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

Consultation on the Issuance of Five ESA Section 10(a)(1)(A) Scientific Research Permits Affecting Salmon, Steelhead, Green Sturgeon, and Eulachon in the West Coast Region Beginning in 2018

NMFS Consultation Number: WCR-2017-8556

Action Agencies: The National Marine Fisheries Service (NMFS)
U.S. Fish and Wildlife Service (U.S. FWS)
U.S. Forest Service (USFS)
U.S. Geological Survey (USGS)

Affected Species and Determinations:

ESA-Listed Species	Status	Is Action Likely To Adversely Affect Species?	Is Action Likely To Jeopardize the Species?	Is Action Likely To Adversely Affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Lower Columbia River (LCR) Chinook salmon (*Oncorhynchus tshawytscha*)	Threatened	Yes	No	No	No
Upper Willamette River (UWR) Chinook salmon *(O. tshawytscha)*	Threatened	Yes	No	No	No
Columbia River (CR) chum salmon *(O. keta)*	Threatened	Yes	No	No	No
LCR coho salmon (*O. kisutch*)	Threatened	Yes	No	No	No
LCR steelhead (*O. mykiss*)	Threatened	Yes	No	No	No
UWR steelhead *(O. mykiss)*	Threatened	Yes	No	No	No
Southern (S) eulachon *(Thaleichthys pacificus)*	Threatened	Yes	No	No	No
Southern (S) green sturgeon *(Acipenser medirostris)*	Threatened	Yes	No	No	No
Southern Resident (SR) killer whales (*Orcinus orca*)	Threatened	No	No	No	No

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

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

Issued By:

FOR Barry A. Thom
Regional Administrator

Date: April 12, 2018

cc: Administrative record number: 151422WCR2017PR00305

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List of Acronyms

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
GPNF – Gifford Pinchot National Forest
ISAB – Independent Scientific Advisory Board
LCR – Lower Columbia River
LCRFB – Lower Columbia River Fish Recovery Board
MSA – Magnuson-Stevens Fishery Conservation and Management Act
NMFS – National Marine Fisheries Service
NOAA – National Oceanic and Atmospheric Administration
ODFW – Oregon Department of Fish and Wildlife
S – Southern
SR – Southern Resident
U.S. FWS – United States Fish and Wildlife Service
USGS –United States Geological Survey
UWR – Upper Willamette River
VSP – Viable Salmonid Population
WDFW – Washington Department of Fish and Wildlife
WDOE – Washington Department of Ecology
WSDOT – Washington Department of Transportation

1. INTRODUCTION

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

1.1 Background

The National Marine Fisheries Service (NMFS) prepared the biological opinion (opinion) and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 USC 1531 et seq.), and implementing regulations at 50 CFR 402. It constitutes NMFS' review of five scientific research permit applications and is based on information provided in the applications for the proposed permits, published and unpublished scientific information on the biology and ecology of potentially affected species under NMFS' jurisdiction in the action areas, and other sources of information.

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

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available through NMFS' Public Consultation Tracking System [https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts]. A complete record of this consultation is on file with the Protected Resources Division in the Portland, Oregon office of NMFS's West Coast Region: 1201 NE Lloyd Blvd, Portland, Oregon 97232.

1.2 Consultation History

The West Coast Region's Protected Resources Division (PRD) received five applications for scientific research permits from municipal, state, federal, and private entities. Because the permit requests are similar in nature and duration and are expected to affect the same listed species, we combined them into a single consultation pursuant to 50 CFR 402.14(c). The affected species are Lower Columbia River (LCR) Chinook salmon, Upper Willamette River (UWR) Chinook salmon, LCR steelhead, UWR steelhead, Columbia River (CR) chum salmon, LCR coho salmon, Southern (S) eulachon, and S green sturgeon. The proposed actions also have the potential to affect Southern Resident (SR) killer whales and their critical habitat by diminishing the whales' prey base. We concluded that the proposed activities are not likely to adversely affect SR killer whales or their critical habitat and the full analysis is found in the "Not Likely to Adversely Affect" Determination section (2.11).

We divide our permit and consultation workload for ESA Section 10(a)(1)(A) scientific research permits into five geographic areas: (1) Puget Sound/Georgia Basin, (2) Lower Columbia-Upper

Willamette/Oregon Coast, (3) Interior Columbia-Snake basins, (4) California Coast, and (5) California Central Valley. This biological opinion covers Lower Columbia and Upper Willamette salmon ESUs and steelhead DPSs, as well as S eulachon, S green sturgeon, and SR killer whales. Two of the permits we analyze here (20713 and 21432) also request take for Interior Columbia-Snake basin ESUs/DPSs. A separate ESA Section 7 consultation (WCR-2018-9183) will cover the species and actions in the Interior Columbia-Snake basins. We will only issue those permits after all the analyses are complete and we have signed all the controlling biological opinions.

The NMFS Northwest Fisheries Science Center (NWFSC) applied for a new permit (20713) on August 31, 2016. We completed an initial review of the application and asked NWFSC for additional information on September 22, 2016. Subsequently the applicant proposed to change their requested start date from March, 2017, to March, 2018. We asked the applicant for additional information on July 5, 2017. We had multiple phone and email correspondences from July 5 to October 16, 2017, during which we provided substantial comment on the application. We received all necessary information from the NWFSC on October 16, 2017, and deemed the application to be complete.

Mount Hood Environmental Services applied for a new permit (21507) on August 31, 2017. The applicant requested authorization for take related to two research activities: (1) sampling the intake channel between the Tualatin River (Oregon) and the water intake to the Spring Hill Pumping Plant, and (2) placing a juvenile fish trap inside the pumping plant to sample fish that might pass through the fish screen at the pumping plant intake. We determined that sampling and take of listed fish related to the second objective would be covered under consultation NWR-2009-2018, *Operation and Maintenance of the Tualatin Project Scoggins Creek (HUC 1709001003), Washington County, Oregon*, and we conveyed this information to the applicant on October 18, 2017. The applicant revised their permit application to request Section 10(a)(1)(A) scientific research permit coverage for the first objective only. We reviewed the revised application and deemed it to be complete on October 19, 2017. We received public comments on the application on December 14, 2017, requested a response to comments from the applicant on December 19, 2017, and received a response from the applicant with all needed information on December 19, 2017.

Cramer Fish Sciences applied for a new permit (21432) on June 16, 2017. We requested additional information on September 18 and September 21, 2017. We received all necessary information and deemed the application complete on September 21, 2017. We received public comments on the application on December 14, 2017. The public comments did not require additional information from Cramer Fish Sciences.

The Oregon Department of Fish and Wildlife (ODFW) submitted a request to modify an existing permit (20492-2M) on August 4, 2017. We reviewed the application and deemed it to be complete on August 8, 2017.

The City of Portland submitted a request to modify an existing permit (16069-3M) on October 10, 2017. We reviewed the application and deemed it to be complete on October 16, 2017. We received public comments on the application on December 6, 2017 and requested a response to comments from the applicant on December 11, 2017. We received a response to comments from the applicant with all required information on December 13, 2017.

When we requested additional information from applicants, typically it was to clarify the proposed sampling dates, locations, or methods. We asked some applicants to revise the numbers of fish in their requested take authorizations to better reflect mortality rates typically associated with specific sampling protocols, or to account for updated information on the distribution and abundance of ESA-listed species.

We provided information on the applications in a Federal Register notice on November 15 2017 (82 FR 52884). We accepted public comments on the applications until December 15, 2017, and then commenced consultation. We do not present the full consultation histories for the actions here because they are lengthy and not directly relevant to the analysis. We maintain a complete record of this consultation at NMFS Protected Resources Division in Portland, Oregon.

1.2 Proposed 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). When analyzing 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 research actions. In the absence of any such actions, the proposed action here is NMFS's proposal to issue permits to the various applicants.

"Take" is defined in section 3 of the ESA; it means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect [a listed species] or to attempt to engage in any such conduct. The NMFS has not promulgated protective regulations via Section 4(d) of the ESA for eulachon. Promulgation of 4(d) take prohibitions for eulachon shall result in a reinitiation of this opinion if the effects of the research program considered in this opinion results in take that is prohibited by the 4(d) rule.

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] Biological opinion WCR-2018-9183 evaluates some of the take in proposed permits 20713 and 21432. We issue permits after we sign all controlling biological opinions.

[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 we use the terms "artificially propagated" and "hatchery" are used interchangeably in the Opinion, as are the terms "naturally propagated" and "natural."

NMFS' issuance of permits for scientific research activities proposed by the NWFSC, Mount Hood Environmental, Cramer Fish Sciences, the ODFW, and the City of Portland constitutes the proposed federal action. As the action agency, NMFS is responsible for complying with section 7 of the ESA, which requires Federal agencies to ensure any actions they fund, permit, or carry out are not likely to jeopardize listed species' continued existence nor destroy or adversely modify their critical habitat. This consultation examines the effects of the proposed research on LCR Chinook salmon, UWR Chinook salmon, LCR steelhead, UWR steelhead, CR chum salmon, LCR coho salmon, S eulachon, S green sturgeon, and SR killer whales. This consultation also examines the effects of the permits NMFS proposes to issue, and thus it fulfills NMFS' section 7 consultation obligations.

Permit 20713

The Northwest Fisheries Science Center (NWFSC) is seeking a permit for two years to take juvenile LCR Chinook salmon, UWR Chinook salmon, CR chum salmon, LCR coho salmon, LCR steelhead, UWR steelhead, and S green sturgeon. Researchers may also capture adult S eulachon, for which there are currently no ESA take prohibitions. The purpose of the study is to measure contaminant levels in juvenile UWR Chinook salmon in the lower Willamette River (Oregon), a Superfund site with high levels of pollutants, and to evaluate associations between toxins in fish tissues and fish growth and immune response. The permit would expire on December 31, 2019.

The researchers plan to complete all sampling between March and June, 2018, but fieldwork could extend to other months and to 2019 if sample size targets are not met in the initial timeframe. The researchers propose to collect fish with beach seines at sites in the lower 20 miles of the Willamette River. The researchers would hold fish in buckets, identify and count fish, check fish for passive integrated transponder and coded wire tags, and then immediately release any fish that is not a juvenile Chinook salmon with an intact adipose fin. The researchers propose to kill natural-origin juvenile Chinook salmon that are between 50 and 80 mm in fork length using a lethal dose of MS-222. The target ESU for contaminant analysis is UWR Chinook, but juvenile Chinook salmon from other ESUs in the Columbia River basin would likely be killed, too, because juveniles from different ESUs cannot be distinguished visually. The researchers would freeze the sacrificed fish individually and later identify each to ESU using genetic analysis. The researchers would pool UWR Chinook specimens into composite samples for toxicological analysis and would use scales and otoliths for analysis of age and growth. For specimens that are identified through genetic analysis to an ESU other than the UWR Chinook, the researchers propose to make them available for use in other studies pending NMFS approval.

The NWFSC researchers used information from past studies to estimate the number of fish needed to obtain enough tissues for statistically robust sample sizes, and to estimate expected mortality rates of fish from non-target ESUs. Based on this information, the NWFSC proposes to kill up to: 201 natural-origin and 9 hatchery-origin (intact adipose fin) juvenile UWR Chinook salmon; 119 natural-origin and 5 hatchery-origin (intact adipose fin) juvenile LCR Chinook salmon; 4 natural-origin juvenile SR fall-run Chinook salmon; 2 natural-origin juvenile SR spring/summer-run Chinook salmon; and 5 natural-origin juvenile UCR spring-run Chinook salmon. Any Chinook salmon unintentionally killed during the research would be used in lieu of a fish that would otherwise be sacrificed. The NWFSC does not intend to kill any fish that is not a juvenile Chinook salmon, but a small number may die as an unintended result of the research activities.

Permit 21507

Mount Hood Environmental is seeking a research permit for three years to take juvenile and adult UWR steelhead and UWR Chinook in the Tualatin River (Oregon). The purpose of the research is to determine if salmonids and lamprey are present in the intake channel from the Tualatin River to the Spring Hill Pumping Plant and if these fish are likely to be entrained in the intake. The researchers propose to measure water temperature and velocity in the intake channel, capture fish by seining, trapping, and boat-electrofishing, hold fish in aerated buckets, identify fish, and then release fish back to the channel. The researchers do not propose to kill any fish but a small number may die as an unintended result of research activities.

Permit 21432

Cramer Fish Sciences is seeking a research permit for two years to take juvenile LCR Chinook, LCR coho, and LCR steelhead in the Klickitat, Wind, and White Salmon River subbasins (Washington). The purpose of the research is to determine fish occupancy in stream reaches in lands owned by SDS Lumber Company. The permit would expire on December 31, 2019.

Cramer Fish Sciences proposes to capture fish using single-pass backpack electrofishing, identify fish while they are held briefly in hand-held dip nets, and return fish to the stream. The researchers would compare results of the electrofishing surveys with e-DNA studies done in the same stream reaches. The researchers do not propose to kill any fish but a small number may die as an unintended result of research activities.

Permit 20492-2M

The ODFW is seeking to modify a permit that currently authorizes research in lake, river, backwater, slough, and estuary habitats in the Willamette and Columbia basins (Oregon) and on the Oregon coast. The permit would cover the following projects: (1) Warmwater and Recreational Game Fish Management, (2) District Fish Population Sampling in the Upper Willamette Basin, and (3) Salmonid Assessment and Monitoring in the Deschutes River. The modified permit would authorize take of juvenile UCR spring-run Chinook salmon, UCR steelhead, SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, SR Basin steelhead, SR sockeye salmon, MCR steelhead, LCR Chinook salmon, LCR coho salmon, LCR steelhead, CR chum salmon, and OC coho salmon; juvenile and adult UWR Chinook salmon and UWR steelhead; and adult S green sturgeon. Researchers may also capture adult S eulachon, for which there are currently no ESA take prohibitions. The permit would expire on December 31, 2021.

Researchers propose to sample fish using boat electrofishing. A subset of captured juveniles would be anesthetized, weighed and measured, allowed to recover, and then released. Most juveniles and all adults would be allowed to swim away after being electroshocked, or they would be netted and released immediately. The permit modification would not change the methods or scope of the ongoing research, except to add take of juvenile and adult UWR Chinook and UWR steelhead at new research sites in the Tualatin and Yamhill Rivers. The ODFW does not intend to kill any of the fish being captured, but a small number may die as an unintended result of the activities.

Permit 16069-3M

The City of Portland is seeking to modify a permit that currently authorizes them to take juvenile and adult MCR steelhead, UCR spring Chinook salmon, UCR steelhead, SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, SR steelhead, SR sockeye salmon, LCR Chinook salmon, LCR coho salmon, LCR steelhead, CR chum salmon, UWR Chinook salmon, UWR steelhead, OC coho salmon, and S green sturgeon in the Columbia and Willamette rivers and tributaries (Oregon). Researchers may also capture adult S eulachon, for which there are currently no ESA take prohibitions. The permit would expire on December 31, 2021.

This research is part of the Portland Watershed Management Plan, which aims to improve watershed health in the Portland area. In this program, researchers sample 37 sites annually across all Portland watersheds for hydrology, habitat, water chemistry, and biological communities. The City of Portland proposes to capture juvenile fish using backpack and boat electrofishing, hold fish in a bucket of aerated water, take caudal fin clips for genetic analysis, and release fish at a point near their capture site that would be chosen to minimize the likelihood of recapture. The researchers would avoid contact with adult fish. The permit modification would not change the methods or scope of the ongoing research, except to increase the number of mortalities authorized for juvenile UWR steelhead from one to five juvenile fish annually. The researchers do not propose to kill any fish but a small number may die as an unintended result of the activities.

Common Elements among the Proposed Permit Actions

In each of the permit applications, the applicant has requested take numbers that are slightly higher than they expect to occur. This is done to avoid exceeding take limits due to higher-than-expected encounter rates that could result from unexpected environmental conditions, higher-than-expected population abundance, or other reasons. Inflating take estimates also helps us to conduct a conservative analysis of the effects of the actions, because the actual levels of take typically are lower than analyzed.

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

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

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

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

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

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

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

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

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

9. The permit holder using backpack electrofishing equipment must comply with NMFS' Backpack Electrofishing Guidelines (June 2000) available at: http://www.westcoast.fisheries.noaa.gov/publications/reference_documents/esa_refs/section4d/electro2000.pdf.

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

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

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

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

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

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

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

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

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

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

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

"Permit holder" means the permit holder or any employee, contractor, or agent of the permit holder. NMFS may include conditions specific to the proposed research in the individual permits. NMFS uses annual reports for each permit to monitor the actual number of listed fish taken annually in the scientific research activities and will adjust permitted take levels if they are deemed to be excessive or if cumulative take levels rise to the point where they are detrimental to the listed species.

2. ENDANGERED SPECIES ACT BIOLOGICAL OPINION

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 at the conclusion of consultation, section 7(b)(3) of the ESA requires that NMFS provide an opinion stating how the proposed action would affect listed species and their critical habitats. If incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an incidental take statement (ITS) that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

2.1 Analytical Approach

This biological opinion includes both a jeopardy analysis and/or an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of “to jeopardize the continued existence of” a listed species, which is “to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species” (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

This biological opinion relies on the definition of "destruction or adverse modification," which “means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features” (81 FR 7214). The adverse modification analysis considers the impacts of the federal action on the conservation value of designated critical habitat.

The designation(s) of critical habitat for (species) use(s) the term primary constituent element (PCE) or essential features. New critical habitat regulations (81 FR 7414) published in 2016 replace this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting an analysis of ‘‘destruction or adverse modification.” In this biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

ESA Section 4(d) protective regulations prohibit the take of naturally spawned salmonids and of listed hatchery salmonids with an intact adipose fin, but do not prohibit take of listed hatchery salmonids that have their adipose fins removed prior to release into the wild (70 FR 37160 and 71 FR 834). As a result, researchers do not require a permit to take hatchery fish that have had their adipose fin removed. Nevertheless, this document evaluates impacts on both natural and hatchery fish to allow a full examination of the effects of the action on the species as a whole.

Section 4(d) protective regulations prohibit the take of S green sturgeon (75 FR 30714). The NMFS has not promulgated protective regulations via Section 4(d) of the ESA for eulachon. Nonetheless, because S eulachon are a listed species with proposed or designated critical habitat, we must perform the jeopardy and adverse modification analyses laid out in the previous section.

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

- *Identify the rangewide status of the species and critical habitat likely to be affected by the proposed action* (Section 2.2). We describe the current status of each listed species and its critical habitat relative to the conditions needed for recovery. We use viability assessments and criteria in technical recovery team documents and recovery plans, which provide assessments for specific populations, major population groups, and species. We determine the rangewide status of critical habitat by examining the condition of PBFs, which were identified when the critical habitat was designated. We also discuss potential past and future effects of climate change on the status of the species and critical habitat.
- *Describe the environmental baseline in the action area* (Section 2.4). We describe the environmental baseline, which includes the past and present impacts of federal, state, or private actions and other human activities *in the action area*. The environmental baseline includes the anticipated impacts of proposed federal projects that have already undergone formal or early section 7 consultation and the impacts of state or private actions that are contemporaneous with the consultation in process.
- *Analyze the effects of the proposed action on species and habitat using an "exposure-response-risk" approach* (Section 2.5). We consider how the proposed action would affect the species' reproduction, numbers, and distribution or, in the case of salmon and steelhead, VSP characteristics. We also evaluate the proposed action's effects on critical habitat.
- *Describe any cumulative effect in the action area* (Section 2.6). We describe cumulative effects, which are defined as the effects of future state or private activities, not involving federal activities, that are reasonably certain to occur within the action area (50 CFR 402.02). Future federal actions that are unrelated to the proposed action are not considered because they require separate section 7 consultation.
- *Integrate and synthesize the above factors* (Section 2.7). We analyze how the effects of the action integrate with the environmental baseline and the cumulative effects. We assess whether the action could reasonably be expected to (1) reduce appreciably the likelihood of both survival and recovery of each listed species in the wild by reducing its numbers, reproduction, or distribution, or (2) reduce the value of designated or proposed critical habitat for the conservation of the listed species. In making these assessments, we fully consider the status of the species and critical habitat.
- *Reach a conclusion about whether species are jeopardized or critical habitat is adversely modified* (Section 2.8). We describe our conclusions regarding jeopardy and the destruction or adverse modification of critical habitat.
- *List reasonable and prudent alternatives, if warranted.* If necessary, we suggest a reasonable and prudent alternative to the proposed action.

2.2 Rangewide Status of the Species and Critical Habitat

In this opinion we examine the status of each species that would be adversely affected by the proposed action. We evaluate 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 our 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. We also examine the condition of critical habitat throughout the designated area, evaluate the conservation value of the watersheds and coastal and marine environments that make up the designated area, and discuss the current function of the essential PBFs that help to form that conservation value.

The ESA defines species to include "any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature." NMFS adopted a policy for identifying salmon DPSs in 1991 (56 FR 58612). The policy states that a population or group of populations is considered an ESU if it is "substantially reproductively isolated from conspecific populations," and if it represents "an important component of the evolutionary legacy of the species." The policy equates an ESU with a DPS. Hence, the Chinook, chum, and coho salmon listing units in this biological opinion constitute ESUs of the species *O. tshawytscha*, *O. keta*, and *O. kisutch.* The steelhead listing units in this biological opinion constitute DPSs of the species *O. mykiss.* The ESUs and DPSs of salmon and steelhead include natural-origin populations and hatchery populations, as described below. Finally, the eulachon and green sturgeon listing units in this biological opinion constitute DPSs.

2.2.1 Status of the Species

For Pacific salmon, steelhead, eulachon, and green sturgeon, NMFS uses four parameters to assess the viability of populations: spatial structure, diversity, abundance, and productivity (McElhaney et al. 2000). These "viable salmonid population" (VSP) criteria encompass the "reproduction, numbers, or distribution" of a species, which are described in 50 CFR 402.02. Adequate population spatial structure, diversity, abundance, and productivity reflect that a population is well adapted to environmental conditions and other influences that affect individuals throughout the life cycle (e.g., biological interactions, harvest).

"Spatial structure" refers both to the spatial distributions of individuals in populations 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. For the spatial structure analysis of salmonids in the Willamette and Lower Columbia domains, the Oregon and Washington recovery plans evaluated (1) the proportion of stream miles currently accessible to the species relative to the historical miles accessible, and (2) quality of currently accessible habitat, and (3) loss of habitat considered to be a key production area (ODFW 2010; LCFRB 2010).

"Diversity" refers to the distribution of traits within and among populations. These traits range in scale from DNA sequence variation at single genes to complex life-history traits. Diversity in salmon populations is represented by differences within and among populations in morphology, fecundity, run timing, spawn timing, juvenile behavior, age at smolting, age at maturity, egg size, developmental rate, ocean distribution patterns, male and female spawning behavior, physiology and molecular genetic characteristics (McElhaney et al. 2000). Some of these traits are genetically based while others vary as a result of combined environmental and genetic factors.

