivers	2015-2019	690	78,532
Snoqualmie River	2015-2019	500	56,863
Stillaguamish River	2015-2019	487	55,346
Tolt River	2015-2019	40	4,498
TOTAL		**19,456**	**2,210,140**

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

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. The combined hatchery production goal for listed HCS chum salmon from Table 7 is 150,000 unmarked juvenile chum salmon.

Table 7. Expected 2019 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 40,526 adult spawners (38,697 natural-origin and 1,829 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 2013 to 2017, Jimmycomelately Creek averaged 2,634 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 2,521 and 332, respectively, for the 2013-2017 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	2,634	406	13.35%	444,570
Salmon Creek	2,521	0	0.00%	368,728
Snow Creek	332	0	0.00%	48,511
Chimacum Creek	1,611	0	0.00%	235,549
Population Average[d]	7,098	406	5.41%	1,097,359
Hood Canal Population				
Big Quilcene River	11,472	0	0.00%	1,677,808
Little Quilcene River	900	0	0.00%	131,586
Big Beef Creek	34	0	0.00%	5,024
Dosewallips River	4,329	2	0.05%	633,424
Duckabush River	6,151	2	0.04%	899,993
Hamma Hamma River	3,718	0	0.00%	543,729
Anderson Creek	3	0	0.00%	374
Dewatto River	159	0	0.00%	23,298
Lilliwaup Creek	784	960	55.03%	255,106

Population Name	Natural-origin Spawners[a]	Hatchery-origin Spawners[a]	% Hatchery Origin	Expected Number of Outmigrants[c]
Skokomish River	489	395	44.68%	129,222
Tahuya River	1,869	64	3.33%	282,815
Union River	1,690	0	0.00%	247,125
Population Average[d]	31,599	1,423	4.31%	4,829,506
ESU Average	**38,697**	**1,829**	**4.51%**	**5,926,865**

[a] Five-year geometric mean of post fishery natural-origin spawners (2013-2017).
[b] Five-year geometric mean of post fishery hatchery-origin spawners (2013-2017).
[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 (2013-2017).

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% 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 – 18,237 females), the ESU is estimated to produce approximately 45.6 million eggs annually. For HCS chum salmon, freshwater mortality rates are high with no more than 13% of the eggs expected to survive to the juvenile migrant stage (Quinn 2005). With an estimated survival rate of 13%, the ESU should produce roughly 5.93 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).

Table 9. Recent Five-Year Geometric Means for the Estimated Juvenile Outmigrations and Adult returns of Snake River Fall-run Chinook (Zabel 2015, 2017a, 2017b, 2018, 2020, AMIP 2019).

Life Stage	Origin	Outmigration/Return
Juvenile	Natural	692,819
Juvenile	LHAC	2,483,713
Juvenile	LHIA	2,862,418
Adult	Natural	10,337
Adult	LHAC	12,508
Adult	LHIA	13,551

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 fifteen 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 10).

Table 10. 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			Hatchery-	
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%
Kalama	2011-2014	115	-	-
North Fork Lewis	2010-2014	217	0	0.00%

Population Name	Years	Natural-origin Spawners[a]	Hatchery-origin Spawners[a]	% Hatchery Origin
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 11).

Table 11. 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			Hatchery-	
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 steelhead salmon populations is 35,217 adult spawners (12,920 natural-origin and 22,297 hatchery-origin spawners; Table 12).

Table 12. 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%

Population Name	Years	Natural-origin Spawners[a]	Hatchery-origin Spawners[a]	% Hatchery Origin
Clackamas	2014-2015	3,607	1,876	34.21%
Sandy	2013-2015	3,810	284	6.94%
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 13).

Table 13. 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	-	-

Population Name	Years	Natural-origin Spawners[a]	Hatchery-origin Spawners[a]	% Hatchery Origin
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	-	-
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 14).

Table 14. 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 15).

Table 15. 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).

Yea	Natural Escapement
2013-2014	5,349
2014-2015	4,508
2015-2016	5,778
2016-2017	822
2017-2018	1,829
	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 16).

Table 16. 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 Outmigrants[b]
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

Population Name	Natural-origin Spawners[a]	Hatchery-origin Spawners[a]	% Hatchery Origin	Expected Number of Outmigrants[b]
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
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 17). 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%. Thus, we can estimate that roughly the Oregon Coast ESU produces 6.64 million juvenile coho salmon annually.

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 17).

Table 17. 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 18).

Table 18. 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

Population Groups	Run	Populations
	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 19). 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 19. 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 20).

Table 20. 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/documents.html), 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
	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

Stratum	Waterbody	Run	Years	Abundance	Expected Number of Outmigrants[a]
	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 20). 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 21 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 21).

Table 21. 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

Population	Years	Spawners	Expected Number of Outmigrants[ab]
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

[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 22). 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 2018).

[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.

Table 22. 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.

[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 23. 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

[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 24). 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 26).

Table 24. 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 25).

Table 25. 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 26. 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 27). 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 27).

Table 27. Geometric Mean Abundances of CCC Steelhead Spawners Escapements by Population (Ettlinger et al. 2012, Jankovitz 2013, Manning and Martini-Lamb (ed.) 2012, 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 Outmigrants[ab]**
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

			Abundance		
Stratum	**Waterbody**	**Years**	**Natural Origin**	**Hatchery Origin**	**Expected Number of Outmigrants[ab]**
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
	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 28). 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 28. 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
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 29. 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

Stratum	Waterbody	Years	Abundance	Expected Number of Outmigrants[a]
	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 29). 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 29).

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 sDPS eulachon 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 2015 through 2019, the eulachon spawner population estimate for the Fraser River is 2,877,962 adults and for the Columbia River 29,151,081 adults (Table 30). The combined spawner estimate from the Columbia and Fraser rivers is 32.03 million eulachon.

Table 30. 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[b]	Biomass estimate (metric tons)	Estimated spawner population[c]
2011	31	765,445	1503	37,000,000
2012	120	2,963,013	1463	36,000,000
2013	100	2,469,177	4469	110,000,000
2014	66	1,629,657	7313	180,000,000
2015	317	7,827,292	4469	110,000,000
2016	44	1,086,438	2217	54,556,500
2017	35	864,212	744	18,307,100
2018	408	10,074,244	167	4,104,300
2019	108	2,666,712	1897	46,684,800
2015-2019[d]	**117**	**2,877,962**	**1,184**	**29,151,081**

[a] DFO 2020
[b] Estimated population numbers are calculated as 11.16 eulachon per pound.
[c] Langness et al. 2020
[d] Five-year geometric mean of mean eulachon biomass estimates (2015-2019).

Southern Green Sturgeon

Green sturgeon are composed of two DPSs with two geographically distinct spawning locations. The northern DPS spawn in rivers north of and including the Eel River in Northern California with known spawning occurring in the Eel, Klamath, and Trinity rivers in California and the Rogue and Umpqua rivers in Oregon. The southern DPS 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 31; Mora et al. 2018).

Table 31. Six-year geometric mean (2010-2015) abundance estimate of SDPS green sturgeon (Mora et al. 2018).

Life stage	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
ESU abundance[a]	**17,548**	**12,614**	**22,482**

2.2.2 Status of the Species' Critical Habitat

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

For most salmon and steelhead, NMFS's critical habitat analytical review teams (CHARTs) ranked watersheds within designated critical habitat at the scale of the fifth-field hydrologic unit code (HUC5) in terms of the conservation value they provide to each ESA-listed species that they support (NMFS 2005). The conservation rankings were high, medium, or low. To determine the conservation value of each watershed to species viability, the CHARTs evaluated the quantity and quality of habitat features, the relationship of the area compared to other areas within the species' range, and the significance to the species of the population occupying that area. Even if a location had poor habitat quality, it could be ranked with a high conservation value if it were essential due to factors such as limited availability, a unique contribution of the population it served, or is serving another important role.
A summary of the status of critical habitats, considered in this opinion, is provided in Table 32, below.

Table 32. Critical habitat, designation date, federal register citation, and status summary for critical habitat considered in this opinion.

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
Puget Sound Chinook salmon	09/02/2005 70 FR 52630	Critical habitat for Puget Sound Chinook salmon includes 1,683 miles of streams, 41 square mile of lakes, and 2,182 miles of nearshore marine habitat in Puget Sounds. The Puget Sound Chinook salmon ESU has 61 freshwater and 19 marine areas within its range. Of the freshwater watersheds, 41 are rated high conservation value, 12 low conservation value, and eight received a medium rating. Of the marine areas, all 19 are ranked with high conservation value. Primary constitute

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
		elements relevant for this consultation include: 1) Estuarine areas free of obstruction with water quality and aquatic vegetation to support juvenile transition and rearing; 2) Nearshore marine areas free of obstruction with water quality conditions, forage, submerged and overhanging large wood, and aquatic vegetation to support growth and maturation; 3) Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.
Puget Sound steelhead	02/24/2016 81 FR 9252	Critical habitat for Puget Sound steelhead includes 2,031 stream miles. Nearshore and offshore marine waters were not designated for this species. There are 66 watersheds within the range of this DPS. Nine watersheds received a low conservation value rating, 16 received a medium rating, and 41 received a high rating to the DPS.
Hood Canal summer-run chum salmon	09/02/2005 70 FR 52630	Critical habitat for Hood Canal summer-run chum salmon includes 79 miles and 377 miles of nearshore marine habitat in HC. Primary constituent elements relevant for this consultation include: 1) Estuarine areas free of obstruction with water quality and aquatic vegetation to support juvenile transition and rearing; 2) Nearshore marine areas free of obstruction with water quality conditions, forage, submerged and overhanging large wood, and aquatic vegetation to support growth and maturation; 3) Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.
Upper Columbia River steelhead	09/02/2005 70 FR 52630	Critical habitat encompasses 10 subbasins in Washington containing 31 occupied watersheds, as well as the Columbia River rearing/migration corridor. Most HUC5 watersheds with PBFs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 20 watersheds, medium for eight watersheds, and low for three watersheds.
Middle Columbia River steelhead	09/02/2005 70 FR 52630	Critical habitat encompasses 15 subbasins in Oregon and Washington containing 111 occupied watersheds, as well as the Columbia River rearing/migration corridor. Most HUC5 watersheds with PBFs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of occupied HUC5 watersheds as high for 80 watersheds, medium for 24 watersheds, and low for 9 watersheds.
Snake River spring/summer-run Chinook salmon	10/25/1999 64 FR 57399	Critical habitat consists of river reaches of the Columbia, Snake, and Salmon rivers, and all tributaries of the Snake and Salmon rivers (except the Clearwater River) presently or historically accessible to this ESU (except reaches above impassable natural falls and Hells Canyon Dam). Habitat quality in tributary streams varies from excellent in wilderness and roadless areas, to poor in areas subject to heavy agricultural and urban development (Wissmar et al. 1994). Reduced summer stream flows, impaired water quality, and reduced habitat complexity are common problems. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Snake River fall-run Chinook salmon	10/25/1999 64 FR 57399	Critical habitat consists of river reaches of the Columbia, Snake, and Salmon rivers, and all tributaries of the Snake and Salmon rivers presently or historically accessible to this ESU (except reaches above impassable natural falls, and Dworshak and Hells Canyon dams). Habitat quality in tributary streams varies from excellent in wilderness and roadless areas, to poor in areas subject to heavy agricultural and urban development (Wissmar et al. 1994). Reduced summer stream flows, impaired water quality, and reduced habitat complexity are common problems. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Snake River basin steelhead	09/02/2005 70 FR 52630	Critical habitat encompasses 25 subbasins in Oregon, Washington, and Idaho. Habitat quality in tributary streams varies from excellent in wilderness and roadless

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

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
		channels; reduced riparian area functions (stream temperature regulation, wood recruitment, sediment and nutrient retention); and altered flow and sediment regimes (NMFS 2016b). Several historical and ongoing land uses have reduced stream capacity and complexity in Oregon coastal streams and lakes through disturbance, road building, splash damming, stream cleaning, and other activities. Beaver removal, combined with loss of large wood in streams, has also led to degraded stream habitat conditions for coho salmon (Stout et al. 2012)
Southern Oregon/Northern California Coast coho salmon	05/05/1999 64 FR 24049	Critical habitat includes all areas accessible to any life-stage up to long-standing, natural barriers and adjacent riparian zones. SONCC coho salmon critical habitat within this geographic area has been degraded from historical conditions by ongoing land management activities. Habitat impairments recognized as factors leading to decline of the species that were included in the original listing notice for SONCC coho salmon include: 1) Channel morphology changes; 2) substrate changes; 3) loss of in-stream roughness; 4) loss of estuarine habitat; 5) loss of wetlands; 6) loss/degradation of riparian areas; 7) declines in water quality; 8) altered stream flows; 9) fish passage impediments; and 10) elimination of habitat
Northern California steelhead	9/2/2005 70 FR 52488	There are approximately 3,028 miles of stream habitats and 25 square miles of estuary habitats designated as critical habitat for NC steelhead. NMFS determined that marine areas did not warrant consideration as critical habitat for this DPS. NC steelhead PBFs are sites and habitat components which support one or more life stages. There are 50 watersheds within the range of this DPS. Nine watersheds received a low rating, 14 received a medium rating, and 27 received a high rating of conservation value to the DPS. Two estuarine habitats, Humboldt Bay and the Eel River estuary, have high conservation value ratings. Since designation, critical habitat for this species has continued to be degraded somewhat by the factors listed above in the status section. Nonetheless, a number of restoration efforts have been undertaken by local, state, and Federal entities resulting in slightly improved conditions in some areas and a slowing of the negative trend.
California Coastal Chinook salmon	09/02/2005 70 FR 52488	Critical habitat includes approximately 1,475 miles of stream habitats and 25 square miles of estuary habitats. There are 45 watersheds within the range of this ESU. Eight watersheds received a low rating, 10 received a medium rating, and 27 received a high rating of conservation value to the ESU. Two estuarine habitat areas used for rearing and migration (Humboldt Bay and the Eel River Estuary) also received a high conservation value rating. PBFs include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, and nearshore marine areas. Since designation, critical habitat for this species has continued to be. Nonetheless, a number of restoration efforts have been undertaken by local, state, and Federal entities resulting in slightly improved conditions in some areas and a slowing of the negative trend.
Central Valley spring-run Chinook salmon	09/02/2005 70 FR 52488	Critical habitat includes approximately 1,373 miles of stream habitats and 427 square miles of estuary habitats in 37 watersheds. The CHART rated seven watersheds as having low, three as having medium, and 27 as having high conservation value to the ESU. Four of these watersheds comprise portions of the San Francisco-San Pablo-Suisun Bay estuarine complex, which provides rearing and migratory habitat for the ESU. PBFs include freshwater spawning sites, freshwater rearing sites, and freshwater migration corridors. Since designation, critical habitat for this species has continued to be degraded somewhat by the factors listed above in the status section. Nonetheless, a number of restoration efforts have been undertaken by local, state, and Federal entities resulting in slightly improved conditions in some areas and a slowing of the negative trend.
California Central Valley steelhead	9/2/2005 70 FR 52488	There are approximately 2,308 miles of stream habitats and 254 square miles of estuary habitats designated as critical habitat for CCV steelhead. NMFS determined that marine areas did not warrant consideration as critical habitat for this DPS. CCV steelhead PBFs are those sites and habitat components which support one or more life stages. There are 67 watersheds within the range of this

