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

Opinion on the Issuance of Five Scientific Research Permits Affecting Five Salmonid Species in the Interior Columbia River Basin Beginning in 2017

NMFS Consultation Number: **WCR-2017-7689**

Action Agencies:	The National Marine Fisheries Service (NMFS) The Bonneville Power Administration (BPA) The U.S. Bureau of Indian Affairs (BIA)

Affected Species and Determinations:

Listed Species	Status	Likely to Adversely affect Species or Critical Habitat?	Likely to Jeopardize the Species?	Likely to Adversely Affect Critical Habitat?	Likely to Destroy or Adversely Modify Critical Habitat?
Upper Columbia River (UCR) Chinook Salmon (*Oncorhynchus tshawytscha)*	**Endangered**	**Yes.**	**No.**	**Yes.**	**No.**
UCR Steelhead (*O. mykiss*)	**Threatened**	**Yes.**	**No.**	**Yes.**	**No.**
Snake River Spring/Summer Chinook Salmon (*O. tshawytscha*)	**Threatened**	**Yes.**	**No.**	**Yes.**	**No.**
Snake River Steelhead (*O. mykiss*)	**Threatened**	**Yes.**	**No.**	**Yes.**	**No.**
Middle Columbia River (MCR) Steelhead (*O. mykiss*)	**Threatened**	**Yes.**	**No.**	**Yes.**	**No.**
Southern Resident Killer Whales (*Orcinus orca*)	**Threatened**	**No.**	**No.**	**Yes.**	**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 #WCR-2017-7689

Consultation Conducted By: National Marine Fisheries Service, Northwest Region

Issued By: Chris E Yates

For Barry Thom
Regional Administrator

Date: September 29, 2017

Administrative record number: 151422WCR2017PR00217

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1.0 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 this biological opinion (opinion) in accordance with section 7(b) of the ESA of 1973, as amended (16 U.S.C. 1531 et seq.) and implementing regulations at 50 CFR 402. It constitutes our review of five proposed 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permit applications and is based on information provided in the applications for the proposed permits, published and unpublished scientific information on the biology and ecology of listed salmonids in the action areas, and other sources of information.

We also completed an Essential Fish Habitat (EFH) consultation on the proposed actions. It was prepared in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA)(16USC 1801, et seq.) and implementing regulations at 50 CFR 600.

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available through NMFS' Public Consultation Tracking System. 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 Protected Resources Division (PRD) of NMFS's West Coast Region received five applications to conduct scientific research in the Pacific Northwest. All of the applications are to renew previously approved work. The applicants and the associated permit numbers are laid out in the following table.

Table 1. The Applications (and their Associated Applicants) Considered in this Biological Opinion.

Permit Number	*Applicant*
Permit 1379 – 7R	The Columbia River Inter-Tribal Fish Commission (CRITFC)
Permit 13381 – 3R	The Northwest Fisheries Science Center (NWFSC)
Permit 13382 – 3R	The NWFSC
Permit 17222 – 2R	The Confederated Tribes of the Warm Springs Reservation of Oregon (CTWSRO)
Permit 17306 – 2R	The Oregon Department of Fish and Wildlife (ODFW)

Because the permit requests are similar in nature and duration and are largely expected to affect the same listed species, we combined them into a single consultation pursuant to 50 CFR 402.14(c). All five of the applications are requests to renew research that has been previously approved; in three of the cases, the research has been previously approved at least twice. As noted on the cover page, the affected species are upper Columbia River (UCR) spring Chinook, UCR steelhead, Snake River (SR) spr/sum Chinook, and middle Columbia River (MCR) steelhead (and their critical habitat).

Because they may affect listed Chinook salmon, the proposed actions also have the potential to affect southern resident killer whales and their critical habitat by diminishing the whales’ prey base. However, we concluded that because the proposed activities would have such an insignificant effect on that prey base, they were not likely—even in combination—to adversely affect SR killer whales or their critical habitat. The full analysis for this conclusion is found in the "Not Likely to Adversely Affect" determination section (2.11).

We received the first permit request (Permit 1379-7R) in the form of an application on December 7, 2016; the other applications came in over the following four months. When the applications arrived, we determined that all were incomplete to greater or lesser degrees. After communicating with the applicants, all the applications were determined to be complete and we published notice in the *Federal Register* asking for public comment on the applications—82 FR 24304 (May 26, 2017). All of this took place after a period of pre-consultation. The public was then given 30 days to comment on the applications after each publication and, once that period closed, we initiated consultation on June 27, 2017. The full consultation histories for the five actions are not directly relevant to this analysis and so are not detailed here. That history is documented in the docket for this consultation, which is maintained by the PRD in Portland, Oregon.

1.3 Proposed Federal Actions

“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.

Therefore we are proposing to issue five separate research permits pursuant to section 10(a)(1)(A) of the ESA. The permits would variously authorize researchers to take endangered UCR spring Chinook, threatened UCR steelhead, threatened SR spr/sum Chinook, threatened SR steelhead, and threatened MCR steelhead. “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 analysis here therefore examines the take that may affect the evolutionarily significant units (ESUs) and distinct population segments (DPSs) that are the subject of this opinion.[1]

Permit 1379 – 7R

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

The research, as a whole, would benefit listed fish by helping managers set in-river and ocean harvest regimes so that they have minimal impacts on listed populations. It would also help managers prioritize projects in a way that gives maximum benefit to listed species–including

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[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, we use the terms “artificially propagated” and “hatchery” interchangeably in the opinion (and the terms “naturally propagated” and “natural”).

projects designed to help the listed fish recover. The researchers would use beach- and stick seines to capture and tag juvenile fish in the Hanford reach of the Columbia River and capture fish during mid-water trawls in Lake Wenatchee. Those fish that are not immediately released upon capture would be transported to a holding facility where they would be anesthetized, examined for marks, adipose-clipped, coded wire tagged, allowed to recover, and released. The researchers would also collect, anesthetize, tissue-sample, and tag adult salmonids at Tumwater and Wells Dams in Washington State. The CRITFC researchers do not intend to kill any of the fish being captured but a small number may die as an unintended result of the activities.

Permit 13381 – 3R

The Northwest Fisheries Science Center (NWFSC) is seeking to renew their permit to annually take natural juvenile SR spring/summer Chinook salmon and SR steelhead in various places in the Salmon River drainage in Idaho and at Little Goose and Lower Granite Dams on the lower Snake River. The purpose of the research is to continue monitoring parr-to-smolt survival and outmigration behavior in SR wild spring/summer Chinook salmon populations from Idaho. Steelhead juveniles that are inadvertently collected would also be tagged to help supplement an ongoing Idaho Department of Fish and Game study. The research would benefit the fish by continuing to supply managers with the information they need to budget water releases at hydropower facilities in ways designed to help protect migrating juvenile salmonids. The information gained would also be used to build long-term data sets on parr-to-smolt migration behavior and survival rates. This information, coupled with water quality, weather, and climate data, is intended to provide a foundation for understanding these populations' life histories—the knowledge of which is critical to building effective recovery actions. The listed fish would be captured (using seines, dip nets, and electrofishing), anesthetized, tagged, and released. A portion of these fish would also be re-captured at a smolt bypass facility, anesthetized, weighed, measured, and released. The researchers do not intend to kill any of the fish being captured, but a small percentage may die as an unintended result of the research activities.

Permit 13382 – 3R

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

The purposes of the research are therefore (1) to continue monitoring the effects of supplementation among steelhead and spring/summer Chinook salmon populations in Idaho, and (2) measure cardiac performance in juvenile salmonids. The research would benefit the fish by continuing to supply managers with the information they need when seeking to use hatchery programs to conserve listed species. In addition, the researchers will gather important data on juvenile salmonids’ stress response to increased water temperature—that information will be used to help evaluate survival rates and sublethal effects in the event that climate change causes stream temperatures to rise in the Columbia basin. The researchers do not intend to kill any of the fish being captured, but some may die as an unintended result of the process.