"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). In this opinion we also describe abundance for juvenile life stages and hatchery-produced fish. There are nuances to consider when interpreting estimates for juvenile abundance, including: (1) we generally report data for outmigrating smolts; however, research effects occur at other juvenile life stages (e.g., egg, fry, parr) and we typically do not have comparable data sets for these other life stages; (2) estimates of juvenile abundance often are derived from data on spawner abundance, sex ratios and fecundity, and these data are associated with high levels of uncertainty; (3) survival rates between life stages often are unknown and are subject to multiple natural and human-induced influences (e.g., predation, floods, harvest). For hatchery-origin fish, estimates of juvenile abundance may also be affected by the factors above; however, hatchery production generally is easier to quantify than natural production.

"Productivity" reflects survival across 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. McElhaney 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 reflects the long-term population growth rate.

For species with multiple populations, NMFS assesses status using criteria for groups of populations. These groups of populations, called major population groups (MPGs) or strata, typically are populations within the same ecological zone and with similar life history traits. Considerations for species viability include having multiple populations that are viable, ensuring that populations with unique life histories and phenotypes are viable, and ensuring that some viable populations are close enough to allow functioning as metapopulations while other viable populations are dispersed enough to avoid concurrent extinctions from mass catastrophes (McElhaney et al. 2000). Recovery plans and guidance documents from technical recovery teams explain these criteria in detail.

Information on the status and distribution of the species considered here can be found in the following documents:

- Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest (NWFSC 2015)
- Status review update of eulachon (*Thaleichthys pacificus*) listed under the Endangered Species Act: Southern Distinct Population Segment (Gustafson et al. 2016)
- 2016 5-Year Review: Summary & Evaluation of Upper Willamette River Steelhead, Upper Willamette River Chinook (NMFS 2016)
- 2016 5-Year Review: Summary & Evaluation of Lower Columbia River Chinook Salmon, Columbia River Chum Salmon, Lower Columbia River Coho Salmon, Lower Columbia River Steelhead (NMFS 2016)

2.2.1.1 Status of Lower Columbia River Chinook Salmon

Description and Geographic Range

We listed Lower Columbia River (LCR) Chinook salmon as threatened on March 24, 1999 (64 FR 14308) and confirmed its threatened status in 2005 (70 FR 37160), 2011 (76 FR 50448), and 2016 (81 FR 33468). The ESU is defined as naturally spawned Chinook salmon originating from the Columbia River and its tributaries downstream of a transitional point east of the Hood and White Salmon Rivers, and any such fish originating from the Willamette River and its tributaries below Willamette Falls. Not included in this DPS are: (1) spring-run Chinook salmon originating from the Clackamas River; (2) fall-run Chinook salmon originating from Upper Columbia River bright hatchery stocks, that spawn in the mainstem Columbia River below Bonneville Dam, and in other tributaries upstream from the Sandy River to the Hood and White Salmon Rivers; (3) spring-run Chinook salmon originating from the Round Butte Hatchery (Deschutes River, Oregon) and spawning in the Hood River; (4) spring-run Chinook salmon originating from the Carson National Fish Hatchery and spawning in the Wind River; and (5) naturally spawning Chinook salmon originating from the Rogue River Fall Chinook Program. The ESU also includes Chinook salmon from 15 artificial propagation programs (79 FR 20802).

There are six MPGs containing 32 demographically independent populations in this ESU: 9 spring-run, 21 fall-run, and 2 late fall-run (Table 1; NWFSC 2015). Historically, spring Chinook salmon were found in the upper portions of basins with snowmelt-driven flow regimes, fall Chinook salmon were found throughout the range of the ESU, and late fall Chinook salmon were found in only two basins in the Cascade stratum.

Spawning and juvenile rearing occurs throughout the range of the ESU. Fish usually smolt and migrate to the ocean as subyearlings, although some spring-run populations have many yearling outmigrants. In the ocean, subadults and adults forage in coastal and offshore waters of the North Pacific Ocean. Late fall Chinook salmon tend to migrate farther north in the ocean than spring and fall LCR Chinook. Spring and fall Chinook salmon typically mature at age 3-4, while late fall Chinook typically mature at age 4 to 6. Adults return to natal streams to spawn.

Spatial Structure and Diversity

Spatial structure is moderate to very high for 24 of 31 populations (Table 1, ODFW 2010; LCFRB 2010). Populations with the lowest ratings have fish passage barriers. Management actions are underway to improve habitat quality and access for several populations with low ratings. Diversity is low to very low for 18 of 31 populations (Table 1; ODFW 2010, LCFRB 2010). The ESU has lost about 80% of spring run populations. High proportions of fish on spawning grounds are hatchery origin. In addition, habitat loss and degradation contributes to low diversity ratings (Good et al. 2005; Ford 2011). Good et al. (2005) identified diversity as the VSP criterion with the highest risk for the ESU.

Table 1. Historical population structure and viability status for Lower Columbia River Chinook salmon (VL=very low, L=low, M=moderate, H=high, VH=very high; ODFW 2010; LCFRB 2010).

Stratum (Run)	Population	Viability Status		
		A&P	Spatial	Diversity
Coastal (Fall)	Youngs	L	VH	L
	Grays/Chinook	VL	H	VL
	Big Creek	VL	H	L
	Elochoman/Skamokowa	VL	H	L
	Clatskanie	VL	VH	L
	Mill/Abernathy/Germany	VL	H	L
	Scappoose	L	H	L
Cascade (Fall)	Coweeman	VL	H	H
	Lower Cowlitz	VL	H	M
	Upper Cowlitz	VL	VL	M
	Toutle	VL	H	M
	Kalama	VL	H	M
	Lewis	VL	H	H
	Clackamas	VL	VH	L
	Washougal	VL	H	M
	Sandy	VL	M	L
Columbia Gorge (Fall)	Lower gorge	VL	M	L
	Upper gorge	VL	M	L
	Hood	VL	VH	L
	Big White Salmon	VL	L	L
Cascade (Late Fall)	Sandy	VH	M	M
	North Fork Lewis	VH	H	H
Cascade (Spring)	Upper Cowlitz	VL	L	M
	Cispus	VL	L	M
	Tilton	VL	VL	VL
	Toutle	VL	H	L
	Kalama	VL	H	L
	Lewis	VL	L	M
	Sandy	M	M	M
Gorge (Spring)	Big White Salmon	VL	VL	VL
	Hood	VL	VH	VL

Abundance and Productivity

Abundance of adult natural-origin LCR Chinook salmon is approximately 29,469. (Table 2). All but three populations have low to very low ratings for abundance and productivity (Table 1). Only five populations currently meet recovery goals for abundance, and for one of these populations, the White Salmon, we do not know what portion of spawners are hatchery origin. There was little change in biological risk for the ESU between the 2011 and 2016 status reviews (Ford et al. 2011; NWFSC 2016).

Table 2. 5-year average adult abundance estimates for LCR Chinook salmon populations (ODFW 2016a; WDFW 2016).

Stratum (Run)	Population	Years	Total	HOR(1)	NOR(2)
Coastal (Fall)	Youngs Bay	2012-2014	5,839	5,606	233
	Grays/Chinook	2010-2014	457	357	100
	Big Creek	2012-2014	1,542	1,510	32
	Elochoman/Skamokowa	2010-2014	696	580	116
	Clatskanie	2012-2014	3,291	3,193	98
	Mill/Abernathy/Germany	2010-2014	897	805	92
Cascade (Fall)	Lower Cowlitz	2010-2013	919	196	723
	Upper Cowlitz	2010-2013	3,834	961	2,873
	Toutle	2010-2014	8,705	5,400	3,305
	Coweeman	2010-2014	1,348	963	385
	Kalama	2010-2014	9,694	8,892	803
	Lewis	2010-2014	3,121	943	2,178
	Washougal	2010-2014	309	116	192
	Clackamas	2012-2014	4,227	2,955	1,272
	Sandy	2012-2014	1,527	320	1,207
Columbia Gorge (Fall)	Lower gorge	2003-2007	146	Unknown	146
	Upper gorge	2010-2012	527	327	200
	White Salmon	2010-2014	1,075	246	829
Cascade (Late Fall)	North Fork Lewis	2010-2014	12,330	0	12,330
Cascade (Spring)	Upper Cowlitz/Cispus	2010-2014	3,893	3,614	279
	Kalama	2011-2014	115	na	115
	North Fork Lewis	2010-2014	217	0	217
	Sandy	2010-2014	3,201	1,470	1,731
Gorge (Spring)	White Salmon	2013-2014	152	140	13
Total			68,061	38,594	29,469

(1) Hatchery Origin (HOR) spawners.
(2) Natural Origin (NOR) spawners.

To estimate abundance of juvenile LCR Chinook salmon, we calculate average abundance of outmigrating smolts for the past five years, using estimates for annual abundance provided by the NWFSC (Table 3; Zabel 2014a, 2014b, 2015, 2017a, 2017b).

Table 3. Average estimated outmigration for listed LCR Chinook salmon (2013-2017).

Origin	Outmigration
Natural	12,164,845
Listed hatchery intact adipose	1,204,984
Listed hatchery adipose clip	33,631,872

Limiting Factors

LCR Chinook salmon populations are depleted due to combined effects of habitat degradation, dams, fishing, and hatcheries. Changes in habitat connectivity, stream flow regimes, sediment budgets, stream morphology, floodplain interactions, riparian habitat, and water quality have affected habitat adversely. In addition, high proportions of hatchery fish on spawning grounds threaten the diversity of LCR Chinook salmon. A number of efforts are underway to improve conditions for LCR Chinook. Dam removals (i.e., Condit Dam, Marmot Dam, and Powerdale Dam) have improved fish passage and habitat conditions. Commercial and recreational fisheries in the ocean and lower Columbia River have been curtailed substantially to reduce fishery impacts on wild salmonids (LCFRB 2010; ODFW 2010). Hatchery managers have worked to reduce negative effects of hatcheries by using best practices for broodstock sourcing, breeding, rearing, release of hatchery fish, and management of hatchery facilities to protect water quality and access to habitat for wild fish. Despite continued efforts, however, ongoing land development and habitat degradation will continue to influence the ESU negatively.

Status Summary

Abundance of LCR Chinook salmon is low relative to historical levels (ODFW 2010; LCFRB 2010; NWFSC 2016). The recent development and implementation of stock transfer policies in Oregon and Washington may help reduce hatchery effects on natural fish. However, more time is needed to determine if new hatchery policies will better protect listed fish. Trap and haul programs have begun to re-introduce Chinook salmon to many miles of habitat, potentially improving the spatial structure and diversity of the species.

2.2.1.2 Status of Upper Willamette River Chinook Salmon

Description and Geographic Range

We listed Upper Willamette River (UWR) Chinook salmon as threatened on March 24, 1999 (64 FR 14308) and confirmed its threatened status in 2005 (70 FR 37160), 2011, (76 FR 50448), and 2016 (81 FR 33468). We define the ESU as all naturally spawned populations of spring-run Chinook salmon in the Clackamas River and in the Willamette River and its tributaries above Willamette Falls, Oregon. The ESU also includes spring-run Chinook salmon from six artificial propagation programs (79 FR 20802). Fall-run Chinook that occur in the UWR are not considered part of the listed ESU, because fall-run fish did not migrate upstream past Willamette Falls before the fish ladder was built.

The ESU is composed of seven populations in one stratum (Table 4). The populations are delineated based on geography, migration rates, genetic attributes, life history patterns, phenotypic characteristics, population dynamics, and environmental and habitat characteristics. Core populations were historically the most productive populations and the McKenzie population also is considered a “genetic legacy population” because it is particularly important for meeting genetic diversity goals (ODFW 2011; Table 4).

Table 4. Historical population structure and viability status for UWR Chinook salmon (ODFW 2011).

Population	Population Classification	Viability Status		
		A&P	Spatial	Diversity
Clackamas	Core population	M	H	M
Molalla		VL	L	L
N. Santiam	Core population	VL	L	L
S. Santiam		VL	M	M
Calapooia		VL	VL	L
McKenzie	Core and Genetic Legacy	VH	M	M
Middle Fork	Core population	VL	L	L

Spawning and juvenile rearing occurs throughout the range of the ESU. Parr may emigrate to the ocean as subyearlings or yearlings; typically they smolt and begin outmigrating in the spring. Subadults and adults forage in coastal and offshore waters of the North Pacific Ocean before returning to spawn in natal streams. Historically, 5-year-old fish dominated the spawning migration runs; recently, however, most fish mature at age 4.

Spatial Structure and Diversity

Spatial structure ranges from low to high (Table 4). Populations with low ratings have fish passage barriers, stream channel modifications, and water quality problems that degrade habitat quality or block access to historical habitat (ODFW 2011). Diversity is moderate to low (Table 4). These lower ratings stem from loss of habitat above dams and hatchery production (Good et al. 2005, ODFW 2011). Introduction of fall-run Chinook and passage at Willamette Falls during low-water periods via the fish ladder have increased the potential for genetic introgression between wild spring and hatchery fall Chinook (Good et al. 2005).

Abundance and Productivity

The spring run of UWR Chinook salmon has been counted at Willamette Falls since 1946, but “jacks” (sexually mature males that return to freshwater to spawn after only a few months in the ocean) were not differentiated from the total count until 1952. The average estimated run size from 1946 through 1950 was 43,300 fish, compared to 3,900 in 1994. Even though the number of naturally spawning fish has increased gradually in recent years, many are first generation hatchery fish. Juvenile spring Chinook produced by hatchery programs are released throughout the basin and adult Chinook returns to the ESU are typically 80-90% hatchery origin fish. In the recovery plan, ODFW (2011b) found the UWR Chinook ESU to be extremely depressed, likely numbering less than 10,000 fish, with the Clackamas and McKenzie populations accounting for most of the production (Table 5).

Table 5. Estimated recent abundance, viability goals, and abundance targets for UWR Chinook salmon populations (ODFW 2011).

Population	Wild Abundance (1990-2004)	Viability Goal	Abundance Goal
Clackamas	1,100	Very High	2,046
Molalla	25	High	1,434
N. Santiam	50	High	5,450
S. Santiam	50	High	4,910
Calapooia	25	High	1,225
McKenzie	1,995	Very High	5,486
Middle Fork	50	High	5,870

All but two of the populations are rated as very low for abundance and productivity (Table 4; ODFW 2011). Most populations of the UWR Chinook ESU are far below the recovery goal (Table 5). Abundance in the Clackamas population would need to nearly double, and in the North and South Santiam and Middle Fork populations a 100-fold increase is needed to meet recovery goals.

Abundance of adult UWR spring Chinook has declined since the highs witnessed around the turn of this century (Table 6). The 5-year average return (2011-2015) for UWR spring Chinook salmon is 11,443 naturally produced adults and 34,454 hatchery adults.

Table 6. Adult UWR spring Chinook escapement to the Clackamas River and Willamette Falls fish ladder (ODFW and WDFW 2012, 2013, 2014, 2015; ODFW 2017).

Year	Total Escapement	Hatchery Escapement	Natural Escapement
2011	51,922	36,506	15,416
2012	43,012	32,334	10,678
2013	35,714	24,332	11,382
2014	37,300	30,959	6,341
2015	61,534	48,137	13,397
Average	45,896	34,454	11,443

To estimate abundance of juvenile UWR Chinook salmon, we calculate average abundance of outmigrating smolts for the past five years, using estimates for annual abundance provided by the NWFSC (Table 7; Zabel 2014a, 2014b, 2015, 2017a, 2017b).

Table 7. Average estimated outmigration for listed UWR Chinook salmon (2013-2017).

Origin	Outmigration
Natural	1,275,681
Listed hatchery intact adipose	16,278
Listed hatchery adipose clipped	5,543,371

Limiting Factors

Limiting factors for UWR Chinook include habitat (quality, quantity, and access), water quality, competition, disease, food web, population traits, and predation (ODFW 2011). Primary threats to UWR Chinook include flood control/hydropower system operations, land use practices, harvest, hatchery operations, and other species. In upper subbasin mainstem reaches and subordinate tributary streams, the major drivers of current habitat conditions are past and present forest practices, roads, and barriers. In the Willamette River mainstem and lower sub-basin mainstem reaches, high-density urban development and widespread agricultural effects have harmed aquatic and riparian habitat quality and complexity, sediment and water quality and quantity, and watershed processes. The primary activities that have contributed to current estuary and lower mainstem habitat conditions include channel confinement (primarily through diking), channel manipulation (primarily dredging), floodplain development, and water withdrawal for urbanization and agriculture (LCFRB 2004).

Harvest impacts from commercial and recreational fisheries on UWR spring Chinook have been reduced substantially in response to extremely low returns in the mid-1990's and subsequent ESA listings in 1999. For spring Chinook, freshwater fishery impacts have been reduced by approximately 75% from 2001 to present compared to 1980 to the late 1990's (ODFW 2011). This reduction was accomplished by implementing selective harvest of hatchery-origin fish and requiring that unmarked, wild fish be released. Current mortality of naturally produced Chinook in ocean fisheries averages 11% (1996-2006) and freshwater fisheries 9% (2000-2010) (ODFW 2011).

Many UWR Chinook populations are characterized by high proportions of hatchery fish on the spawning grounds (ODFW 2011). The vast majority of the UWR Chinook escapement is hatchery fish (Table 6). The major concern with hatcheries is the negative effect hatchery fish spawning in the natural environment have on productivity and long-term fitness of naturally spawning populations.

ODFW identified negative effects of both native and introduced plant and animal species as limiting factors and threats to UWR Chinook (ODFW 2011). Ecosystem alterations attributable to hydropower dams and to modification of estuarine habitat have increased predation on UWR Chinook. In the estuary, habitat modification has increased the number and/or predation effectiveness of Caspian terns, double-crested cormorants, and a variety of gull species (LCREP 2006; Fresh et al. 2005).

Status Summary

The updated information provided in Oregon's recovery plan (2011b) and the information contained in previous UWR Chinook salmon status reviews indicate that most spring-run populations are likely extirpated, or nearly so. The only populations considered potentially self-sustaining are the Clackamas and McKenzie River populations, but abundance is relatively low, with most fish being of hatchery origin. Substantial changes, such as an increase in abundance and a reduction in hatchery influences, are needed before this ESU can recover. Dams, as well as other habitat alterations and hatchery and harvest effects have affected the listed species. NMFS'

Willamette Project biological opinion addresses fish passage and water temperature issues. Efforts to make the dams more fish-friendly and to improve river water temperatures should improve the status of the species, but the process has just begun, and more time is needed before we can know the effect of these actions.

2.2.1.3 Status of Columbia River Chum Salmon

Description and Geographic Range

We listed Columbia River (CR) chum salmon as threatened on March 25, 1999 (64 FR 14507) and confirmed its threatened status in 2005 (70 FR 37160), 2011 (76 FR 50448), and 2016 (81 FR 33468). The ESU is defined as "naturally spawned chum salmon originating from the Columbia River and its tributaries in Washington and Oregon." The ESU also includes chum salmon from two artificial propagation programs (79 FR 20802).

The CR chum salmon ESU consists of 17 historical populations in three MPGs: Coastal, Cascade, and Gorge. CR chum salmon are fall-run fish.

Spawning typically occurs in the mainstem and lower portions of river basins and is currently limited to tributaries below Bonneville Dam. Most spawning occurs in two areas on the Washington side of the Columbia River: Grays River, near the mouth of the Columbia River, and Hardy and Hamilton Creeks, approximately three miles below Bonneville Dam. Some chum salmon pass Bonneville Dam, but there are no known extant spawning areas in the Bonneville pool. Juveniles migrate to the ocean almost immediately after emergence from the gravel and do not have a distinct smolt phase like other salmonids. Subadults and adults forage in coastal and offshore waters of the North Pacific Ocean. Adults enter the Columbia River from mid-October through early December and return to their natal streams to spawn from early November to mid-January. Adults typically mature as 4-year-olds, although age-3 and age-5 fish are also common (Fulton 1970).

Spatial Structure and Diversity

The Willamette/Lower Columbia River Technical Recovery Team (WLC-TRT) partitioned CR chum salmon into three strata based on ecological zones. Ecological zones range from areas at the mouth of the Columbia River that are influenced by the ocean to the Columbia River gorge above Bonneville Dam. The WLC-TRT analysis suggests that a viable ESU would need multiple viable populations in each stratum (Good et al. 2005). Substantial spawning occurs in only two of the 16 historical populations, meaning 88% of the historical populations are extirpated, or nearly so (Table 8). The two extant populations, Grays River and the lower gorge population, appear to contain only a fraction of the wild historic abundance. Both populations have benefited from artificial spawning channels constructed to provide habitat that is lacking in the Columbia River.

Table 8. Historical population structure and abundance of CR chum salmon.

Ecological Zone	Population	EDT estimate of historical abundance*
Coastal	Youngs Bay	ND
	Grays/Chinook	7,511
	Big Creek	ND
	Elochoman/Skamania	ND
	Clatskanine River	ND
	Mill/Abernathy/Germany	ND
	Scappoose Creek	ND
Cascade	Cowlitz River	141,582
	Kalama River	9,953
	Lewis River	89,671
	Salmon Creek	ND
	Clackamas River	ND
	Sandy River	ND
	Washougal River	15,140
Columbia Gorge	Lower gorge tributaries	>3,141
	Upper gorge tributaries	>8,912
TOTAL		>283,421

ND = no data

* The EDT estimate of historical abundance is based on analysis by WDFW of equilibrium abundance under historical habitat conditions (Busack and Rawding 2003).

A large portion of the upper gorge chum population is believed to have been inundated by Bonneville Dam. The WDFW and ODFW conducted surveys to determine the distribution and abundance of chum salmon in the lower Columbia. Very small numbers were observed in several locations in Washington; one chum salmon was observed in Oregon out of 30 sites surveyed (Good et al. 2005).

The leading factor affecting CR chum salmon diversity is the extirpation or near-extirpation of 14 of the 16 historical populations. The remaining populations are at low abundance, although increases in the early 2000s are encouraging. Chum run-timing is rather fixed, compared to other salmon and steelhead, and thus may not help improve the overall diversity of the ESU.

Hatchery programs are established for CR chum in the Chinook, Grays, and Washougal Rivers, but it is unknown how they have affected natural CR chum salmon. Chum are released at a small size and are not marked externally before release, though many are otolith marked. The WDFW collected otoliths from spawning chum salmon, but the data will need to be analyzed before any conclusions regarding the hatchery’s effects on CR chum salmon diversity can be made. CR chum salmon diversity may not be adversely affected by hatchery releases because the releases have been small and intermittent compared to other stocks in the Columbia River (McElhaney et al. 2004).

Abundance and Productivity

Historically, CR chum salmon supported a large commercial fishery that landed more than 500,000 fish per year, and chum salmon were reported in almost every river in the lower Columbia River basin. However, most runs disappeared by the 1950s. There are now no recreational or directed commercial fisheries for chum salmon in the Columbia River, although chum salmon are taken incidentally in the gill-net fisheries for coho and Chinook salmon, and some tributaries support a minor recreational harvest. The estimated minimum run size for the Columbia River has been at a relatively stable but low level since the run collapsed during the mid-1950s. Current abundance is probably less than 1% of historical levels, and the species has undoubtedly lost genetic diversity.