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
		DPS. Twelve watersheds received a low rating, 18 received a medium rating, and 37 received a high rating of conservation value to the DPS. Since designation, critical habitat for this species has continued to be degraded somewhat by the factors listed above in the status section. Nonetheless, a number of restoration efforts have been undertaken by local, state, and Federal entities resulting in slightly improved conditions in some areas and a slowing of the negative trend.
Central California Coast steelhead	9/2/2005 70 FR 52488	There are approximately 1,465 miles of stream habitats and 386 square miles of estuary habitats designated as critical habitat for CCC steelhead. NMFS determined that marine areas did not warrant consideration as critical habitat for this DPS. CCC steelhead PBFs are sites and habitat components which support one or more life stages including freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, and nearshore marine areas. There are 46 watersheds within the range of this DPS. For conservation value to the DPS, fourteen watersheds received a low rating, 13 received a medium rating, and 19 received a high rating. Since designation, critical habitat for this species continues to be degraded by several factors listed in the status section. Nonetheless, a number of restoration efforts have been undertaken by local, state, and Federal entities to improve conditions in some areas and slow the negative trend.
South-Central California Coast steelhead	9/2/2005 70 FR 52488	There are approximately 1,249 miles of stream habitats and three square miles of estuary habitats designated as critical habitat for S-CCC steelhead. NMFS determined that marine areas did not warrant consideration as critical habitat for this DPS. S-CCC steelhead PBFs are sites and habitat components which support one or more life stages including freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, and nearshore marine areas. There are 30 watersheds within the range of this DPS. For conservation value to the DPS, six watersheds received a low rating, 11 received a medium rating, and 13 received a rated high. Morro Bay, an estuarine habitat, is used as rearing and migratory habitat for spawning and rearing steelhead. S-CCC steelhead inhabit coastal river basins from the Pajaro River south to, but not including, the Santa Maria River. Major watersheds include Pajaro River, Salinas River, Carmel River, and numerous smaller rivers and streams along the Big Sur coast and southward. Only winter-run steelhead are found in this DPS. The climate is drier and warmer than in the north that is reflected in vegetation changes from coniferous forests to chaparral and coastal scrub. The mouths of many rivers and streams in this DPS are seasonally closed by sand berms that form during the low stream flows of summer. Since designation, critical habitat for this species continues to be degraded by several factors listed in the status section Nonetheless, a number of restoration efforts have been undertaken by local, state, and Federal entities to improve conditions in some areas and slow the negative trend.
Southern DPS of eulachon	10/20/2011 76 FR 65324	Critical habitat for eulachon includes portions of 16 rivers and streams in California, Oregon, and Washington. All of these areas are designated as migration and spawning habitat for this species. In Oregon, we designated 24.2 miles of the lower Umpqua River, 12.4 miles of the lower Sandy River, and 0.2 miles of Tenmile Creek. We also designated the mainstem Columbia River from the mouth to the base of Bonneville Dam, a distance of 143.2 miles. Dams and water diversions are moderate threats to eulachon in the Columbia and Klamath rivers where hydropower generation and flood control are major activities. Degraded water quality is common in some areas occupied by southern DPS eulachon. In the Columbia and Klamath river basins, large-scale impoundment of water has increased winter water temperatures, potentially altering the water temperature 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

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
		to eulachon in the Columbia River. Dredging during eulachon spawning would be particularly detrimental.
Southern DPS of green sturgeon	10/09/2009 74 FR 52300	Critical habitat has been designated in coastal U.S. marine waters within 60 fathoms depth from Monterey Bay, California (including Monterey Bay), north to Cape Flattery, Washington, including the Strait of Juan de Fuca, Washington, to its United States boundary; the Sacramento River, lower Feather River, and lower Yuba River in California; the Sacramento-San Joaquin Delta and Suisun, San Pablo, and San Francisco bays in California; tidally influenced areas of the Columbia River estuary from the mouth upstream to river mile 46; and certain coastal bays and estuaries in California (Humboldt Bay), Oregon (Coos Bay, Winchester Bay, Yaquina Bay, and Nehalem Bay), and Washington (Willapa Bay and Grays Harbor), including, but not limited to, areas upstream to the head of tide in various streams that drain into the bays, as listed in Table 1 in USDC (2009). The CHART identified several activities that threaten the PBFs in coastal bays and estuaries and necessitate the need for special management considerations or protection. The application of pesticides is likely to adversely affect prey resources and water quality within the bays and estuaries, as well as the growth and reproductive health of Southern DPS green sturgeon through bioaccumulation. Other activities of concern include those that disturb bottom substrates, adversely affect prey resources, or degrade water quality through re-suspension of contaminated sediments. Of particular concern are activities that affect prey resources. Prey resources are affected by: commercial shipping and activities generating point source pollution and non-point source pollution that discharge contaminants and result in bioaccumulation of contaminants in green sturgeon; disposal of dredged materials that bury prey resources; and bottom trawl fisheries that disturb the bottom (but result in beneficial or adverse effects on prey resources for green sturgeon).
Southern resident killer whale	11/29/2006 71 FR 69054	Critical habitat consists of three specific marine areas of inland waters of Washington: 1) the Summer Core Area in Haro Strait and waters around the San Juan Islands; 2) Puget Sound; and 3) the Strait of Juan de Fuca. These areas comprise approximately 2,560 square miles of marine habitat. Based on the natural history of the Southern Residents and their habitat needs, NMFS identified three PBFs, or physical or biological features, essential for the conservation of Southern Residents: 1) Water quality to support growth and development; 2) prey species of sufficient quantity, quality, and availability to support individual growth, reproduction and development, as well as overall population growth; and 3) passage conditions to allow for migration, resting, and foraging Water quality in Puget Sound, in general, is degraded. On September 19, 2019 NMFS proposed to revise the critical habitat designation for the SRKW DPS under the ESA by designating six new areas along the U.S. West Coast (84 FR 49214). Specific new areas proposed along the U.S. West Coast include 15,626.6 square miles (mi\2\) (40,472.7 square kilometers (km\2\)) of marine waters between the 6.1-meter (m) (20 feet (ft)) depth contour and the 200-m (656.2 ft) depth contour from the U.S. international border with Canada south to Point Sur, California. The proposed rule to revise critical habitat designation was based on new information about the SRKW's habitat use along the coast.

2.3 Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). For the purposes of this opinion, the action area includes nearly all river reaches accessible to listed Chinook salmon, chum salmon, coho salmon, steelhead, eulachon, and green sturgeon in all sub-basins of Washington, Oregon, California and much of Idaho. Additionally, the action area includes all marine waters off the West Coast of the contiguous United States (including nearshore waters, from California to the Canadian border and Puget Sound) accessible to listed Chinook salmon, chum salmon, coho salmon, steelhead, eulachon, and green sturgeon.

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

In most cases, the proposed research activities would take place in individually very small sites. For example, the researchers might electrofish a few hundred feet of river, deploy a beach seine covering only a few hundred square feet of stream, or operate a screw trap in a few tens of square feet of habitat. Many of the proposed research activities would take place in designated critical habitat. More detailed habitat information (i.e., migration barriers, physical and biological habitat features, and special management considerations) for species considered in this opinion may be found in the Federal Register notices designating critical habitat (Table 32).

2.4 Environmental Baseline

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

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

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

2.4.1 Summary for all Listed Species

Factors Limiting Recovery

The best scientific information presently available demonstrates that a multitude of factors, past and present, have contributed to the decline of west coast salmonids, eulachon and sturgeon. NMFS' status reviews, Technical Recovery Team publications, and recovery plans for the listed species considered in this opinion identify several factors that have caused them to decline, as well as those that prevent them from recovering (many of which are the same). Very generally, these include harvest and hatchery practices and habitat degradation and curtailment caused by human development and resource extraction. NMFS' decisions to list the species identified a variety of factors that were limiting their recovery. None of these documents identifies scientific research as either a cause for decline or a factor preventing their recovery. See Tables 2 and 32 for summaries of the major factors limiting recovery of the listed species and how various factors have degraded PBFs and harmed listed species considered in this opinion. Also, please see Section 2.2 for information regarding how climate change has affected and is affecting species and habitat in the action areas. Climate change was not generally considered a relevant factor when the species were listed and the critical habitat designated, but it is now.

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

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

Research Effects

Although not identified as a factor for decline or a threat preventing recovery, scientific research and monitoring activities have the potential to affect the species' survival and recovery by killing listed salmonids—whether intentionally or not. For the year 2021, 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 33).

Table 33. Total Expected Take of Salmon and Steelhead for Scientific Research and Monitoring in 2021.

Species	Life Stage	Origin[1]	Authorized Handling Take	Authorized Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Puget Sound Chinook salmon	Adult	Natural	721	34	3.356	0.158
		LHIA	826	10	10.260	0.388
		LHAC	1,027	60		
	Juvenile	Natural	80,040	4,090	2.530	0.129
		LHIA	59,790	2,267	0.800	0.030
		LHAC	68,284	8,690	0.144	0.018
Puget Sound steelhead	Adult	Natural	107	9	0.750	0.082
		LHIA	5	0		
		LHAC	34	7		
	Juvenile	Natural	15,571	297	0.705	0.013
		LHIA	1,631	28	1.450	0.025
		LHAC	1,805	66	1.641	0.060
Hood Canal summer-run chum salmon	Adult	Natural	27	7	0.107	0.028
	Juvenile	Natural	5,012	139	0.129	0.004
		LHIA	195	20	0.130	0.013
		LHAC	85	18	-	-
Upper Columbia River steelhead	Adult	Natural	235	4	12.170	0.207
		LHIA	94	2	8.083	0.172
		LHAC	219	6	4.125	0.113
	Juvenile	Natural	31,353	650	15.725	0.326
		LHIA	2,418	69	1.745	0.050
		LHAC	10,334	248	1.503	0.036
Middle Columbia River steelhead	Adult	Natural	174	7	3.444	0.139
		LHIA	130	5	116.071	4.464
		LHAC	25	2	5.580	0.446
	Juvenile	Natural	58,614	1,274	14.377	0.312
		LHIA	8,963	126	8.114	0.114
		LHAC	581	35	0.131	0.008
Snake River spring/summer-run Chinook salmon	Adult	Natural	1,878	16	14.674	0.125
		LHIA	378	3	89.786	0.713
		LHAC	1,233	12	51.655	0.503
	Juvenile	Natural	398,293	3,960	39.532	0.393
		LHIA	44,155	404	5.695	0.052
		LHAC	76,627	1,056	1.721	0.024
Snake River fall-run Chinook salmon	Adult	Natural	251	14	2.428	0.135
		LHIA	200	2	1.476	0.015
		LHAC	257	19	1.657	0.123
	Juvenile	Natural	913	99	0.132	0.014
		LHIA	122	29	0.004	0.001

Species	Life Stage	Origin[1]	Authorized Handling Take	Authorized Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
		LHAC	645	149	0.026	0.006
Snake River Basin steelhead	Adult	Natural	6,604	90	62.615	0.853
		LHIA	2,103	28	13.032	0.174
		LHAC	2,373	32	2.985	0.040
	Juvenile	Natural	136,664	1,841	17.118	0.231
		LHIA	33,659	359	4.771	0.051
		LHAC	75,395	840	2.285	0.025
Lower Columbia River Chinook salmon	Adult	Natural	127	10	0.431	0.034
		LHIA	12	0	0.422	
		LHAC	151	13		
	Juvenile	Natural	14,968	470	0.127	0.004
		LHIA	183	32	0.019	0.003
		LHAC	2,063	583	0.007	0.002
Lower Columbia River coho salmon	Adult	Natural	664	10	2.223	0.033
		LHIA	31	0	6.336	0.455
		LHAC	526	40		
	Juvenile	Natural	11,413	328	1.725	0.050
		LHIA	175	108	0.070	0.043
		LHAC	2,060	927	0.028	0.013
Lower Columbia River steelhead	Adult	Natural	1,079	13	8.351	0.101
		LHAC	86	4	0.386	0.018
	Juvenile	Natural	9,657	331	2.742	0.094
		LHIA	3	0	0.033	0.000
		LHAC	840	58	0.070	0.005
Columbia River chum salmon	Adult	Natural	34	5	0.319	0.047
		LHIA	1	0	0.235	0.000
	Juvenile	Natural	2,216	81	0.033	0.001
		LHIA	17	12	0.003	0.002
		LHAC	10	0	-	-
Upper Willamette River Chinook salmon	Adult	Natural	66	5	0.647	0.049
		LHAC	86	11	0.273	0.035
	Juvenile	Natural	9,492	248	0.783	0.020
		LHIA	24	3	0.570	0.071
		LHAC	1,641	153	0.035	0.003
Upper Willamette River steelhead	Adult	Natural	23	2	0.790	0.069
	Juvenile	Natural	3,519	65	2.506	0.046
Oregon Coast coho salmon	Adult	Natural	660	26	0.700	0.028
		LHAC	15	4	2.683	0.716
	Juvenile	Natural	3,446	199	0.052	0.003