Permit 17222 – 2R

The Confederated Tribes of the Warm Springs Reservation of Oregon (CTWSRO) are seeking a five-year permit to annually take MCR steelhead during the course of research designed to determine the feasibility of PIT-tagging juvenile summer/fall Chinook (a non-listed species) in the Deschutes River, Oregon. The purpose of the research is to generate population metrics such as juvenile growth rates, smolt-to-adult return ratios, size/condition at emigration, etc. This information would be used to develop performance indicators for monitoring the fishes’ status and trends. This research would benefit listed species by helping managers develop a picture of river health and salmonid population trends in the Deschutes River. That information, in turn, would be used in recovery planning efforts and generally incorporated into resource management decisions that may affect the Deschutes River. The researchers intend to use seines to capture the fish and all captured MCR steelhead will be released immediately. The researchers do not propose to kill any of the listed salmonids being captured, but a small number may die as an unintended result of the activities.

Permit 17306 – 2R

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

Common Elements among the Proposed Actions

Research permits lay out the conditions to be followed before, during, and after the research activities are conducted. These conditions are intended to (a) manage the interaction between scientists and listed salmonids by requiring that research activities be coordinated among permit holders, and between permit holders and NMFS, (b) minimize impacts on listed species, and (c) ensure that NMFS receives information about the effects the permitted activities have on the species concerned. All research permits we issue 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 conditions in this 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. Each researcher must stop capturing and handling listed fish if the water temperature exceeds 70 degrees Fahrenheit at the capture site. Under these conditions, listed fish may only be identified and counted. Additionally, electrofishing is not permitted if water temperatures exceed 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 just determining fish presence.

9. The permit holder using backpack electrofishing equipment must comply with NMFS' Backpack Electrofishing Guidelines (June 2000) available at http://www.nwr.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. Also, NMFS may include conditions specific to the proposed research in certain permits.

Finally, NMFS will use the annual reports to monitor the actual number of listed fish taken annually in the scientific research activities and will adjust annual 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.

2.0 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, Federal agencies must ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, Federal action agencies consult with NMFS and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provides an opinion stating how the agency’s actions would affect listed species and their critical habitat. If incidental take is expected, section 7(b)(4) requires NMFS to provide an incidental take statement (ITS) that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures and terms and conditions to minimize such impacts.

2.1 Analytical Approach

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

This biological opinion relies on the definition of "destruction or adverse modification," which “means a direct or indirect alteration that appreciably diminishes the value of critical habitat 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 critical habitat designations for the species considered here used the term primary constituent element (PCE) or essential features. The new critical habitat regulations (81 FR 7414) replace this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a ‘‘destruction or adverse modification’’ analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

Section 4(d) protective regulations prohibit taking naturally spawned fish and listed hatchery fish with an intact adipose fin but do not prohibit taking listed hatchery fish that have had their adipose fins removed (70 FR 37160, 71 FR 834, 73 FR 7816). 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 determine the effects of the action on each species as a whole.

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 adversely affected by the proposed action.
- Describe the environmental baseline in the action area.
- Analyze the effects of the proposed action on both species and their habitat using an “exposure-response-risk” approach. For research actions, exposure equates to capturing and handling the animals (including tagging, etc.); response is the degree to which

they're affected by the actions (e.g., injured or killed); and risk relates to what those responses mean at the individual, population, and species levels.
- Describe any cumulative effects in the action area.
- Integrate and synthesize the above factors to assess the risk that the proposed action poses to species and critical habitat.
- Reach jeopardy and adverse modification conclusions.
- If necessary, define a reasonable and prudent alternative to the proposed action.

2.2 Rangewide Status of the Species and Critical Habitat

This opinion examines the status of each species that would be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02. The opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the current function of the essential physical and biological features 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 distinct population segments (DPS) in 1991 (56 FR 58612). It states that a population or group of populations is considered an "evolutionarily significant unit" (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. In 1996 NMFS and the U.S. Fish and Wildlife Service adopted a joint DPS policy, and in 2005 NMFS began applying that policy to *O. mykiss* (steelhead). Hence, UCR Chinook salmon, SR fall Chinook salmon, and SR spr/sum Chinook salmon constitute ESUs of the species *O. tshawytscha*; UCR steelhead, MCR steelhead, and SR steelhead constitute DPSs of the species *O. mykiss*; and SR sockeye salmon constitute an ESU of the species *O. nerka*. These ESUs and DPSs include natural-origin populations and hatchery populations, as described in the species status sections below.

2.2.1 Climate Change

One factor affecting the status of the species considered here, and aquatic habitat at large, is climate change.

As reviewed in Independent Scientific Advisory Board (ISAB) (2007), the current status of salmon and steelhead species and their critical habitat in the Pacific Northwest has been influenced by climate change over the past 50-100 years and this change is expected to continue into the future. Average annual Northwest air temperatures have increased by approximately 1°C since 1900, which is nearly twice that for the last 100 years, indicating an increasing rate of change. The latest climate models project a warming of 0.1 to 0.6°C per decade over the next century. This change in surface temperature has already modified, and is likely to continue to modify, freshwater, estuarine, and marine habitats of salmon and steelhead, including designated critical habitat. Consequently, abundance, productivity, spatial distribution, and diversity of salmonid life stages occupying each type of affected habitat is likely to be further modified, generally in a detrimental manner. There is still a great deal of uncertainty associated with predicting specific changes in timing, location and magnitude of future climate change. It is also likely that the intensity of climate change effects on salmon and steelhead will vary by geographic area.

Precipitation trends during the next century are less certain than for temperature but more precipitation is likely to occur during October through March and less during summer months, and more of the winter precipitation is likely to fall as rain rather than snow (ISAB 2007; USGCRP 2009). Where snow occurs, a warmer climate will cause earlier runoff so stream flows in late spring, summer, and fall will be lower and water temperatures will be warmer (ISAB 2007; USGCRP 2009).

Higher winter stream flows increase the risk that winter floods in sensitive watersheds will damage spawning redds and wash away incubating eggs. Earlier peak stream flows will also flush some young salmon and steelhead from rivers to estuaries before they are physically mature, increasing stress and the risk of predation. Lower stream flows and warmer water temperatures during summer will degrade summer rearing conditions, in part by increasing the prevalence and virulence of fish diseases and parasites (USGCRP 2009). Other adverse effects are likely to include altered migration patterns, accelerated embryo development, premature emergence of fry, variation in quality and quantity of tributary rearing habitat, and increased competition and predation risk from warm-water, non-native species (ISAB 2007).

The earth's oceans are also warming, with considerable interannual and inter-decadal variability superimposed on the longer-term trend (Bindoff *et al.* 2007). Historically, warm periods in the coastal Pacific Ocean have coincided with relatively low abundances of salmon and steelhead, while cooler ocean periods have coincided with relatively high abundances (Scheuerell and Williams 2006; Zabel *et al.* 2006; USGCRP 2009). Ocean conditions adverse to salmon and steelhead may be more likely under a warming climate (Zabel *et al.* 2006). Moreover, as atmospheric carbon emissions increase, increasing levels of carbon are absorbed by the oceans, changing the pH of the water. Marine fish species have exhibited negative responses to ocean acidification conditions that include changes in growth, survivorship, and behavior. Marine phytoplankton, which are the base of the food web for many oceanic species, have shown varied responses to ocean acidification that include changes in growth rate and calcification (Feely *et al.* 2012).

2.2.2 Status of the Species

For Pacific salmon and steelhead, NMFS commonly uses four parameters to assess the viability of the populations that, together, constitute the species: spatial structure, diversity, abundance, and productivity (McElhany et al. 2000). These "viable salmonid population" (VSP) criteria therefore encompass the species' "reproduction, numbers, or distribution" as described in 50 CFR 402.02. When a population or species has sufficient spatial structure, diversity, abundance, and productivity, it will generally be able to maintain its capacity to adapt to various environmental conditions and sustain itself in the natural environment. These attributes are influenced by survival, behavior, and experiences throughout a species' entire life cycle, and these characteristics, in turn, are influenced by habitat and other environmental conditions.

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

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

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

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

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

A species' status thus is a function of how well its biological requirements are being met: the greater the degree to which the requirements are fulfilled, the better the species' status. Information on the status and distribution of all the species considered here can be found in a number of documents: the status review prepared by the NWFSC (Waples et al. 1991); the Status Review of West Coast Steelhead from Washington, Idaho, Oregon, and California (Busby et al.1996); the Status Review Update for West Coast Steelhead from Washington, Idaho, Oregon, and California (NMFS 1997); the Preliminary Conclusions Regarding the Updated Status of Listed ESUs of West Coast Salmon and Steelhead (NMFS 2003); the Updated Status of Federally Listed ESUs of West Coast Salmon and Steelhead (Good et al. 2005); and most importantly for this opinion, the Status Review Update for Pacific Salmon and Steelhead Listed Under the Endangered Species Act: Northwest and 2015 (Ford 2011 and NWFSC 2015, respectively). These documents (and other relevant information) may be found at www.nwr.NOAA.gov; the discussions they contain are summarized below. For the purposes of our later analysis, all the species considered here require functioning habitat and adequate spatial structure, abundance, productivity, and diversity to ensure their survival and recovery in the wild.