WDFW monitors several natural "index" populations: in Grays River, in two small streams near Bonneville Dam, and in the mainstem area next to those two streams. Average annual natural escapement to the index spawning areas was approximately 1,300 fish from 1990 through 1998. The WDFW surveyed other non-index areas in 1998 and found only small numbers of chum salmon (typically less than 10 fish per stream) in Elochoman, Abernathy, Germany, St. Cloud, and Tanner Creeks and in the North Fork Lewis and the Washougal Rivers. Consistent with the BRT status review (Ford 2011), the ODFW recovery plan concluded that chum are extirpated or nearly so in all Oregon Columbia River populations (ODFW 2010). A few chum are encountered occasionally during surveys or return to hatchery collection facilities, but these are likely either strays from one of the Washington populations or part of a few extremely small and erratic remnant populations. Recent estimates for the lower Columbia Gorge and Grays River chum salmon populations range from 10,000 to 20,000 adults. WDFW spawning surveys in the Grays/Chinook, Washougal, Lower Gorge, and Upper Gorge populations estimated an average of 8,508 adult chum for the years 2007-2011 (WDFW 2014). We do not have recent adult abundance data for any of the other populations.

The Lower Columbia Fish Recovery Board (LCFRB 2010) developed planning ranges for abundance of viable CR chum salmon populations (Table 9). Some abundance goals were not set; the range of abundance is from less than 100 (in the Salmon population) to 6,000 fish (in the Grays/Chinook population). Two of the populations either reach or exceed abundance targets. However, all of the populations are below the planning targets.

Table 9. Recovery goals for CR chum salmon populations (LCFRB 2010, WDFW 2016a).

Population	Viability Goal	Current Viability	Abundance Goal	Adult Escapement		
				Years	Natural	Hatchery
Grays/Chinook	High+	Low+	6,000	2010-2014	6,604	421
Eloch/Skamania	High	Low	1,100	2002-2004	122	
Mill/Aber/Germany	High	V. Low	1,100	2002-2004	40	
Youngs Bay	High	Unknown				
Big Creek	Low	Unknown				
Clatskanie	Med	Unknown				
Scappoose	Low	Unknown				
Cowlitz	Med	V. Low	600			
Kalama	Low	V. Low	150			
Lewis	High	V. Low	1,100	2011-2013	36	
Salmon	V. Low	V. Low	75			
Washougal	High+	Low	5,200	2010-2014	2,440	
Clackamas	Med	Unknown				
Sandy	High	Unknown				
L. Gorge	High+	Med+	2,800	2010-2014	1,600	5
U. Gorge	Med	V. Low	600	2010-2014	106	
Total					10,644	426

Current abundance numbers are observed 4-year averages or assumed natural spawning escapements.

To estimate abundance of juvenile CR chum salmon, we calculate average abundance of outmigrating smolts for the past five years, using estimates for annual abundance provided by the NWFSC (Table 10; Zabel 2014a, 2014b, 2015, 2017a, 2017b).

Table 10. Average estimated outmigration for listed CR chum salmon (2013-2017).

Origin	Outmigration
Natural	5,362,740
Listed hatchery intact adipose	648,047
Listed hatchery adipose clipped	6,512

Trends and growth rate for CR chum salmon are difficult to determine because 14 of the 16 historical populations are extirpated, or nearly so. The two extant populations are at Grays River and the lower Columbia Gorge. The majority of chum salmon spawning in the Grays River currently occurs in less than 1.1 km of the river. Previous to its destruction in a 1998 flood, approximately 50% of the Grays River population spawning occurred in an artificial spawning channel created by the WDFW in 1986. Data from a WDFW analysis conducted in 2000 shows a small upward trend from 1967 to 1998, and a low probability that the population is declining. However, a longer data set indicates that both long- and short-term trends are negative over the period 1950–2000, with a high probability that the trend and growth rate are less than one. Data from the Gorge populations showed a downward trend since the 1950s and a relatively low abundance up to 2000. However, preliminary data indicate that the 2002 abundance showed a substantial increase, estimated to be more than 2,000 chum salmon in Hamilton and Hardy

Creeks, plus another 8,000 or more in the mainstem. Overall, due to a limited number of populations and low abundance, CR chum salmon productivity is low (Good et al. 2005).

Status Summary

Despite improvement in spawner abundance in certain areas, the overall abundance is still only a fraction of historical levels and many of the populations are extirpated, or nearly so. The species' productivity, spatial structure, and diversity are at low levels. Habitat conditions have been fundamentally altered throughout the Columbia River basin by the dams, and overall stream habitat productivity in the lower Columbia has been degraded for all salmon and steelhead. Substantial changes, such as the increase in abundance seen in the early 2000s, are needed before this ESU can recover.

Limiting Factors

Chum salmon prefer particular microhabitats for spawning and do not ascend falls or steep gradients like steelhead and other salmon. Overall, fish have been affected adversely by changes in access, stream flow, water quality, sedimentation, habitat diversity, channel stability, riparian conditions, and floodplain interactions. These large scale changes have altered habitat conditions and processes important to migratory and resident fish and wildlife (NMFS 2006).

Habitat conditions for anadromous fish have been fundamentally altered throughout the Columbia River basin by the construction and operation of a complex of tributary and mainstem dams and reservoirs for power generation, navigation, and flood control. CR chum salmon are affected by hydrosystem-related effects on flow (in reservoirs and downstream of dams), water quality, and fish passage. For example, a large portion of the upper gorge chum habitat is believed to have been inundated by Bonneville Dam. Chum are affected to a lesser extent than other salmon and steelhead, but dams in many of the larger subbasins have blocked access to large areas of productive habitat (NMFS 2006).

Chum salmon were once very abundant in the Columbia basin, with commercial landings ranging from 1 to 8 million pounds (80,000 to 650,000 fish) in most years before the early 1940s. Chum escapements have been extremely small since the late 1950s, but improved somewhat recently. The total estimated escapement in 2002 was just under 20,000. NMFS biological opinions now limit the incidental impact of Columbia River fisheries targeting other species to an expected 2% and not to exceed 5% of the annual return of chum listed under the ESA. No sport or commercial fisheries specifically target chum salmon and the current impacts of 3% or less are incidental to fisheries for other species. Numbers incidentally taken in current freshwater or ocean fisheries are not significant. Even though no fisheries target chum salmon, incidental catch in sport and commercial fisheries and illegal harvest can affect the species VSP criteria.

2.2.1.4 Status of Lower Columbia River Coho Salmon

Description and Geographic Range

We listed Lower Columbia River (LCR) coho salmon as threatened on June 28, 2005 (70 FR 37160) and confirmed its threatened status in 2011 (76 FR 50448) and 2016 (81 FR 33468). The ESU is defined as “naturally spawned coho salmon originating from the Columbia River and its tributaries downstream from the Big White Salmon and Hood Rivers (inclusive) and any such fish originating from the Willamette River and its tributaries below Willamette Falls.” The ESU also includes coho salmon from 21 artificial propagation programs (79 FR 20802).

Coho salmon occur in most major river basins around the Pacific Rim from Monterey Bay, California, north to Point Hope, Alaska, through the Aleutians, and from the Anadyr River south to Korea and northern Hokkaido, Japan. From central British Columbia south, most coho salmon adults are 3-year-olds, having spent approximately 18 months in fresh water and 18 months in salt water. Both early-and late-run stocks were present historically and persist in the lower Columbia River. Type S is an early type that enters the river from mid-August to September, spawns in mid-October to early November, and generally spawns in higher tributaries. Ocean migration for these fish is coastal Washington, Oregon, and Northern California. Type N is a late type that enters the river from late September to December, spawns in November to January, and generally spawns in lower tributaries. Ocean migration for these fish is coastal British Columbia, Washington, and Oregon.

The LCR coho salmon ESU includes 25 populations that existed historically in the Columbia River basin from the Hood River downstream (Table 11). Until recently, Columbia River coho salmon were managed primarily as a hatchery stock. Coho were present in all lower Columbia River tributaries but the run now consists of very few wild fish. Twenty-one of the 24 populations in the ESU are at a very high risk of extinction (Table 11). It is possible that some native coho populations are now extinct, but the presence of naturally spawning hatchery fish makes this difficult to ascertain. The strongest remaining populations occur in Oregon and include the Clackamas River and Scappoose Creek.

Table 11. Historical population structure and viability status for LCR coho salmon (ODFW 2010; LCFRB 2010).

Stratum	Population	Viability Status		
		A&P	Spatial	Diversity
Coastal	Grays/Chinook	VL	H	VL
	Elochoman/Skamokawa	VL	H	VL
	Mill/Abernathy/Germany	VL	H	L
	Youngs	VL	VH	VL
	Big Creek	VL	H	L
	Clatskanine	L	VH	M
	Scappoose	M	H	M
Cascade	Lower Cowlitz	VL	M	M
	Upper Cowlitz	VL	M	L
	Cispus	VL	M	L
	Tilton	VL	M	L
	South Fork Toutle	VL	H	M
	North Fork Toutle	VL	M	L
	Coweeman	VL	H	M
	Kalama	VL	H	L
	North Fork Lewis	VL	L	L
	East Fork Lewis	VL	H	M
	Salmon Creek	VL	M	VL
	Washougal	VL	H	L
	Clackamas	M	VH	H
	Sandy	VL	H	M
Gorge	Lower Gorge	VL	M	VL
	White Salmon	VL	M	VL
	Hood	VL	VH	L

Spatial Structure and Diversity

For the spatial structure analysis, the Oregon and Washington recovery plans evaluated the proportion of stream miles currently accessible to the species relative to the historical miles accessible (ODFW 2010; LCFRB 2010). The recovery plans adjusted the rating downward if portions of the currently accessible habitat were qualitatively determined to be seriously degraded. The recovery plans also adjusted the rating downward if the portion of historical habitat lost was a key production area.

The Oregon and Washington recovery plans rate spatial structure as moderate to very high in nearly all populations of LCR coho. The populations that rate lowest have fish passage barriers. Trap and haul operations on the Cowlitz River pass adults upriver, but downstream passage and survival of juvenile fish is very low. This problem also affects spatial structure in the Cispus and Tilton populations. Merwin Dam blocks access to most of the available spawning habitat in the North Fork Lewis populations. The relicensing agreement for Lewis River hydroelectric projects calls for reintroduction of coho salmon but adequate passage through the system must be achieved to realize the habitat potential. Condit Dam on the White Salmon River blocked access to most of the historical spawning habitat but was removed in 2011. Thus, the LCR coho salmon spatial structure is less diverse than historically, but management actions are underway to improve the situation.

Diversity is low to very low for most coho populations (Table 11; ODFW 2010; LCFRB 2010). In the 1980s and 1990s there were no observations of coho spawning in lower Columbia River tributaries. Small populations have reduced genetic variability due to population bottlenecks. Hatchery-origin fish typically comprise a large fraction of the spawners in natural production areas. Widespread inter-basin stock transfers within the ESU have homogenized many populations. While historical population structure likely included significant genetic differences among populations in each watershed, except for the Clackamas and Sandy rivers in Oregon, we can no longer distinguish genetic differences in natural populations of coho salmon in the lower Columbia River (ODFW 2010; LCFRB 2010).

Abundance and Productivity

Wild coho in the Columbia basin have been in decline for the last 50 years. The number of wild coho returning to the Columbia River historically was at least 600,000 fish (Chapman 1986). At a recent low point in 1996, the total return of wild fish may have been as few as 400 fish. Coinciding with this decline in total abundance has been a reduction in the number of self-sustaining wild populations. Of the 24 historical populations that comprised the LCR coho ESU, only in the case of the Clackamas and Sandy is there direct evidence of persistence during the adverse conditions of the 1990s. Since 2000, the numbers of wild coho have increased in both the Clackamas and Sandy basins. During this same period, naturally reproducing coho populations have become re-established in the Scappoose and Clatskanie basins (ODFW 2010).

Based on the best available data and using a three-year average, the average number of LCR coho salmon spawning in the wild is 32,986 naturally produced fish and 23,082 hatchery produced fish (Table 12).

Table 12. Estimated abundance of adult LCR coho (ODFW 2016a; WDFW 2016b).

Stratum	Population	Years	Hatchery	Natural
Coastal	Grays/Chinook	2010-2012	2,155	445
	Elochoman/Skamokawa	2010-2012	1,185	730
	Mill/Abernathy/Germany	2010-2012	51	340
	Youngs	2010-2012	178	119
	Big Creek	2010-2012	136	283
	Clatskanine	2012-2014	250	1,396
	Scappoose	2010-2012	-	823
Cascade	Lower Cowlitz	2010-2012	711	4,834
	Upper Cowlitz/Cispus	2010-2012	9,543	4,015
	Tilton	2010-2012	4,936	1,418
	South Fork Toutle	2010-2012	296	1,357
	North Fork Toutle	2010-2012	467	360
	Coweeman	2010-2012	225	2,976
	Kalama	2010-2012	367	37
	North Fork Lewis	2010-2012	31	533
	East Fork Lewis	2010-2012	365	2,023
	Salmon Creek	2010-2012	426	1,573
	Washougal	2010-2012	253	629
	Clackamas	2012-2014	666	5,151
	Sandy	2012-2014	97	2,591
Gorge	Lower Gorge	2010-2012	269	882
	Upper Gorge/White Salmon	2011-2013		104
	Hood	2012-2014	477	367
	Total		23,082	32,986

To estimate abundance of juvenile LCR coho salmon, we calculate average abundance of outmigrating smolts for the past five years, using estimates for annual abundance provided by the NWFSC (Table 13; Zabel 2014a, 2014b, 2015, 2017a, 2017b).

Table 13. Average estimated outmigration for listed LCR coho salmon (2013-2017).

Origin	Outmigration
Natural	639,015
Listed hatchery intact adipose	215,952
Listed hatchery adipose clipped	7,424,506

Limiting Factors

The status of LCR coho results from the combined effects of habitat degradation, dam building and operation, fishing, hatchery operations, ecological changes, and natural environmental fluctuations. Habitat for LCR coho has been adversely affected by changes in access, stream flow, water quality, sedimentation, habitat diversity, channel stability, riparian conditions, channel alternations, and floodplain interactions. These large-scale changes have altered habitat conditions and processes important to migratory and resident fish and wildlife. Additionally, habitat conditions have been fundamentally altered throughout the Columbia River basin by the construction and operation of a complex of tributary and mainstem dams and reservoirs for power generation, navigation, and flood control. LCR coho are adversely affected by hydrosystem-related flow and water quality effects, obstructed and/or delayed passage, and ecological changes in impoundments. Dams in many of the larger subbasins have blocked anadromous fishes' access to large areas of productive habitat.

Hatchery programs can harm salmonid viability in several ways: hatchery-induced genetic change can reduce fitness of wild fish; hatchery-induced ecological effects—such as increased competition for food and space—can reduce population productivity and abundance; hatchery imposed environmental changes can reduce a population's spatial structure by limiting access to historical habitat; hatchery-induced disease conveyance can reduce fish health. Practices that introduce native and non-native hatchery fish can increase predation on juvenile life stages. Hatchery practices that affect natural fish production include removal of adults for broodstock, breeding practices, rearing practices, release practices, number of fish released, reduced water quality, and blockage of access to habitat.

The primary fisheries targeting Columbia River hatchery coho salmon occur in West Coast ocean and Columbia River mainstem fisheries. Most of these fisheries have hatchery-selective harvest regulations or time and area strategies to limit impacts to wild coho. The exploitation rate of coho prior to the 1990s fluctuated from approximately 60% to 90% but now the aggregate annual exploitation rate of wild coho is about 20% or less, while the exploitation of hatchery coho is significantly greater because of mark-selective fisheries. It is unclear whether current exploitation rate limitations for wild coho provide adequate protection for the weak populations included in the aggregate. Wild coho are harvested in Washington, Oregon, California, and Canadian Ocean commercial and sport fisheries (about 9% of the total run), and in Columbia River sport, commercial, and treaty Indian fisheries and tributary sport fisheries (about 9% more). Regulations in most fisheries specify the release of all wild (non-fin clipped) coho but some coho are likely retained and others die after release. Fishing-related threats to wild coho salmon escapements include: (1) Ocean and in-river harvest; (2) Release mortalities from hatchery-selective fisheries; and (3) Illegal harvest.

Status Summary

The most serious concern for this ESU is the scarcity of naturally produced spawners and the attendant risks associated with small populations—loss of diversity and fragmentation and isolation among the remaining naturally produced fish. Trap and haul programs have begun to re-introduce coho salmon to many miles of habitat, improving the spatial structure and diversity of the species. Additionally, recent adult returns were up noticeably in some areas, and we have seen evidence for limited natural production in some areas outside the Sandy and Clackamas Rivers. However, more time is needed before we will know if their status will improve.

2.2.1.5 Status of Lower Columbia River Steelhead

Description and Geographic Range

We listed LCR steelhead as threatened on March 19, 1998 (63 FR 13347) and confirmed its threatened status in 2006 (71 FR 834), 2011 (76 FR 50448), and 2016 (79 FR 20802). The DPS is defined as "naturally spawned anadromous *O. mykiss* (steelhead) originating below natural and manmade impassable barriers from rivers between the Cowlitz and Wind Rivers (inclusive) and the Willamette and Hood Rivers (inclusive); excludes such fish originating from the upper Willamette River basin above Willamette Falls." The ESU also includes steelhead from 7 artificial propagation programs (79 FR 20802).

The LCR steelhead DPS includes 30 historical populations in five strata (Table 14). LCR steelhead have both winter and summer runs, and several river basins have both (e.g., Kalama River, Sandy River, Clackamas River, and Hood River). Most steelhead in the Lower Columbia River smolt at two years and spend two years in salt water before re-entering fresh water, where they may remain up to a year before spawning. Juvenile life stages (i.e., eggs, alevins, fry, and parr) inhabit freshwater/riverine areas throughout the range of this listed species. Parr usually undergo a smolt transformation as 2-year-olds, at which time they migrate to the ocean. Subadults and adults forage in coastal and offshore waters of the North Pacific Ocean before returning to spawn in their natal streams.

Table 14. Historical population structure and viability status for LCR steelhead (ODFW 2010; LCFRB 2010).

Stratum (Run)	Population	A&P	Spatial	Diversity
Cascade (Winter)	Lower Cowlitz	L	M	M
	Upper Cowlitz	VL	M	M
	Cispus	VL	M	M
	Tilton	VL	M	M
	South Fork Toutle	M	VH	H
	North Fork Toutle	VL	H	H
	Coweeman	L	VH	VH
	Kalama	L	VH	H
	North Fork Lewis	VL	M	M
	East Fork Lewis	M	VH	M
	Salmon Creek	VL	H	M
	Washougal	L	VH	M
	Clackamas	M	VH	M
	Sandy	L	M	M
Cascade (Summer)	Kalama	H	VH	M
	North Fork Lewis	VL	VL	VL
	East Fork Lewis	VL	VH	M
	Washougal	M	VH	M
Gorge (Winter)	Lower Gorge	L	VH	M
	Upper Gorge	L	M	M
	Hood	M	VH	M
Gorge (Summer)	Wind	VH	VH	H
	Hood	VL	VH	M

Unlike Pacific salmon, steelhead are iteroparous—capable of spawning more than once before death. However, it is rare for steelhead to spawn more than once before dying, and almost all that do so are females (Nickelson et al. 1992). Busby et al. (1996) reviewed data on North American populations, and first time (maiden) spawners comprised 94% of adults in the Columbia River. The majority of repeat spawners are female, presumably due to the extended time and energy males spend on the spawning ground competing for and guarding females and nests.

Spatial Structure and Diversity

For the spatial structure analysis, the Oregon and Washington recovery plans evaluated the proportion of stream miles currently accessible to the species relative to the historical miles accessible (ODFW 2010; LCFRB 2010). The recovery plans adjusted the rating downward if portions of the currently accessible habitat were qualitatively determined to be seriously degraded. The recovery plans also adjusted the rating downward if the portion of historical habitat lost was a key production area.

The Oregon and Washington recovery plans rate spatial structure to be moderate to very high in nearly all populations of LCR steelhead. The populations that rate lowest have fish passage barriers. Trap and haul operations on the Cowlitz River pass adults upriver, but downstream passage and survival of juvenile fish is very low. This problem also affects spatial structure in the Cispus and Tilton populations. Merwin Dam blocks access to most of the available spawning habitat in the North Fork Lewis populations. However, the relicensing agreement for Lewis River hydroelectric projects calls for reintroduction of steelhead. Condit Dam on the White Salmon River blocked access to most of the historical spawning habitat up until the date it was removed in 2011. Thus, the LCR steelhead current spatial structure is less diverse than its historical structure, but management actions are underway to improve the situation.

The Oregon and Washington recovery plans (ODFW 2010; LCFRB 2010) rate diversity to be moderate to high in all but one population (Table 14). One of the leading factors affecting the diversity of this DPS is the loss of habitat associated with construction of dams. As described above, many of the historical populations were affected by dams built 60 to 90 years ago in upper tributaries.

Artificial propagation has been identified as another major factor affecting diversity of LCR steelhead. For many basins, the number of stocks planted, the size and frequency of annual releases, and the percentage of smolts released changed a great deal between the time periods before and after 1985. At present, fewer stocks are used, fewer hatchery fish are released, and a higher percentage of the fish that are released are ready to quickly migrate to the ocean. This change came about in response to the development of wild fish policies in Oregon and Washington. In Washington, the development and implementation (in 1991) of a new stock transfer policy (WDF 1991) designed to foster local brood stocks resulted in a substantial reduction in the transfer of eggs and juveniles between watersheds. The policy mandates that hatchery programs use local brood stocks in rivers with extant indigenous stocks.

Abundance and Productivity

Since the last status evaluation, all populations increased in abundance during the early 2000s, generally peaking in 2004. Abundance of most populations has since declined back to levels close to the long-term mean. Exceptions are the Washougal summer and North Fork Toutle winter populations, for which abundance is higher than the long-term average, and the Sandy, for which abundance is below the long-term average. The North Fork Toutle winter steelhead population appears to be experiencing an increasing trend dating back to 1990, which is likely partially the result of recovery of habitat since the eruption of Mt. St. Helens in 1980. In general, the LCR steelhead populations do not show any sustained, dramatic changes in abundance since the previous status review (Ford et al. 2010).

The recovery plans identified 16 populations as currently at low to very low viability and five with moderate viability. The Wind River and Kalama River summer-run populations are the only ones that rated high to very high for abundance and productivity. The Oregon and Washington recovery plans (ODFW 2010; LCFRB 2010) developed planning ranges for abundance of viable LCR steelhead populations (Table 15). Some abundance goals were not set; the range of abundance is from 322 in the Upper Gorge to 10,655 in the Clackamas. The viability ratings are based on long-term trends whereas recent abundance estimates show a slightly different picture (Table 18). Several populations appear to be approaching the abundance targets, and one (the E.F. Lewis) exceeded it.

Table 15. Abundance estimates for adult LCR steelhead populations (Streamnet 2016; WDFW 2016a; ODFW 2016a).