Species	Life Stage	Origin[1]	Authorized Handling Take	Authorized Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
		LHAC	185	17	0.308	0.028
Southern Oregon/Northern California Coast coho salmon	Adult	Natural	106	11	1.169	0.121
		LHIA	81	7	0.997	0.119
		LHAC	28	6		
	Juvenile	Natural	82,643	1,511	4.104	0.075
		LHIA	7,448	504	1.295	0.088
		LHAC	2,541	53	1.270	0.026
Northern California steelhead	Adult	Natural	420	11	5.816	0.152
	Juvenile	Natural	98,991	2,130	12.052	0.259
California Coastal Chinook salmon	Adult	Natural	294	21	4.180	0.299
	Juvenile	Natural	55,398	1,385	4.334	0.108
Central Valley spring-run Chinook salmon	Adult	Natural	1,465	23	39.308	0.617
		LHAC	478	79	21.029	3.476
	Juvenile	Natural	407,636	12,274	52.566	1.583
		LHAC	8,127	3,149	0.375	0.145
California Central Valley steelhead	Adult	Natural	2,242	78	132.977	4.626
		LHAC	1,867	90	48.418	2.334
	Juvenile	Natural	45,723	1,593	7.253	0.253
		LHAC	23,259	1,439	1.453	0.090
Central California Coast steelhead	Adult	Natural	2,391	47	109.328	2.149
		LHAC	492	17	12.726	0.440
	Juvenile	Natural	221,178	5,063	88.908	2.035
		LHIA	6,200	124	-	-
		LHAC	12,881	355	1.985	0.055
South-Central California Coast steelhead	Adult	Natural	264	8	37.986	1.151
	Juvenile	Natural	24,578	647	31.089	0.818
Southern DPS eulachon	Adult	Natural	31,827	30,973	0.104	0.101
	Subadult	Natural	1,030	1,030		
	Juvenile	Natural	540	456		
Southern DPS green sturgeon	Adult	Natural	130	5	6.173	0.237
	Subadult	Natural	81	6	0.733	0.054
	Juvenile	Natural	1,702	71	38.796	1.618
	Larvae	Natural	11,010	1,010	-	-
	Egg	Natural	1,250	1,250		

[1] LHIA=Listed hatchery intact adipose; LHAC=Listed hatchery adipose clipped

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 over the past 10 years researchers in the 4d program, on average, end up taking only 28 percent or less of the number of fish requested, and the actual mortality that occurs is only 15 percent or less of what was requested for any life stage. 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

“Effects of the action” means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur.

2.5.1 Effects on Critical Habitat

Full descriptions of effects of the proposed activities are found in the state submittals (CDFW 2021, IDFG 2020, ODFW 2020, and WDFW 2020). 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 further below, 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, and in some cases intentionally sacrificing small numbers of juvenile 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 2021, IDFG 2020, ODFW 2020, and WDFW 2020) 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 pre-established set of mitigation measures described above and incorporated into every research project approval 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.

Gill and 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.

<u>Electrofishing</u>

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 pre-established set of mitigation measures, as well as any other project-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 Programs

In previous sections, we estimated the annual abundance of adult and juvenile listed salmonids, eulachon, and green sturgeon. Since there are no measurable habitat effects, the analysis will consist primarily of examining directly measurable impacts of the Programs on abundance. Abundance effects are themselves relevant to extinction risk, are directly related to productivity effects, and are somewhat but less directly to structure and diversity effects. Table 34 displays the estimated annual abundance of the listed species.

Table 34. Estimated annual abundance of ESA listed fish.

Species	Life Stage	Origin[1]	Abundance
Puget Sound Chinook salmon	Adult	Natural	21,486
		Listed Hatchery	18,060
	Juvenile	Natural	3,163,652
		LHIA	7,470,630
		LHAC	47,372,500

Species	Life Stage	Origin[1]	Abundance
Puget Sound steelhead	Adult	Natural and Listed Hatchery	19,456
	Juvenile	Natural	2,210,140
		LHIA	112,500
		LHAC	110,000
Hood Canal summer-run chum salmon	Adult	Natural	25,146
		LHIA	1,452
	Juvenile	Natural	3,889,955
		LHIA	150,000
Upper Columbia River steelhead	Adult	Natural	1,931
		LHIA	1,163
		LHAC	5,309
	Juvenile	Natural	199,380
		LHIA	138,601
		LHAC	687,567
Middle Columbia River steelhead	Adult	Natural	5,052
		LHIA	112
		LHAC	448
	Juvenile	Natural	407,697
		LHIA	110,469
		LHAC	444,973
Snake River spring/summer-run Chinook salmon	Adult	Natural	12,798
		LHIA	421
		LHAC	2,387
	Juvenile	Natural	1,007,526
		LHIA	775,305
		LHAC	4,453,663
Snake River fall-run Chinook salmon	Adult	Natural	10,337
		LHIA	13,551
		LHAC	15,508
	Juvenile	Natural	692,819
		LHIA	2,862,418
		LHAC	2,483,713
Snake River Basin steelhead	Adult	Natural	10,547
		LHIA	16,137
		LHAC	79,510
	Juvenile	Natural	798,341
		LHIA	705,490
		LHAC	3,300,152
Lower Columbia River Chinook salmon	Adult	Natural	29,469
		Listed Hatchery	38,594
	Juvenile	Natural	11,745,027
		LHIA	962,458
		LHAC	31,353,395
Lower Columbia River coho salmon	Adult	Natural	29,866
		Listed Hatchery	8,791
	Juvenile	Natural	661,468
		LHIA	249,784
		LHAC	7,287,647
Lower Columbia River steelhead	Adult	Natural	12,920
		Listed Hatchery	22,297
	Juvenile	Natural	352,146
		LHIA	9,138

Species	Life Stage	Origin[1]	Abundance
		LHAC	1,197,156
Columbia River chum salmon	Adult	Natural	10,644
		LHIA	426
	Juvenile	Natural	6,626,218
		LHIA	601,503
Upper Willamette River Chinook salmon	Adult	Natural	10,203
		Listed Hatchery	31,476
	Juvenile	Natural	1,211,863
		LHIA	4,214
		LHAC	4,709,045
Upper Willamette River steelhead	Adult	Natural	2,912
	Juvenile	Natural	140,396
Oregon Coast coho salmon	Adult	Natural	94,320
		LHAC	559
	Juvenile	Natural	6,641,564
		LHAC	60,000
Southern Oregon/Northern California Coast coho salmon	Adult	Natural	9,065
		Listed Hatchery	10,934
	Juvenile	Natural	2,013,593
		LHIA	575,000
		LHAC	200,000
Northern California steelhead	Adult	Natural	7,221
	Juvenile	Natural	821,389
California Coastal Chinook salmon	Adult	Natural	7,034
	Juvenile	Natural	1,278,078
Central Valley spring-run Chinook salmon	Adult	Natural	3,727
		LHAC	2,273
	Juvenile	Natural	775,474
		LHAC	2,169,329
California Central Valley steelhead	Adult	Natural	1,686
		LHAC	3,856
	Juvenile	Natural	630,403
		LHAC	1,600,653
Central California Coast steelhead	Adult	Natural	2,187
		LHAC	3,866
	Juvenile	Natural	248,771
		LHAC	648,891
South-Central California Coast steelhead	Adult	Natural	695
	Juvenile	Natural	79,057
Southern DPS eulachon	Adult	Natural	32,029,043
Southern DPS green sturgeon	Adult	Natural	2,106
	Subadult	Natural	11,055
	Juvenile	Natural	4,387

[1] LHIA=Listed hatchery intact adipose; LHAC=Listed hatchery adipose clipped

The analysis process relies on multiple sources of data. In Section 2.2.1 (Status of the Species), we estimated the average annual abundance for the species considered in this document. For most of the listed species, we estimated abundance for adult returning fish and outmigrating smolts. These data come from estimates compiled by our Science Centers for the species status reviews, which are updated every five years. Additional data sources include state agencies (i.e. WDFW, IDFW, ODFW, and CDFW), county and local agencies, and educational and non-profit institutions. These sources are vetted for scientific accuracy before their use. For hatchery propagated juvenile salmonids, we use hatchery production goals. Table 33 displays the estimated annual abundance of hatchery-propagated and naturally produced listed fish.

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 Washington, Idaho, Oregon, and California) 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.

WDFW's Research Program

The specific projects and related take estimates are described in detail in the WDFW submittal (WDFW 2020) and that document is incorporated in full herein. The WDFW submitted 33 projects for work to be conducted in the state of Washington. All of the projects in WDFW's Program would be conducted by the WDFW. The WDFW submittal details their forecast of calendar year 2021 research and monitoring activities that may affect 14 threatened species of salmon and steelhead, as well as green sturgeon and eulachon in the state of Washington. The amount of take the WDFW is requesting is found in the table below.

Table 35. Proposed take and comparison of possible lethal take to annual abundance at the ESU/DPS scale under WDFW's research program;.

Species	Life Stage	Origin[1]	Take Action[2]	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Puget Sound Chinook salmon	Adult	Natural	O/H	400	0	1.8617%	0.0000%
			C/H/R	124	1	0.5771%	0.0047%
		LHIA	O/H	1500	0	8.3056%	0.0000%
			C/H/R	101	1	0.5592%	0.0055%
		LHAC	C/H/R	113	0	0.6257%	0.0000%
	Spawned Adult/ Carcass	Natural	O/ST D	2170	0		
			C/H/R	10	0		
		LHIA	O/ST D	780	0		
		LHAC	O/ST D	1180	0		
	Juvenile	Natural	C/M, T, ST/R	174385	2255	5.5121%	0.0713%
			IM	1626	1626	0.0514%	0.0514%
			C/H/R	99222	558	3.1363%	0.0176%
		LHIA	C/M, T, ST/R	16000	235	0.2142%	0.0031%
			IM	290	290	0.0039%	0.0039%
			C/H/R	1116	6	0.0149%	0.0001%
		LHAC	C/M, T, ST/R	4945	77	0.0104%	0.0002%
			IM	1560	1560	0.0033%	0.0033%
			C/H/R	121551	1123	0.2566%	0.0024%
	Adult	Natural	O/H	300	0	1.5419%	0.0000%

Puget Sound steelhead			C/M, T, ST/R	1575	28	8.0952%	0.1439%
			C/H/R	77	1	0.3958%	0.0051%
		LHIA	C/M, T, ST/R	15	0	0.0771%	0.0000%
	Spawned Adult/ Carcass	Natural	C/M, T, ST/R	17	0		
	Juvenile	Natural	C/M, T, ST/R	15445	232	0.6988%	0.0105%
			IM	150	150	0.0068%	0.0068%
			C/H/R	11747	152	0.5315%	0.0069%
		LHIA	C/H/R	616	9	0.5476%	0.0080%
		LHAC	C/H/R	3145	41	2.8591%	0.0373%
Hood Canal summer-run chum salmon	Adult	Natural	C/H/R	1050	14	4.1756%	0.0557%
	Spawned Adult/ Carcass	Natural	O/ST D	200	0		
	Juvenile	Natural	C/M, T, ST/R	22300	252	0.5733%	0.0065%
			C/H/R	494211	1791	12.7048%	0.0460%
		LHIA	C/H/R	50	1	0.0333%	0.0007%
Upper Columbia River steelhead	Juvenile	Natural	C/H/R	800	12	0.4012%	0.0060%
Middle Columbia River steelhead	Adult	Natural	C/M, T, ST/R	275	5	5.4434%	0.0990%
			C/H/R	1	0	0.0198%	0.0000%
		LHIA	C/M, T, ST/R	35	1	31.2500%	0.8929%
		LHAC	C/M, T, ST/R	25	1	5.5804%	0.2232%
	Spawned Adult/ Carcass	Natural	C/M, T, ST/R	125	2		
		LHIA	C/M, T, ST/R	20	1		
		LHAC	C/M, T, ST/R	12	1		
	Juvenile	Natural	C/M, T, ST/R	3300	87	0.8094%	0.0213%
			C/H/R	190	5	0.0466%	0.0012%
		LHIA	C/M, T, ST/R	150	4	0.1358%	0.0036%
			C/H/R	40	2	0.0362%	0.0018%
		LHAC	C/M, T, ST/R	150	4	0.0337%	0.0009%
			C/H/R	40	2	0.0090%	0.0004%
Snake River fall-run Chinook salmon	Juvenile	Natural	C/H/R	220	3	0.0318%	0.0004%
		LHIA	C/H/R	20	1	0.0007%	0.0000%
		LHAC	C/H/R	20	1	0.0008%	0.0000%
Snake River spring/summer-run Chinook salmon	Spawned Adult/ Carcass	Natural	O/ST D	50	0		
		LHIA	O/ST D	15	0		
		LHAC	O/ST D	15	0		
	Juvenile	Natural	C/H/R	420	5	0.0417%	0.0005%
		LHIA	C/H/R	20	1	0.0026%	0.0001%
		LHAC	C/H/R	20	1	0.0004%	0.0000%
Snake River Basin steelhead	Juvenile	Natural	C/H/R	420	5	0.0526%	0.0006%
		LHIA	C/H/R	20	1	0.0028%	0.0001%
		LHAC	C/H/R	20	1	0.0006%	0.0000%