Upper Columbia River Chinook

On March 24, 1999, NMFS first listed UCR spring-run Chinook salmon as an endangered species under the ESA (NOAA 1999). In that listing determination, NMFS concluded that the UCR spring-run Chinook salmon were in danger of extinction throughout all or a significant portion of their range. When NMFS re-examined the status of the UCR Chinook in 2005 (70 FR 37160), we came once again to the conclusion that the species warranted listing as endangered. On August 15, 2011, NMFS announced the results of an ESA 5-year review UCR Chinook (76 FR 50448). After reviewing new information on the viability of this species, ESA section 4 listing factors, and efforts being made to protect the species, NMFS concluded that this species should retain its endangered listing classification. A recovery plan is available for this species (Upper Columbia Salmon Recovery Board 2007).

Spatial Structure and Diversity

The UCR spring-run Chinook salmon inhabit tributaries upstream from the Yakima River to Chief Joseph Dam. Adult UCR Chinook return to the Wenatchee River from late March through early May, and to the Entiat and Methow Rivers from late March through June. These three areas comprise the species' three populations—there was one other considered, the Okanogan, but it was determined to have been extirpated. Most adults return after spending two years in the ocean, although 20 percent to 40 percent return after three years at sea. Peak spawning for all three populations occurs from August to September. Smolts typically spend one year in freshwater before migrating downstream. There are slight genetic differences between this species and others containing stream-type fish, but more importantly, the ESU boundary was defined using ecological differences in spawning and rearing habitat (Myers et al. 1998). The Grand Coulee Fish Management Program (1939 through 1943) may have had a major influence on this species' diversity because fish from multiple populations were mixed into one relatively homogenous group and redistributed into streams throughout the upper Columbia River region. Currently, approximately 65% of the fish retuning to this ESU are hatchery fish. The NMFS originally determined that six hatchery stocks in the UCR basin (Chiwawa, Methow, Twisp, Chewuch, and White Rivers and Nason Creek) should be included as part of the species because they were considered essential for recovering the fish. The artificially propagated stocks changed slightly in the subsequent review, in that the Winthrop composite stocks were listed and the Nason Creek stock was not. The ICTRT identified no MPGs due to the relatively small geographic area affected (IC-TRT 2003; McClure et al. 2005; Ford 2011, NWFSC 2015) (Table 2).

Table 2. Scores for the key elements (A&P, diversity, and SS/D) used to determine current overall viability risk for spring-run UCR Chinook salmon (NWFSC 2015). Risk ratings included very low (VL), low (L), moderate (M), high (H), very high (VH), and extirpated (E).

Population	A&P	Diversity	Integrated SS/D	Overall Viability Risk
Wenatchee River	H	H	H	H
Entiat River	H	H	H	H
Methow River	H	H	H	H
Okanogan River				E

The composite SS/D risks are "high" for all three of the extant populations in this MPG. The spatial processes component of the SS/D risk is "low" for the Wenatchee River and Methow River populations and "moderate" for the Entiat River (loss of production in lower section increases effective distance to other populations). All three of the extant populations in this MPG are at “high” risk for diversity, driven primarily by chronically high proportions of hatchery-origin spawners in natural spawning areas and lack of genetic diversity among the natural-origin spawners (Ford 2011, NWFSC 2015).

Increases in natural origin abundance relative to the extremely low spawning levels observed in the mid-1990s are encouraging; however, average productivity levels remain extremely low. Overall, the viability of Upper Columbia Spring Chinook salmon ESU has likely improved somewhat since the last status review, but the ESU is still clearly at “moderate-to-high” risk of extinction (Ford 2011, NWFSC 2015).

Abundance

There are no estimates of historical abundance specific to this species prior to the 1930s. The drainages supporting this species are all above Rock Island Dam on the upper Columbia River. Rock Island Dam is the oldest major hydroelectric project on the Columbia River; it began operations in 1933. Counts of returning Chinook have been made since the 1930s. Annual estimates of the aggregate return of spring Chinook to the upper Columbia are derived from the dam counts based on the nadir between spring and summer return peaks. Spring Chinook salmon currently spawn in three major drainages above Rock Island Dam—the Wenatchee, Methow and Entiat Rivers. Historically, spring Chinook may have also used portions of the Okanogan River.

The 1998 Chinook Status Review (Myers et al. 1998) reported that long-term trends in abundance for upper Columbia spring Chinook populations were generally negative, ranging from -5% to +1%. Analyses of the data series, updated to include 1996-2001 returns, indicate that those trends have continued. The long-term trend in spawning escapement is downward for all three systems. The Wenatchee River spawning escapements have declined an average of 5.6% per year, the Entiat River population at an average of 4.8%, and the Methow River population an average rate of 6.3% per year since 1958 (NMFS 2003).

In the 1960s and 1970s, spawning escapement estimates were relatively high with substantial year-to-year variability. Escapements declined in the early 1980s, then peaked at relatively high levels in the mid-1980s. Returns declined sharply in the late 1980s and early 1990s. The 1900-1994 returns were at the lowest levels observed in the 40-plus years of the data sets, and from 1995 through 1999, the returns averaged 282 fish (PCSRF 2007).

The Upper Columbia Biological Requirements Workgroup (Ford et al. 2001) recommended interim delisting levels of 3,750, 500, and 2,200 spawners for the populations returning to the Wenatchee, Entiat, and Methow drainages, respectively. Five-year geometric mean spawning escapements from 1997 to 2001 were at 8%-15% of these levels. Target levels have not been exceeded since 1985 for the Methow run and the early 1970s for the Wenatchee and Entiat populations (NMFS 2003).

In the 1960s and 1970s, spawning escapement estimates were relatively high, with substantial year-to-year variability. Escapements declined in the early 1980s, then peaked at relatively high levels in the mid-1980s. Returns declined sharply in the late 1980s and early 1990s. Returns from 1990 to 1994 were at the lowest levels observed in the 40-plus years of the data sets. The Upper Columbia Biological Requirements Workgroup (Ford et al. 2001) recommended interim delisting levels of 3,750, 500, and 2,200 spawners for the populations returning to the Wenatchee, Entiat, and Methow river drainages, respectively. The 5-year geometric mean spawning escapements for 1997 to 2001) were at 8–15% of these levels. Target levels have not been exceeded since 1985 for the Methow River run, and since the early 1970s for the Wenatchee and Entiat river populations. From the year 2006 through 2010, the five-year average return to the ESU—as measured primarily by spawning surveys--was 3,900 (Salmonid Population Summary (SPS) query, April 2014[2]); of these, approximately 65% were of hatchery origin. Counts at Rock Island Dam in 2008, 2010, and 2011 showed an average estimated 1,668 natural fish retuning to the ESU which, given a 35% natural origin for the overall return, indicated that the total return was on the order of 4,766 fish. (The counts did not differentiate between adipose-clipped fish hatchery and hatchery fish with an intact adipose, and there is a data gap for the year 2009). The figures just quoted demonstrate that there is some degree of variability in the various sources for returning adult numbers. As a result, it is sometimes difficult to take all the various factors into account (survey types, data gaps, various dam counts, hatchery vs. wild components, etc.) and clearly and accurately determine what the returns actually are. Nonetheless, the figures we believe to be the most likely to represent the actual returns come from the U.S. v. Oregon Technical Advisory Committee (TAC) numbers derived from dam counts and complied by the WDFW (WDFW 2013). These numbers are widely used throughout the region for management purposes (particularly in setting harvest quotas), and at this point represent the very best available scientific and technical knowledge to which we have access. The most recent year for which these numbers have been calculated and published is 2014 from NMFS's Adaptive Management Implementation Plan (AMIP 2014). That year, the UCR Chinook total return to Rock Island Dam was 3,986 natural adults. The most recent four-year average to that date was 3,170 fish. Given that these fish comprise approximately 35% of the total run, it signifies that the total return for 2014 was 11,388 fish and the most recent four year average was 9,057 adults.