Stratum (Run)	Population	Years	Total	HOR(1)	NOR(2)	Recovery Target(3)
Cascade (Winter)	Lower Cowlitz	2009	4,559	4559		
	Upper Cowlitz/Cispus	2010-2014	489	51	438	500
	Tilton	2010-2013	279	0	279	200
	South Fork Toutle	2010-2014	508	7	501	500
	North Fork Toutle	2010-2014	507	121	387	600
	Coweeman	2010-2014	462	166	296	600
	Kalama	2011-2015	930	455	475	600
	North Fork Lewis	2007-2011	2,355	2,126	129	400
	East Fork Lewis	2010-2014	364	0	364	500
	Washougal	2010-2014	362	195	167	350
	Clackamas	2014-2015	5,483	1,876	3,607	10,655
	Sandy	2013-2015	4,094	284	3,810	1,510
Cascade (Summer)	Kalama	2011-2015	626	499	127	500
	North Fork Lewis	2009	10,508	10,508		
	East Fork Lewis	2011-2015	928	168	760	500
	Washougal	2012-2015	723	621	102	500
Gorge (Winter)	Upper Gorge	2010-2014	36		36	322
	Hood	2003-2007	818	380	438	1,633
Gorge (Summer)	Wind	2010-2014	805	42	763	1,000
	Hood	2003-2007	480	239	241	1,988
Total			35,316	22,297	12,920	

(1) Hatchery Origin (HOR) spawners.
(2) Natural Origin (NOR) spawners.

Availability of data for abundance of naturally spawning adult steelhead is highly variable (Table 15). The years of record vary considerably for each population and for some populations we could only find one data year. Based on the best available data, the estimated spawning population of LCR steelhead is 22,297 hatchery origin and 12,920 natural origin adult spawners.

To estimate abundance of juvenile LCR steelhead, we calculate average abundance of outmigrating smolts for the past five years, using estimates for annual abundance provided by the NWFSC (Table 16; Zabel 2014a, 2014b, 2015, 2017a, 2017b).

Table 16. Average estimated outmigration for listed LCR steelhead (2013-2017).

Origin	Outmigration
Natural	323,607
Listed hatchery intact adipose	22,649
Listed hatchery adipose clipped	1,194,301

Limiting Factors

The status of lower Columbia River steelhead results from the combined effects of habitat degradation, dam building and operation, fishing, hatchery operations, ecological changes, and natural environmental fluctuations. Habitat for LCR steelhead has been adversely affected by changes in access, stream flow, water quality, sedimentation, habitat diversity, channel stability, riparian conditions, channel alternations, and floodplain interactions. These large-scale changes have altered habitat conditions and processes important to migratory and resident fish and wildlife. Additionally, habitat conditions have been fundamentally altered throughout the Columbia River basin by the construction and operation of a complex of tributary and mainstem dams and reservoirs for power generation, navigation, and flood control. Lower Columbia steelhead are adversely affected by hydrosystem-related flow and water quality effects, obstructed and/or delayed passage, and ecological changes in impoundments. Dams in many of the larger subbasins have blocked anadromous fishes' access to large areas of productive habitat.

Fishery impacts on wild summer steelhead are currently limited to incidental mortality in freshwater fisheries. Populations above Bonneville are also subject to treaty tribal subsistence and commercial fisheries. Interception of steelhead in ocean salmon fisheries is rare. Fishing rates on wild steelhead have been reduced from their historical peaks in the 1960s by over 90% following prohibition of commercial steelhead harvest in the mainstem (except the mainstem above Bonneville) and hatchery-only retention regulations for recreational fisheries. Wild steelhead mortality is incidental (less than 10% of the wild run). Ongoing threats to wild steelhead populations from fishing include illegal harvest and the incidental mortality from fisheries targeting hatchery fish and other species.

Hatchery programs can harm salmonid viability in several ways: hatchery-induced genetic change can reduce fitness of wild fish; hatchery-induced ecological effects—such as increased competition for food and space—can reduce population productivity and abundance; hatchery imposed environmental changes can reduce a population's spatial structure by limiting access to historical habitat; hatchery-induced disease conveyance can reduce fish health. Practices that introduce native and non-native hatchery fish can increase predation on juvenile life stages. Hatchery practices that affect natural fish production include removal of adults for broodstock, breeding practices, rearing practices, release practices, number of fish released, reduced water quality, and blockage of access to habitat.

Status Summary

Most LCR steelhead populations are at relatively low abundance, and those with enough data to be modeled are estimated to have a relatively high extinction probability. The WLC-TRT described two historical populations as either extinct or at very high risk; most other populations are at high risk. The hatchery contribution to natural spawning remains high in many populations. Some populations, particularly summer run, have shown higher returns in recent years. Additionally, trap and haul programs are re-introducing steelhead to many miles of habitat improving the spatial structure and diversity of the species. However, more time is needed before we will know if their status will improve.

2.2.1.6 Status of Upper Willamette River Steelhead

Description and Geographic Range

We listed the UWR steelhead DPS as threatened on August 18, 1997 (62 FR 43937) and confirmed its threatened status in 2006 (71 FR 834) and 2011 (76 FR 50448). We define the DPS as "naturally spawned anadromous winter-run *O. mykiss* (steelhead) originating below natural and manmade impassable barriers from the Willamette River and its tributaries upstream of Willamette Falls to and including the Calapooia River." No artificially propagated stocks are considered part of the listed species. The hatchery summer-run steelhead in the basin are an out-of-basin stock and not considered part of the DPS.

UWR steelhead are late-migrating winter steelhead, entering fresh water primarily in January through April (ODFW 2011). This atypical run timing appears to be an adaptation for ascending Willamette Falls, which functioned as an isolating mechanism for the UWR basin before a fish ladder was built. Reproductive isolation resulting from passing above the falls may explain the genetic distinction between steelhead from the UWR and those in the lower river. A resident form of O. mykiss co-occurs with the anadromous form and juvenile life stages of the two forms can be very difficult to differentiate.

There are four demographically independent populations of steelhead: Molalla, North Santiam, South Santiam, and Calapooia (Table 17; ODFW 2011). Winter steelhead have been reported spawning in the west-side tributaries to the Willamette River, but these tributaries were not considered to have constituted an independent population historically and may serve as a population sink for the DPS (Myers et al. 2006). A naturally reproducing population of UWR steelhead became established in the Middle Fork Willamette in the 1950's following introductions of hatchery fish produced from the North Santiam. It is generally agreed, however, that steelhead historically did not emigrate farther upstream than the Calapooia River (Dimick and Merryfield 1945; Fulton 1970) and these fish are not included in the DPS.

Spawning and juvenile rearing occurs throughout the range of the listed species. Parr usually smolt and then migrate to the ocean as 2-year-olds. Subadults and adults forage in coastal and offshore waters of the North Pacific Ocean before returning to spawn in natal streams. The UWR steelhead are an ocean-maturing fish with most adults first returning to spawn at age 4 and a small proportion first returning at age 5.

Unlike Pacific salmon, steelhead are iteroparous, meaning they can spawn more than once, although repeat-spawning is uncommon. In a meta-analysis, Busby et al. (1996) found that first-time spawners comprised 94% of adults in the Columbia River. Most repeat-spawners are female (Nickelson et al. 1992), presumably due to the extended time and energy males spend on the spawning ground competing for and guarding females and nests.

Table 17. Historical population structure and viability status for UWR steelhead (ODFW 2011).

Population	Viability Status		
	A&P	Spatial	Diversity
Molalla	M	M	M
N. Santiam	H	L	M
S. Santiam	H	M	M
Calapooia	M	VL	M

Spatial Structure and Diversity

Spatial structure is rated as low to very low for the North Santiam and Calapooia populations, and moderate for the Molalla and South Santiam populations (Table 17). The low ratings are due to fish passage barriers, stream channel modifications, and poor water quality. Diversity for UWR steelhead populations is rated as very low, principally due to loss of habitat associated with dams. Artificial propagation is another major factor affecting diversity of UWR steelhead. Although releases of summer steelhead have been reduced and releases of non-listed early winter-run steelhead have been discontinued, hatchery effects continue to be a threat because summer and early winter-run steelhead, and natural production deriving from them, still interact negatively with the late-run winter fish. (ODFW 2010; Table 17).

Abundance and Productivity

ODFW counts adult winter steelhead at the Willamette Falls fish ladder from November 1 – May 31. Most UWR winter steelhead return to freshwater in January through April, pass Willamette Falls from mid-February to mid-May, and spawn in March through June. Abundance of natural origin winter steelhead in the UWR has fluctuated significantly for decades, with a range of 1,801 to 26,647 fish counted annually between 1971 and 2016. In 2016-2017, adult abundance was only 822, which is the lowest number recorded since comparable fish counts started in 1971. The most recent five-year average (2013-2017) for adult winter steelhead passing Willamette Falls is 4,280 adults (Table 18). This is comparable to historically low counts during the 1990s, where the five-year average (1995-2000) ranged from 3981 to 4337 fish.

Table 18. UWR winter-run steelhead abundance (ODFW 2017).

Year	Natural-origin Spawners
2012-2013	4,944
2013-2014	5,349
2014-2015	4,508
2015-2016	5778
2016-2017	822
Average	4,280

In 2011, UWR steelhead populations were considered to have moderate to high viability potential; however, there was considerable uncertainty in these ratings (ODFW 2011). Sharp decreases in abundance since 2011 have most certainly decreased viability status.

To estimate abundance of juvenile UWR steelhead, we calculate average abundance of outmigrating smolts for the past five years, using estimates for annual abundance provided by the NWFSC (Table 19; Zabel 2014a, 2014b, 2015, 2017a, 2017b).

Table 19. Average estimated outmigration for listed UWR steelhead (2013-2017).

Origin	Outmigration
Natural	143,898
Listed hatchery intact adipose	0
Listed hatchery adipose clipped	0

Limiting Factors

Limiting factors for UWR steelhead include habitat access, physical habitat quality and quantity, water quality, competition, disease, predation, effects from non-native plants and animals, and maladapted population traits (ODFW 2011). Primary threats include hydropower operations, land use practices (e.g., road building, riparian development), hatchery operations, and interactions with other species. Ocean harvest is not a limiting factor; steelhead are not intercepted in ocean fisheries to a measurable degree and the current exploitation rate on wild steelhead from sport fisheries is 3% (ODFW 2011).

Legacy effects from past land use practices, including agriculture, timber harvest, mining and grazing activities, diking, damming, development of transportation, and urbanization, limit viability of UWR steelhead (ODFW 2011). These past land management activities have blocked access to historically productive habitats and reduced the quality of remaining habitat areas. Hydrosystem operations, river channel alteration from diking and dredging, floodplain development, and water withdrawals for municipal and agricultural uses have combined to severely degrade juvenile rearing habitat for UWR steelhead in the lower Columbia mainstem and estuary (LCFRB 2004). In the estuary, habitat modification has led to increased predation on

UWR steelhead by Caspian terns, double-crested cormorants, and a variety of gull species (LCREP 2006; Fresh et al. 2005).

In the lower Willamette River mainstem, high-density urban development and widespread agricultural effects have decreased aquatic habitat through impacts to riparian habitat, water quality, stream flows, and sediment budgets. In the upper Willamette River mainstem and tributaries, forest practices, roads, and fish barriers have affected habitat for UWR steelhead. Past and current land use practices affect fundamental watershed processes that regulate stream channel morphology, including riparian and floodplain connectivity. In many areas, flood control/hydropower structures have created new baseline conditions for the river ecosystem, upon which subsequent habitat alterations have occurred.

There are no hatchery programs for winter-run steelhead in the Upper Willamette subbasin. Non-native summer steelhead are raised at most of the rearing facilities in the upper Willamette River subbasins, and released as smolts in the North and South Santiam, McKenzie and Middle Fork Willamette subbasins. Differences in spawn timing among these stocks may limit, but not eliminate, the potential for interbreeding. Negative effects from large numbers of out-of-ESU steelhead include effects on genetic diversity as well as ecological impacts (Kostow 2009). Kostow and Zhou (2006) suggested that adult hatchery summer steelhead may have a competitive advantage in occupying choice feeding territories, because they typically spawn and emerge earlier than do wild winter steelhead. In addition, large hatchery releases can result in density-dependent mortality of wild fish.

Status Summary

All four UWR steelhead populations are at low abundance. Although hatchery production has been reduced or eliminated, effects on natural spawning remain high. No single population has been identified as naturally self-sustaining. Dams have substantially affected the Santiam populations' spatial structure and habitat and have most likely had a negative effect on the DPS as a whole. NMFS' Willamette Project biological opinion addresses fish passage and water temperature. Efforts to make the dams more fish-friendly and to improve river water temperatures should lead to improved habitat access and quality.

2.2.1.7 Status of Southern Eulachon

Description and Geographic Range

We listed the southern Distinct Population Segment (DPS) of Pacific eulachon (hereafter, "eulachon") as a threatened on March 16, 2010 (75 FR 13012) and confirmed its status as threatened in 2016 (81 FR 33468). We define the DPS as "eulachon originating from the Skeena River in British Columbia south to and including the Mad River in northern California (79 FR 20802).

In May of 2011, the Committee on the Status for Endangered Wildlife in Canada (COSEWIC) released their assessment and status report for eulachon in Canada. COSEWIC divided the Canadian portion of the US designated Southern DPS into three designatable units (DUs) – Nass/Skeena Rivers population, Central Pacific Coast population, and Fraser River population (COSEWIC 2011a). DUs are discrete evolutionarily significant units, where “significant” means that the unit is important to the evolutionary legacy of the species as a whole and if lost would likely not be replaced through natural dispersion (COSEWIC 2009). Thus, DUs are biologically similar to ESU and DPS designations under the ESA. The Fraser River population (the closest Canadian population to the conterminous U.S.) was assessed as endangered by COSEWIC, and the listing decision for the Species at Risk Act (SARA) registry is currently scheduled for 2014 or later (COSEWIC 2011b).

Eulachon are endemic to the northeastern Pacific Ocean; they range from northern California to southwest and south-central Alaska and into the southeastern Bering Sea. Puget Sound lies between two of the larger eulachon spawning rivers (the Columbia and Fraser rivers) but lacks a regular eulachon run of its own (Gustafson et al. 2010). Within the conterminous U.S., most eulachon production originates in the Columbia River basin and the major and most consistent spawning runs return to the Columbia River mainstem and Cowlitz River. Adult eulachon have been found at several Washington and Oregon coastal locations, and they were previously common in Oregon’s Umpqua River and the Klamath River in northern California. Runs occasionally occur in many other rivers and streams but often erratically, appearing in some years but not in others and only rarely in some river systems (Hay and McCarter 2000, Willson et al. 2006, Gustafson et al. 2010). Since 2005, eulachon in spawning condition have been observed nearly every year in the Elwha River by Lower Elwha Tribe Fishery Biologists (Lower Elwha Tribe, 2011). The Elwha is the only river in the United States’ portion of Puget Sound and the Strait of Juan de Fuca that supports a consistent eulachon run.

Eulachon generally spawn in rivers fed by either glaciers or snowpack and that experience spring freshets. Since these freshets rapidly move eulachon eggs and larvae to estuaries, it is believed that eulachon imprint and home to an estuary into which several rivers drain rather than individual spawning rivers (Hay and McCarter 2000). From December to May, eulachon typically enter the Columbia River system with peak entry and spawning during February and March (Gustafson et al. 2010). They spawn in the lower Columbia River mainstem and multiple tributaries of the lower Columbia River.

Eulachon eggs, averaging 1 mm in size, are commonly found attached to sand or pea-sized gravel, though eggs have been found on a variety of substrates, including silt, gravel-to-cobble sized rock, and organic detritus (Smith and Saalfeld 1955, Langer et al. 1977, Lewis et al. 2002). Eggs found in areas of silt or organic debris reportedly suffer much higher mortality than those found in sand or gravel (Langer et al. 1977). Length of incubation ranges from about 28 days in 4°-5° C waters to 21-25 days in 8° C waters. Upon hatching, stream currents rapidly carry the newly hatched larvae, 4-8 mm in length, to the sea. Young larvae are first found in the estuaries of known spawning rivers and then disperse along the coast. After yolk sac depletion, eulachon larvae acquire characteristics to survive in oceanic conditions and move off into open marine environments as juveniles. Eulachon return to their spawning river at ages ranging from two to five years as a single age class. Prior to entering their spawning rivers, eulachon hold in brackish waters while their bodies undergo physiological changes in preparation for fresh water and to synchronize their runs. Eulachon then enter the rivers, move upstream, spawn, and die to complete their semelparous life cycle (COSEWIC 2011a).

Adult eulachon weigh an average of 40 g each and are 15 to 20 cm long with a maximum recorded length of 30 cm. They are an important link in the food chain between zooplankton and larger organisms. Small salmon, lingcod, white sturgeon, and other fish feed on small larvae near river mouths. As eulachon mature, a wide variety of predators consume them (Gustafson et al. 2010).

On September 6, 2017, we published the final recovery plan for eulachon (NMFS 2017).

Spatial Structure and Diversity

There are no distinct differences among eulachon throughout the range of the southern DPS. However, the eulachon Biological Review Team (BRT) did separate the DPS into four subpopulations in order to rank threats they face. These are the Klamath River (including the Mad River and Redwood Creek), the Columbia River (including all of its tributaries), the Fraser River, and the BC coastal rivers (north of the Fraser River up to, and including, the Skeena River). Eulachon population structure has not been analyzed below the DPS level. The COSEWIC assessed eulachon populations in Canada and designated them with the following statuses: Nass/Skeena Rivers population (threatened), Central Pacific population (endangered), and Fraser River population (endangered) (COSEWIC 2011a).

Eulachon of the southern DPS are distinguished from eulachon occurring north of the DPS range by a number of factors including genetic characteristics. Significant microsatellite DNA variation in eulachon has been reported from the Columbia River to Cook Inlet, Alaska (Beacham et al. 2005). Within the range of the southern DPS, Beacham et al. (2005) found genetic affinities among the populations in the Fraser, Columbia, and Cowlitz rivers and also among the Kemano, Klinaklini, and Bella Coola rivers along the central British Columbia coast. In particular, there was evidence of a genetic discontinuity north of the Fraser River, with Fraser and Columbia/Cowlitz samples diverging three to six times more from samples further to the north than they did from each other. Similar to the study of McLean et al. (1999), Beacham et al. (2005) found that genetic differentiation among populations was correlated with geographic distances. The authors also suggested that the pattern of eulachon differentiation was similar to that typically found in studies of marine fish, but less than that observed in most salmon species.

The BRT was concerned about risks to eulachon diversity due to its semelparity (spawn once and die) and data suggesting that Columbia and Fraser River spawning stocks may be limited to a single age class. These characteristics likely increase their vulnerability to environmental catastrophes and perturbations and provide less of a buffer against year-class failure than species such as herring that spawn repeatedly and have variable ages at maturity (Gustafson et al. 2010).

Abundance and Productivity

Eulachon are a short-lived, high-fecundity, high-mortality forage fish; and such species typically have extremely large population sizes. Fecundity estimates range from 7,000 to 60,000 eggs per female with egg to larva survival likely less than 1% (Gustafson et al. 2010). Among such marine species, high fecundity and mortality conditions may lead to random “sweepstake recruitment” events where only a small minority of spawning individuals contribute to subsequent generations (Hedgecock 1994).

Prior to 2011, few direct estimates of eulachon abundance existed. Escapement counts and spawning stock biomass estimates are only available for a small number of systems. Catch statistics from commercial and First Nations fisheries are available for some systems in which no direct estimates of abundance are available. However, inferring population status or even trends from yearly catch statistic changes requires making certain assumptions that are difficult to corroborate (e.g., assuming that harvest effort and efficiency are similar from year to year, assuming a consistent relationship among the harvested and total stock portion, and certain statistical assumptions, such as random sampling). Unfortunately, these assumptions cannot be verified, few fishery-independent sources of eulachon abundance data exist, and in the United States, eulachon monitoring programs just started in 2011. However, the combination of catch records and anecdotal information indicates that there were large eulachon runs in the past and that eulachon populations have severely declined (Gustafson et al. 2010). As a result, eulachon numbers are at, or near, historically low levels throughout the range of the southern DPS.

Similar abundance declines have occurred in the Fraser and other coastal British Columbia rivers (Hay and McCarter 2000, Moody 2008). Over a three-generation time of 10 years (1999-2009), the overall Fraser River eulachon population biomass has declined by nearly 97% (Gustafson et al. 2010). In 1999, the biomass estimates were 418 metric tons[2]; and by 2010, had dropped to just 4 metric tons (Table 20). Abundance information is lacking for many coastal British Columbia subpopulations, but Gustafson et al. (2010) found that eulachon runs were universally larger in the past. Furthermore, the BRT was concerned that four out of seven coastal British Columbia subpopulations may be at risk of extirpation as a result of small population concerns such as Allee[3] effects and random genetic and demographic effects (Gustafson et al. 2010). Under SARA, Canada designated the Fraser River population as endangered in May 2011 due to a 98% decline in spawning stock biomass over the previous 10 years (COSEWIC 2011a). From 2013 through 2017, the Fraser River eulachon spawner population estimate is 1,968,688 adults (Table 20).

[2] The U.S. ton is equivalent to 2,000 pounds and the metric ton is equivalent to 2,204 pounds.

[3] The negative population growth observed at low population densities. Reproduction—finding a mate in particular— for migratory species can be increasingly difficult as the population density decreases.

Table 20. Southern DPS eulachon spawning estimates for the lower Fraser River, British Columbia (data from http://www.pac.dfo-mpo.gc.ca/science/species-especes/pelagic-pelagique/herring-hareng/herspawn/pages/river1-eng.html).

Year	Biomass estimate (metric tons)	Estimated spawner population[a]
2008	10	246,918
2009	14	345,685
2010	4	98,767
2011	31	765,445
2012	120	2,963,013
2013	100	2,469,177
2014	66	1,629,657
2015	317	7,827,292
2016	44	1,086,438
2017	35	864,211
2013-2017[b]	**80**	**1,968,688**

[a] Estimated population numbers are calculated as 11.2 eulachon per pound.
[b] Five-year geometric mean of eulachon biomass estimates (2013-2017).

The Columbia River and its tributaries support the largest known eulachon run. Although direct estimates of adult spawning stock abundance are limited, commercial fishery landing records begin in 1888 and continue as a nearly uninterrupted data set to 2010 (Gustafson et al. 2010). From about 1915 to 1992, historic commercial catch levels were typically more than 500 metric tons, occasionally exceeding 1,000 metric tons. In 1993, eulachon catch levels began to decline and averaged less than five metric tons from 2005-2008 (Gustafson et al. 2010). Persistent low eulachon returns and landings in the Columbia River from 1993 to 2000 prompted the states of Oregon and Washington to adopt a Joint State Eulachon Management Plan (WDFW and ODFW 2001). From 2011 through 2013, all recreational and commercial fisheries for eulachon were closed in Washington and Oregon; but the fisheries were reopened in 2014. Beginning in 2011, ODFW and Washington Department of Fish and Wildlife (WDFW) began eulachon biomass surveys similar to those conducted on the Fraser River. From 2013 through 2015, eulachon abundance increased with a peak of over 84.2 million eulachon spawners in 2014. Since that 2014 peak, eulachon numbers have decreased annually with the lowest spawner run total, since the surveys began in 2011, of 8.15 million in 2017 (Langness 2017). From 2013 through 2017, the estimated eulachon spawner estimate for the Columbia River and its tributaries is 75,629,327 eulachon spawning adults (Table 21).