Lower Columbia River Chinook salmon	Adult	Natural	O/H	200	0	0.6787%	0.0000%
			C/M, T, ST/R	50	1	0.1697%	0.0034%
			C/H/R	11	1	0.0373%	0.0034%
		LHIA	O/H	5	0	0.0130%	0.0000%
		LHAC	O/H	400	0	1.0364%	0.0000%
	Spawned Adult/ Carcass	Natural	C/H/R	10	0		
	Juvenile	Natural	C/M, T, ST/R	176700	2844	1.5045%	0.0242%
			IM	50	50	0.0004%	0.0004%
			C/H/R	151065	1649	1.2862%	0.0140%
Lower Columbia River coho salmon	Adult	Natural	O/H	100	0	0.3348%	0.0000%
			C/M, T, ST/R	50	1	0.1674%	0.0033%
			C/H/R	15	1	0.0502%	0.0033%
		LHAC	O/H	200	0	2.2751%	0.0000%
			C/M, T, ST/R	75	1	0.8531%	0.0114%
	Juvenile	Natural	C/M, T, ST/R	56190	652	8.4947%	0.0986%
			C/H/R	60610	658	9.1630%	0.0995%
		LHIA	C/H/R	350	4	0.1401%	0.0016%
		LHAC	C/M, T, ST/R	170	4	0.0023%	0.0001%
			C/H/R	8150	70	0.1118%	0.0010%
Lower Columbia River steelhead	Adult	Natural	O/H	100	0	0.7740%	0.0000%
			C/M, T, ST/R	900	11	6.9659%	0.0851%
		LHAC	O/H	100	0	0.4485%	0.0000%
	Spawned Adult/ Carcass	Natural	C/H/R	10	0		
	Juvenile	Natural	C/M, T, ST/R	20685	229	5.8740%	0.0650%
			C/H/R	7550	106	2.1440%	0.0301%
		LHAC	C/H/R	1470	14	0.1228%	0.0012%
Columbia River chum salmon	Adult	Natural	C/H/R	5	1	0.0470%	0.0094%
	Juvenile	Natural	C/M, T, ST/R	20000	200	0.3018%	0.0030%
			C/H/R	2450	37	0.0370%	0.0006%
		LHIA	C/H/R	335	3	0.0557%	0.0005%
Southern DPS eulachon	Adult	Natural	C/M, T, ST/R	20	5	0.0001%	0.0000%
			C/H/R	280	41	0.0009%	0.0001%
Southern DPS green sturgeon	Adult	Natural	C/M, T, ST/R	150	3	7.1225%	0.1425%
	Subadult	Natural	C/M, T, ST/R	150	3	1.3569%	0.0271%

[1] LHIA=Listed hatchery intact adipose; LHAC=Listed hatchery adipose clipped
[2] C/H/R=Capture, Handle, Release; C/M, T, ST/R= Capture, Mark, Tag, Sample Tissue, Release; O/H=Observe/Harass; O/ST D=Observe, Sample Tissue Dead Animal, IM= Intentional mortality

Under the 33 projects in WDFW's research program juvenile salmon and steelhead would be observed via snorkel surveys and captured using backpack electrofishing equipment, traps, nets, seines, and hook and line. Most of the juvenile salmon and steelhead would be released shortly after capture. A subsample of captured juvenile salmon and steelhead may be anesthetized, checked for tags/marks, tissue sampled, and tagged/marked prior to release. A small number of juvenile Chinook salmon and steelhead would be sacrificed for tissue analysis.

Adult salmon and steelhead would be observed via snorkel surveys or spawning surveys and captured using fish ladders, hook and line, nets, seines, and traps. Tissues would be collected from any carcasses encountered during snorkel and spawning surveys. Most of the adult salmon and steelhead would be released shortly after capture. A subsample of captured adult salmon and steelhead may be anesthetized, checked for tags/marks, tissue sampled, and tagged/marked prior to release.

Adult/subadult green sturgeon would be captured with gill nets, anesthetized, tissue sampled and tagged. Adult eulachon may also be captured, although none of the research is specifically targeting eulachon.

With the exception of a small number of intentional mortalities of juvenile Puget Sound Chinook salmon and steelhead, and Lower Columbia River Chinook salmon, researchers in WDFW's program are not proposing to kill any of the fish being captured, but a small number of fish may be killed as an inadvertent result of these activities. Researchers are directed to substitute inadvertent mortalities for planned intentional lethal sacrifice individuals whenever possible to minimize the total mortality associated with these studies. Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected (see status section) for the species—these figures are presented in the last column of the table above.

The permitted activities may thus cause the death of a very small number of juvenile and adult fish. The permitted activities may kill no more than 0.14% of the expected abundance for any of the listed salmon, steelhead, sturgeon, or eulachon. Moreover, that take (and any of its potential impacts) would be spread out over tributary and marine habitat in Washington. Thus, no population is likely to experience a disproportionate amount of even these small losses. As a result, the activities are likely to have only a minimal impact on species abundance (and therefore productivity) and no appreciable impact on structure or diversity. And that minimal effect is likely to be even less than displayed because over the last ten years (2011-2020), researchers in WDFW's Program have generally killed only 9.1% of the adult fish and 17.4% of the juvenile fish they were allotted.

IDFG's Research Program

The specific projects and related take estimates are described in detail in the IDFG submittal (IDFG 2020) and that document is incorporated in full herein. The IDFG submitted 14 projects for work to be conducted in the state of Idaho. The IDFG Program contains five applications for work to be conducted by the IDFG and nine to be conducted by other researchers and coordinated with the IDFG. The IDFG submittal details their forecast of calendar year 2021 research and monitoring activities that may affect three threatened species of salmon and steelhead covered by the 4(d) rule in the state of Idaho. The amount of take the IDFG is requesting is found in the table below.

Table 36. Proposed take and comparison of possible lethal take to annual abundance at the ESU/DPS scale under IDFG's research program.

Species	Life Stage	Origin[1]	Take Action[2]	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Snake River fall-run Chinook salmon	Spawned Adult/ Carcass	Natural	C/H/R	5	-		
	Juvenile	Natural	C/H/R	50	4	0.0072%	0.0006%
Snake River spring/summer-run Chinook salmon	Adult	Natural	C/H/R	11	1	0.0860%	0.0078%
		LHIA	C/H/R	5	-	1.1876%	0.0000%
		LHAC	C/H/R	7	-	0.2933%	0.0000%
	Spawned Adult/ Carcass	Natural	O/ST D	4,055	-		
		LHIA	O/ST D	770	-		
		LHAC	O/ST D	870	-		
	Juvenile	Natural	O/H	1,400	-	0.1390%	0.0000%
			C/H/R	123,144	1,303	12.2224%	0.1293%
			C/M, T, ST/R	55,020	591	5.4609%	0.0587%
		LHIA	C/H/R	1,300	13	0.1677%	0.0017%
		LHAC	C/H/R	5,190	87	0.1165%	0.0020%
Snake River Basin steelhead	Adult	Natural	C/H/R	66	1	0.6258%	0.0095%
			C/M, T, ST/R	1,136	17	10.7708%	0.1612%
		LHIA	C/M, T, ST/R	60	5	0.3718%	0.0310%
		LHAC	C/H/R	150	1	0.1887%	0.0013%
			C/M, T, ST/R	245	10	0.3081%	0.0126%
	Spawned Adult/ Carcass	Natural	C/H/R	35	3		
			C/M, T, ST/R	626	7		
			O/ST D	110	-		
	Juvenile	Natural	O/H	800	-	0.1002%	0.0000%
			C/H/R	67,494	838	8.4543%	0.1050%
			C/M, T, ST/R	64,282	663	8.0519%	0.0830%
		LHIA	C/H/R	150	2	0.0213%	0.0003%
		LHAC	C/H/R	1,960	22	0.0594%	0.0007%
			C/M, T, ST/R	100	1	0.0030%	0.0000%

[1] LHIA=Listed hatchery intact adipose; LHAC=Listed hatchery adipose clipped
[2] C/H/R=Capture, Handle, Release; C/M, T, ST/R= Capture, Mark, Tag, Sample Tissue, Release; O/H=Observe/Harass; O/ST D=Observe, Sample Tissue Dead Animal, IM= Intentional mortality

Under the 14 projects in IDFG's research program juvenile salmon and steelhead would be observed via snorkel surveys and captured using backpack electrofishing equipment, traps, nets, seines, and hook and line. Most of the juvenile salmon and steelhead would be released shortly after capture. A subsample of captured juvenile salmon and steelhead may be anesthetized, checked for tags/marks, tissue sampled, and tagged/marked prior to release.

Adult salmon and steelhead would be observed via spawning surveys and captured using fish hook and line, nets, seines, and traps. Tissues would be collected from any carcasses encountered during snorkel and spawning surveys. Most of the adult salmon and steelhead would be released shortly after capture. A subsample of captured adult salmon and steelhead may be anesthetized, checked for tags/marks, tissue sampled, and tagged/marked prior to release.

Researchers in IDFG's program are not proposing to kill any of the fish being captured, but a small number of fish may be killed as an inadvertent result of these activities. Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected (see status section) for the species—these figures are presented in the last column of the table above.

The permitted activities may thus unintentionally cause the death of a very small number of juvenile and adult fish. The permitted activities may kill no more than 0.16% of the expected abundance for any of the listed salmon or steelhead. Moreover, that take (and any of its potential impacts) would be spread out over tributary habitat in Idaho. Thus, no population is likely to experience a disproportionate amount of even these small losses. As a result, the activities are likely to have only a minimal impact on species abundance (and therefore productivity) and no appreciable impact on structure or diversity. And that minimal effect is likely to be even less than displayed because over the last ten years (2011-2020), researchers in IDFG's Program have generally killed only 6.8% of the adult fish and 27.4% of the juvenile fish they were allotted.

ODFW's Research Program

The ODFW submitted 71 projects, more than half of which would be conducted by the ODFW and the rest by other researchers and coordinated with the ODFW through the Oregon Plan for Salmon and Watersheds (OPSW). The OPSW is a cooperative effort of state, local, Federal, tribal, and private organizations and individuals. Its purpose is to restore Oregon's wild salmon and trout populations. Monitoring the health of salmonids and their watersheds, and monitoring the results of research are key components of the OPSW. The ODFW submittal details their forecast of calendar year 2021 research and monitoring activities that may affect eulachon, green sturgeon, and 12 threatened salmon and steelhead in the state of Oregon (Table 37).

Table 37. Proposed take and comparison of possible lethal take to annual abundance at the ESU/DPS scale under ODFW's research program.

Species	Life Stage	Origin[1]	Take Action[2]	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Middle Columbia River steelhead	Adult	Natural	O/H	360	-	7.1259%	0.0000%
			C/M, T, ST/R	665	3	13.1631%	0.0594%
			C/H/R	1	1	0.0198%	0.0198%
		LHAC	C/M, T, ST/R	800	8	178.5714%	1.7857%

	Spawned Adult/ Carcass	Natural	C/M, T, ST/R	30	-		
			C/H/R	5	-		
	Juvenile	Natural	O/H	2,900	-	0.7113%	0.0000%
			C/M, T, ST/R	33,780	531	8.2856%	0.1302%
			IM	296	296	0.0726%	0.0726%
			C/H/R	14,300	324	3.5075%	0.0795%
Snake River fall-run Chinook salmon	Adult	Natural	C/H/R	6	-	0.0580%	0.0000%
		LHIA	C/H/R	2	-	0.0148%	0.0000%
		LHAC	C/H/R	2	-	0.0129%	0.0000%
	Juvenile	Natural	IM	2	2	0.0003%	0.0003%
			C/H/R	815	22	0.1176%	0.0032%
		LHIA	C/H/R	175	4	0.0061%	0.0001%
		LHAC	C/H/R	250	7	0.0101%	0.0003%
Snake River spring/summer-run Chinook salmon	Adult	Natural	C/H/R	19	1	0.1485%	0.0078%
		LHIA	C/H/R	2	-	0.4751%	0.0000%
		LHAC	C/H/R	17	-	0.7122%	0.0000%
	Juvenile	Natural	IM	3	3	0.0003%	0.0003%
			C/H/R	7,855	214	0.7796%	0.0212%
		LHIA	C/H/R	200	4	0.0258%	0.0005%
		LHAC	C/H/R	2,108	53	0.0473%	0.0012%
Snake River Basin steelhead	Adult	Natural	C/M, T, ST/R	10	-	0.0948%	0.0000%
			C/H/R	18	1	0.1707%	0.0095%
		LHAC	C/H/R	2	-	0.0025%	0.0000%
	Juvenile	Natural	IM	3	3	0.0004%	0.0004%
			C/H/R	6,825	189	0.8549%	0.0237%
		LHIA	C/H/R	15	1	0.0021%	0.0001%
		LHAC	C/H/R	865	26	0.0262%	0.0008%
Lower Columbia River Chinook salmon	Adult	Natural	C/M, T, ST/R	70	1	0.2375%	0.0034%
			C/H/R	50	2	0.1697%	0.0068%
	Spawned Adult/ Carcass	Natural	C/H/R	10	-		
	Juvenile	Natural	O/H	1,150	-	0.0098%	0.0000%
			C/M, T, ST/R	1,020	12	0.0087%	0.0001%
			IM	23	23	0.0002%	0.0002%
			C/H/R	3,020	66	0.0257%	0.0006%
		LHIA	C/H/R	120	4	0.0125%	0.0004%
		LHAC	C/M, T, ST/R	20	-	0.0001%	0.0000%
			C/H/R	345	8	0.0011%	0.0000%
Lower Columbia River coho salmon	Adult	Natural	C/M, T, ST/R	25	1	0.0837%	0.0033%
			C/H/R	150	2	0.5022%	0.0067%
	Spawned Adult/ Carcass	Natural	C/H/R	15	-		
	Juvenile	Natural	O/H	9,500	-	1.4362%	0.0000%
			C/M, T, ST/R	1,533	19	0.2318%	0.0029%
			IM	52	52	0.0079%	0.0079%
			C/H/R	7,363	144	1.1131%	0.0218%