Juvenile abundance estimates are published each spring in an annual memorandum estimating percentage of listed Pacific salmon and steelhead smolts arriving at various locations in the Columbia River basin. The averages of the five most recent projections for the UCR Chinook juvenile outmigration are displayed below.

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[2] The data contained in the SPS database are primarily summary data, compiled at the population level. The database also includes a limited number of series representing the aggregate returns to groups of populations (e.g., Lower Granite Dam counts) or counts of spawners within a subsection of a population where expansions to the population level were not feasible.

Table 3. Recent Five-Year Average Projected Outmigrations for UCR Chinook (Dey 2012; Zabel 2013; Zabel 2014, Zabel 2015, Zabel 2016).

Origin	Outmigration
Natural	521,802
Listed Hatchery: Adipose Clipped*	507,920
Listed Hatchery: Intact Adipose*	592,379

*When the above species was listed, NMFS included certain artificially propagated (hatchery-origin) populations in the listing. Some of those listed fish have had their adipose fins clipped at their respective hatcheries and some have not.

Productivity

All three existing Upper Columbia River spring-run Chinook salmon populations have exhibited similar trends and patterns in abundance over the past 40 years. The 1998 Chinook salmon status review (Myers et al. 1998) reported that long-term trends in abundance for upper Columbia River spring-run Chinook salmon populations were generally negative, ranging from –5% to +1%. Analyses of the data series, updated to include 1996–2001 returns, indicate that those trends have continued. The long-term trend in spawning escapement is downward for all three systems. Between 1958 and 2001, Wenatchee River spawning escapements declined at an average rate of 5.6% per year, the Entiat River population at an average of 4.8% per year, and the Methow River population at an average of 6.3% per year Good et al. 2005). These rates of decline were calculated from the redd count data series. Out of the 12 sub-populations identified in the ESU, only two showed short-term increases in productivity between 1997 and 2001—though all other sub-populations were decreasing at slower rates than in the previous five years.

McClure et al. (2003) reported standardized quantitative risk assessment results for 152 listed salmon stocks in the Columbia River basin, including representative data sets (1980–2000 return years) for upper Columbia River spring-run Chinook salmon. Average annual growth rate (λ) for the upper Columbia River spring-run Chinook salmon population was estimated at 0.85, the lowest average reported for any of the Columbia River ESUs analyzed in the study. Assuming that population growth rates were to continue at the 1980–2000 levels, upper Columbia River spring-run Chinook salmon populations are projected to have a very high probability of a 90% decline within 50 years (0.87 for the Methow River population, 1.0 for the Wenatchee and Entiat runs). In more recent year (1995 – 2008) production seems to have increased and, depending upon hatchery effectiveness, has varied between .92 and 1.13 (Ford 2011).

Limiting Factors

As noted above, UCR spring-run Chinook salmon inhabit tributaries upstream from the Yakima River to Chief Joseph Dam and the Columbia River mainstem upstream from the Yakima River. Though UCR Chinook are rarely intercepted in ocean fisheries, they face other difficulties (Upper Columbia Salmon Recovery Board 2007; NOAA Fisheries 2011):

- Effects related to hydropower system in the mainstem Columbia River, including reduced upstream and downstream fish passage, altered ecosystem structure and function, altered flows, and degraded water quality
- Degradation of floodplain connectivity and function, channel structure and complexity, riparian areas and large woody debris recruitment, stream flow, and water quality
- Degraded estuarine and nearshore marine habitat
- Hatchery-related effects
- Persistence of non-native (exotic) fish species continues to affect habitat conditions for listed species
- Harvest in Columbia River fisheries

Habitat in the area has been degraded by a number of factors, primarily high temperatures, excess sediment, outright habitat loss, degraded channels, impaired floodplains, and reduced stream flow. All of these factors (and others) have negatively affected the ESU's PCEs (see "Approach to the Analysis" above) to the extent that it was necessary to list them under the ESA. Additionally, and as noted above, both passage barriers and hatchery effects have had negative impacts on this species. (Although steps are being taken to improve both those factors through recovery planning.)

Status Summary

Several factors—both population- and habitat-related have caused this ESU to decline to the point that it is likely to become extinct in the foreseeable future. Ford (2011) found all three populations to still be at high risk with regard to their viability. While there has been some improvement in some areas, particularly since the historic lows of the 1990s, the general outlook in terms of all four criteria is that the ESU is still at high risk of becoming extinct and the species is not currently viable (Ford 2011, NWFSC 2015).

Upper Columbia River Steelhead

On August 18, 1997, NMFS first listed UCR steelhead as an endangered species under the ESA (62 FR 43937). In that determination, NMFS concluded that the UCR steelhead were in danger of extinction throughout all or a significant portion of their range. When NMFS re-examined the status of the UCR steelhead, explicitly taking into account the effect of abundant hatchery steelhead on the immediacy of the risk, we determined that the DPS was likely to become endangered in the foreseeable future (threatened), rather than presently endangered (71 FR 834). That listing was set aside on June 13, 2007 (Trout Unlimited et al. v. Lohn; Case Number CV06-0483-JCC), and the status of the species reverted to endangered as a result of the court's order. The district court's order is on appeal to the Ninth Circuit. The most recent listing included fish from five hatchery programs (Table 4). Under the final listing in 2006, the section 4(d) protections, and limits on them, apply to natural and hatchery threatened salmon with an intact adipose fin, but not to listed hatchery fish that have had their adipose fin removed. This document evaluates impacts on both listed natural and listed hatchery fish. A recovery plan is available for this species (Upper Columbia Salmon Recovery Board 2007).

Table 4. List of Hatchery Stocks Included in the UCR Steelhead DPS.

Artificial Propagation Program	Run	Location (State)
Wenatchee River Steelhead *	Summer	Wenatchee River (Washington)
Wells Hatchery Steelhead *	Summer	Methow River (Washington)
	Summer	Okanogan River (Washington)
Winthrop NFH Steelhead (Wells Steelhead)	Summer	Methow River (Washington)
Omak Creek Steelhead	Summer	Okanogan River (Washington)
Ringold Hatchery (Wells Steelhead)	Summer	Middle Columbia River (Washington)

* Denotes programs that were listed as part of the 1999 listing of the DPS

Structure and Diversity

The UCR steelhead inhabit the Columbia River and its tributaries upstream of the Yakima River. This region includes several rivers that drain the east slopes of the Cascade Mountains and several that originate in Canada (only U.S. populations are included in the listed species). Dry habitat conditions in this area are less conducive to steelhead survival than those in many other parts of the Columbia River basin (Mullen et al. 1992a). Although the life history of these fish is similar to that of other inland steelhead, smolt ages are some of the oldest on the West Coast (up to seven years old), probably due to the ubiquitous cold water temperatures (Mullen et al. 1992b). Adults spawn later than in most downstream populations—remaining in fresh water up to a year before spawning. Most current natural production occurs in the Wenatchee and Methow River systems, with a smaller run returning to the Entiat River (WDF et al. 1993). Very limited spawning also occurs in the Okanagan River basin. Most of the fish spawning in natural production areas are of hatchery origin. NMFS originally determined that one hatchery stock in the upper Columbia River basin, the Wells Hatchery stock, should be considered part of the species because it was essential for the recovery of the species at the time. The final listing in

2006, the section 4(d) protections, and limits on them, apply to natural and hatchery threatened salmon with an intact adipose fin, but not to listed hatchery fish that have had their adipose fin removed.

Life histories are relatively uniform throughout all populations in the UCR steelhead DPS. In 2000, NMFS developed an initial set of population definitions for this DPS, along with basic criteria for evaluating the status of each population using guidelines described in McElhany et al. (2000). The definitions and criteria are described in Ford et al. (2001) and have been used in the development and review of Mid-Columbia PUD plans and the FCRPS Biological Opinion. The interim population definitions and criteria have been submitted as recommendations to the Interior Columbia Basin Technical Recovery Team. Briefly, the joint technical team recommended that the Wenatchee, Entiat, and Methow Rivers be considered separate populations within the UCR steelhead DPS. The Okanogan River may have supported a fourth population, but the committee deferred a making a recommendation regarding the putative Okanogan population to the Technical Recovery Team. The four populations are divided into two stock groupings: Wenatchee/Entiat and Methow/Okanogan. Ford et al. (2001) developed and described abundance, productivity, and spatial structure criteria for each population in the DPS. Due largely to the small geographic area involve, the ICTRT did not identify any MPGs for this species.