Table 21. Annual Columbia River eulachon run size 2000-2017; pounds converted to numbers of fish at 11.16 fish/pound (WDFW and ODFW 2016). The estimates were calculated based on methods developed by Parker (1985), Jackson and Cheng (2001), and Hay et al. (2002) to estimate spawning biomass of pelagic fishes. For 2000 through 2010 estimates were back-calculated using historical larval density data.

Year	Maximum Estimates	Mean Estimates	Minimum Estimates
2000	8,971,500	5,421,500	3,205,200
2001	128,960,500	77,512,900	35,121,600
2002	76,645,800	59,114,500	42,541,900
2003	99,395,400	64,670,000	45,137,700
2004	—	—	—
2005	1,450,800	783,400	226,500
2006	3,527,700	1,233,200	387,300
2007	3,272,100	1,605,900	863,800
2008	6,510,700	2,418,400	713,100
2009	10,034,000	4,873,600	1,984,200
2010	4,281,000	1,759,900	612,700
2011	69,661,800	36,775,900	17,860,400
2012	61,437,400	35,722,100	20,008,600
2013	197,943,400	107,794,900	45,546,700
2014	323,778,300	185,965,200	84,243,100
2015	207,570,500	123,582,000	57,525,700
2016	111,991,000	54,556,500	21,654,800
2017	34,071,100	18,307,100	8,148,600
2013-2017[a]	138,390,008	75,629,327	32,968,415

[a] Five-year geometric mean of eulachon biomass estimates (2013-2017).

In Northern California, no long-term eulachon monitoring programs exist. In the Klamath River, large eulachon spawning aggregations once regularly occurred but eulachon abundance has declined substantially (Fry 1979, Moyle et al. 1995, Larson and Belchik 1998, Hamilton et al. 2005). Recent reports from Yurok Tribal fisheries biologists mentioned only a few eulachon captured incidentally in other fisheries.

Beacham et al. (2005) reported that marine sampling by trawl showed that eulachon from different rivers mix during their 2 to 3 years of pre-spawning life in offshore marine waters, but not thoroughly. Their samples from southern British Columbia comprised a mix of fish from multiple rivers, but were dominated by fish from the Columbia and Fraser River populations. The combined estimate from the Columbia and Fraser rivers is 77.60 million eulachon.

Limiting Factors

Climate change impacts on ocean habitat are the most serious threat to persistence of the southern DPS of eulachon (Gustafson et al. 2010), thus it will be discussed in greater detail in this section. Scientific evidence strongly suggests that global climate change is already altering marine ecosystems from the tropics to polar seas. Physical changes associated with warming include increases in ocean temperature, increased stratification of the water column, and changes in the intensity and timing of coastal upwelling. These changes will alter primary and secondary productivity and the structure of marine communities (ISAB 2007).

Although the precise changes in ocean conditions cannot be predicted they present a potentially severe threat to eulachon survival and recovery. Increases in ocean temperatures have already occurred and will likely continue to impact eulachon and their habitats. In the marine environment, eulachon rely upon cool or cold ocean regions and the pelagic invertebrate communities therein (Willson et al. 2006). Warming ocean temperatures will likely alter these communities, making it more difficult for eulachon and their larvae to locate or capture prey (Roemmich and McGowan 1995, Zamon and Welch 2005). Warmer waters could also allow for the northward expansion of eulachon predator and competitor ranges, increasing the already high predation pressure on the species (Rexstad and Pikitch 1986, McFarlane et al. 2000, Phillips et al. 2007).

Climate change along the entire Pacific Coast is expected to affect fresh water as well. Changes in hydrologic patterns may pose challenges to eulachon spawning because of decreased snowpack, increased peak flows, decreased base flow, changes in the timing and intensity of stream flows, and increased water temperatures (Morrison et al. 2002). In most rivers, eulachon typically spawn well before the spring freshet, near the seasonal flow minimum. This strategy typically results in egg hatch coinciding with peak spring river discharge. The expected alteration in stream flow timing may cause eulachon to spawn earlier or be flushed out of spawning rivers at an earlier date. Early emigration may result in a mismatch between entry of larval eulachon into the ocean and coastal upwelling, which could have a negative impact on marine survival of eulachon during this critical transition period (Gustafson et al. 2010).

In the past, commercial and recreational harvests likely contributed to eulachon decline. The best available information for catches comes from the Columbia River, where from 1938 to 1993 landings have averaged almost 2 million pounds per year (approximately 24.6 million fish), and have been as high as 5.7 million pounds in a single year (approximately 70 million fish) (Wydoski and Whitney 2003, Gustafson et al. 2010). Between 1994 and 2010, no catch exceeded one million pounds (approximately 12.3 million fish) annually and the median catch was approximately 43,000 pounds (approximately 529,000 fish), which amounts to a 97.7% reduction in catch (WDFW and ODFW 2001, JCRMS 2011). Catch from recreational eulachon fisheries was also high historically (Wydoski and Whitney 2003); and at its height in popularity, the fishery would draw thousands of participants annually. Currently, commercial and recreational harvest of eulachon is prohibited in both Washington and Oregon.

In British Columbia, the Fraser River supports the only commercial eulachon fishery that is within the range of the southern DPS. This fishery has been essentially closed since 1997, only opening briefly in 2002 and 2004 when only minor catches were landed (DFO 2008).

Historically, bycatch of eulachon in the pink shrimp fishery along the U.S. and Canadian coasts has been very high (composing up to 28% of the total catch by weight; Hay and McCarter 2000, DFO 2008). Prior to the mandated use of bycatch-reduction devices (BRDs) in the pink shrimp fishery, 32–61% of the total catch in the pink shrimp fishery consisted of non-shrimp biomass, made up mostly of Pacific hake, various species of smelt including Pacific eulachon, yellowtail rockfish, sablefish, and lingcod (*Ophiodon elongatus*) (Hannah and Jones 2007). Reducing bycatch in this fishery has long been an active field of research (Hannah et al. 2003, Hannah and Jones 2007, Frimodig 2008) and great progress has been made in reducing bycatch. As of 2005, following required implementation of BRDs, the total bycatch by weight had been reduced to about 7.5% of the total catch and osmerid smelt bycatch was reduced to an estimated average of 0.73% of the total catch across all BRD types (Hannah and Jones 2007). Despite this reduction, bycatch of eulachon in these fisheries is still significant. The total estimated bycatch of eulachon in the Oregon and California pink shrimp fisheries ranged from 217,841 fish in 2004 to 1,008,260 fish in 2010 (the most recent year that data is available; Al-Humaidhi et al. 2012).

Hydroelectric dams block access to historical eulachon spawning grounds and affect the quality of spawning substrates through flow management, altered delivery of coarse sediments, and siltation. Dredging activities during the eulachon spawning run may entrain and kill adult and larval fish and eggs. Eulachon carry high levels of pollutants – arsenic, lead, mercury, DDE, 9H-Fluorene, Phenanthrene (EPA 2002), and although it has not been demonstrated that high contaminant loads in eulachon have increased mortality or reduced reproductive success, such effects have been shown in other fish species (Kime 1995). The negative effects of these factors on the species and its habitat contributed to the determination to list the southern DPS of Pacific eulachon under the ESA.

Status Summary

Adult spawning abundance of the southern DPS of eulachon has clearly increased since the listing occurred in 2010 (Gustafson et al. 2016). The improvement in estimated abundance in the Columbia River, relative to the time of listing, reflects both changes in biological status and improved monitoring. The documentation of eulachon returning to the Naselle, Chehalis, Elwha, and Klamath rivers over the 2011–2015 also likely reflects both changes in biological status and improved monitoring. The Biological Review Team (BRT) concluded that, starting in 1994, the southern DPS of eulachon experienced an abrupt decline in abundance throughout its range (Gustafson et al. 2010). Although eulachon abundance in monitored rivers improved in the 2013–2015 return years, recent conditions in the northeast Pacific Ocean are likely linked to the sharp declines in eulachon abundance in monitored rivers in 2016 and 2017. The likelihood that these poor ocean conditions will persist into the near future suggest that subpopulation declines may again be widespread in the upcoming return years (NMFS 2017).[4] Since the 2014 eulachon

[4] National Marine Fisheries Service. September 2017. Recovery Plan for the Southern Distinct Population Segment of Eulachon (*Thaleichthys pacificus*). National Marine Fisheries Service, West Coast Region, Protected Resources Division, Portland, OR, 97232.

spawner peak, eulachon runs have decreased each year with the 2017 Columbia River run being the smallest since the eulachon surveys began in 2011 (pers. comm., R. Gustafson, June 8, 2017).

2.2.1.8 Status of S Green Sturgeon

Description and Geographic Range

We listed the southern DPS of North American green sturgeon (S green sturgeon) as a threatened species on April 7, 2006 (71 FR 17757). The DPS consists of coastal and Central Valley populations south of the Eel River (exclusive). The only known spawning population is in the Sacramento River.

S green sturgeon, like all sturgeon, is a long-lived, slow-growing species. Mature females produce 60,000-140,000 eggs. The larvae of green sturgeon differ from other sturgeon in that they lack a distinct swim-up or post-hatching stage. Larvae grow fast and metamorphosis to juveniles is complete at 45 days. Both larvae and juveniles are nocturnal. Juveniles appear to spend one to three years in freshwater before they enter the ocean (NMFS 2005a). In the Klamath River, Nakamoto et al. (1995) found a lack of females from ages 3 to 13 and males from ages 3 to 9 suggesting an entirely marine existence during those ages. S green sturgeon disperse widely in the ocean between their freshwater life stages. Green sturgeon reach maturity at 14 years for males and 16 years for females (Van Eenennaam et al. 2006) with maximum ages of 60 to 70 years or longer (Moyle 2002). Adults typically migrate into fresh water beginning in late February and spawn from March to July. Mature females return every two to four years to spawn (Erickson and Webb 2007).

Lindley et al. (2008) found that green sturgeon make rapid, long distance season migrations along the continental shelf of North America from central California to central British Columbia. S green sturgeon have been observed near Vancouver Island (NMFS 2005a).

In stock assessments by Israel et al. (2009) approximately 70% to 90% of green sturgeon in the Columbia River estuary and Willapa Bay were assigned to the southern DPS, and about 40% of green sturgeon in Grays Harbor were assigned to the southern DPS (Israel et al. 2009).

In the fall, green sturgeon move northward to or past the northern end of Vancouver Island, stay there for the winter, and then return southward during the spring. In an acoustic transmitter study, Moser and Lindley (2007) found that green sturgeon were routinely detected in Willapa Bay during the summer when estuarine water temperatures were greater than the coastal temperatures. However, green sturgeon were not detected in Willapa Bay during the winter when temperatures were below 10° C.

Spatial Structure and Diversity

Green sturgeon are composed of two DPS 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. Historic spawning grounds were blocked by the construction of Shasta Dam (1938-1945) and Keswick Dam (1941-1950) on the Sacramento River and Oroville Dam (1961-1968) on the Feather River. Spawning grounds became limited to an area downstream of Shasta Dam that was impacted by high temperatures until the construction of a temperature control device in Shasta Dam in 1997 (Adams et al. 2007).

The CDFG reported that Oroville Dam limits access to potential spawning habitat, and warm water releases from the Thermalito Afterbay reservoir may increase temperatures to levels unsuitable for green sturgeon spawning and incubation in the Feather River (CDFG 2002). Adult green sturgeons have also been captured in the San Joaquin River delta (Adams et al. 2002). Moyle et al. (1992) suggested that green sturgeon presence in the delta is evidence that green sturgeon are spawning in the San Joaquin River. But, there are no documented observations of green sturgeon in the San Joaquin River upstream of the delta.

Diversity in sturgeon populations can range in scale from genetic differences within and among populations to complex life-history traits. One of the leading factors affecting the diversity of green sturgeon is the loss of habitat due to impassable barriers such as dams. As described above, several tributaries to the Sacramento River have been blocked and have therefore almost certainly reduced the DPS's diversity. Although this DPS migrates over long distances, its spawning locations are small and have been greatly affected by human activities.

Abundance and Productivity

Since 2006, research conducted and published has enhanced the understanding of Southern green sturgeon biology and life history, including reproductive characteristics (NMFS 2015). Southern green sturgeon typically spawn every three to four years (range two to six years) and primarily in the Sacramento River (Brown 2007; Poytress et al. 2012). Adult Southern green sturgeon enter San Francisco Bay in late winter through early spring and spawn from April through early July, with peaks of activity influenced by factors including water flow and temperature (Heublein et al. 2009; Poytress et al. 2011). Spawning primarily occurs in the cool sections of the upper mainstem Sacramento River in deep pools containing small to medium sized gravel, cobble or boulder substrate (NMFS 2015). Eggs incubate for a period of seven to nine days and remain near the hatching area for 18 to 35 days prior to dispersing (Van Eenennaam et al. 2001; Deng et al. 2002; Poytress et al. 2012). Based on length of juvenile sturgeon captured in the San Francisco Bay Delta, Southern green sturgeon migrate downstream toward the estuary between 6 months and 2 years of age (Radtke et al. 1966; NMFS 2015).

Since 2010, Dual Frequency Identification Sonar (DIDSON) surveys of aggregating sites in the upper Sacramento River for Southern green sturgeon have been conducted. Results from these surveys combined with the observed three to four year spawning cycle for Southern green sturgeon resulted in an estimate of 1,348 adults (Table 22; NMFS 2015). There are no estimates for juvenile S green sturgeon.

Table 22. Green sturgeon adult spawner numbers from DIDSON surveys in the upper Sacramento River and ESU estimate (NMFS 2015).

Year	Adult green sturgeon	95% Confidence Interval
2010	164	117 - 211
2011	220	178 - 262
2012	329	272 - 386
2013	338	277 - 399
2014	526	462 - 590
ESU abundance[a]	**1,348**	**824 – 1,872**

[a] ESU abundance for Southern green sturgeon numbers calculated from returning spawners in the Sacramento River and the observed spawning three to four year spawning cycle.

Limiting Factors

Many of the principle factors considered when listing Southern DPS green sturgeon as threatened are relatively unchanged (NMFS 2015). Recent studies confirm that the spawning area utilized by Southern green sturgeon is small. Confirmation of Feather River spawning is encouraging and the decommissioning of Red Bluff Diversion Dam and breach of Shanghai Bench makes spawning conditions more favorable, although Southern green sturgeon still encounter impassible barriers in the Sacramento, Feather and other rivers that limit their spawning range. The relationship between altered flows and temperatures in spawning and rearing habitat and Southern green sturgeon population productivity is uncertain. Entrainment as well as stranding in flood diversions during high water events also negatively impact Southern green sturgeon. The prohibition of retention in commercial and recreational fisheries has eliminated a known threat and likely had a very positive effect on the overall population, although recruitment indices are not presently available (NMFS 2015).

Status Summary

The southern DPS of North American green sturgeon remains vulnerable due to having only one small spawning population, potential growth-limiting and lethal temperatures, harvest concerns, loss of spawning habitat, and entrainment by water projects. There will have to be substantial changes in this species' status before it can recover.

2.2.2 Climate Change

Average annual air temperatures in the Pacific Northwest have increased by approximately 1°C since 1900 and climate models predict that air temperatures will increase 0.1 to 0.6°C per decade over the next century. This change in air temperature affects freshwater, estuarine, and marine ecosystems (ISAB 2007).

Projected Climate Change

The Intergovernmental Panel on Climate Change (IPCC) and U.S. Global Change Research Program published updated assessments of anthropogenic influence on climate, as well as projections of climate change over the next century (IPCC 2013; Melillo et al. 2014). Reports from both groups document evidence that recent warming is due to rising concentrations of greenhouse gas emissions. There is moderate certainty that the 30-year average temperature in the Northern Hemisphere is now higher than it has been over the past 1,400 years. In addition, there is high certainty that ocean acidity has increased with a drop in pH of 0.1 (NWFSC 2015).

Trends in warming and ocean acidification are highly likely to continue during the next century (IPCC 2013). In winter across the west, the highest elevations will shift from consistent longer (>5 months) snow-dominated winters to a shorter period (3-4 months) of reliable snowfall (Klos et al. 2014). Lower, more coastal, or more southerly watersheds will shift from consistent snowfall during winter to alternating periods of snow and rain. Lower elevations or warmer watersheds will lose snowfall completely, and rain-dominated watersheds will experience more intense precipitation events and possible shifts in the timing of the most intense rainfall (e.g., Salathe et al. 2014). Warmer summer air temperatures will increase both evaporation and direct radiative heating. When combined with reduced winter water storage, warmer summer air temperatures will lead to lower minimum flows in many watersheds. Higher summer air temperatures will depress minimum flows and raise maximum stream temperatures even if annual precipitation levels do not change (e.g., Sawaske and Freyberg 2014; NWFSC 2015).

Higher sea surface temperatures and increased ocean acidity are predicted for marine environments in general (IPCC 2013). However, regional marine impacts will vary, especially in relation to productivity. The California Current is strongly influenced by seasonal upwelling of cool, deep, water that is high in nutrients and low in dissolved oxygen and pH. An analysis of 21 global climate models found that most predicted a slight decrease in upwelling in the California Current, although there is a latitudinal cline in the strength of this effect, with less impact toward the north (Rykaczewski et al. 2015; NWFSC 2015).

Impacts on Salmon

Climate variation can affect salmon populations via numerous mechanisms. Higher stream and ocean temperatures can increase fish mortality from heat stress, alter growth rates, and decrease resistance to disease. Changes in streamflow regimes, such as flooding and low flow events, affect survival and behavior of salmonids. Expected behavioral responses include shifts in seasonal timing of important life history events including adult migration, spawning, fry emergence, and juvenile migration (NWFSC 2015).

Climate impacts in one life stage generally affect body size or timing in the next life stage and can be negative across multiple life stages (Healey 2011; Wade et al. 2013; Wainwright and Weitkamp 2013). Changes in winter precipitation could affect incubation and rearing life stages. Changes in the intensity of cool season precipitation could influence migration cues for fall and spring adult migrants, such as coho salmon and steelhead. Egg survival rates may suffer from more intense flooding that scours or buries redds. Changes in hydrological regime, such as a shift from mostly snow to more rain, could drive changes in life history, potentially threatening diversity within an ESU (Beechie et al. 2006). Changes in summer temperature and flow will affect both juvenile and adult stages in some populations, especially those with yearling life histories and summer migration patterns (Quinn 2005; Crozier and Zabel 2006; Crozier et al. 2010). Adults that migrate or hold during peak summer temperatures can experience high mortality in unusually warm years. For example, in 2015 only 4 percent of adult Redfish Lake sockeye survived the migration from Bonneville to Lower Granite Dam after confronting temperatures over 22°C in the lower Columbia River. Climate-induced contraction of thermally suitable habitat also can affect marine migration patterns. Abdul-Aziz et al. (2011) modeled changes in summer thermal ranges in the open ocean for Pacific salmon under multiple IPCC warming scenarios. For chum salmon, pink salmon, coho salmon, sockeye salmon, and steelhead, they predicted contractions in suitable marine habitat of 30-50 percent by the 2080s, with an even larger contraction (86-88 percent) for Chinook salmon under medium and high emissions scenarios (NWFSC 2015).

Freshwater Habitat

Likely impacts of climate change on fish in freshwater systems in the Northwest include reduction of cold water habitat, variation in quality and quantity of tributary rearing habitat, alterations to migration patterns, accelerated embryo development, premature emergence of fry, and competition among species. Recent modeling results indicate that increased summer temperatures or decreased fall streamflow are likely to significantly reduce parr-smolt survival of salmon and steelhead by 2040, and this result may also be applicable to other species with similar life history strategies in the Northwest (ISAB 2007).

Estuarine Habitat

In estuaries, higher winter freshwater flows and higher sea level elevation may lead to increased sediment deposition and wave damage; lower freshwater flows in late spring and summer may lead to upstream extension of the salt wedge, possibly influencing the distribution of salmonid prey and predators; and increased temperature of freshwater inflows may extend the range of warm-adapted non-indigenous species that are normally found only in freshwater. In all of these cases, the specific effects on salmon and steelhead abundance, productivity, spatial distribution and diversity are poorly understood (ISAB 2007).

Marine Habitat

Climate change is likely to cause increased ocean temperature, increased stratification of the water column, and changes in intensity and timing of coastal upwelling. These continuing changes will alter primary and secondary productivity, the structure of marine communities, and in turn, the growth, productivity, survival, and migrations of salmonids. A mismatch between earlier smolt migrations (due to earlier peak spring freshwater flows and decreased incubation period) and altered upwelling may reduce marine survival rates. Increased concentration of CO2 reduces the availability of carbonate for shell-forming invertebrates, including some that are prey items for juvenile salmonids (ISAB 2007).

2.2.3 Status of the Species' Critical Habitat

We review the status of designated critical habitat affected by the proposed action by examining the condition and trends of essential physical and biological features throughout the designated area[5]. These features are essential to the conservation of the 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). Below we summarize the status of the species'critical habitat; for more detailed information refer to NOAA Fisheries (2005) and the critical habitat final rules, which are cited for individual species in the subsections below.

For salmon and steelhead, NMFS 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 listed species they support[6]; the conservation rankings are high, medium, or low. To determine the conservation value of each watershed to species viability, NMFS' critical habitat analytical review teams (CHARTs; NOAA Fisheries 2005) evaluated the quantity and quality of habitat features (for example, spawning gravels, wood and water condition, side channels), 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. Thus, even a location with poor quality habitat could be ranked with a high conservation value if it were essential due to factors such as limited availability (e.g., one of a very few spawning areas), a unique contribution of the population it served (e.g., a population at the extreme end of geographic distribution), or serving other important roles (e.g., obligate area for migration to upstream spawning areas).

The CHARTs identified habitat-related human activities that affect PCE quantity and/or quality. The primary categories of habitat-related activities identified by the CHART are (1) forestry, (2) agriculture, (3) channel modifications/diking, (4) road building/maintenance, (5) urbanization, (6) dams, (7) irrigation impoundments and withdrawals, and (8) wetland loss/removal. All of these activities have PBF-related impacts because they have altered one or more of the following: stream hydrology, flow and water-level modifications, fish passage, geomorphology and sediment transport, temperature, dissolved oxygen, vegetation, soils, nutrients and chemicals, physical habitat structure, and stream/estuarine/marine biota and forage. And the degrees to which these alterations have affected the region's watersheds are the main factors that lead to the CHART teams' high-, medium-, and low conservation value ratings.