		LHAC	C/M, T, ST/R	10	-	0.0001%	0.0000%
			IM	10	10	0.0001%	0.0001%
			C/H/R	460	11	0.0063%	0.0002%
Lower Columbia River steelhead	Adult	Natural	C/M, T, ST/R	695	6	5.3793%	0.0464%
	Spawned Adult/ Carcass	Natural	C/H/R	35	4		
		LHAC	C/H/R	35	4		
	Juvenile	Natural	O/H	1,250	-	0.3550%	0.0000%
			C/M, T, ST/R	13,820	142	3.9245%	0.0403%
			IM	133	133	0.0378%	0.0378%
			C/H/R	9,655	134	2.7418%	0.0381%
		LHAC	C/M, T, ST/R	20,310	203	1.6965%	0.0170%
			C/H/R	50	1	0.0042%	0.0001%
Columbia River chum salmon	Juvenile	Natural	IM	12	12	0.0002%	0.0002%
			C/H/R	1,141	32	0.0172%	0.0005%
Upper Willamette River Chinook salmon	Adult	Natural	O/H	30	-	0.2940%	0.0000%
			C/H/R	102	1	0.9997%	0.0098%
		LHAC	O/H	110	-	0.3495%	0.0000%
			C/H/R	52	1	0.1652%	0.0032%
	Spawned Adult/ Carcass	Natural	C/H/R	10	-		
	Juvenile	Natural	O/H	200	-	0.0165%	0.0000%
			C/M, T, ST/R	12,805	214	1.0566%	0.0177%
			IM	24	24	0.0020%	0.0020%
			C/H/R	12,700	222	1.0480%	0.0183%
		LHIA	O/H	40	-	0.9492%	0.0000%
			C/H/R	20	1	0.4746%	0.0237%
		LHAC	O/H	210	-	0.0045%	0.0000%
			C/M, T, ST/R	235	15	0.0050%	0.0003%
			C/H/R	5,650	75	0.1200%	0.0016%
Upper Willamette River steelhead	Adult	Natural	O/H	5	-	0.1717%	0.0000%
			C/M, T, ST/R	30	-	1.0302%	0.0000%
			C/H/R	155	2	5.3228%	0.0687%
	Juvenile	Natural	O/H	1,505	-	1.0720%	0.0000%
			C/M, T, ST/R	3,275	71	2.3327%	0.0506%
			IM	2	2	0.0014%	0.0014%
			C/H/R	5,695	121	4.0564%	0.0862%
Oregon Coast coho salmon	Adult	Natural	O/H	15,950	-	16.9105%	0.0000%
			C/M, T, ST/R	6,720	67	7.1247%	0.0710%
			C/H/R	612	8	0.6489%	0.0085%
		LHAC	O/H	200	-	35.7782%	0.0000%
			C/H/R	5	-	0.8945%	0.0000%
	Spawned Adult/ Carcass	Natural	O/ST D	50	-		
	Juvenile	Natural	O/H	148,200	-	2.2314%	0.0000%
			C/M, T, ST/R	115,581	2,028	1.7403%	0.0305%
			IM	10	10	0.0002%	0.0002%

			C/H/R	361,634	8,666	5.4450%	0.1305%
		LHAC	C/H/R	140	4	0.2333%	0.0067%
Southern Oregon/Northern California Coast coho salmon	Adult	Natural	O/H	100	-	1.1031%	0.0000%
			C/M, T, ST/R	300	3	3.3094%	0.0331%
			C/H/R	242	4	2.6696%	0.0441%
		LHAC	C/H/R	520	6	4.7558%	0.0549%
	Juvenile	Natural	O/H	9,300	-	0.4619%	0.0000%
			C/M, T, ST/R	1,200	14	0.0596%	0.0007%
			IM	7	7	0.0003%	0.0003%
			C/H/R	8,205	147	0.4075%	0.0073%
		LHAC	C/H/R	1,250	17	0.2174%	0.0030%
Southern DPS eulachon	Adult	Natural	C/H/R	1,060	25	0.0033%	0.0001%
Southern DPS green sturgeon	Adult	Natural	C/H/R	11	1	0.5223%	0.0475%
	Subadult	Natural	C/H/R	2	-	0.0181%	0.0000%

[1] LHIA=Listed hatchery intact adipose; LHAC=Listed hatchery adipose clipped
[2] C/H/R=Capture, Handle, Release; C/M, T, ST/R= Capture, Mark, Tag, Sample Tissue, Release; O/H=Observe/Harass; O/ST D=Observe, Sample Tissue Dead Animal, IM= Intentional mortality

Under the 71 projects in ODFW's research program juvenile salmon and steelhead would be observed via stream or snorkel surveys, and captured using backpack electrofishing equipment, traps, nets, seines, and hook and line. Most of the juvenile salmon and steelhead would be released shortly after capture. A subsample of captured juvenile salmon and steelhead may be anesthetized, checked for tags/marks, tissue sampled, and tagged/marked prior to release. A small number of juvenile salmon and steelhead would be sacrificed for tissue analysis.

Adult salmon and steelhead would be observed via snorkel surveys or spawning surveys and captured using fish ladders, hook and line, nets, seines, and traps. Tissues would be collected from any carcasses encountered during snorkel and spawning surveys. Most of the adult salmon and steelhead would be released shortly after capture. A subsample of captured adult salmon and steelhead may be anesthetized, checked for tags/marks, tissue sampled, and tagged/marked prior to release.

A small number of adult/subadult green sturgeon and eulachon may be captured using nets, seines, and traps. None of the research in ODFW's Program is specifically targeting green sturgeon or eulachon. Researchers would handle and quickly release all green sturgeon and eulachon.

With the exception of a small number of intentional mortalities of juvenile salmon and steelhead, researchers in ODFW's program are not proposing to kill the great majority of fish being captured, but a small number may additionally be killed as an inadvertent result of these activities. Researchers are directed to substitute inadvertent mortalities for planned intentional lethal sacrifice individuals whenever possible to minimize the total mortality associated with these studies. Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected (see status section) for the species—these figures are presented in the last column of the table above.

The permitted activities may thus cause the death of a very small number of juvenile and adult fish. The permitted activities may kill no more than 0.13% of the expected abundance for any of the listed salmon, steelhead, sturgeon, or eulachon. Moreover, that take (and any of its potential impacts) would be spread out over tributary and estuarine habitat in Oregon. Thus, no population is likely to experience a disproportionate amount of even these small losses. As a result, the activities are likely to have only a minimal impact on species abundance (and therefore productivity) and no appreciable impact on structure or diversity. And that minimal effect is likely to be even less than displayed because over the last ten years (2011-2020), researchers in ODFW's Program have generally killed only 7.5% of the adult fish and 12.7% of the juvenile fish they were allotted.

CDFW's Research Program

The specific projects and related take estimates are described in detail in the CDFW submittal (CDFW 2021) and that document is incorporated in full herein. The CDFW submitted 86 projects for work to be conducted in the state of California. The CDFW Program contains 20 applications for work to be conducted by the CDFW and 66 to be conducted by other researchers and coordinated with the CDFW. The CDFW submittal details their forecast of calendar year 2021 research and monitoring activities that may affect threatened species of salmon and steelhead, as well as green sturgeon and eulachon in the state of California. The amount of take the CDFW is requesting is found in the table below.

Table 38. Proposed take and comparison of possible lethal take to annual abundance at the ESU/DPS scale under CDFW's research program.

Species	Life Stage	Origin[1]	Take Action[2]	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Southern Oregon/Northern California Coast coho salmon	Adult	Natural	O/H	9220	0	101.7099%	0.0000%
			C/M, T, ST/R	870	5	9.5974%	0.0552%
			C/H/R	15	0	0.1655%	0.0000%
		LHIA	O/H	470	0	4.2985%	0.0000%
			C/M, T, ST/R	1570	9	14.3589%	0.0823%
	Spawned Adult/ Carcass	Natural	O/ST D	1518	0		
		LHIA	O/ST D	205	0		
	Juvenile	Natural	O/H	36000	0	1.7878%	0.0000%
			C/M, T, ST/R	28355	371	1.4082%	0.0184%
			C/H/R	19935	260	0.9900%	0.0129%
		LHIA	IM	125	125	0.0217%	0.0217%
Northern California steelhead	Adult	Natural	O/H	7590	0	105.1101%	0.0000%
			C/M, T, ST/R	300	6	4.1545%	0.0831%
			C/H/R	60	1	0.8309%	0.0138%
	Spawned Adult/ Carcass	Natural	O/H	120	0		
			C/M, T, ST/R	50	0		

			O/ST D	148	0		
	Juvenile	Natural	O/H	17050	0	2.0758%	0.0000%
			C/M, T, ST/R	4530	49	0.5515%	0.0060%
			C/H/R	10600	96	1.2905%	0.0117%
California Coastal Chinook salmon	Adult	Natural	O/H	16660	0	236.8496%	0.0000%
			C/M, T, ST/R	140	2	1.9903%	0.0284%
	Spawned Adult/ Carcass	Natural	O/ST D	632	0		
	Juvenile	Natural	O/H	9090	0	0.7112%	0.0000%
			C/M, T, ST/R	13455	152	1.0528%	0.0119%
			C/H/R	10780	94	0.8435%	0.0074%
Central Valley spring-run Chinook salmon	Adult	Natural	O/H	53729	0	1441.6152%	0.0000%
			C/M, T, ST/R	50	1	1.3416%	0.0268%
			O/ST D	100	0	2.6831%	0.0000%
			C/H/R	109	4	2.9246%	0.1073%
		LHAC	O/H	9622	0	423.3172%	0.0000%
			C/M, T, ST/R	145	2	6.3792%	0.0880%
			C/H/R	80	3	3.5196%	0.1320%
	Spawned Adult/ Carcass	Natural	O/H	19250	0		
			O/ST D	3730	0		
		LHAC	O/ST D	7175	0		
			C/H/R	2	0		
	Juvenile	Natural	O/H	34455	0	4.4431%	0.0000%
			C/M, T, ST/R	18680	265	2.4088%	0.0342%
			IM	150	150	0.0193%	0.0193%
			C/H/R	420134	4270	54.1777%	0.5506%
		LHAC	O/H	1375	0	0.0634%	0.0000%
			C/M, T, ST/R	10350	206	0.4771%	0.0095%
			IM	160	160	0.0074%	0.0074%
			C/H/R	9260	170	0.4269%	0.0078%
California Central Valley steelhead	Adult	Natural	O/H	7788	0	461.9217%	0.0000%
			C/M, T, ST/R	935	27	55.4567%	1.6014%
			C/H/R	222	4	13.1673%	0.2372%
		LHAC	O/H	5352	0	138.7967%	0.0000%
			C/M, T, ST/R	331	6	8.5840%	0.1556%
			IM	100	100	2.5934%	2.5934%
			C/H/R	168	2	4.3568%	0.0519%
	Spawned Adult/ Carcass	Natural	O/ST D	372	0		
		LHAC	O/ST D	67	0		
	Juvenile	Natural	O/H	71270	0	11.3055%	0.0000%
			C/M, T, ST/R	9585	170	1.5205%	0.0270%
			IM	25	25	0.0040%	0.0040%
			C/H/R	11823	191	1.8755%	0.0303%
		LHAC	O/H	1410	0	0.0881%	0.0000%
			C/M, T, ST/R	721	15	0.0450%	0.0009%
			IM	300	300	0.0187%	0.0187%
			C/H/R	3141	50	0.1962%	0.0031%

Central California Coast steelhead	Adult	Natural	O/H	285	0	13.0316%	0.0000%
			C/M, T, ST/R	80	1	3.6580%	0.0457%
			O/ST D	10	0	0.4572%	0.0000%
			C/H/R	5	0	0.2286%	0.0000%
		LHAC	C/H/R	5	0	0.1293%	0.0000%
	Spawned Adult/ Carcass	Natural	O/ST D	103	0		
	Juvenile	Natural	O/H	430	0	0.1728%	0.0000%
			C/M, T, ST/R	2670	43	1.0733%	0.0173%
			C/H/R	5670	108	2.2792%	0.0434%
		LHAC	C/H/R	250	5	0.0385%	0.0008%
South-Central California Coast steelhead	Adult	Natural	O/H	573	0	82.4460%	0.0000%
			C/M, T, ST/R	255	2	36.6906%	0.2878%
			C/H/R	310	2	44.6043%	0.2878%
	Spawned Adult/ Carcass	Natural	O/H	7	0		
			O/ST D	80	0		
	Juvenile	Natural	O/H	3145	0	3.9781%	0.0000%
			C/M, T, ST/R	6350	79	8.0322%	0.0999%
			C/H/R	5250	71	6.6408%	0.0898%
Southern DPS eulachon	Adult	Natural	C/H/R	103	1	0.0003%	0.0000%
Southern DPS green sturgeon	Egg	Natural	IM	560	560		
	Larvae	Natural	C/H/R	180	25		
	Adult	Natural	O/H	654	0	31.0541%	0.0000%
			C/M, T, ST/R	14	0	0.6648%	0.0000%
			C/H/R	22	0	1.0446%	0.0000%
	Subadult	Natural	C/H/R	2	0	0.0181%	0.0000%
	Juvenile	Natural	O/H	4	0	0.0912%	0.0000%
			C/M, T, ST/R	15	1	0.3419%	0.0228%
			C/H/R	123	2	2.8037%	0.0456%

[1] LHIA=Listed hatchery intact adipose; LHAC=Listed hatchery adipose clipped
[2] C/H/R=Capture, Handle, Release; C/M, T, ST/R= Capture, Mark, Tag, Sample Tissue, Release; O/H=Observe/Harass; O/ST D=Observe, Sample Tissue Dead Animal, IM= Intentional mortality

Under the 86 projects in CDFW's Program juvenile salmon and steelhead would be observed via underwater video or sonar, stream surveys and snorkel surveys, and captured using backpack electrofishing equipment, traps, nets, seines, and hook and line. Most of the juvenile salmon and steelhead would be released shortly after capture. A subsample of captured juvenile salmon and steelhead may be anesthetized, checked for tags/marks, tissue sampled, and tagged/marked prior to release. A small number of juvenile salmon and steelhead would be sacrificed for tissue analysis.

Adult salmon and steelhead would be observed via underwater video or sonar, snorkel surveys and spawning surveys, and captured using fish ladders, hook and line, nets, seines, and traps. Tissues would be collected from any carcasses encountered during snorkel and spawning surveys. Most of the adult salmon and steelhead would be released shortly after capture. A subsample of captured adult salmon and steelhead may be anesthetized, checked for tags/marks, tissue sampled, and tagged/marked prior to release. One study has requested to lethally sample

100 adult CCV hatchery steelhead in the Stanislaus River. Although there are no hatchery programs for steelhead in the Stanislaus River, researcher's frequently observe adipose clipped steelhead that have strayed from another river system. Lethal sampling will allow researchers to reconstruct life history patterns (e.g. length of time spent in freshwater, the estuary, and the ocean).