Hatchery returns dominate the estimated escapement in the Wenatchee, Methow, and Okanogan river drainages. The effectiveness of hatchery spawners relative to their natural counterparts is a major uncertainty for all populations. Although the return timing into the Columbia River is similar for both wild and hatchery steelhead returning to the upper Columbia, the spawning timing in the hatchery is accelerated. The long-term effects of such acceleration on the spawning timing of returning hatchery-produced adults in nature are not known. We have no direct information on relative fitness of UCR steelhead progeny with at least one parent of hatchery origin.

Hatchery production averaged approximately 300,000 smolts/year in the 1960s, 425,000 in the 1970s, 790,000 in the 1980s, and more than 800,000 in the 1990s (including releases exceeding one million fish). Current mitigation and supplementation targets are to use locally obtained returning adults for programs. The objective for the Wenatchee is to release 400,000 smolts per year using broodstock collected from run-of-the-river fish in the Wenatchee (the main collection point is Dryden Dam). Broodstock collected at Wells Dam are used for outplanting in the Methow (380,000 target release) and the Okanogan (100,000 target release). The Entiat Basin has been designated as a natural production “reference” drainage and thus has no hatchery outplanting.

Table 5. Summary of the key elements (A&P, diversity, and SS/D) and scores used to determine current overall viability risk for UCR steelhead populations (NWFSC 2015). Risk ratings included very low (VL), low (L), moderate (M), high (H), and very high (VH).

Population (Watershed)	A&P	Diversity	Integrated SS/D	Overall Viability Risk
Wenatchee River	H	H	H	H
Entiat River	H	H	H	H
Methow River	H	H	H	H
Okanogan River	H	H	H	H

Abundance

Estimates of historical (pre-1960s) abundance specific to the UCR steelhead are available from fish counts at dams. Counts at Rock Island Dam from 1933 to 1959 averaged 2,600 to 3,700, suggesting a pre-fishery run size in excess of 5,000 adults for tributaries above Rock Island Dam (Chapman et al. 1994). Runs may have already been depressed by lower Columbia River fisheries at this time. Steelhead in the upper Columbia River continue to exhibit low abundances, both in absolute numbers and in relation to numbers of hatchery fish throughout the region.

A review of data from the past several years indicates that natural steelhead abundance has declined or remained low in the major river basins occupied by this species since the early 1990s. However, returns of both hatchery and naturally produced steelhead to the upper Columbia have increased somewhat in recent years. Priest Rapids Dam is below the UCR steelhead production areas. The 1997-2001 returns—counted at the Priest Rapids fish ladder—averaged approximately 12,900 steelhead. The average for the five years from 1992 through 1996 was 7,800 fish. In 2004 and 2005, it is estimated that totals of 18,727 and 12,143 UCR steelhead (respectively) returned to their spawning grounds (FPC 2005 and PCSRF 2007). However, returns to the upper Columbia are composed primarily of hatchery-origin fish. The percentage of the run over Priest Rapids of natural origin fish increased to over 25% in the 1980s, then dropped to less than 10% by the mid-1990s. The median percent wild for 1997-2001 was 17% (NMFS 2003; Good et al. 2005). Recent data show that these trends have continued. From the year 2004 through the year 2009, the five-year average return to the DPS—as determined primarily by spawning ground surveys--was 7,757 adult fish (Ford 2011); of these, approximately 80% to 90% were of hatchery origin (PCSRF 2007; Ford 2011). Updated spawning ground surveys show a five-year average return of 7,830 adults, of which 23% were natural fish (NWFSC 2015). The figures just quoted demonstrate that there is some degree of variability in the various sources for returning adult numbers. As a result, it is sometimes difficult to take all the various factors into account (survey types, data gaps, various dam counts, hatchery vs. wild components, etc.) and clearly and accurately determine what the returns actually are. Nonetheless, the figures we believe to be the most likely to represent the actual returns come from the WDFW steelhead run-cycle stock assessment reports at Priest Rapids Dam. These numbers represent the very best available scientific and technical knowledge to which we have access. The most recent year for which these numbers have been calculated and published is 2014 (AMIP). That year, the UCR steelhead total return to Priest Rapids Dam was 3,788 natural adults. The most recent four-year average to that date was 4,410 fish. Given that these fish comprise approximately 23% of the total run, it signifies that the total return for 2013 was 16,469 fish and the most recent four year average was 19,179 adults.

Juvenile abundance estimates are published each spring in an annual memorandum estimating percentage of listed Pacific salmon and steelhead smolts arriving at various locations in the Columbia River basin. The averages of the five most recent projections for the UCR Steelhead juvenile outmigration are displayed below.

Table 6. Recent Five-Year Average Projected Outmigrations for UCR Steelhead (Dey 2012; Zabel 2013; Zabel 2014; Zabel 2015, Zabel 2016).

Origin	Outmigration
Natural	245,890
Listed Hatchery: Adipose Clipped*	631,207
Listed Hatchery: Intact Adipose*	143,502

*When the above species was listed, NMFS included certain artificially propagated (hatchery-origin) populations in the listing. Some of those listed fish have had their adipose fins clipped at their respective hatcheries and some have not.

The natural abundance number should be viewed with caution, however, as it only addresses one of several juvenile life stages. Moreover, deriving any juvenile abundance estimate is complicated by a host of variables, including the facts that: (1) spawner counts and associated sex ratios and fecundity estimates can vary widely between years; (2) multiple juvenile age classes (fry, parr, smolt) are present yet comparable data sets may not exist for all of them; (3) it is very difficult to distinguish between non-listed juvenile rainbow trout and listed juvenile steelhead; and (4) survival rates between life stages are poorly understood and subject to a multitude of natural and human-induced variables (e.g., predation, floods, fishing, etc.).

Productivity

Estimates of natural production in this steelhead DPS are well below replacement—indicating that natural steelhead populations in the upper Columbia River basin are not self-sustaining at the present time. The Biological Review Team discussed anecdotal evidence that resident rainbow trout—present in numerous streams throughout the region—contribute to anadromous run abundance. This would reduce estimates of the natural steelhead replacement ratio.

Natural returns have generally increased since 1991 for both stock groupings (Wenatchee/Entiat and Methow/Okanogan). Population growth rates (expressed as λ, calculated using the running sum method) are substantially influenced by assumptions regarding the relative effectiveness of hatchery spawners. The same key factor must be considered in analyzing return-per-spawner data sets. The relative contribution of returning steelhead of hatchery origin to natural spawning is not clearly understood. There may be timing and spatial differences in the distribution of hatchery- and natural-origin spawners that affect production of juveniles. Eggs and juveniles from natural spawning involving hatchery-origin fish may survive at a different rate than those from natural-origin adults.

Both short-term (1990–2001) and long-term (1976–2001) estimates of λ are positive if it is assumed that hatchery fish have not contributed to natural production in recent years. Assuming that hatchery fish contributed to natural production at the same level as wild fish, λ estimates are substantially lower. Under this scenario, natural production is consistently and substantially below the total number (hatchery plus natural origin) of spawners in any given year. This is consistent with McClure et al. (2003) and the 2000 FCRPS Biological Opinion (NMFS 2000a), in which λ was estimated from the DPS-level time series for the time period 1980–2000. Although all the spawners when taken together have an apparent population growth rate of 1.00 (with relatively high variability), this growth rate is lowered to 0.69 if hatchery fish contributed to subsequent generations at the same rate as wild fish.

Assumptions regarding the relative effectiveness of hatchery-origin spawners also influence return-per-spawner patterns for the two steelhead production areas (Wenatchee/Entiat and Methow/Okanogan). Under the assumption that hatchery and wild spawners are both contributing to the subsequent generation of natural returns, return-per-spawner levels have been consistently below 1.0 since 1976. Under this scenario, natural production would be expected to decline rapidly in the absence of hatchery spawners. Under the assumption that hatchery fish returning to the upper Columbia River do not contribute to natural production, return-per-spawner levels were above 1 until the late 1980s. Return-per-spawner estimates subsequently dropped below replacement (1.0) and remained low until the mid-1990s (and beyond). Nonetheless, the actual contribution of hatchery returns to natural spawning remains a key uncertainty for UCR steelhead.