Lower Columbia River Chinook Salmon

We designated critical habitat for LCR Chinook salmon on September 2, 2005 (70 FR 52630). Critical habitat for LCR Chinook includes 1,293 miles of streams and lakes in 47 watersheds Oregon and Washington. There are 440 miles of spawning/rearing sites, 164 miles of rearing/migration sites, and 688 miles of migration corridors. The CHART rated four watersheds

[5] Refer to 50 CFR 226 for descriptions of critical habitat for the species considered in this opinion. We provide maps and GIS data for critical habitat at
http://www.westcoast.fisheries.noaa.gov/habitat/critical_habitat/critical_habitat_on_the_wc.html
[6] The conservation value of a site depends upon "(1) the importance of the populations associated with a site to the ESU [or DPS] conservation, and (2) the contribution of that site to the conservation of the population through demonstrated or potential productivity of the area" (NOAA Fisheries 2005).

as having low, 13 as having medium, and 30 as having high conservation value to the ESU. Of the 47 watersheds considered for designation, we excluded four low-value and five medium-value watersheds in their entirety, and excluded tributary habitat in one medium-value watershed. Also, we excluded approximately 162 miles of stream covered by two habitat conservation plans because the benefits of exclusion outweigh the benefits of designation. As a result of these considerations, 344 miles of stream habitats were excluded from the designation.

Upper Willamette River Chinook Salmon

We designated critical habitat for UWR Chinook salmon on September 2, 2005 (70 FR 52630). Critical habitat for UWR Chinook includes approximately 1,796 miles of streams in Oregon and Washington. There are 644 miles of spawning/rearing sites, 722 miles of rearing/migration sites, and 106 miles of migration corridors. The CHART rated conservation value of watersheds to the ESU and found that 19 have low, 18 have medium, and 22 have high conservation value. Of 60 watersheds considered for designation, we excluded in their entirety 11 low-value and four medium-value watersheds, and we excluded the tributary portions of eight low-value watersheds. As a result of these considerations, 324 miles of stream habitats were excluded from the designation.

Columbia River Chum Salmon

We designated critical habitat for CR chum salmon on September 2, 2005 (70 FR 52630). There are 20 watersheds within the range of this ESU. The CHART rated three watersheds as having medium and 17 as having high conservation value to the ESU. Habitat areas eligible for designation as critical habitat for this ESU included 725 miles of streams. We excluded 7 stream miles of streams where the economic benefits of exclusion outweigh the benefits of designation. Critical habitat for CR chum includes approximately 19 miles of spawning/rearing sites, 55 miles of rearing/migration sites, and 634 miles of migration corridors.

Lower Columbia River Coho Salmon

We designated critical habitat for LCR coho salmon on February 24, 2016 (81 FR 9251). Critical habitat for LCR Coho includes approximately 2,300 miles of streams in Oregon and Washington. There are 805 miles of spawning/rearing sites, 1,436 miles of rearing/migration sites, and 46 miles of migration corridors. There are 55 watersheds within the range of this ESU. The CHART rated three of the watersheds as having low, eighteen as having medium, and thirty-four as having high conservation value to the ESU. As a result of the economic and other relevant impacts weighed against the conservation value, approximately 1,000 miles of stream habitats were excluded from the designation.

Lower Columbia River Steelhead

We designated critical habitat for LCR steelhead on September 2, 2005 (70 FR 52630). Critical habitat for LCR steelhead includes approximately 2,338 square miles of streams in Oregon and Washington. There are 1,114 miles of spawning/rearing sites, 165 miles of rearing/migration sites, and 1,059 miles of migration corridors. The CHART rated two watersheds as having low, 11 as having medium, and 28 as having high rating for their conservation value to the DPS. Of the 41 watersheds considered for designation, we excluded one low conservation value and three medium-value watersheds in their entirety, and the tributary-only portions of one low-value watershed. Also, we are excluding approximately 125 miles of stream covered by two habitat conservation plans because the benefits of exclusion outweigh the benefits of designation. As a result of the considerations, 335 miles of stream habitats were excluded from the designation.

Upper Willamette River Steelhead

We designated critical habitat for UWR steelhead on September 2, 2005 (70 FR 52630). Critical habitat for UWR steelhead includes approximately 1,277 miles of streams in Oregon and Washington. There are 560 miles of spawning/rearing sites, 613 miles of rearing/migration sites, and 104 miles of migration corridors. The CHART rated two watersheds as having low, 11 as having medium, and 28 as having high rating for their conservation value to the DPS. Of the 41 watersheds within the range of this DPS, we excluded nine low conservation value watersheds in their entirety and the tributary-only portions of eight low-value watersheds. Also, we are excluding approximately 11 miles of stream overlapping Indian Land. As a result of these considerations, 335 miles of stream habitats were excluded from the designation.

Southern Eulachon

We designated critical habitat for eulachon on October 20, 2011 (76 FR 65324). Critical habitat for eulachon includes 16 specific areas in California, Oregon, and Washington. The designated areas are a combination of freshwater creeks and rivers and their associated estuaries, comprising approximately 335 miles of habitat. In our biological report, we found that all of the areas considered for critical habitat designation have a high conservation value. The designated critical habitat areas contain at least one of the following physical and biological features essential to conservation of the species: (1) freshwater spawning and incubation sites; (2) freshwater and estuarine migration corridors; and (3) nearshore and offshore marine foraging sites. Freshwater spawning and incubation sites are essential for successful spawning and offspring production; essential environmental components include specific water flow, quality, and temperature conditions; spawning and incubation substrates; and migratory access. Freshwater and estuarine migration corridors, associated with spawning and incubation sites, are essential for allowing adult fish to swim upstream to reach spawning areas and allowing larval fish to proceed downstream and reach the ocean. Essential environment components include waters free of obstruction; specific water flow, quality, and temperature conditions (for supporting larval and adult mobility), and abundant prey items (for supporting larval feeding after the yolk sac depletion). Nearshore and offshore marine foraging habitat are essential for juvenile and adult survival; essential environmental components include water quality and available prey.

We identified a number of activities that may affect the physical and biological features essential to the southern DPS of eulachon such that special management considerations or protection may be required. Major categories of such activities include: (1) Dams and water diversions; (2) dredging and disposal of dredged material; (3) inwater construction or alterations; (4) pollution and runoff from point and non-point sources; (5) tidal, wind, or wave energy projects; (6) port and shipping terminals; and (7) habitat restoration projects. All of these activities may have an effect on one or more of the essential physical and biological features via their alteration of one or more of the following: stream hydrology; water level and flow; water temperature; dissolved oxygen; erosion and sediment input/transport; physical habitat structure; vegetation; soils; nutrients and chemicals; fish passage; and estuarine/marine prey resources.

Southern Green Sturgeon

We designated critical habitat for green sturgeon on October 9, 2009 (74 FR 52300). We designated approximately 320 miles of freshwater river habitat, 897 square miles of estuarine habitat, 11,421 square miles of marine habitat, 487 miles of habitat in the Sacramento-San Joaquin Delta, and 135 square miles of habitat within the Yolo and Sutter bypasses (Sacramento River, CA) as critical habitat for the Southern DPS of green sturgeon. Of the areas considered for critical habitat, the Critical Habitat Review Team rated 18 areas as having high, twelve as having medium, and eleven as having low rating for their conservation value to the DPS. Areas designated for critical habitat include coastal U.S. marine waters within 60 fathoms depth from Monterey Bay, California north to Cape Flattery, Washington, including the Strait of Juan de Fuca, Washington, to its United States boundary; the lower Columbia River estuary; and certain coastal bays and estuaries in Washington (Willapa Bay and Grays Harbor).

Based on the best available scientific information, we identified PCEs for freshwater riverine systems, estuarine areas, and nearshore marine waters (74 FR 52300). For freshwater riverine systems, the specific PCEs for species conservation are (1) food resources, (2) substrate type or size, (3) water flow, (4) water quality, (5) migratory corridor, (6) water depth, and (7) sediment quality. For estuarine areas, the specific PCEs for species conservation are (1) food resources, (2) water flow, (3) water quality, (4) migratory corridor, (5) water depth, and (6) sediment quality. For coastal marine areas, the specific PCEs for species conservation are (1) migratory corridor, (2) water quality, and (3) food resources.

From analyses of the identified PCEs and examination of economic activities, NMFS verified that at least one activity in each specific area may threaten at least one PCE such that special management considerations or protection may be required (NMFS 2009). Major categories of habitat-related activities include: (1) dams, (2) water diversions, (3) dredging and disposal of dredged material, (4) in-water construction or alterations, (5) National Pollutant Discharge Elimination System (NPDES) activities and activities generating non-point source pollution, (6) power plants, (7) commercial shipping, (8) aquaculture, (9) desalination plants, (10) proposed alternative energy hydrokinetic projects, (11) Liquefied Natural Gas (LNG) projects, (12) habitat restoration, and (13) bottom trawl fisheries.

2.3 Action Area

"Action area" means all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action (50 CFR 402.02). For the purposes of this opinion, the action area includes all river reaches accessible to listed Chinook salmon, chum salmon, coho salmon, steelhead, eulachon, and green sturgeon in all sub-basins of the Lower Columbia and Willamette Rivers. Additionally, the action area includes all marine waters off the

West Coast of the continuous United States, including nearshore waters from the Mexican to Canadian borders, which are accessible to these species. Wherever possible we account for a more limited geographic scope when analyzing a proposed action's impacts on listed species and their critical habitat.

The action area thus encompasses a large and discontinuous areas. Salmon exist in large areas between the locations for the multiple proposed actions, but they would not be affected by the proposed activities. There is one geographically distinct area: the portion of the Puget Sound occupied by SR killer whales. As noted earlier, the proposed actions could affect Chinook salmon, which constitutes the killer whales' prey base. Therefore some effects of the proposed actions could be felt as much as hundreds of miles away from where the activities would take place. Those effects are described in the Not Likely to Adversely Affect section (2.11).

In all cases, the proposed research activities would take place in individually small sites. For example, 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 actions would take place in designated critical habitat.

Detailed habitat information (e.g., 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 for LCR Chinook Salmon, UWR Chinook Salmon, CR chum salmon, LCR steelhead, and UWR steelhead (70 FR 52630); LCR coho salmon (81 FR 9251); eulachon (76 FR 65324); and green sturgeon (74 FR 52300).

2.4 Environmental Baseline

The "environmental baseline" includes past and present impacts of all federal, state, or private actions and other human activities in the action area, anticipated impacts of all proposed federal projects in the action area that have undergone formal or early section 7 consultation, and impacts of state or private actions that are contemporaneous with the consultation in process (50 CFR 402.02). The environmental baseline for this opinion therefore includes the impacts of many activities on survival and recovery of the listed species. Because the action area for this opinion includes much of the range of the listed species in Oregon and Washington, effects from many past and present actions are reflected by species status (Section 2.2). For habitat, the environmental baseline reflects effects of these multiple actions on the PBFs that are essential to conservation of the species. For proposed actions where the action area can be defined at spatial scales smaller than the ESU/DPS, we consider the environmental baseline at these finer scales.

2.4.2 Summary for all Listed Species

Factors Limiting Recovery

The best scientific information available demonstrates that multiple factors have contributed to the decline of west coast salmonids (Table 23). NMFS' status reviews, Technical Recovery

Team publications, and recovery plans for the listed species in this opinion identify factors that have caused decline and factors that prevent recovery. These include habitat degradation caused by human development and harvest and hatchery practices. Migratory fish in the Columbia River basin have been affected profoundly by dams that alter river flow and water quality, obstruct or delay passage of fish, and fundamentally change river ecology. In many larger subbasins of the Columbia River, dams block access of anadromous fish to large areas of productive habitat. Climate change (Section 2.2.2) also represents a potentially significant threat to all listed species. None of the references cited in Section 2.2 of this opinion identify scientific research as a factor associated with the decline or recovery potential of west coast salmonids.

Table 23. Major Factors Limiting Recovery (Adapted from NOAA, NMFS, 2005 Report to Congress: Pacific Coast Salmon Recovery Fund FY 2000-2004, 51p. July 2005.)

	Estuarine and Nearshore Marine	Floodplain Connectivity and Function	Channel Structure and Complexity	Stream Substrate	Stream Flow	Water Quality	Fish Passage	Harvest-related Adverse Effects	Predation/Competition/ Disease
LCR Chinook	●	●	●	●	●		●	●	
UWR Chinook		●	●			●	●		
CR chum	●	●	●	●	●		●		
LCR coho		●	●	●	●	●		●	
LCR steelhead		●	●	●	●	●	●		●
UWR steelhead		●	●		●		●		
S green sturgeon	●	●	●	●	●	●	●		
S eulachon				●		●	●	●	●

For detailed information on how various factors have degraded PCEs in the Idaho, Oregon, and Washington see Busby et al. (1996), Ford (2011), Good et al. (2005), Gustafson et al. (2010), LCFRB (2004), LCFRB (2010), McElhaney et al. (2004), NMFS (1991), NMFS (1997), NMFS (1998), NMFS (2004), NMFS (2008), NMFS (2011), Nickelson et al. (1992), ODFW (2005b), ODFW (2010), Weitkamp et al. (1995), Ford et al. 2010, and WDFW (2010).

Research Effects

Scientific research has the potential to affect survival and recovery of listed species by killing fish. Several dozen section 10(a)(1)(A) scientific research permits have already been authorized, permitting researchers to take listed salmonids and green sturgeon in the Pacific Northwest. These previously authorized Section 10 permits expire between 2018 and, 2022. In addition, NMFS is in the process of re-authorized state scientific research programs for Oregon, Washington, and Idaho for 2018, under ESA section 4(d). Because the state Section 4(d) authorizations have not been finalized, we use the take authorized for State 4(d) programs in 2017 to estimate the baseline levels of take. Therefore, the total levels of take previously authorized for research in 2018 under ESA Sections 10(a)(1)(A) and in 2017 under Section 4(d) represent the “baseline” take for the species considered in this Opinion (Table 24).

In practice, take levels from research activities typically are far lower than authorizations allow. We work with research permit applicants to establish best estimates for take, and then suggest that they inflate these estimates slightly in their requested take levels to allow for higher-than-expected encounter rates or unexpected mortalities. Our research tracking system reveals that researchers report, on average, 28% of the total take and 15% of the mortalities that are authorized in their permits.

Table 24. Baseline effects for scientific research studies in 2018 for the species considered in this opinion. For salmon, steelhead, and green sturgeon, we authorized these take levels in research permits. The NMFS has not promulgated take prohibitions for eulachon. See text for explanation of data sources. LHAC = Listed Hatchery Adipose Clipped, LHIA = Listed Hatchery Intact Adipose.

			4(d) Baseline (2017)		Sec 10(a)(1)(A) Baseline		Total Baseline	
ESU/DPS	Life Stage	Origin	Take	Mortality	Take	Mortality	Authorized Take	Authorized Mortality
CR chum	Adult	Natural	17	0	35	1	52	1
	Adult	LHAC	n/a	n/a	n/a	n/a	n/a	n/a
	Adult	LHIA	0	0	0	0	0	0
	Adult	Total	17	0	35	1	52	1
	Juvenile	Natural	18,612	204	3,440	109	22,052	313
	Juvenile	LHAC	0	0	0	0	0	0
	Juvenile	LHIA	550	6	12	12	562	18
	Juvenile	Total	19,162	210	3,452	121	22,614	331
LCR Chinook	Adult	Natural	916	11	116	2	1,032	13
	Adult	LHAC	809	19	124	2	933	21
	Adult	LHIA	55	2	7	0	62	2
	Adult	Total	1,780	32	247	4	2,027	36
	Juvenile	Natural	1,248,717	15,010	15,639	497	1,264,356	15,507
	Juvenile	LHAC	85,850	1,634	2,683	292	88,533	1,926
	Juvenile	LHIA	165	4	313	44	478	48
	Juvenile	Total	1,334,732	16,648	18,635	833	1,353,367	17,481
LCR coho	Adult	Natural	2,679	28	666	6	3,345	34
	Adult	LHAC	2,503	48	500	8	3,003	56
	Adult	LHIA	220	4	30	0	250	4
	Adult	Total	5,402	80	1,196	14	6,598	94
	Juvenile	Natural	217,378	2,669	11,997	379	229,375	3,048
	Juvenile	LHAC	66,253	1,208	3,915	966	70,168	2,174
	Juvenile	LHIA	2,035	21	342	107	2,377	128
	Juvenile	Total	285,666	3,898	16,254	1,452	301,920	5,350

Table 24, continued.

ESU/DPS	Life Stage	Origin	4(d) Baseline (2017)		Sec 10(a)(1)(A) Baseline		Total Baseline	
			Take	Mortality	Take	Mortality	Authorized Take	Authorized Mortality
LCR steelhead	Adult	Natural	2,618	25	1,079	11	3,697	36
	Adult	LHAC	83	2	86	2	169	4
	Adult	LHIA	0	0	0	0	0	0
	Adult	Total	2,701	27	1,165	13	3,866	40
	Juvenile	Natural	58,454	986	8,110	278	66,564	1,264
	Juvenile	LHAC	55,616	1,090	1,079	54	56,695	1,144
	Juvenile	LHIA	0	0	0	0	0	0
	Juvenile	Total	114,070	2,076	9,189	332	123,259	2,408
UWR Chinook	Adult	Natural	226	2	28	0	254	2
	Adult	LHAC	210	6	33	0	243	6
	Adult	LHIA	0	0	0	0	0	0
	Adult	Total	436	8	61	0	497	8
	Juvenile	Natural	50,421	755	2,605	154	53,026	909
	Juvenile	LHAC	7,887	100	2,272	155	10,159	255
	Juvenile	LHIA	22	1	16	7	38	8
	Juvenile	Total	58,330	856	4,893	316	63,223	1,172
UWR steelhead	Adult	Natural	261	2	15	0	276	2
	Adult	LHAC	n/a	n/a	n/a	n/a	n/a	n/a
	Adult	LHIA	n/a	n/a	n/a	n/a	n/a	n/a
	Adult	Total	261	2	15	0	276	2
	Juvenile	Natural	5,167	162	1,107	41	6,274	203
	Juvenile	LHAC	n/a	n/a	n/a	n/a	n/a	n/a
	Juvenile	LHIA	n/a	n/a	n/a	n/a	n/a	n/a
	Juvenile	Total	5,167	162	1,107	41	6,274	203

Table 24, continued.

ESU/DPS	Life Stage	Origin	4(d) Baseline (2017)		Sec 10(a)(1)(A) Baseline		Total Baseline	
			Take	Mortality	Take	Mortality	Authorized Take	Authorized Mortality
S Eulachon	Adult	Natural	2,202	98	3,663	2,906	5,865	3,004
	Juvenile	Natural	0	0	405	356	405	356
S green sturgeon	Adult	Natural	63	0	132	5	195	5
	Juvenile	Natural	18	0	2,037	118	2,055	118
	Larvae+Egg	Natural	242	176	8,365	1,000	8,607	1,176

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

"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

We describe the effects of the proposed activities in detail in the following section. In general, the activities would be (1) electrofishing, (2) capturing fish with angling equipment, traps, and nets of various types, (3) sampling tissues from live fish, and (4) tagging fish. These techniques are minimally intrusive in terms of their effect on habitat because they would involve little, if any, disturbance of streambeds or adjacent riparian zones. None of the activities will measurably affect any habitat PBF listed earlier. Moreover, the proposed activities are all of short duration. Therefore, we conclude that the proposed activities are not likely to have an adverse impact on any designated critical habitat.

2.5.2 Effects on the Species

As discussed above, the proposed research activities will have no measurable effects on the habitat of listed salmonids, eulachon, or green sturgeon. The actions are not likely to affect measurably any of the listed species by reducing their habitat's ability to contribute to their survival and recovery.

We discuss the effects of the sampling activities that are proposed collectively in the five permit applications in the following subsections. We describe the activities in terms broad enough to apply to all the permits. In all cases, trained professionals would use established protocols to conduct the research.

Observation

For some parts of the proposed studies, listed fish would be observed in-water (e.g., by snorkel surveys or from the banks). Direct observation 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 will be on the listed species in the form of capturing and handling 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, populations, and species (Sharpe et al. 1998). Handling of fish may cause stress, injury, or death, which typically are due to overdoses of anesthetic, differences in water temperatures between the river and holding buckets, depleted dissolved oxygen in holding buckets, holding fish out of the water, and physical trauma. Stress on salmonids increases rapidly from handling if the water temperature exceeds 18ºC or dissolved oxygen is below saturation. Fish transferred to holding buckets can experience trauma if care is not taken in the transfer process, and fish can experience stress and injury from overcrowding in traps, nets, and buckets. Decreased survival of fish can result when stress levels are high because stress can be immediately debilitating and may also increase the potential for vulnerability to subsequent challenges (Sharpe et al. 1998). The permit conditions identified in Section 1.3 contain measures that mitigate factors that commonly lead to stress and trauma from handling, and thus minimize the harmful effects of capturing and handling fish. When these measures are followed, fish typically recover fairly rapidly from handling.

Electrofishing

Electrofishing is a process by which an electrical current is passed through water containing fish in order to stun them—thus making them easy to capture. It can cause a suite of effects ranging from simply disturbing the fish to actually killing them. The amount of unintentional mortality attributable to electrofishing varies widely depending on the equipment used, the settings on the equipment, and the expertise of the technician. Electrofishing can have severe effects on adult salmonids. Spinal injuries in adult salmonids from forced muscle contraction have been documented. Sharber and Carothers (1988) reported that electrofishing killed 50 percent of the adult rainbow trout in their study.

Most of the studies on the effects of electrofishing on fish have been conducted on adult fish greater than 300 mm in length (Dalbey et al. 1996). The relatively few studies that have been conducted on juvenile salmonids indicate that spinal injury rates are substantially lower than they are for large fish. 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) found a 5.1% injury rate for juvenile Middle Columbia River steelhead captured by electrofishing in the Yakima River subbasin. The incidence and severity of electrofishing damage is partly related to the type of equipment used and the waveform produced (Sharber and Carothers 1988, McMichael 1993, Dalbey et al. 1996; Dwyer and White 1997). Continuous direct current (DC) or low-frequency (30 Hz) pulsed DC have been recommended for electrofishing (Fredenberg 1992; Snyder 1992, 1995; Dalbey et al. 1996) because lower spinal injury rates, particularly in salmonids, occur with these waveforms (Fredenberg 1992, McMichael 1993, Sharber et al. 1994, Dalbey et al. 1996). Only a few recent studies have examined the long-term effects of electrofishing on salmonid survival and growth (Dalbey et al. 1996, Ainslie et al. 1998). These studies indicate that although some of the fish suffer spinal injury, few die as a result. However, severely injured fish grow at slower rates and sometimes they show no growth at all (Dalbey et al. 1996).