Larval, juvenile, subadult, and adult green sturgeon would be observed via underwater video or sonar, stream surveys and snorkel surveys, and captured using backpack electrofishing equipment, traps, nets, seines, and hook and line. Researchers would release most of the green sturgeon shortly after capture. A subsample of captured green sturgeon may be anesthetized, checked for tags/marks, tissue sampled, and tagged/marked prior to release. Researchers may also sacrifice up to 560 green sturgeon eggs. The annual abundance of green sturgeon eggs 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 560 egg mortalities would represent a very small fraction of the annual abundance of those life stages for the DPS.

A small number of adult eulachon may also be captured using nets, seines, and traps. Researchers would handle and quickly release all eulachon.

With the exception of a small number of intentional mortalities of green sturgeon eggs, juvenile salmon and steelhead, and hatchery steelhead, researchers in CDFW's program are not proposing to kill any of the fish being captured, but a small number of fish may be killed as an inadvertent result of these activities. Researchers are directed to substitute inadvertent mortalities for planned intentional lethal sacrifice individuals whenever possible to minimize the total mortality associated with these studies. Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected (see status section) for the species—these figures are presented in the last column of the table above.

The permitted activities may thus cause the death of a very small number of fish of various life stages. The permitted activities may kill no more than 1.6% of the expected abundance for any of the naturally produced listed salmon, steelhead, sturgeon, or eulachon, and for most of these species the potential mortality is less than 0.1%. Moreover, that take (and any of its potential impacts) would be spread out over tributary habitat in California. Thus, no population is likely to experience a disproportionate amount of even these small losses. As a result, the activities are likely to have only a minimal impact on species abundance (and therefore productivity) and no appreciable impact on structure or diversity. And that miniscule effect is likely to be even more minimal than displayed because over the last ten years (2011-2020), researchers in CDFW's Program have generally not killed any of the adult fish and only 16.6% of the juvenile fish they were allotted.

2.6 Cumulative Effects

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

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

Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the species status/environmental baseline vs. cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the status section (Section 2.2).

In developing this biological opinion, we considered several efforts being made at the local, tribal, state, and national levels to conserve listed species—primarily final recovery plans and efforts laid out in the Status review updates for Pacific salmon and steelhead listed under the Endangered Species Act.[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 2.2.1).
The result of that review was that salmon take—particularly take associated with monitoring and habitat restoration—is likely to continue to increase in the region for the foreseeable future. However, as noted above, all actions falling in those categories would also have to undergo consultation (like that in this opinion) before they are allowed to proceed.

Future state, tribal, and local government actions will likely be in the form of legislation, administrative rules, or policy initiatives. Government and private actions may include changes in land and water uses, including ownership and intensity, any of which could affect listed species or their habitat. Government actions are subject to political, legislative, and fiscal uncertainties. These realities, added to the geographic scope of the action area, which encompasses numerous government entities exercising various authorities, make any analysis of cumulative effects difficult and speculative. For more information on the various efforts being made at the local, tribal, state, and national levels to conserve listed salmonids, see any of the recent status reviews, listing Federal Register notices, and recovery planning documents, as well as recent consultations on issuance of section 10(a)(1)(A), 4(d) and Tribal 4(d) 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

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

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

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

Puget Sound/Western Washington

Non-Federal actions are likely to continue affecting listed species. The cumulative effects in this portion of the action area are difficult to analyze because of this opinion's geographic scope, however, based on the trends identified in the baseline, the adverse cumulative effects are likely to increase. From 1960 through 2016, the population in Puget Sound has increased from 1.77 to 4.86 million people (Source: WA state Office of Financial Management homepage). During this population boom, urban land development has eliminated hydrologically mature forest and undisturbed soils resulting in significant change to stream channels (altered stream flow patterns, channel erosion) which eventually results in habitat simplification (Booth et al. 2002).

Combining this population growth with over a century of resource extraction (logging, mining, etc.), Puget Sound's hydrology has been greatly changed and has created a different environment than what Puget Sound salmonids evolved in (Cuo et al. 2009). Scholz et al. (2011) has documented adult coho salmon mortality rates of 60-100% for the past decade in urban central Puget Sound streams that are high in metals and petroleum hydrocarbons especially after stormwater runoff. In addition, marine water quality factors (e.g. climate change, pollution) are likely to continue to be degraded by various human activities that will not undergo consultation. Although state, tribal, and local governments have developed plans and initiatives to benefit listed fish, they must be applied and sustained in a comprehensive way before NMFS can consider them "reasonably foreseeable" in its analysis of cumulative effects. Thus, the most likely cumulative effect is that the habitat in the action area is likely to continue to be degraded with respect to its ability to support the listed salmonids.

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.

Western Oregon

The situation in Western Oregon is likely to be similar to that of the Puget Sound region: cumulative effects are likely to continue increasing both in the Willamette valley and along the coast, with nearly all counties showing year-by-year population increases of about 0.5% to 1.5% over the last several years.[6] The result of this growth is that there will be more development and therefore more habitat impacts such as simplification, hydrologic effects, greater levels of pollution (in the Willamette Valley), other water quality impacts, soil disturbance, etc. These effects would be somewhat lessened in the coastal communities, but resource extraction (particularly timber harvest) would probably continue to increase slightly. Though once again, most such activities, whether associated with development or extraction, would undergo formal consultation if they were shown to take place in (or affect) critical habitat or affect listed species. Thus, 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 Programs considered here would be authorized for a single year, 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.

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

[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"

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 Programs considered here would be authorized for a single year, and the effects on listed species abundance they generate could continue for up to four years after that, though they would decrease in each succeeding year. We are unaware of any major non-Federal activity that could affect listed salmonids and is certain to occur in the action area during that timeframe.

2.7 Integration and Synthesis

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

Aside from the considerations listed above, these assessments are also made in consideration of the other research that has been authorized and that may affect the various listed species. The reasons we integrate the proposed take in the permits considered here with the take from previous (but ongoing) research authorizations are that they are similar in nature and we have good information on what the effects are, and thus it is possible to determine the overall effect of all research in the region on the species considered here. The following tables therefore (a) combine the proposed take for the Programs considered in this opinion for all components of each species (Table 39), (b) add that take to the take that has already been authorized in the region and (c) compare those totals to the estimated annual abundance of each species under consideration (Table 40).

Researchers, when submitting their applications, estimated the number of listed species 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 the listed species, the requested take and requested mortality in this evaluation were increased by ten percent. Although it is difficult to anticipate how much more research may be requested, NMFS believes this ten percent would be sufficient to include any changes or additions. The table below compares the total requested take from the Programs, plus the ten percent buffer, to the species' estimated abundance.

Table 39. Total requested take for the Programs, plus the ten percent buffer, and percentages of the ESA listed species for permits covered in this Biological Opinion.

Species	Life Stage	Origin[1]	Requested Take plus 10%	Requested Mortality plus 10%	Percent of ESU/DPS handled	Percent of ESU/DPS killed
Puget Sound Chinook salmon	Adult	Natural	136	1	0.635	0.005
		LHIA	111	1	1.303	0.006
		LHAC	124	0		
	Juvenile	Natural	302,756	4,883	9.57	0.154
		LHIA	19,147	584	0.256	0.008
		LHAC	140,862	3,036	0.297	0.006
Puget Sound steelhead	Adult	Natural	1,817	32	9.425	0.164
		LHIA	16	0		
	Juvenile	Natural	30,076	587	1.361	0.027
		LHIA	678	10	0.602	0.009
		LHAC	3,460	45	3.145	0.041
Hood Canal summer-run chum salmon	Adult	Natural	1,155	15	4.593	0.061
	Juvenile	Natural	568,162	2,247	14.606	0.058
		LHIA	55	1	0.037	<0.001
Upper Columbia River steelhead	Juvenile	Natural	880	13	0.441	0.007
Middle Columbia River steelhead	Adult	Natural	1,036	10	20.511	0.196
		LHIA	38	1	34.375	0.982
		LHAC	908	10	202.567	2.21
	Juvenile	Natural	57,053	1,367	13.994	0.335
		LHIA	209	7	0.189	0.006
		LHAC	209	7	0.047	0.001
Snake River spring/summer-run Chinook salmon	Adult	Natural	33	2	0.258	0.017
		LHIA	8	0	1.829	0
		LHAC	26	0	1.106	0
	Juvenile	Natural	205,086	2,328	20.355	0.231
		LHIA	1,672	20	0.216	0.003
		LHAC	8,050	155	0.181	
Snake River fall-run Chinook salmon	Adult	Natural	7	0	0.064	0
		LHIA	2	0	0.016	0
		LHAC	2	0	0.014	0
	Juvenile	Natural	1,196	34	0.173	0.005
		LHIA	214	6	0.007	<0.001
		LHAC	297	9	0.012	<0.001
Snake River Basin steelhead	Adult	Natural	1,353	21	12.828	0.198
		LHIA	66	6	0.409	0.034
		LHAC	437	12	0.549	0.015
	Juvenile	Natural	152,926	1,868	19.156	0.234
		LHIA	204	4	0.029	<0.001

Species	Life Stage	Origin[1]	Requested Take plus 10%	Requested Mortality plus 10%	Percent of ESU/DPS handled	Percent of ESU/DPS killed
		LHAC	3,240	55	0.098	0.002
Lower Columbia River Chinook salmon	Adult	Natural	199	6	0.676	0.019
	Juvenile	Natural	365,066	5,108	3.108	0.043
		LHIA	132	4	0.014	<0.001
		LHAC	402	9	0.001	<0.001
Lower Columbia River coho salmon	Adult	Natural	264	6	0.884	0.018
		LHAC	82	1	0.938	0.013
	Juvenile	Natural	138,323	1,678	20.911	0.254
		LHIA	385	4	0.154	0.002
		LHAC	9,680	104	0.133	0.001
Lower Columbia River steelhead	Adult	Natural	1,754	19	13.58	0.145
	Juvenile	Natural	57,027	818	16.194	0.232
		LHAC	24,013	240	2.006	0.02
Columbia River chum salmon	Adult	Natural	6	1	0.052	0.01
	Juvenile	Natural	25,963	309	0.392	0.005
		LHIA	368	3	0.061	<0.001
Upper Willamette River Chinook salmon	Adult	Natural	112	1	1.1	0.011
		LHAC	57	1	0.182	0.003
	Juvenile	Natural	28,082	506	2.317	0.042
		LHIA	22	1	0.522	0.026
		LHAC	6,474	99	0.137	0.002
Upper Willamette River steelhead	Adult	Natural	204	2	6.988	0.076
	Juvenile	Natural	9,869	213	7.03	0.152
Oregon Coast coho salmon	Adult	Natural	8,065	82	8.551	0.087
		LHAC	6	0	0.984	0
	Juvenile	Natural	524,948	11,774	7.904	0.177
		LHAC	154	4	0.257	0.007
Southern Oregon/Northern California Coast coho salmon	Adult	Natural	1,570	13	17.316	0.146
		LHIA	1,727	10	21.026	0.151
		LHAC	572	7		
	Juvenile	Natural	63,472	879	3.152	0.044
		LHIA	138	138	0.024	0.024
		LHAC	1,375	19	0.688	0.009
Northern California steelhead	Adult	Natural	396	8	5.484	0.107
	Juvenile	Natural	16,643	160	2.026	0.019
California Coastal Chinook salmon	Adult	Natural	154	2	2.189	0.031
	Juvenile	Natural	26,659	271	2.086	0.021
Central Valley spring-run Chinook salmon	Adult	Natural	175	6	4.693	0.148
		LHAC	248	6	10.889	0.242
	Juvenile	Natural	482,860	5,154	62.266	0.665
		LHAC	21,747	590	1.002	0.027

Species	Life Stage	Origin[1]	Requested Take plus 10%	Requested Mortality plus 10%	Percent of ESU/DPS handled	Percent of ESU/DPS killed
California Central Valley steelhead	Adult	Natural	1,273	34	75.486	2.023
		LHAC	659	119	17.088	3.081
	Juvenile	Natural	23,576	425	3.74	0.067
		LHAC	4,578	402	0.286	0.025
Central California Coast steelhead	Adult	Natural	94	1	4.275	0.05
		LHAC	6	0	0.142	0
	Juvenile	Natural	9,174	166	3.688	0.067
		LHAC	275	6	0.042	<0.001
South-Central California Coast steelhead	Adult	Natural	622	4	89.424	0.633
	Juvenile	Natural	12,760	165	16.14	0.209
Southern DPS eulachon	Adult	Natural	1,593	76	0.005	<0.001
Southern DPS green sturgeon	Adult	Natural	217	4	10.29	0.209
	Subadult	Natural	169	3	1.532	0.03
	Juvenile	Natural	152	3	3.46	0.075
	Larvae	Natural	198	28	-	-
	Egg	Natural	616	616	-	-

[1] LHIA=Listed hatchery intact adipose; LHAC=Listed hatchery adipose clipped

Thus, the activities contemplated in this opinion may kill—in combination and at most—as much as 2% of the natural-origin component of any listed species; that component is natural adult California Central Valley steelhead. In all other species found in the table above, the effect is (at most) about one-third of the 2% figure and, in the majority of cases, the effect is orders of magnitude smaller. It should be noted, however, that over the past ten years (2011-2020), researchers in the Programs have only taken 29% of the number of natural-origin adult fish requested and killed 6% of the number of mortalities requested. Similarly, over the same period, researchers in the Programs have only taken 25% of the number of natural-origin juvenile fish requested and killed 15% of the number of mortalities requested. We therefore expect the actual effect of research on all species will be less than one-sixth of the mortalities displayed.