Limiting Factors

This DPS occupies the Columbia River upstream from the Yakima River. The streams in this region primarily drain the Northern Cascade Mountains of Washington State. The river valleys are deeply dissected and maintain low gradients except for the extreme headwaters. Stream flow in this area is provided by melting snowpack, groundwater, and runoff from alpine glaciers. This leads to exceedingly cold stream temperatures which, in turn, may lead to some of the oldest ages for smolts on record—up to seven years. Habitat in the area has been degraded by a number of factors, primarily high temperatures, excess sediment, outright habitat loss, degraded channels, impaired floodplains, and reduced stream flow. All of these factors (and others) have negatively affected the DPS' PCEs to the extent that it was necessary to list them under the ESA (Upper Columbia Salmon Recovery Board 2007; NOAA Fisheries 2011):

- Adverse effects related to the mainstem Columbia River hydropower system
- Impaired tributary fish passage
- Degradation of floodplain connectivity and function, channel structure and complexity, riparian areas, large woody debris recruitment, stream flow, and water quality
- Hatchery-related effects
- Predation and competition
- Harvest-related effects

Status Summary

Several factors—both population- and habitat-related have caused this DPS to decline to the point that it is likely to become endangered in the foreseeable future. While there has been some improvement in a number of areas, particularly in the realm of recent returns, it is not enough to prevent them from being threatened. Overall, Ford et al. (2011) found this species to be at high risk for all four VSP parameters in all four of its populations.

Middle Columbia River Steelhead

MCR steelhead were first listed as a threatened species on March 5, 1999 (64 FR 14517). That status was reaffirmed on January 5, 2006 (71 FR 834); the listing includes all naturally spawned steelhead populations beginning upstream from the Wind River in Washington and the Hood River in Oregon and proceeding to the Yakima River, Washington (see Figure 1). It does not include fish from the Snake River basin. Fish from seven artificial propagation programs were also listed—the Touchet River, Satus Creek, Toppenish Creek, Naches River, Upper Yakima River, Umatilla River, and Deschutes River stocks, that listing was reaffirmed on April 14, 2014 (79 FR 20802). A recovery plan is available for this species (NMFS 2009b).

Spatial Structure and Diversity

MCR steelhead are predominantly summer steelhead, but winter-run fish are found in the Klickitat River and Fifteenmile Creek. Most MCR steelhead smolt at two years and spend one to two years in salt water before re-entering fresh water, where they may remain for up to a year before spawning. Historically, the species was made up of five major population groups (MPGs), one of which—Willow Creek—has been extirpated. The four remaining MPGs comprise 17 extant populations and two that have been extirpated (see Table 7).

Table 7. MPGs, populations, and scores for the key elements (A&P, diversity, and SS/D) used to determine current overall viability risk for MCR steelhead (NMFS 2009; Ford 2011, NWFSC 2015). Risk ratings included very low (VL), low (L), moderate (M), high (H), very high (VH), and extirpated (E). Maintained (MT) population status indicates that the population does not meet the criteria for a viable population but does support ecological functions and preserve options for recovery of the DPS.

Major Population Group	Population (Watershed)	A&P	Diversity	Integrated SS/D	Overall Viability Risk
Cascade Eastern Slope Tributaries	Fifteenmile Creek	L	L	L	Viable
	Klickitat River	M	M	M	MT?
	Eastside Deschutes River	L	M	M	Viable
	Westside Deschutes River	H	M	M	H*
	Rock Creek	H	M	M	H?
	White Salmon				E*
	Crooked River				E*
John Day River	Upper Mainstem	M	M	M	MT
	North Fork	VL	L	L	Highly Viable
	Middle Fork	M	M	M	MT
	South Fork	M	M	M	MT
	Lower Mainstem	M	M	M	MT
Walla Walla and Umatilla rivers	Umatilla River	M	M	M	MT
	Touchet River	M	M	M	H
	Walla Walla River	M	M	M	MT
Yakima River	Satus Creek	M	M	M	Viable (MT)
	Toppenish Creek	M	M	M	Viable (MT)
	Naches River	H	M	M	H
	Upper Yakima	H	H	H	H

* Re-introduction efforts underway (NMFS 2009).

Hatchery fish stray to spawn naturally throughout the range of the species. Estimates of the proportion of hatchery-origin natural spawners range from low (Yakima, Walla Walla, and John Day Rivers) to moderate (Umatilla and Deschutes Rivers) (NMFS 2003). Most hatchery production is derived primarily from within-basin stocks. One recent area of concern is the increase in the number of Snake River hatchery steelhead that stray and spawn naturally within the Deschutes River subbasin. In addition, one of the main threats cited in NMFS' listing decision for this species was the fact that hatchery fish constituted a steadily increasing proportion of MCR steelhead natural escapement (62 FR 43937). Straying frequencies into at least the Lower John Day River are high. Out-of-basin hatchery stray proportions, although reduced, remain very high in the Deschutes River basin.

Abundance and Productivity

Escapements to all extant MPGs have recently shown overall upward trends, though some tributary counts in the Deschutes River have been moving downward for years and the Yakima River is still recovering from extremely low abundance in the 1980s. The John Day River represents the largest native, naturally-spawning stock in the species. The combined spawner surveys for the John Day River showed spawner declines of about 15% per year from 1985 to 1999, but trends have largely been up since then (NMFS 2003, Ford 2011, NWFSC 2015) and the North Fork John Day population, for instance is a very low risk to abundance and productivity factors. When we proposed to list these fish, we cited low returns to the Yakima River, poor abundance estimates for the Klickitat River and Fifteenmile Creek winter steelhead, and overall declines among naturally-producing stocks. However, recent dam counts show an overall increase in MCR steelhead abundance and a relatively stable naturally-produced component.

The species' populations are generally considered to be at medium to low risk with respect to abundance and productivity, but a few populations remain at high risk (see Table 7). On a positive note, the most recent 20-year productivity averages are showing greater-than-replacement levels in all populations for which we have data. Moreover, from the year 2004 through the year 2009, the five-year average return to the ESU was 14,364 adult fish (Ford 2011). Updated surveys running through 2011 showed that the spawner returns to the DPS from 2007 through 2011 totaled an average of about 19,570 fish, of which approximately 91% (or 17,809 fish) were of natural origin-- (SPS Database—Query April, 2014). More recent numbers can be gleaned from expanding dam counts on the Yakima River. For the 2014 year class, 4,255 natural fish have returned to the Yakima (AMIP), that number needs to be expanded by 35% due to run timing (Ritchie Graves, NMFS, pers. comm. April 17, 2015), so the actual number is 5,744 adults. The Yakima River produces approximately one-third of the fish in the DPS, so that means approximately 17,232 natural adults returned to the DPS as a whole. Given that natural fish make up 91% of all the fish in the DPS, that means the total return was on the order of 18,782 adults.

Juvenile abundance estimates are published each spring in an annual memorandum estimating percentage of listed Pacific salmon and steelhead smolts arriving at various locations in the Columbia River basin. The averages of the five most recent projections for the MCR juvenile outmigration are displayed below.

Table 8. Recent Five-Year Average Projected Outmigrations for MCR Steelhead (Dey 2012; Zabel 2013; Zabel 2014; Zabel 2015, Zabel 2016).

Origin	Outmigration
Natural	448,242
Listed Hatchery: Adipose Clipped*	347,853
Listed Hatchery: Intact Adipose*	202,573

*When the above species was listed, NMFS included certain artificially propagated (hatchery-origin) populations in the listing. Some of those listed fish have had their adipose fins clipped at their respective hatcheries and some have not.

The natural abundance number should be viewed with caution, however, as it only addresses one of several juvenile life stages. Moreover, deriving any juvenile abundance estimate is complicated by a host of variables, including the facts that: (1) spawner counts and associated sex ratios and fecundity estimates can vary widely between years; (2) multiple juvenile age classes (fry, parr, smolt) are present yet comparable data sets may not exist for all of them; (3) it is very difficult to distinguish between non-listed juvenile rainbow trout and listed juvenile steelhead; and (4) survival rates between life stages are poorly understood and subject to a multitude of natural and human-induced variables (e.g., predation, floods, fishing, etc.). The numbers—especially for the natural component, are therefore probably greater than those displayed.