Permit conditions will require that all researchers follow NMFS' electrofishing guidelines (NMFS 2000). The guidelines require that field crews be trained in observing animals for signs of stress and shown how to adjust electrofishing equipment to minimize that stress. All areas are visually searched for fish before electrofishing may begin. Electrofishing is not done in the vicinity of redds or spawning adults. All electrofishing equipment operators are trained by qualified personnel to be familiar with equipment handling, settings, maintenance, and safety. Operators work in pairs to increase both the number of fish that may be seen and the ability to identify individual fish without having to net them. Working in pairs also allows the researcher to net fish before they are subjected to higher electrical fields. Only DC units are used, and the equipment is regularly maintained to ensure proper operating condition. Voltage, pulse width, and rate are kept at minimal levels and water conductivity is tested at the start of every electrofishing session so those minimal levels can be determined. Due to the low settings used, shocked fish normally revive instantaneously. Fish requiring revivification receive immediate, adequate care. In all cases, electrofishing is used only when other survey methods are not feasible. During electrofishing, electrical current is passed through water in order to stun fish, which makes them easier to capture. Electrofishing can cause a suite of effects ranging from disturbing the fish to killing them. Rates of injury and mortality of fish from electrofishing vary widely depending on the equipment used, the settings on the equipment, and the expertise of technicians. Electrofishing can have severe effects on adult fish. Spinal injuries in adult salmonids from forced muscle contraction have been documented. Sharber and Carothers (1988) reported that electrofishing killed 50 percent of the adult rainbow trout in their study.

Most of the studies on the effects of electrofishing have been conducted on adult fish greater than 300 mm in length (Dalbey et al. 1996). The relatively few studies that have been conducted on juvenile salmonids indicate that spinal injury rates are substantially lower than they are for large fish. 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) found a 5.1% injury rate for juvenile Middle Columbia River steelhead captured by electrofishing in the Yakima River subbasin. The incidence and severity of injury from electrofishing is partly related to the type of equipment used and the waveform produced (Sharber and Carothers 1988, McMichael 1993, Dalbey et al. 1996; Dwyer and White 1997). Continuous direct current (DC) or low-frequency (30 Hz) pulsed DC have been recommended for electrofishing (Fredenberg 1992; Snyder 1992, 1995; Dalbey et al. 1996) because lower spinal injury rates, particularly in salmonids, occur with these waveforms (Fredenberg 1992, McMichael 1993, Sharber et al. 1994, Dalbey et al. 1996). Only a few studies have examined the long-term effects of electrofishing on salmonid survival and growth (Dalbey et al. 1996, Ainslie et al. 1998). These studies indicate that although some of the fish suffer spinal injury, few die as a result. However, severely injured fish grow at slower rates and sometimes they show no growth at all (Dalbey et al. 1996).

Research permit conditions would require that all researchers follow NMFS' electrofishing guidelines (NMFS 2000). The guidelines require that field crews be trained to recognize signs of stress in fish and that staff know how to adjust electrofisher settings to minimize that stress. The guidelines also require that researchers: (1) visually search all areas for fish before electrofishing; (2) avoid electrofishing in the vicinity of redds or spawning adults; (3) receive training by qualified personnel to be understand equipment handling, settings, maintenance, and safety; (4) work in pairs to increase both the number of fish that may be seen and the ability to identify individual fish without having to net them; (5) net fish quickly; (6) use DC units in proper operating condition; and (7) test water conductivity at the start of every electrofishing session and adjust voltage, pulse width, and rate to minimal effective levels. Due to the low settings used, shocked fish normally revive instantaneously. When fish require reviving, they should receive immediate and adequate care. In all cases, electrofishing should only be used only when other survey methods are not feasible. Furthermore, permit conditions prohibit researchers from targeting adult fish and the researcher must stop electrofishing if they encounter an adult fish.

The preceding discussion focused on the effects of using a backpack unit for 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 and, as a result, can have a greater impact on fish. In addition, the environmental conditions in larger, more turbid streams can limit researchers' ability to minimize impacts on fish. That is, in areas of lower visibility it can be difficult for researchers to detect the presence of adults and take steps to avoid them. In any case, the permit conditions requiring the researchers to follow NMFS' electrofishing guidelines apply to researchers intending to use boat electrofishing as well. Permit conditions prohibit the researcher from intentionally targeting adult fish and the researcher must stop electrofishing if they encounter an adult fish.

Tissue Sampling

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

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

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

Tagging/Marking

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

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

PIT tags have very little effect on growth, mortality, or behavior. The few reported studies of PIT tags have shown no effect on growth or survival (Prentice et al., 1987; Jenkins and Smith, 1990; Prentice et al., 1990). For example, in a study between the tailraces of Lower Granite and McNary Dams (225 km), Hockersmith et al. (2000) concluded that the performance of yearling chinook salmon was not adversely affected by gastrically- or surgically implanted sham radio tags or PIT-tags. Additional studies have shown that growth rates among PIT-tagged Snake

River juvenile fall chinook salmon in 1992 (Rondorf and Miller, 1994) were similar to growth rates for salmon that were not tagged (Conner et al., 2001). Prentice and Park (1984) also found that PIT-tagging did not substantially affect survival in juvenile salmonids.

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

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

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

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

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

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

2.5.3 Species-Specific Effects of Each Permit

In the "Status of the Species" section, we estimated the average annual abundance for adult and juvenile listed salmonids, which we summarize below (Table 25). For the listed salmonids, we estimated abundance for outmigrating smolts and adult returning fish. For hatchery propagated juvenile salmonids, we use hatchery production estimates. We do not have separate estimates for adult abundance of "Listed Hatchery Adipose Clip' (LHAC) and 'Listed Hatchery Intact Adipose' (LHIA) fish. In our analysis (Sections 2.5.3 and 2.7) we apply LHIA:LHAC proportions for juveniles to the abundance estimate for hatchery-origin adults to estimate the adult proportions.

We evaluate the effects of proposed scientific research at the spatial scale or scales that are most relevant to the proposed action, i.e., at population- to ESU-scales. For the proposed permits that we consider in this opinion, effects could occur broadly across the entire ESU/DPSs, and so we analyzed effects at the ESU/DPS scale. We evaluated proposed levels of total take and potential mortalities for each project. We then quantified how each permit's potential take would affect abundance of the ESU/DPS by life stage (juvenile, adult) and origin (natural, LHAC, LHIA).

Table 25. Estimated annual abundance for the species considered in this opinion.

ESU/DPS	Life Stage	Origin	Abundance
CR chum	Adult	Natural	10,644
	Adult	LHAC	0
	Adult	LHIA	426
	Adult	Total	11,070
	Juvenile	Natural	5,362,740
	Juvenile	LHAC	6,512
	Juvenile	LHIA	648,047
	Juvenile	Total	6,017,299
LCR Chinook	Adult	Natural	29,469
	Adult	LHAC	37,286
	Adult	LHIA	1,308
	Adult	Total	68,063
	Juvenile	Natural	12,164,845
	Juvenile	LHAC	34,347,631
	Juvenile	LHIA	1,204,984
	Juvenile	Total	47,717,460
LCR coho	Adult	Natural	32,986
	Adult	LHAC	22,430
	Adult	LHIA	652
	Adult	Total	56,068
	Juvenile	Natural	639,015
	Juvenile	LHAC	7,424,506
	Juvenile	LHIA	215,952
	Juvenile	Total	8,279,472
LCR steelhead	Adult	Natural	12,920
	Adult	LHAC	21,882
	Adult	LHIA	415
	Adult	Total	35,217
	Juvenile	Natural	323,607
	Juvenile	LHAC	1,194,301
	Juvenile	LHIA	22,649
	Juvenile	Total	1,540,557

Table 25, continued.

ESU/DPS	Life Stage	Origin	Abundance
UWR Chinook	Adult	Natural	11,443
	Adult	LHAC	34,353
	Adult	LHIA	101
	Adult	Total	45,897
	Juvenile	Natural	1,275,681
	Juvenile	LHAC	5,543,371
	Juvenile	LHIA	16,278
	Juvenile	Total	6,835,329
UWR steelhead	Adult	Natural	4,280
	Adult	LHAC	0
	Adult	LHIA	0
	Adult	Total	4,280
	Juvenile	Natural	143,898
	Juvenile	LHAC	0
	Juvenile	LHIA	0
	Juvenile	Total	143,898
S Eulachon	Adult	Natural	77,598,015
	Juvenile	Natural	n/a
S green sturgeon	Adult	Natural	1,348
	Juvenile	Natural	n/a
	Larvae+Egg	Natural	n/a

2.5.3.1 Permit 20713

The NWFSC applied for a new permit to take juvenile LCR Chinook salmon, UWR Chinook salmon, CR chum salmon, LCR coho salmon, LCR steelhead, UWR steelhead, and green sturgeon in the Lower Willamette River. Researchers may also take adult S eulachon, for which there are currently no ESA take prohibitions. The researchers propose to kill natural-origin juvenile Chinook salmon that are between 50 and 80 mm in fork length using a lethal dose of MS-222. The target for contaminant analysis is natural-origin UWR Chinook, but juvenile Chinook salmon from other ESUs in the Columbia River basin would likely be killed, too, because juveniles from different ESUs cannot be distinguished visually. Hatchery-origin Chinook salmon with intact adipose fins could also be killed because they cannot be distinguished from wild fish in the field. In addition, a few individuals from other ESU/DPSs could be killed unintentionally due to capture and handling during seining surveys. The NWFSC researchers used past survey data from the Lower Willamette and Columbia rivers to predict the proportions of Chinook salmon and other species that they would be likely to capture during their surveys and to plan the timing of their surveys to target UWR Chinook outmigrants (Table 26).

Table 26. Take proposed for Permit 20713. Mortalities are also counted in the Proposed Take column. Take activities include Capture/Handle/Release (C/H/R) and Directed (intentional) Mortality (DM).

ESU/DPS	Life Stage	Origin	Take Activity	Proposed Take	Proposed Mortalities
CR chum	Juvenile	Natural	C/H/R	10	1
		LHAC	C/H/R	10	1
LCR Chinook	Juvenile	Natural	C/H/R	50	1
			DM	119	119
		LHAC	C/H/R	101	1
		LHIA	DM	5	5
LCR coho	Juvenile	Natural	C/H/R	25	1
		LHAC	C/H/R	30	1
LCR steelhead	Juvenile	Natural	C/H/R	2	1
		LHAC	C/H/R	2	1
UWR Chinook	Juvenile	Natural	C/H/R	50	1
			DM	201	201
		LHAC	LHAC	174	2
		LHIA	DM	9	9
UWR steelhead	Juvenile	Natural	C/H/R	5	1
S eulachon	Adult	Natural	C/H/R	100	2
S green sturgeon	Adult	Natural	C/H/R	1	0

We expect less than a 1% incidental mortality rate to be associated with beach seining. For each combination of ESU/DPS, life stage, and origin, less than 0.15% of the fish would be taken. Although the researchers would kill up to 120 LCR Chinook and 202 UWR Chinook salmon, these ESUs have high numbers of juvenile, natural-origin fish (Table 24), and thus the mortality rates at the ESU scale would be very low. For natural-origin juveniles, less than 0.016% of UWR Chinook and less than 0.001% of LCR Chinook salmon would be killed. For other species, very low numbers of natural-origin juveniles would be killed (less than 0.0001% of CR chum, 0.0003% of LCR steelhead, and 0.0007% of UWR steelhead). The researchers would kill up to two eulachon and no green sturgeon, and we expect encounter rates with these species to be very low (Table 27).

Table 27. Percent of the ESU/DPS taken or killed by activities conducted under permit 20713.

ESU/DPS	Life Stage	Origin	Take	Percent of ESU/DPS Taken	Mortality	Percent of ESU/DPS Killed
CR chum	Juvenile	Natural	10	0.0002%	1	<0.0001%
		LHAC	10	0.15%	1	0.015%
LCR Chinook	Juvenile	Natural	169	0.001%	120	0.001%
		LHAC	101	0.0003%	1	<0.0001%
		LHIA	5	0.0004%	5	0.0004%
LCR coho	Juvenile	Natural	25	0.004%	1	0.0002%
		LHAC	30	0.0004%	1	<0.0001%
LCR steelhead	Juvenile	Natural	2	0.0006%	1	0.0003%
		LHAC	2	0.0002%	1	<0.0001%
UWR Chinook	Juvenile	Natural	251	0.02%	202	0.016%
		LHAC	174	0.003%	2	<0.0001%
		LHIA	9	0.055%	9	0.055%
UWR steelhead	Juvenile	Natural	5	0.004%	1	0.0007%
S eulachon	Adult	Natural	100	0.0001%	2	<0.0001%
S green sturgeon	Adult	Natural	1	0.074%	0	0%

Research associated with Permit 20713 would have a very small impact on abundance and productivity and no measureable impact on spatial structure or diversity for these listed species. Results from this study would benefit listed species by supporting an ongoing Natural Resource Damage Assessment. In addition, the data would be used in Chinook salmon life cycle models to compare how chemical pollution affects UWR Chinook salmon populations relative to other stressors.

2.5.3.2 Permit 21507

Mount Hood Environmental applied for a new permit to take UWR steelhead and UWR Chinook in the intake channel between the Tualatin River and the Spring Hill Pumping Plant (Table 28). The researchers would capture fish by seining, trapping, and boat electrofishing.

Table 28. Take proposed for Permit 21507. Mortalities are also counted in the Proposed Take column. C/H/R = Capture/Handle/Release.

ESU/DPS	Life Stage	Origin	Take Activity	Proposed Take	Proposed Mortalities
UWR Chinook	Adult	Natural	C/H/R	1	0
	Juvenile	Natural	C/H/R	350	7
UWR steelhead	Adult	Natural	C/H/R	1	0
	Juvenile	Natural	C/H/R	350	7

We expect at least 99% of the fish that are captured using seines and traps to survive, and we expect at least 97% of fish that are captured by boat electrofishing to survive. For each combination of ESU/DPS, life stage, and origin, less than 0.24% of the fish would be taken. No adults would be killed. For natural-origin juveniles, less than 0.005% of the UWR steelhead DPS and 0.0006% of UWR Chinook salmon ESU would be killed (Table 29).

Table 29. Percent of the ESU/DPS taken or killed by activities conducted under permit 21507.

ESU/DPS	Life Stage	Origin	Take	Percent of ESU/DPS Taken	Mortality	Percent of ESU/DPS Killed
UWR Chinook	Adult	Natural	1	0.009%	0	0%
	Juvenile	Natural	350	0.03%	7	0.0006%
UWR steelhead	Adult	Natural	1	0.02%	0	0%
	Juvenile	Natural	350	0.24%	7	0.005%

Research associated with Permit 21507 would have a negligible impact on abundance, productivity, spatial structure, and diversity for UWR Chinook salmon and UWR steelhead. The study would benefit listed fish by providing information to manage and mitigate for potential entrainment of these fish during early life stages.

2.5.3.3 Permit 21432

Cramer Fish Sciences requested to take juvenile LCR Chinook, LCR coho, and LCR steelhead by single-pass backpack electrofishing in the Klickitat, Wind, and White Salmon River subbasins (Table 30).

Table 30. Take proposed for Permit 21432. Mortalities are also counted in the Proposed Take column. C/H/R = Capture/Handle/Release.

ESU/DPS	Life Stage	Origin	Take Activity	Proposed Take	Proposed Mortalities
LCR Chinook	Juvenile	Natural	C/H/R	140	4
	Juvenile	LHAC	C/H/R	20	2
LCR coho	Juvenile	Natural	C/H/R	140	4
	Juvenile	LHAC	C/H/R	20	2
LCR steelhead	Juvenile	Natural	C/H/R	140	4
	Juvenile	LHAC	C/H/R	20	2

We expect at least 97% of the fish that are captured using backpack electrofishing to survive. For the LHAC component of each ESU/DPS, the applicant requested to capture up to 20 fish and kill up to 2 of these. These numbers translate into apparently high mortality rates (10%) associated with electrofishing. We do not expect these rates to occur, however. The researchers expect to encounter very few, if any, hatchery fish during their surveys, but requested two mortalities so they do not reach their take limit with a single mortality.

For each combination of ESU/DPS and origin, less than 0.04% of juveniles would be taken. No adults would be taken. For natural-origin juveniles, less than 0.001% of the LCR steelhead DPS, 0.0006% of the LCR coho ESU, and 0.0001% of LCR Chinook ESU would be killed (Table 29).

Table 31. Percent of the ESU/DPS taken or killed by activities conducted under permit 21432.

ESU/DPS	Life Stage	Origin	Take	Percent of ESU/DPS Taken	Mortality	Percent of ESU/DPS Killed
LCR Chinook	Juvenile	Natural	140	0.001%	4	<0.0001%
		LHAC	20	<0.0001%	2	<0.0001%
LCR coho	Juvenile	Natural	140	0.02%	4	0.0006%
		LHAC	20	0.0003%	2	<0.0001%
LCR steelhead	Juvenile	Natural	140	0.04%	4	0.001%
		LHAC	20	0.002%	2	0.0002%

Research associated with Permit 21507 would have a negligible impact on abundance, productivity, spatial structure, and diversity for LCR Chinook, LCR coho, and UWR steelhead. The study would benefit listed fish by affording them protections if they are found in streams that previously were assessed as non-fish bearing. The study also would provide valuable information about the utility of using less-invasive e-DNA survey techniques in place of traditional electrofishing surveys to provide information on fish occupancy.

2.5.3.4 Permit 20492-2M

The ODFW currently holds permit 20492, which will expire on December 31, 2021. The permit authorizes the ODFW to take listed species by boat electrofishing in the Willamette and Columbia basins and on the Oregon coast. The ODFW proposes to modify their permit to add take of adult and juvenile UWR Chinook salmon and UWR steelhead at new research sites in the Tualatin and Yamhill Rivers (Table 32).

Table 32. New take proposed for Permit 20492-2M. Mortalities are also counted in the Proposed Take column. Take activities include Capture (C), Handle (H), and Release (R).

ESU/DPS	Life Stage	Origin	Take Activity	Proposed Take	Proposed Mortalities
UWR Chinook	Adult	Natural	C/H/R	4	0
	Juvenile	Natural	C/H/R	400	12
UWR Steelhead	Adult	Natural	C/H/R	4	0
	Juvenile	Natural	C/H/R	400	12

We previously analyzed effects for this permit in consultations WCR-2017-6650 and WCR-2017-6413 at the ESU/DPS scale because the UWR Chinook salmon and UWR steelhead captured could potentially come from any population within the ESU/DPS. The additional take being requested for the modification would occur at a smaller spatial scale (the Tualatin and Yamhill Rivers in the Upper Willamette basin), however the collective take (previous and new authorizations) for permit 20492-2M could affect all populations of UWR Chinook and UWR steelhead. Therefore we analyzed take for this proposed action at the ESU/DPS scale.

Given the methods proposed by the ODFW, we expect all adult and at least 97% of juvenile UWR Chinook and UWR steelhead that are captured during research activities to survive with no long-term consequences. For each combination of ESU/DPS, life stage, and origin, less than 0.27% of the fish would be taken. The research activities would kill negligibly small fractions of the natural components of juvenile UWR Chinook salmon (0.0009%) and juvenile UWR steelhead. (0.008%; Table 33).

Table 33. Percent of the ESU/DPS taken or killed by activities conducted under permit 20492-2M.

ESU/DPS	Life Stage	Origin	Take	Percent of ESU/DPS Taken	Mortality	Percent of ESU/DPS Killed
UWR Chinook	Adult	Natural	4	0.03%	0	0%
	Juvenile	Natural	400	0.03%	12	0.0009%
UWR Steelhead	Adult	Natural	4	0.09%	0	0%
	Juvenile	Natural	400	0.27%	12	0.008%

The proposed levels of take for this modification would have a negligible impact on abundance, productivity, spatial structure, and diversity for UWR Chinook salmon and UWR steelhead. Annual reports for permit 1318-9R, an expired permit that included the projects considered here, show that ODFW did not often take listed species during fieldwork for these projects. Take occurred at rates of 0-7% of authorized levels and mortalities occurred at rates of 0-3% of authorized levels. This research would benefit listed species by providing information on fish population structure, abundance, genetics, disease occurrences, and species interactions. This information is used to direct management actions to benefit listed species.

2.5.3.5 Permit 16069-3M

The City of Portland requested to modify a permit that they currently hold, which authorizes them to take numerous listed species by backpack and boat electrofishing. Permit 16069-2R currently authorizes take of 150 juvenile, natural-origin UWR steelhead. The City of Portland requested to increase the number of mortalities authorized for juvenile, natural-origin UWR steelhead from one (in the current permit) to five fish annually (Table 34). The City of Portland does not request any increase in total take for UWR steelhead or any other species. The permit modification would not change the methods or otherwise change the scope of the ongoing research. The baseline take in this opinion (Table 24) includes the portion of take for this permit that currently is authorized and that would continue to be authorized in the modified permit.

Table 34. New take requested for Permit 16069-3M. Mortalities are also counted in the Requested Take column. C=Capture, M,T,S = Mark, Tag, Sample Tissue, R=Release.

ESU/DPS	Life Stage	Origin	Take Activity	Take	Mortalities
UWR steelhead	Juvenile	Natural	C/M,T,S/R	0	4

Given the methods proposed by the City of Portland, we expect at least 96% of juvenile UWR steelhead that are captured during research activities to survive with no long-term consequences. Their current permit authorizes the City of Portland to handle no more than 0.05% of juvenile UWR steelhead in the ESU, and the permit modification would not change the number of fish handled. The proposed research activities would kill no more than 0.0027% of natural-origin juveniles in the UWR steelhead DPS (Table 35).

Table 35. Percent of the ESU/DPS taken or killed by activities conducted under permit 16069-3M.

ESU/DPS	Life Stage	Origin	Take	Percent of ESU/DPS Taken	Mortality	Percent of ESU/DPS Killed
UWR Steelhead	Juvenile	Natural	0	0%	4	0.0027%

The proposed research would have a negligible impact on the abundance, productivity, spatial structure and diversity of UWR steelhead. Annual reports show that from 2012-2017 the City of Portland never killed more than 33% of the number authorized for any combination of ESU, life stage, and origin. During fieldwork they typically encountered few or no listed fish. The research would benefit the species by providing information to assess watershed health, freshwater habitat, effectiveness of restoration actions, and compliance with regulatory requirements.

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). We do not consider future federal actions that are unrelated to the proposed action in this section because they require separate consultation pursuant to section 7 of the ESA.

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

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 and the many private landholdings, make any analysis of cumulative effects difficult and speculative. However, projects affecting salmon, steelhead, and other listed fish species generally require federal funding or authorization to be completed, and so we can reasonably state that the vast majority of such actions in the region will undergo section 7 consultation.

In developing this biological opinion we considered efforts at the local, tribal, state, and national levels to conserve listed salmonids. These include the Lower Columbia Salmon Recovery and Fish and Wildlife Subbasin Plan (LCFRB 2010), the ESA Recovery Planning for Salmon and Steelhead in the Willamette and Lower Columbia River Basins (NMFS 2005b), the Lower Columbia River Conservation and Recovery Plan for Oregon Populations of Salmon and Steelhead (ODFW 2010), the Upper Willamette River Conservation and Recovery Plan for Chinook Salmon and Steelhead (ODFW 2011), the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (WDFW 2010), and the Status Review Updates for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest (Ford et al. 2011, NWFSC 2015). The result of that review was that salmon take—particularly associated with research, monitoring, and habitat restoration—is likely to continue to increase in the region for the foreseeable future. However, as noted above, all actions falling in those categories would also have to undergo consultation before they are allowed to proceed.