For the remainder of the analysis we focus only on the naturally produced components of these ESUs/DPSs. Although the Programs may also kill listed hatchery fish, we do not consider take of hatchery-origin fish to pose a demographic risk to the any of the species in this biological opinion. Hatchery-origin fish production can be adjusted in response to changing conditions, and hatchery programs are able to produce far greater numbers of salmonids than would be impacted by these research projects. The hatchery fish that may be taken for this research are therefore considered to be surplus to what is needed for recovery. In addition, to be conservative in our assessment of impacts to the species all unmarked fish that cannot be positively identified as hatchery-origin (i.e., by fin clip, tag, or otolith mark) are assumed to be natural-origin for authorization and reporting. The result is that our analysis of putative natural-origin fish does include the unmarked component of hatchery fish in any ESU or DPS where they exist in the action area.

The final step in the analysis is to add the take requested in the Programs to the research take in the baseline (Table 40).

Table 40. Total expected take of the ESA listed species for scientific research and monitoring already approved for 2021 plus the Programs covered in this Biological Opinion.

Species	Life Stage	Origin[1]	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Puget Sound Chinook salmon	Adult	Natural	857	35	3.991	0.163
		LHIA	937	11	11.564	0.394
		LHAC	1,151	60		
	Juvenile	Natural	382,796	8,973	12.1	0.284
		LHIA	78,937	2,851	1.057	0.038
		LHAC	209,146	11,726	0.441	0.025
Puget Sound steelhead	Adult	Natural	1,924	41	10.175	0.246
		LHIA	22	0		
	Juvenile	Natural	45,647	884	2.065	0.04
		LHIA	2,309	38	2.052	0.034
		LHAC	5,264	111	4.786	0.101
Hood Canal summer-run chum salmon	Adult	Natural	1,182	22	4.701	0.089
	Juvenile	Natural	573,174	2,386	14.735	0.061
		LHIA	250	21	0.167	0.014
Upper Columbia River steelhead	Juvenile	Natural	32,233	663	16.167	0.333
Middle Columbia River steelhead	Adult	Natural	1,210	17	23.955	0.335
		LHIA	168	6	150.446	5.446
		LHAC	932	12	208.147	2.656
	Juvenile	Natural	115,667	2,641	28.371	0.648
		LHIA	9,172	133	8.303	0.12
		LHAC	790	42	0.178	0.009
Snake River spring/summer-run Chinook salmon	Adult	Natural	1,911	18	14.932	0.142
		LHIA	386	3	91.615	0.713
		LHAC	1,259	12	52.761	0.503
	Juvenile	Natural	603,379	6,288	59.887	0.624
		LHIA	45,827	424	5.911	0.055
		LHAC	84,677	1,211	1.901	0.027
Snake River fall-run Chinook salmon	Adult	Natural	258	14	2.492	0.135
		LHIA	202	2	1.492	0.015
		LHAC	259	19	1.671	0.123
	Juvenile	Natural	2,109	133	0.304	0.019
		LHIA	336	34	0.012	0.001
		LHAC	942	158	0.038	0.006
Snake River Basin steelhead	Adult	Natural	7,957	111	75.443	1.051
		LHIA	2,169	34	13.441	0.208

Species	Life Stage	Origin[1]	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
		LHAC	2,810	44	3.534	0.055
	Juvenile	Natural	289,590	3,709	36.274	0.465
		LHIA	33,863	363	4.8	0.052
		LHAC	78,635	895	2.383	0.027
Lower Columbia River Chinook salmon	Adult	Natural	326	16	1.107	0.053
	Juvenile	Natural	380,034	5,578	3.236	0.047
		LHIA	315	36	0.033	0.004
		LHAC	2,464	592	0.008	0.002
Lower Columbia River coho salmon	Adult	Natural	928	16	3.107	0.052
		LHAC	608	41	7.274	0.468
	Juvenile	Natural	149,736	2,006	22.637	0.303
		LHIA	560	112	0.224	0.045
		LHAC	11,740	1,032	0.161	0.014
Lower Columbia River steelhead	Adult	Natural	2,834	32	21.931	0.245
	Juvenile	Natural	66,684	1,149	18.937	0.326
		LHAC	24,853	298	2.076	0.025
Columbia River chum salmon	Adult	Natural	40	6	0.371	0.057
	Juvenile	Natural	28,179	390	0.425	0.006
		LHIA	386	15	0.064	0.003
Upper Willamette River Chinook salmon	Adult	Natural	178	6	1.747	0.06
		LHAC	143	12	0.455	0.038
	Juvenile	Natural	37,574	754	3.101	0.062
		LHIA	46	4	1.092	0.097
		LHAC	8,114	252	0.172	0.005
Upper Willamette River steelhead	Adult	Natural	226	4	7.778	0.144
	Juvenile	Natural	13,388	278	9.536	0.198
Oregon Coast coho salmon	Adult	Natural	8,725	108	9.251	0.115
		LHAC	20	4	3.667	0.716
	Juvenile	Natural	528,394	11,973	7.956	0.18
		LHAC	339	21	0.565	0.036
Southern Oregon/Northern California Coast coho salmon	Adult	Natural	1,676	24	18.485	0.267
		LHIA	1,808	17	22.023	0.27
		LHAC	600	13		
	Juvenile	Natural	146,115	2,390	7.256	0.119
		LHIA	7,586	642	1.319	0.112
		LHAC	3,916	72	1.958	0.036
Northern California steelhead	Adult	Natural	816	19	11.3	0.259
	Juvenile	Natural	115,634	2,290	14.078	0.279
California Coastal Chinook salmon	Adult	Natural	448	23	6.369	0.33
	Juvenile	Natural	82,057	1,656	6.42	0.13
	Adult	Natural	1,640	28	44.001	0.765

Species	Life Stage	Origin[1]	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Central Valley spring-run Chinook salmon		LHAC	726	84	31.918	3.718
	Juvenile	Natural	890,496	17,428	114.833	2.247
		LHAC	29,874	3,739	1.377	0.172
California Central Valley steelhead	Adult	Natural	3,515	112	208.464	6.649
		LHAC	2,526	209	65.506	5.415
	Juvenile	Natural	69,299	2,018	10.993	0.32
		LHAC	27,837	1,840	1.739	0.115
Central California Coast steelhead	Adult	Natural	2,484	48	113.603	2.199
		LHAC	498	17	12.869	0.44
	Juvenile	Natural	230,352	5,229	92.596	2.102
		LHAC	13,156	360	2.027	0.056
South-Central California Coast steelhead	Adult	Natural	886	12	127.41	1.784
	Juvenile	Natural	37,338	812	47.229	1.027
Southern DPS eulachon	Adult	Natural	33,420	31,049	0.109	0.102
Southern DPS green sturgeon	Adult	Natural	347	9	16.462	0.446
	Subadult	Natural	250	9	2.265	0.084
	Juvenile	Natural	1,854	74	42.257	1.694
	Larvae	Natural	11,208	1,038	-	-
	Egg	Natural	1,866	1,866	-	-

[1] LHIA=Listed hatchery intact adipose; LHAC=Listed hatchery adipose clipped

As the table above illustrates, in many cases the dead natural-origin fish from all of the permits in this opinion and all the previously authorized research would amount to less than half a percent of each species' total abundance. In these instances, the total mortalities are so small and so spread out across each listed unit that they are unlikely to have any lasting detrimental effect on the species' numbers, reproduction, or distribution. However, in 11 cases involving 8 species, the total potential mortality of natural-origin fish could amount to a more substantial percentage of an ESU/DPS component (i.e., life stage). As a result, we will review the potential mortality in these instances in more detail. As mentioned above, because we do not consider the take of hatchery fish to pose a demographic risk to any of the species we will focus our analysis on take of natural-origin fish.

2.7.1 Listed Species

As Tables 39 and 40 illustrate, in most instances, the research—even in total—would have only very small effects on any species' abundance (and therefore productivity) and no discernible effect on structure or diversity because the effects would be attenuated across each entire species. Nonetheless, there are some instances where closer scrutiny of the effects on a particular component is warranted. The newly proposed research, when considered with research already authorized would potentially kill more than one half of one percent of the estimated abundance of the adult and/or juvenile natural-origin component of the following listed species: Middle Columbia River steelhead, Snake River spring/summer Chinook salmon, Snake River Basin steelhead, Central Valley spring-run Chinook salmon, California Central Valley steelhead, Central California Coast steelhead, South-Central California Coast steelhead, and Southern DPS green sturgeon. Detailed descriptions of these effects for juveniles and adults follow in the paragraphs below.

A few considerations apply generally to our analyses of the total mortalities that would be permitted for juveniles and adults of each of these species (Table 40). First, as described above, we do not expect the potential mortality of hatchery-origin fish contemplated in this opinion to have any genuine effect on the species' survival and recovery in the wild because, while they are listed, they are generally considered surplus to recovery needs. The take of unmarked hatchery fish in these ESUs or DPSs is also considered in our analysis because fish which cannot be confirmed to be of hatchery origin are conservatively assumed to be naturally produced (see below). We therefore focus primarily on the naturally-produced ESU or DPS components for the remainder of this discussion. Another result of this approach is that in cases where unmarked hatchery fish are present, the natural-origin component of the ESU or DPS would in actuality be affected to a lesser degree than the percentages displayed above. It is not possible to know how much smaller the take figures would be, but that they are smaller is not in doubt.

Second, the true numbers of fish that would actually be taken would most likely be smaller than the amounts authorized. We develop conservative estimates of abundance, as described in Section 2.2. As noted repeatedly in the effects section, the researchers generally request more take than they estimate will actually occur. It is therefore very likely that researchers will take fewer fish than estimated, and that the actual effect is likely to be lower than the numbers stated in the tables above. The degree to which these values are likely overestimates, based on actual reported data from recent years of the research program, is discussed above for each state's Program.

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

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

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

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

Juveniles

The newly proposed research would, in combination with mortalities already authorized for research in the region, necessitate further discussion of potential effects on juvenile MCR steelhead, SR spr/sum Chinook salmon, CVS Chinook salmon, CCC steelhead, SCCC steelhead, and sDPS green sturgeon.

For all of these ESUs and DPSs, the majority of the stated take in Table 40 has already been analyzed in previous opinions and been determined not to jeopardize any of the species considered here. In fact, for CVS Chinook salmon, CCC steelhead, SCCC steelhead, and sDPS green sturgeon roughly 1-2% lethal take of the ESU/DPS was already authorized for these species through prior opinions. The newly proposed take considered here represents an incremental increase in percent of the DPS/ESU that may be killed of 0.7% for CVS Chinook salmon, 0.3% for MCR steelhead, 0.2% for SR spr/sum Chinook salmon and CCC steelhead, and less than 0.1% for SCCC steelhead and sDPS green sturgeon juveniles.

When combined with the existing authorized research take, the effects from the activities contemplated in this opinion were still found to incur losses that are very small, the effects are only seen in reductions in abundance and productivity and, as described above, the estimates of mortalities are almost certainly much greater than the actual numbers are likely to be. Even in the worst case scenario (which assumes that all authorized mortalities would occur), for all ESUs and DPSs the effects would be small and restricted to abundance and productivity reductions, and to some degree the negative effects would be offset by the information to be gained—information that in all cases would be used to protect listed fish or promote their recovery. The specific circumstances of each ESU and DPS warranting further evaluation are discussed in detail below.

Middle Columbia River Steelhead

A figure requiring a closer view is the 0.65% of the natural-origin MCR steelhead juveniles killed by research activities in the Deschutes River basin. The actions considered in this opinion would add 1,367 fish to the total being allotted, which represents an incremental increase of 0.34% of the DPS over an amount of take that has previously been found to not jeopardize the species. Out of an abundance of caution, prior opinions analyzed the effect of removing juveniles from the Deschutes River Non-essential Experimental Population (NEP) as if they were part of the listed unit, but in fact, it will be four years until they are actually considered to be part of the MCR steelhead DPS. Therefore the total take of MCR steelhead that are part of the DPS will actually be lower than 0.65%. Still, if the all the fish that are permitted to be taken were to be taken in fact, it would likely result in small but measurable abundance and productivity losses for the DPS. Over the last five years, the average amount of natural MCR steelhead juveniles taken was only 25% of what has been permitted—and the mortality rate has averaged only 14% of what has been permitted (APPS permit website). As a result, the effects of the program as a whole are very likely to be much smaller than those displayed above—probably around one seventh of the figure displayed. The losses would also be spread out across the species' entire range, so there would be no measurable effect on structure or diversity, and no single population would bear the brunt of the effect.

The impact of these Programs—even in their entirety—are thus a very small effect on abundance and productivity, the activities analyzed here would add little increment to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

Snake River Spring/Summer-run Chinook salmon

Under the research program as a whole, 0.62% of the natural-origin juvenile SR spr/sum Chinook salmon may be killed in a given year. The actions considered in this opinion would add 2,328 fish to the total being allotted, which represents an incremental increase of 0.23% of the ESU over an amount of lethal take that has previously been found to not jeopardize the species.

Over the last five years, the average amount of natural SR spr/sum Chinook salmon juveniles taken was only 12% of what has been permitted—and the mortality rate has averaged only 7% of what has been permitted (APPS permit website). As a result, the effects of the program as a whole are very likely to be much smaller than those displayed above—probably less than one tenth of the figure displayed. The losses would also be spread out across the species' entire range, so there would be no measurable effect on structure or diversity, and no single population would bear the brunt of the effect.

The impact of these Programs—even in their entirety—are thus a very small effect on abundance and productivity, the activities analyzed here would add little increment to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

Central Valley Spring-run Chinook salmon

Under the research program as a whole, 2.25% of the natural-origin juvenile CVS Chinook salmon may be killed in a given year. The actions considered in this opinion would add 5,154 fish to the total being allotted for lethal take, which represents an incremental increase of 0.67% of the ESU over an amount that has previously been found to not jeopardize the species.

Over the last five years, the average amount of natural CVS Chinook salmon juveniles taken was only 17% of what has been permitted—and the mortality rate has averaged only 12% of what has been permitted (APPS permit website). As a result, the effects of the program as a whole are very likely to be much smaller than those displayed above—probably less than one eighth of the figure displayed. The losses would also be spread out across the species' entire range, so there would be no measurable effect on structure or diversity, and no single population would bear the brunt of the effect.