Limiting Factors

The major limiting factors for MCR steelhead are degraded tributary habitat conditions, impaired mainstem and tributary passage, hatchery related effects, and predation, competition, and disease (NMFS 2009 (recovery plan)). The threats contributing to the limiting factors and causes for a salmonid species' decline are often described in terms of the "four Hs" – habitat (usually relating to the effects of land use and tributary water use), hydropower, harvest, and hatcheries. Climate change also represents a potentially significant threat to salmon and steelhead. With regard to tributary habitat, MCR steelhead are subject to the detrimental effects associated with degraded riparian areas, reduced LWD recruitment, altered sediment routing, low or altered stream flows, degraded water quality especially high water temperatures), impaired floodplain connectivity/function, altered channel structure/complexity, and impaired fish passage. MCR steelhead experience impaired passage at up to four mainstem Columbia River dams and blocked/difficult passage in nearly all main tributaries except the John Day River. The main problems associated with hatchery programs involve out-of-basin hatchery fish straying onto the spawning grounds in all MPGs (especially the Deschutes River). MCR steelhead also are subject to predation (from birds, other fish, and pinnipeds) and disease (primarily in the mainstem) and competition (primarily with rainbow trout) largely in the tributaries—particularly in the Deschutes River (NMFS 2009 (recovery plan)).

The limiting factors identified in the recovery plan are:

- Degradation of floodplain connectivity and function, channel structure and complexity, riparian areas, fish passage, stream substrate, stream flow, and water quality
- Mainstem Columbia River hydropower-related impacts
- Degraded estuarine and nearshore marine habitat
- Hatchery-related effects
- Harvest-related effects
- Effects of predation, competition, and disease.

Status Summary

Several factors—both population- and habitat-related—have caused this species to decline to the point that it is likely to become endangered in the foreseeable future. While there has been some improvement in a number of areas, particularly with regard to the MCR steelhead’s productivity and strong natural component, it is not enough to prevent them from being threatened. Nonetheless, there is some cause for optimism in that the biological requirement risk factors for the species are currently moderate to low in almost every population (Ford 2011, NWFSC 2015).

Snake River Spr/sum Chinook Salmon

Snake River spr/sum Chinook salmon were first listed as threatened on April 22, 1992 (NOAA 1992). At the time, it included all natural-origin populations in the Tucannon, Grande Ronde, Imnaha, and Salmon Rivers. Some or all of the fish returning to several of the hatchery programs were also listed, including those returning to the Tucannon River, Imnaha River, and Grande Ronde River hatcheries, and to the Sawtooth, Pahsimeroi, and McCall hatcheries on the Salmon River. When NMFS re-examined the status of these fish, we determined that they still warranted listing as threatened, but we expanded to 15 the list of hatchery programs contributing fish considered to constitute part of the species. Subsequently that list was reduced to the programs displayed in the table below (79 FR 20802). Under the final listing in 2005, the section 4(d) protections, and limits on them, apply to natural and hatchery threatened salmon with an intact adipose fin, but not to listed hatchery fish that have had their adipose fin removed. This document evaluates impacts on both listed natural and listed hatchery fish. We are developing a recovery plan for this species.

Table 9. List of Hatchery Stocks Included in the SR Spr/sum Chinook Salmon ESU.

Artificial Propagation Program	Run	Location (State)
Tucannon River Program*	Spring	Tucannon River (Washington)
Lostine River (captive*/conventional)	Summer	Grande Ronde (Oregon)
Catherine Creek (captive/conventional)	Summer	Grande Ronde (Oregon)
Lookingglass Hatchery (reintroduction)	Summer	Grande Ronde (Oregon)
Upper Grande Ronde (captive/conventional)	Summer	Grande Ronde (Oregon)
Imnaha River	Spring/ Summer	Imnaha River (Oregon)
Big Sheep Creek	Spring/ Summer	Imnaha River (Oregon)
McCall Hatchery	Summer	South Fork Salmon River (Idaho)
Johnson Creek Artificial Propagation Enhancement*	Summer	East Fork South Fork Salmon River (Idaho)
Pahsimeroi Hatchery	Summer	Salmon River (Idaho)
Sawtooth Hatchery	Spring	Upper Mainstem Salmon River (Idaho)

* denotes programs that were listed as part of the 1999 listing of the ESU

Structure and Diversity

The present range of spawning and rearing habitat for naturally spawned SR spring/summer Chinook salmon is primarily limited to the Salmon, Grande Ronde, Imnaha, and Tucannon River subbasins. Historically, the Salmon River system may have supported more than 40% of the total return of spring/summer-run Chinook salmon to the Columbia River system (e.g., Fulton 1968). Most SR spring/summer Chinook salmon enter individual subbasins from May through September. Juvenile SR spring/summer Chinook salmon emerge from spawning gravels from February through June (Peery and Bjornn 1991). Typically, after rearing in their nursery streams for about one year, smolts begin migrating seaward in April and May (Bugert et al. 1990, Cannamela 1992). After reaching the mouth of the Columbia River, spring/summer Chinook salmon probably inhabit nearshore areas before beginning their northeast Pacific Ocean migration, which lasts two to three years.

This ESU includes production areas characterized by spring- and summer-timed returns, and combinations from the two adult timing patterns. Runs classified as spring-run Chinook salmon are counted at Bonneville Dam beginning in early March and ending the first week of June; runs classified as summer-run Chinook salmon return to the Columbia River from June through

August. Returning fish hold in deep mainstem and tributary pools until late summer, when they emigrate up into tributary areas and spawn. In general, spring-run type Chinook salmon tend to spawn in higher-elevation reaches of major Snake River tributaries in mid- through late August, and summer-run Chinook salmon spawn approximately one month later than spring-run fish. Summer-run Chinook salmon tend to spawn lower in the Snake River drainages, although their spawning areas often overlap with spring-run spawners.

The South Fork and Middle Fork Salmon River currently support the bulk of natural production in the drainage. Two large tributaries entering above the confluence of the Middle Fork Salmon River, the Lemhi and Pahsimeroi Rivers drain broad alluvial valleys and are believed to have historically supported substantial, relatively productive anadromous fish runs. Returns into the upper Salmon River tributaries were reestablished after passage was opened around Sunbeam Dam on the mainstem Salmon River downstream of Stanley in 1934.

SR spring/summer Chinook salmon are produced at a number of artificial production facilities in the Snake River basin. Much of the production was initiated under the Lower Snake River Compensation Plan (LSRCP). Lyons Ferry Hatchery serves as a rearing station for Tucannon River spring-run Chinook salmon broodstock. Rapid River Hatchery and McCall Hatchery provide rearing support for a regionally derived summer-run Chinook salmon broodstock released into lower Salmon River areas. Two major hatchery programs operate in the upper Salmon Basin—the Pahsimeroi and Sawtooth facilities. Since the mid-1990s, small-scale natural stock supplementation studies and captive breeding efforts have been initiated in the Snake River basin. Historically, releases from broodstock originating outside the basin constituted a relatively small fraction of the total release into the basin. The 1998 Chinook salmon status review (Myers et al. 1998) identified concerns regarding the use of the Rapid River Hatchery stock reared at Lookingglass Hatchery in the Grande Ronde River basin. The Rapid River Hatchery stock was originally developed from broodstock collected from the spring-run Chinook salmon returns to historical production areas above the Hells Canyon Dam complex.

One threat to diversity from hatchery introgression—the use of the Rapid River Hatchery stock in Grande Ronde drainage hatchery programs—has been phased out since the late 1990s. In addition, a substantial proportion of marked returns of Rapid River Hatchery stock released in the Grande Ronde River have been intercepted and removed at the Lower Granite Dam ladder and at some tributary-level weirs. Carcass survey data indicate large declines in hatchery contributions to natural spawning in areas previously subject to Rapid River Hatchery stock strays.

Table 10. MPGs, populations, and scores for the key elements (A&P, diversity, and SS/D) used to determine current overall viability risk for SR spring/summer-run Chinook salmon (NWFSC 2015). Risk ratings included very low (VL), low (L), moderate (M), high (H), very high (VH), and extirpated (E).