Non-federal activities are likely to continue to affect listed species and habitat within the action area. These cumulative effects in the action area are difficult to analyze because of this opinion's large geographic scope, the different resource authorities in the action area, the uncertainties associated with government and private actions, and the changing economies of the region. Whether these effects will increase or decrease is a matter of speculation; however, it seems likely that they will continue to increase as a general pattern over time. The primary cumulative effects will arise from those water quality and quantity impacts that occur as upland human population growth and development shift the pattern of water use and land use, creating more intense pressure on streams and rivers within this geography in terms of volume, velocities, pollutants, base flows, and peak flows. But the specifics of these effects, too, are impossible to predict at this time. 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 we can consider them "reasonably foreseeable" in an analysis of cumulative effects.

One final point to consider regarding cumulative effects is the length of time over which the proposed action would occur. These permits would be approved for up to five years. Considering the life history for all potentially affected species, the proposed actions could affect the listed species for up to four years after an action ceases, with effects diminishing gradually over that time. 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 time frame.

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 due to implementing the proposed action. In this section, we assess this risk by integrating information on the status of the species and critical habitat (Section 2.2), the environmental baseline (Section 2.4), the potential effects of the proposed action (Section 2.5), and cumulative effects (Section 2.6). We formulate the agency's biological opinion as to whether the proposed action is likely to: (1) reduce appreciably the likelihood of survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) diminish appreciably the value of designated or proposed critical habitat for the conservation of the species. We integrate the take proposed for the permits considered here with that for research permits previously authorized under ESA Sections 10(a)(1)(A) or 4(d) to determine total take. We then compare this total take for research permits to the estimated annual abundance of each species. As discussed in Section 2.5.2, effects of the proposed research on listed species are likely to be lower than the levels calculated in this analysis, because actual take described in annual reports typically is far less than the levels analyzed and authorized for research permits.

Table 36. Take and mortalities for proposed permits analyzed in this opinion ('Proposed') and proposed permits plus already authorized permits ('Proposed Plus Baseline') relative to abundance (LHAC[a] = Listed Hatchery Adipose Clipped, LHIA = Listed Hatchery Intact Adipose).

ESU/DPS	Life Stage	Origin	Abundance	Proposed Action				Proposed Plus Baseline			
				Proposed Take	Proposed % Taken	Proposed Mortality	Proposed % Killed	Total Take	Total % Take	Total Mortality	Total % Mortality
CR chum	Adult	Natural	10,644	0	0%	0	0%	52	0.49%	1	0.01%
	Adult	LHAC	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	Adult	LHIA	426	0	0%	0	0%	0	0%	0	0%
	Adult	Total	11,070	0	0%	0%	0%	52	0.47%	1	0.009%
	Juvenile	Natural	5,362,740	10	0.0002%	1	0.00002%	22,062	0.41%	314	0.006%
	Juvenile	LHAC	6,512	10	0.15%	1	0.016%	10	0.15%	1	0.02%
	Juvenile	LHIA	648,047	0	0%	0	0%	562	0.09%	18	0.003%
	Juvenile	Total	6,017,299	20	0.0003%	2	0.00003%	22,634	0.38%	333	0.006%
LCR Chinook	Adult	Natural	29,469	0	0%	0	0%	1,032	3.50%	13	0.04%
	Adult	LHAC	37,286	0	0%	0	0%	933	2.50%	21	0.06%
	Adult	LHIA	1,308	0	0%	0	0%	62	4.74%	2	0.15%
	Adult	Total	68,063	0	0%	0	0%	2,027	2.98%	36	0.05%
	Juvenile	Natural	12,164,845	309	0.003%	124	0.001%	1,264,665	10.40%	15,631	0.13%
	Juvenile	LHAC	34,347,631	121	0.0004%	3	0.00001%	88,654	0.26%	1,929	0.006%
	Juvenile	LHIA	1,204,984	5	0.0004%	5	0.0004%	483	0.04%	53	0.004%
	Juvenile	Total	47,717,460	435	0.0009%	132	0.0003%	1,353,802	2.84%	17,613	0.04%
LCR coho	Adult	Natural	32,986	0	0%	0	0%	3,345	10.14%	34	0.10%
	Adult	LHAC	22,430	0	0%	0	0%	3,003	13.39%	56	0.25%
	Adult	LHIA	652	0	0%	0	0%	250	38.32%	4	0.61%
	Adult	Total	56,068	0	0%	0	0%	6,598	11.77%	94	0.17%
	Juvenile	Natural	639,015	165	0.03%	5	0.0008%	229,540	35.92%	3,053	0.48%
	Juvenile	LHAC	7,424,506	50	0.0007%	3	0.00004%	70,218	0.95%	2,177	0.03%
	Juvenile	LHIA	215,952	0	0%	0	0%	2,377	1.10%	128	0.06%
	Juvenile	Total	8,279,472	215	0.003%	8	0.0001%	302,135	3.65%	5,358	0.07%

Table 36, continued.

ESU/DPS	Life Stage	Origin	Abundance	Proposed Action				Proposed Plus Baseline			
				Proposed Take	Proposed % Taken	Proposed Mortality	Proposed % Killed	Total Take	Total % Take	Total Mortality	Total % Mortality
LCR steelhead	Adult	Natural	12,920	0	0%	0	0%	3,697	28.61%	36	0.28%
	Adult	LHAC	21,882	0	0%	0	0%	169	0.77%	4	0.02%
	Adult	LHIA	415	0	0%	0	0%	0	0.00%	0	0%
	Adult	Total	35,217	0	0%	0	0%	3,866	10.98%	40	0.11%
	Juvenile	Natural	323,607	142	0.04%	5	0.002%	66,706	20.61%	1,269	0.39%
	Juvenile	LHAC	1,194,301	0	0%	0	0%	56,695	4.75%	1,144	0.10%
	Juvenile	LHIA	22,649	0	0%	0	0%	0	0.00%	0	0%
	Juvenile	Total	1,540,557	142	0.009%	0	0%	123,401	8.01%	2,413	0.16%
UWR Chinook	Adult	Natural	11,443	5	0.04%	0	0%	259	2.26%	2	0.02%
	Adult	LHAC	34,353	0	0%	0	0%	243	0.71%	6	0.02%
	Adult	LHIA	101	0	0%	0	0%	0	0.00%	0	0%
	Adult	Total	45,897	5	0.01%	0	0%	502	1.09%	8	0.02%
	Juvenile	Natural	1,275,681	1,001	0.08%	221	0.02%	54,027	4.24%	1,130	0.089%
	Juvenile	LHAC	5,543,371	174	0.003%	2	0.00004%	10,333	0.19%	257	0.005%
	Juvenile	LHIA	16,278	9	0.06%	9	0.06%	47	0.29%	17	0.10%
	Juvenile	Total	6,835,329	1,184	0.02%	232	0.004%	64,407	0.94%	1,404	0.02%
UWR steelhead	Adult	Natural	4,280	5	0.12%	0	0%	281	6.57%	2	0.047%
	Adult	LHAC	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	Adult	LHIA	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	Adult	Total	4,280	5	0.12%	0	0%	281	6.57%	2	0.05%
	Juvenile	Natural	143,898	755	0.53%	24	0.02%	7,029	4.88%	227	0.16%
	Juvenile	LHAC	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	Juvenile	LHIA	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	Juvenile	Total	143,898	755	0.52%	24	0.02%	7,029	4.88%	227	0.16%

Table 36, continued.

ESU/DPS	Life Stage	Origin	Abundance	Proposed Action				Proposed Plus Baseline			
				Proposed Take	Proposed % Taken	Proposed Mortality	Proposed % Killed	Total Take	Total % Take	Total Mortality	Total % Mortality
S Eulachon	Adult	Natural	77,598,015	100	0.0001%	2	0.000003%	5,965	0.01%	3,006	0.004%
	Juvenile	Natural	n/a	0	n/a	0	n/a	405	n/a	356	n/a
S green sturgeon	Adult	Natural	1,348	1	0 %	0	0 %	196	14.54%	5	0.37%
	Juvenile	Natural	n/a	0	n/a	0	n/a	2,055	n/a	118	n/a
	Larvae+Egg	Natural	n/a	0	n/a	0	n/a	8,607	n/a	1,176	n/a

[a]We estimate the abundance of (LHAC) adults using data on (1) abundance of all hatchery adults (LHAC + LHIA) and (2) the ratio of LHAC:LHIA for juveniles, assuming equal survival of LHAC and LHIA juveniles to the adult life stage.

Salmonids

The proposed research activities would cause very low rates of take and mortality for salmon and steelhead (Table 36). The effects of the proposed research are best seen in the context of potential mortality. .Among all of the proposed permits, researchers did not request authorization to kill any adult salmonids. The vast majority of adult and juvenile fish that researchers capture and release would recover quickly with no long-term physiological, behavioral, nor reproductive effects. The proposed research projects may kill, in sum, as much as 0.06% of the fish from any component of any listed salmonid species; that component is juvenile hatchery-origin (intact-adipose) UWR Chinook salmon, with 9 mortalities requested for permit 20713. Researchers request to kill up to 0.02% of natural-origin UWR Chinook salmon (221 fish) for permits 20713, 21507, and 20492-2M, collectively. Similarly, researchers request to kill up to 0.02% of natural-origin UWR steelhead (24 fish) for permits 20713, 21507, 20492-2M, and 16069-3M, collectively. And a request to kill one hatchery-origin (LHAC) juvenile CR chum salmon for permit 20713 translates to a mortality rate of 0.016%. For other ESU/DPSs, the proposed mortality rates are always less than 0.01% of estimated abundance for each component. These very small effects would be spread across much of the range of each affected ESU/DPS (see Section 2.5.2).

When considering effects of the proposed research added to previous ESA Sections 10(a)(1)(A) and 4(d) research authorizations (i.e., the baseline), total effects of research on the listed species remain small. We estimate that the proposed plus baseline mortalities would always be less than 0.16% of the total (natural- and hatchery-origin) abundance of juveniles for any ESU/DPS – typically far less. Considering both hatchery- and natural-origin fish together, the highest mortality rates for juvenile salmonids occur for LCR steelhead (0.16%) and UWR steelhead (0.16%). The highest mortality rates for adults occurs for LCR coho (0.17%); however, none of the permits considered in this opinion request to kill any adult salmonid (Table 36).

The low abundance of natural-origin fish relative to hatchery-origin fish for some ESU/DPSs means that mortality rates tend to be higher for the natural-origin component. This is true for the natural-origin component of LCR Chinook juveniles (0.13% mortality rate), LCR coho juveniles (0.48% mortality rate), and LCR steelhead adults (0.28%) and juveniles (0.39%), relative to the hatchery-origin components. A few mortalities of natural origin adults also could occur annually for CR chum, LCR Chinook, LCR coho, UWR Chinook, and UWR steelhead. As stated previously, all of these adult mortalities were authorized previously and are not a part of the proposed action described in this opinion. When requested take is combined with the baseline, the potential mortality would be no more than 0.48 of a percent of the abundance for naturally produced adults or juveniles. Thus the projected mortality for juvenile and adult life stages from all research activities represent only fractions of a percent of the species' total abundance.

Although mortality rates remain low, we note that listed salmonids in the Lower Columbia Recovery domain are subject to high rates of research-related take. Take rates range from 10 to 36% of the estimated abundance for natural-origin juvenile LCR Chinook, natural- and hatchery-origin adult LCR coho, natural-origin juvenile LCR coho, and natural-origin adult and juvenile LCR steelhead (Table 36). Most of this take occurs through capturing, handling, and then releasing fish.

Our analysis of effects is likely to be conservative. As discussed previously, permit applications tend to overestimate actual take so that researchers are not likely to exceed their take authorization. In addition, we use conservative estimates of juvenile abundance. While we describe potential effects on all juvenile life stages (smolts, suyearlings, parr, and fry) as effects on “juveniles,” we estimate abundance of juveniles using data for smolts (Table 25). Sub-yearlings, parr, and fry are life stages that represent multiple spawning years and have many more individuals than survive to the smolt life stage – perhaps as much as an order of magnitude more. Even if the worst case were to occur and the researchers were to take the maximum estimated number of fish, the effects of the losses would be very small, and because they would be spread out over the species’ entire range, they would be restricted to reductions in the species’ total abundance and productivity. Effects on spatial structure and diversity would be unmeasurably small and not assignable to any individual population. In addition, the small reductions in abundance and productivity would be offset to some degree by the information to be gained – information that in most cases would be used to protect salmon and steelhead and promote their recovery.

Eulachon

For eulachon, the proposed permits did not request any directed mortalities. Researchers requested to collect up to 100 eulachon and kill up to 2 of these fish during sampling activities for permit 20713. Mortalities for the proposed plus previously authorized research permits represent 0.004% of the estimated abundance of eulachon (Table 36). In practice, researchers typically capture and kill fewer eulachon than proposed. Annual reports for 2009 to 2015 show that total number of eulachon captured and killed were 37.7% and 38.4%, respectively, of levels authorized for Section 10(a)(1)(A) research permits in Oregon and Washington.

Green Sturgeon

Researchers requested to take one adult green sturgeon during sampling activities for permit 20713. Researchers did not request any mortalities for green sturgeon. Mortalities for previously authorized research permits represent 0.37% of the estimated adult abundance of green sturgeon (Table 36). Most permit holders do not expect to encounter the species but may still request low levels of take to allow for the unlikely event that they encounter green sturgeon. Thus, the actual take for this species has always been far below what was authorized.

Critical Habitat

As noted earlier, we do not expect the individual actions to have any appreciable effect on any listed species’ critical habitat. This remains true for all the proposed permit actions taken together. The short duration, minimal intrusion, and overall lack of measureable effect of the actions on critical habitat signify that the proposed permit actions would have no discernible impact on critical habitat.

Summary

No listed species currently has all of its biological requirements met, as we discussed in Section 2.2. For these species to recover, there must be substantial improvement in habitat and other factors affecting survival. While the proposed research activities would have some negative effect on abundance and productivity for the species considered here, these effects are so small as to be negligible. Research activities have never been identified as a threat to listed fish in the Pacific Northwest. We therefore conclude that the proposed research activities, individually and collectively, do not threaten the listed species.

While specific future cumulative effects are uncertain, cumulative effects will likely continue to be negative. The effects of climate change are also likely to continue to be negative. However, the very small effects from the proposed research activities on abundance and productivity, and even smaller effects on spatial structure and diversity, will not exacerbate any negative cumulative effects on the listed species.

The proposed research activities may benefit these species by providing information on status, trends, and ecological requirements. These data inform NMFS' 5-year status reviews for listed species and species recovery efforts. For example, juvenile fish trapping studies inform population inventories, tagging efforts increase our knowledge of fish migration timing and survival, and fish passage studies enhance our understanding of behavior and survival as fish migrate past dams and through reservoirs. The resulting information improves our understanding of these species' life histories, biological requirements, genetics, migration timing, responses to human activities, and freshwater and marine survival. By issuing research authorizations, NMFS facilitates science-based management of fisheries resources. 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.

Additionally, the proposed research would contribute data to an information base that is, to some extent, legally mandated. Though no law mandates the specific work being done in the proposed research actions, Ssection 4(c)(2) of the ESA requires that we examine the status of each listed species every five years determine whether each listed species should be: (a) removed from the list, (b) have its status changed from threatened to endangered, or (c) have its status changed from endangered to threatened. Thus it is legally incumbent upon us to monitor the status of every species considered here and the research program, as a whole, is one of the primary means we have of doing that.

We expect the detrimental effects on the species to be minimal and those impacts would only be seen in terms of slight reductions in juvenile and adult abundance and productivity. Because these reductions are so slight, the actions—even in combination—would have no appreciable effect on the species' diversity or structure. Habitat effects from the proposed actions would be negligible. Moreover, we expect the actions to provide lasting benefits for the listed fish and to contribute information that is needed to fulfill our mandate under the ESA.

2.8 Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' biological opinion that the proposed actions are not likely to jeopardize the continued existence of LCR Chinook, UWR Chinook, CR chum, LCR coho, LCR steelhead, UWR steelhead, eulachon, or S green sturgeon or destroy or adversely modify designated critical habitat for these species.

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 incidental take statement.

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

There is no incidental take for the actions considered in this opinion. The take associated with these scientific research permits is direct 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. Nonetheless, one of the purposes of an incidental take statement is to lay out the amount or extent of take beyond which individuals carrying out an action cannot go without being in possible violation of section 9 of the ESA. That purpose is fulfilled here by the amounts of direct take laid out in the effects section above (2.5). Those amounts – displayed in the various permits' effects analyses – constitute hard limits on both the amount and extent of take the permit holders would be allowed in a given year. This concept is also reflected in the reinitiation clause just below.

2.10 Reinitiation of Consultation

As 50 CFR 402.16 states, reinitiation of formal consultation is required 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 incidental take statement 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 agency action is subsequently modified in a manner that causes an effect on the listed species or critical habitat that was not considered in this opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

As noted above, in the context of this opinion, there is no incidental take anticipated and the reinitiation trigger set out in (1) is not applicable. However, 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 (U.S. FWS 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.

SR Killer Whales Determination

The SR killer whale DPS composed of J, K, and L pods was listed as endangered under the ESA on November 18, 2005 (70 FR 69903). The final rule listing SR killer whales as endangered identified several potential factors that may have caused their decline or may be limiting recovery. These factors include quantity and quality of prey, toxic chemicals which accumulate in top predators, and disturbance from sound and vessel traffic. The rule also identified oil spills as a potential risk factor for this species. The final recovery plan includes more information on these potential threats to SR killer whales (NMFS 2008).

NMFS published the final rule designating critical habitat for SR killer whales on November 29, 2006 (71 FR 69054). Critical habitat includes approximately 2,560 square miles of inland waters including Puget Sound, but does not include areas with water less than 20 feet deep relative to extreme high water. The physical or biological features (PBFs) of SR killer whale critical habitat are: (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.

SR killer whales spend considerable time in the Georgia Basin from late spring to early autumn, with concentrated activity in the inland waters of Washington State around the San Juan Islands, and then move south into Puget Sound in early autumn. Pods make frequent trips to the outer coast during this season. In the winter and early spring, SR killer whales move into the coastal waters along the outer coast from Southeast Alaska south to central California (NMFS 2008a, Hilborn et al. 2012). Half of the research activities included in the proposed actions would occur in freshwater areas where SR killer whales do not occur; and therefore, the proposed action may only indirectly affect SR killer whales by reducing their prey. The remainder of the research would occur in the critical habitat of SR killer whales (i.e. Puget Sound, Pacific Ocean) but direct interactions among the vessels and their capture equipment would be of an extremely low likelihood, therefore the potential for effects is discountable. This opinion would not authorize marine mammal take, nor has such take ever been observed in the past when similar activities were conducted in the action area. As a whole, the proposed action would only have discountable effects on marine mammals.

SR killer whales consume a variety of fish and one species of squid, but salmon, and Chinook salmon in particular, are their primary prey (review in NMFS 2008a). Ongoing and past diet studies of SR killer whales conduct sampling during spring, summer and fall months in inland waters of Washington State and British Columbia (i.e., Ford and Ellis 2006; Hanson et al. 2010; ongoing research by NWFSC). Genetic analysis of these samples indicate that when SR killer whales are in inland waters from May to September, they consume Chinook salmon stocks that originate from regions including the Fraser River (including Upper Fraser, Mid Fraser, Lower Fraser, N. Thompson, S. Thompson and Lower Thompson), Puget Sound (N. and S. Puget Sound), the Central BC Coast, W. and E. Vancouver Island, and Central Valley California (Hanson et al. 2010). Other research and analysis provides additional information on the age of prey consumed (Hanson unpubl. data, as summarized in Ward et al. unpubl. report), confirming that SR killer whales predominantly consume larger (i.e. older) Chinook salmon when in inland waters (May through September).

The proposed actions may affect SR killer whales indirectly by reducing availability of their primary prey, Chinook salmon. As described in the effects analysis for salmonids, up to 364 juveniles and no adults from the LCR Chinook and UWR Chinook ESUs may be killed during the proposed research. Directed mortalities account for 334 of these mortalities.

The ten-year average smolt-to-adult ratio from coded wire tag returns is no more than 0.5% for hatchery Chinook in the Columbia Basin (http://www.cbr.washington.edu/cwtSAR/). Average smolt-to-adult survival of naturally produced Chinook in the Columbia Basin is 1% (Schaller et al. 2007). If one percent of the 83 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 3.6 adult Chinook salmon per year across a 3-5 year period after the research activities occurred (i.e., by the time these juveniles would have grown to be adults and available prey of killer whales). Additionally, these take estimates are likely an overestimate of the actual number of Chinook salmon that would be taken during research activities, and thus the actual reduction in prey available to the whales is likely smaller than the stated figure.

Given the total quantity of prey available to SR killer whales throughout their range, this reduction in prey is negligible (based on NMFS previous analysis of the effects of salmon harvest on SR killer whales; NMFS 2008). Therefore, the anticipated take of salmonids associated with the proposed actions would result in an insignificant reduction in adult equivalent prey resources for SR killer whales.

Future loss of Chinook salmon from Chinook salmon ESU populations could affect the prey PBF of designated critical habitat. As described above, however, considering the estimate of up to 3.6 adult equivalent Chinook salmon that could be taken by the proposed actions, and the total amount of prey available in the critical habitat, the reduction would be insignificant and would not affect the conservation value of the critical habitat. Proposed research activities would have discountable effects on the water quality or passage PBFs for SR killer whales.

Therefore, we find that potential adverse effects of the proposed research on SR killer whales are discountable or insignificant and we determine 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 the EFH assessment provided by the NMFS and descriptions of EFH for Pacific Coast salmon (PFMC 2014) contained in the fishery management plans developed by the Pacific Fishery Management Council (PFMC) and approved by the Secretary of Commerce.

3.1 Essential Fish Habitat Affected by the Project

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

3.2 Adverse Effects on Essential Fish Habitat

As the Biological Opinion above describes, the proposed research actions are not likely, singly or in combination, to adversely affect the habitat upon which Pacific salmon, groundfish, and coastal pelagic species, depend. 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 NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH Conservation Recommendations [50 CFR 600.920(l)].

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

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

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are the applicants and funding/action agencies listed on the first page. The agencies, applicants, and the American public will benefit from the consultation.
Individual copies of this opinion were made available to the applicants and it will be posted on the Public Consultation Tracking System website (https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts). The format and naming adheres to conventional standards for style.

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 contain more background on information sources and quality.

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

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

5. REFERENCES

5.1 Federal Register Notices

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

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

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

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

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

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February 11, 2016 (81 FR 7214). Final Rule: Interagency Cooperation—Endangered Species Act of 1973, as Amended; Definition of Destruction or Adverse Modification of Critical Habitat.

February 11, 2016 (81 FR 7414). Final Rule: Listing Endangered and Threatened Species and Designating Critical Habitat; Implementing Changes to the Regulations for Designating Critical Habitat.

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