The impact of these Programs—even in their entirety—are thus a very small effect on abundance and productivity, the activities analyzed here would add little increment to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

Central California Coast Steelhead

Under the research program as a whole, 2.1% of the natural-origin juvenile CCC steelhead may be killed in a given year. The actions considered in this opinion would add 166 fish to the total being allotted for lethal take, which represents an incremental increase of 0.067% of the DPS over an amount that has previously been found to not jeopardize the species.

Over the last five years, the average amount of natural CCC steelhead juveniles taken was only 13% of what has been permitted—and the mortality rate has averaged only 4% of what has been permitted (APPS permit website). As a result, the effects of the program as a whole are very likely to be much smaller than those displayed above—probably less than one twentieth of the figure displayed. The losses would also be spread out across the species' entire range, so there would be no measurable effect on structure or diversity, and no single population would bear the brunt of the effect.

The impact of these Programs—even in their entirety—are thus a very small effect on abundance and productivity, the activities analyzed here would add little increment to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

South-Central California Coast Steelhead

Under the research program as a whole, 1.027% of the natural-origin juvenile SCCC steelhead may be killed in a given year. The actions considered in this opinion would add 165 fish to the total being allotted for lethal take, which represents an incremental increase of 0.209% of the DPS over an amount that has previously been found to not jeopardize the species.

Over the last five years, the average amount of natural SCCC steelhead juveniles taken was only 17% of what has been permitted—and the mortality rate has averaged only 4% of what has been permitted (APPS permit website). As a result, the effects of the program as a whole are very likely to be much smaller than those displayed above—probably less than one twentieth of the figure displayed. The losses would also be spread out across the species' entire range, so there would be no measurable effect on structure or diversity, and no single population would bear the brunt of the effect.

The impact of these Programs—even in their entirety—are thus a very small effect on abundance and productivity, the activities analyzed here would add little increment to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

Southern DPS Green Sturgeon

Under the research program as a whole, 1.7% of the natural-origin juvenile sDPS green sturgeon may be killed in a given year. The actions considered in this opinion would add only three fish to the total being allotted for lethal take, which represents an incremental increase of 0.075% of the DPS over an amount that has previously been found to not jeopardize the species.

Over the last five years, the average amount of natural sDPS green sturgeon juveniles taken was only 7% of what has been permitted—and the mortality rate has averaged only 4% of what has been permitted (APPS permit website). As a result, the effects of the program as a whole are very likely to be much smaller than those displayed above—probably less than one twentieth of the figure displayed. The losses would also be spread out across the species' entire range, so there would be no measurable effect on structure or diversity, and no single population would bear the brunt of the effect.

The impact of these Programs—even in their entirety—are thus a very small effect on abundance and productivity, the activities analyzed here would add little increment to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

Adults

For the adults, the research effects are similar to those described for the juveniles. However, killing an adult fish has a potentially much greater effect on the productivity of an ESU or DPS than killing a juvenile, so it is necessary to examine more closely some of those impacts. The newly proposed research would, in combination with mortalities already authorized for research in the region, necessitate further discussion of potential effects on adult SR Basin steelhead, CVS Chinook salmon, CCV steelhead, CCC steelhead, and SCCC steelhead.

As with the juveniles, so few adults from any species would be killed by the new proposed research that nearly all of the stated take in Table 40 has already been analyzed in previous opinions and been determined not to jeopardize any of the species considered here. For species where new adult mortalities would be authorized, effects from the activities contemplated in this opinion were found to incur losses that are very small, the effects are only seen in reductions in abundance and productivity and, as described above, the estimates of mortalities are almost certainly much greater than the actual numbers are likely to be.

Even in the worst case scenario assuming all authorized mortalities did occur, for all ESUs and DPSs the effects would be small and restricted to abundance and productivity reductions, and to some degree the negative effects would be offset by the information to be gained—information that in all cases would be used to protect listed fish or promote their recovery. The specific circumstances of each ESU and DPS warranting further evaluation are discussed in detail below.

Snake River Basin Steelhead

Under the research program as a whole, 1.05% of the natural-origin adult SR Basin steelhead may be killed in a given year. The actions considered in this opinion would add 21 adult fish to the total being allotted for lethal take, which represents an incremental increase of 0.20% of the DPS over an amount that has previously been found to not jeopardize the species.

Over the last five years, the average amount of natural SR Basin steelhead adults taken by the entire research program was only 3% of what has been permitted—and the mortality rate has averaged only 1% of what has been permitted (APPS permit website). As a result, the effects of the program as a whole are very likely to be much smaller than those displayed above—probably less than one hundredth of the figure displayed. The losses would also be spread out across the species' entire range, so there would be no measurable effect on structure or diversity, and no single population would bear the brunt of the effect.

The impact of these Programs—even in their entirety—are thus a very small effect on abundance and productivity, the activities analyzed here would add little increment to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

Central Valley Spring-run Chinook Salmon

Under the research program as a whole, 0.76% of the natural-origin adult CVS Chinook salmon may be killed in a given year. The actions considered in this opinion would add six adult fish to the total being allotted for lethal take, which represents an incremental increase of 0.15% of the ESU over an amount that has previously been found to not jeopardize the species.

Over the last five years, the average amount of natural CVS Chinook salmon adults taken by the entire research program was only 4% of what has been permitted—and there have been zero adult mortalities reported (APPS permit website). As a result, the effects of the program as a whole are very likely to be much smaller than those displayed above—probably less than one hundredth of the figure displayed. The losses would also be spread out across the species' entire range, so there would be no measurable effect on structure or diversity, and no single population would bear the brunt of the effect.

The impact of these Programs—even in their entirety—are thus a very small effect on abundance and productivity, the activities analyzed here would add little increment to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

California Central Valley Steelhead

Under the research program as a whole, 6.65% of the natural-origin adult CCV steelhead may be killed in a given year. The actions considered in this opinion would add 34 adult fish to the total being allotted for lethal take, which represents an incremental increase of 2.02% of the DPS over an amount that has previously been found to not jeopardize the species.

Over the last five years, the average amount of natural CCV steelhead adults taken by the entire research program was only 7% of what has been permitted—and the mortality rate has averaged only 3% of what has been permitted (APPS permit website). As a result, the effects of the program as a whole are very likely to be much smaller than those displayed above—probably less than one twentieth of the figure displayed. The losses would also be spread out across the species' entire range, so there would be no measurable effect on structure or diversity, and no single population would bear the brunt of the effect.

The impact of these Programs—even in their entirety—are thus a very small effect on abundance and productivity, the activities analyzed here would add little increment to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

Central California Coast Steelhead

Under the research program as a whole, 2.2% of the natural-origin adult CCC steelhead may be killed in a given year. The actions considered in this opinion would add one adult fish to the total being allotted for lethal take, which represents an incremental increase of 0.05% of the DPS over an amount that has previously been found to not jeopardize the species.

Over the last five years, the average amount of natural CCC steelhead adults taken by the entire research program was only 6% of what has been permitted—and the mortality rate has averaged only 2% of what has been permitted (APPS permit website). As a result, the effects of the program as a whole are very likely to be much smaller than those displayed above—probably less than one fiftieth of the figure displayed. The losses would also be spread out across the species' entire range, so there would be no measurable effect on structure or diversity, and no single population would bear the brunt of the effect.

The impact of these Programs—even in their entirety—are thus a very small effect on abundance and productivity, the activities analyzed here would add little increment to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

South-Central California Coast Steelhead

Under the research program as a whole, 1.78% of the natural-origin adult SCCC steelhead may be killed in a given year. The actions considered in this opinion would add four adult fish to the total being allotted for lethal take, which represents an incremental increase of 0.63% of the DPS over an amount that has previously been found to not jeopardize the species.

Over the last five years, there has been no reported take or mortality of natural SCCC steelhead adults (APPS permit website). As a result, the effects of the program as a whole are very likely to be much smaller than those displayed above—probably less than one hundredth of the figure displayed. The losses would also be spread out across the species' entire range, so there would be no measurable effect on structure or diversity, and no single population would bear the brunt of the effect.

The impact of these Programs—even in their entirety—are thus a very small effect on abundance and productivity, the activities analyzed here would add little increment to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

2.7.2 Critical Habitat

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

2.7.3 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, and other hydrologic changes. 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 2021 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 (17 out of 204 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 20 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 2021 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 ESA 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 and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent activities, 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. "Harm" is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

In this instance, and for the actions considered in this opinion, there is no incidental take. 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 given above.

Because the action would not cause any incidental take, we are not specifying an amount or extent of incidental take that would serve as a reinitiation trigger. Nonetheless, the amounts of direct take have been specified and analyzed in the effects section above (2.5). Those amounts—displayed in the various Programs' effects analyses and including the buffer within which each Program can operate—constitute hard limits on both the amount and extent of take the Programs would be allowed in 2021. Those amounts are also noted in the reinitiation clause just below because exceeding them would likely trigger the need to reinitiate consultation.

2.10 Reinitiation of Consultation

This concludes formal consultation for "Evaluation and 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" Determination

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

Southern Resident Killer Whales Determination

The Southern Resident killer whale 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 Residents indirectly by reducing availability of their preferred prey, Chinook salmon. This analysis focuses on effects to Chinook salmon availability in the ocean because the best available information indicates that salmon are the preferred prey of Southern Resident killer whales year round, including in coastal waters, and that Chinook salmon are the preferred salmon prey species. To assess the indirect effects of the proposed action on the Southern Resident killer whale DPS, we considered the geographic area of overlap in the marine distribution of Chinook salmon affected by the action, and the range of Southern Resident killer whales. We also considered the importance of the affected Chinook salmon ESUs compared to other Chinook salmon runs in Southern Resident diet composition, and the influence of hatchery mitigation programs. As described in the effects analysis for salmonids, an absolute maximum of 22,797 juvenile and 26 adult Chinook salmon may be killed during the course of the research. As the previous effects analysis illustrated, these losses—even in total—are expected to have only very small effects on salmonid abundance and productivity and no appreciable effect on diversity or distribution for any Chinook salmon ESUs. The affected Chinook salmon species are:

Puget Sound
Snake River spring-summer run
Snake River fall-run
Lower Columbia River
Upper Willamette River
California Coastal
Central Valley spring-run

The fact that the research would kill various Chinook salmon could affect prey availability to the whales in future years throughout their range. For the adult take, many of the 26 fish that could, at maximum, be killed from these ESUs would only be taken by research after they return to shallower bays, estuaries and their natal rivers, and are therefore very unlikely to be available as prey to the whales that typically feed in coastal offshore areas. This portion of the proposed work would very probably therefore have minimal, if any, effect on prey availability for Southern Resident killer whales.

For the juveniles, the most recent ten-year average smolt-to-adult ratio (SAR) from PIT-tagged Chinook salmon returns is from the Snake River, and indicates that SARs are less than 1% (BPA 2018). If one percent of the 22,797 juvenile Chinook salmon that may be killed by the proposed research activities were otherwise to survive to adulthood, this would translate to the effective loss of about 228 adult Chinook salmon. Given that the number of adult Chinook (listed and unlisted) in the ocean at any given time is several orders of magnitude greater than that figure, it is unlikely that SRKW would intercept and feed on many (if any) of these salmon. In addition, the SRKW population must catch and eat a minimum of 1,400 salmon daily to sustain their needs (Center for Whale Research 2018). This means that the research contemplated in this opinion could kill, in its entirety and at an absolute maximum, about 16% of one day's worth of the fish that the SRKWs need to survive. Moreover, that figure would only hold if the SRKWs could somehow intercept *all* the fish that might otherwise reach maturity without the permitted take. In such a case even the maximum effect of a loss of 16% of one day's worth of SRKW food could only occur under circumstances so unlikely as to effectively be impossible.

In addition, as described in Sections 2.4 and 2.5, the estimated Chinook salmon mortality is likely to be much smaller than stated. First, the mortality rate estimates for most of the proposed studies are purposefully inflated to account for potential accidental deaths and it is therefore very likely that fewer salmonids will be killed by the research than stated. In fact, as described in Section 2.4 according to our take tracking in the past researchers have killed 15 percent or less of the fish they have been permitted. Thus, the actual reduction in prey that could possibly become available to the whales is probably closer to 34 than 230 fish.

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

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

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

This analysis is based, in part, on 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 state agency Program managers. The document will be available within two weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/]. The format and naming adheres to conventional standards for style.

This ESA section 7 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)] 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 authorize 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.

5. REFERENCES

5.1 State Fishery Agency Submittals

California Department of Fish and Wildlife (CDFW). 2021. Letter from Jonathan Nelson, California Department of Fish and Wildlife conveying the state's research Program for consideration under the NMFS 4(d) research limit, to Gary Rule, NMFS, January 5, 2021.

Idaho Department of Fish and Game (IDFG). 2020. Letter from Christine Kozfkay, 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, November 25, 2020.

Oregon Department of Fish and Wildlife (ODFW). 2020. 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 8, 2020.

Washington Department of Fish and Wildlife (WDFW). 2020. 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 4, 2020.

5.2 Federal Register Notices

November 20, 1991 (56 FR 58612). Notice of Policy: Policy on Applying the Definition of Species Under the Endangered Species Act to Pacific Salmon.

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.

July 10, 2000 (65 FR 42422). Final Rule: Endangered and Threatened Species; Final Rule Governing Take of 14 Threatened Salmon and Steelhead Evolutionarily Significant Units (ESUs).

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Salmon and Steelhead in Washington, Oregon, and Idaho.
November 18, 2005 (70 FR 69903). Final Rule: Endangered Status for Southern Resident Killer Whales.
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April 7, 2006 (71 FR 17757). Final Rule: Threatened Status for Southern Distinct Population Segment of North American Green Sturgeon.
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May 11, 2007 (72 FR 26722). Final Rule: Endangered and Threatened Species; Final Listing Determination for Puget Sound Steelhead.
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September 25, 2008 (73 FR 55451). Final Rule: Endangered and Threatened Species; Final Protective Regulations for Threatened Puget Sound Steelhead.
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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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