Major Population Groups	Spawning Populations (Watershed)	A&P	Diversity	Integrated SS/D	Overall Viability Risk
Lower Snake River	Tucannon River	H	M	M	H
	Asotin River				E
Grande Ronde and Imnaha rivers	Wenaha River	H	M	M	H
	Lostine/Wallowa River	H	M	M	H
	Minam River	H	M	M	H
	Catherine Creek	H	M	M	H
	Upper Grande Ronde R.	H	M	H	H
	Imnaha River	H	M	M	H
	Big Sheep Creek				E
	Lookingglass Creek				E
South Fork Salmon River	Little Salmon River	*	*	*	H
	South Fork mainstem	H	M	M	H
	Secesh River	H	L	L	H
	EF/Johnson Creek	H	L	L	H
Middle Fork Salmon River	Chamberlin Creek	H	L	L	H
	Big Creek	H	M	M	H
	Lower MF Salmon	H	M	M	H
	Camas Creek	H	M	M	H
	Loon Creek	H	M	M	H
	Upper MF Salmon	H	M	M	H
	Sulphur Creek	H	M	M	H
	Bear Valley Creek	H	L	L	H
	Marsh Creek	H	L	L	H
Upper Salmon River	N. Fork Salmon River	H	L	L	H
	Lemhi River	H	H	H	H
	Pahsimeroi River	H	H	H	H
	Upper Salmon-lower mainstem	H	L	L	H
	East Fork Salmon River	H	H	H	H
	Yankee Fork	H	H	H	H
	Valley Creek	H	M	M	H
	Upper Salmon main	H	M	M	H
	Panther Creek				E

* Insufficient data.

Abundance

No direct estimates of historical spring/summer Chinook returns to the Snake River are available. Chapman (1986) estimated that the Columbia River produced 2.5 million to 3.0 million spring and summer Chinook per year in the late 1800s. Total spring and summer Chinook production from the Snake basin contributed a substantial proportion of those returns; the total annual production of SR spring/summer Chinook may have been in excess of 1.5 million adult returns per year (Matthews and Waples 1991). Returns to Snake River tributaries had dropped to roughly 100,000 adults per year by the late 1960s (Fulton 1968). Increasing hatchery production contributed to subsequent years' returns, masking a continued decline in natural production.

The 1997-2001 geometric mean total return for spring/summer Chinook was slightly more than 6,000 fish. This was a marked improvement over the previous ten years when the geometric mean return was 3,076. That increase continued relatively steadily through 2004, when 97,946 adults returned (including jacks), but dropped off precipitously in 2005 when only 39,126 fish (including jacks) returned above Ice Harbor Dam (FPC 2005). The increases from 2001 through 2004 are generally thought to have been a result of good ocean conditions for rearing and good Columbia River flows for outmigration. But even with generally better trends in recent years, no population of spring/summer Chinook is known to be meeting its interim recovery goals (Good et al. 2005). In fact, the most recent return numbers to individual populations show most of the runs to be at less than half the desired levels (Good et al 2005). Overall, from the year 2008 through the year 2011, the four-year average return to the ESU was 11,819 adult fish (SPS query April 2014); of these, approximately 82% were of natural origin. The figures just quoted demonstrate that there is some degree of variability in the various sources for returning adult numbers. As a result, it is sometimes difficult to take all the various factors into account (survey types, data gaps, various dam counts, hatchery vs. wild components, etc.) and clearly and accurately determine what the returns actually are. Nonetheless, the figures we believe to be the most likely to represent the actual returns come from the U.S. v. Oregon Technical Advisory Committee (TAC) numbers derived from dam counts and complied by the WDFW (WDFW 2013). These numbers are widely used throughout the region for management purposes (particularly in setting harvest quotas), and at this point represent the very best available scientific and technical knowledge to which we have access. The most recent year for which these numbers have been calculated and published is 2014. That year, the SR spr/sum Chinook total return to Lower Granite Dam was 31,208 natural adults (this count includes the Tucannon River)(AMIP). The most recent four-year average to that date was 23,449 fish. Given that these fish comprise approximately 82% of the total run, it signifies that the total return for 2014 was 38,058 fish and the most recent four-year average was 28,596 adults.

Juvenile abundance estimates are published each spring in an annual memorandum estimating percentage of listed Pacific salmon and steelhead smolts arriving at various locations in the Columbia River basin. The averages of the five most recent projections for the SR spr/sum Chinook salmon juvenile outmigration are displayed below.

Table 11. Recent Five-Year Average Projected Outmigrations for SR spr/sum Chinook Salmon (Dey 2012; Zabel 2013; Zabel 2014; Zabel 2015, Zabel 2016).

Origin	Outmigration
Natural	1,397,403
Listed Hatchery: Adipose Clipped*	4,288,088
Listed Hatchery: Intact Adipose*	1,115,848

*When the above species was listed, NMFS included certain artificially propagated (hatchery-origin) populations in the listing. Some of those listed fish have had their adipose fins clipped at their respective hatcheries and some have not.

The natural abundance number should be viewed with caution, however, as it only addresses one of several juvenile life stages. Moreover, deriving any juvenile abundance estimate is complicated by a host of variables, including the facts that: (1) spawner counts and associated sex ratios and fecundity estimates can vary widely between years; (2) multiple juvenile age classes (fry, parr, smolt) are present yet comparable data sets may not exist for all of them; (3) it is very difficult to distinguish between non-listed juvenile rainbow trout and listed juvenile steelhead; and (4) survival rates between life stages are poorly understood and subject to a multitude of natural and human-induced variables (e.g., predation, floods, fishing, etc.).

Productivity

Unfortunately, the available data on productivity is somewhat out of date. It is expected that the recovery planning process, the associated technical recovery team work, and research will produce a much clearer picture in the next year or so. In any case, as of 2001, the long-term trend and λ estimates were less than 1 for all natural production data sets, reflecting the large declines since the 1960s. Short-term trends and λ estimates were generally positive, with relatively large confidence intervals (Good et al. 2005). Grande Ronde and Imnaha data sets had the highest short-term growth rate estimates. Tucannon River, Poverty Flat (2000 and 2001 not included), and Sulphur Creek index areas had the lowest short-term λ estimates in the series.

Limiting Factors

This ESU occupies the Snake River Basin—including the headwaters of many streams—from its confluence with the Columbia River, upstream to the Hells Canyon complex of Dams. The area is generally a mix of dry forest, upland steppe, and semi-arid grassland. Streams tend to lose much of their flow through percolation and evaporation, and only the larger rivers that lie below the water table contain substantial flows year round. Extended dry intervals are very common in the Snake River Plateau. Mainstem Columbia and Snake River hydroelectric development has greatly disrupted migration corridors and affected flow regimes and estuarine habitat. There is habitat degradation in many areas related to forest, grazing, and mining practices, with major factors being lack of pools, high temperatures, low flows, poor overwintering conditions, and high sediment loads. Therefore all of these factors—along with harvest interceptions and hydropower system mortalities—have negatively affected the ESU to the extent that it was necessary to list it under the ESA:

- Degradation of floodplain connectivity and function, channel structure and complexity, riparian areas and large woody debris recruitment, stream flow, and water quality.
- Effects related to the hydropower system in the mainstem Columbia River, including reduced upstream and downstream fish passage, altered ecosystem structure and function, altered flows, and degraded water quality.
- Harvest-related effects.
- Predation.

Status Summary

Several factors—both population- and habitat-related–have caused this ESU to decline to the point that it is likely to become endangered in the foreseeable future. While there has been some improvement in a number of areas, particularly the 10-year average abundance, it is not enough to prevent them from being threatened. Ford (2011) rated every population in the ESU (all 28 of them) as being at “high risk” when the four VSP parameters were combined into an overall score for each. In general, those ratings were driven by high risk ratings for the abundance and productivity parameters.

Snake River Steelhead

Snake River (SR) steelhead were listed as a threatened species on January 5, 2006 (71 FR 834); the listing includes all naturally spawning populations of steelhead in streams in the Snake River basin of southeast Washington, northeast Oregon, and Idaho. Six artificial propagation programs are considered part of the listed species (Table 12). Under the final listing in 2006, the section 4(d) protections, and limits on them, apply to natural and hatchery threatened salmon with an intact adipose fin, but not to listed hatchery fish that have had their adipose fin removed. This document evaluates impacts on both listed natural and listed hatchery fish. We are developing a recovery plan for this species.

Table 12. Listed Hatchery Populations of SR Steelhead.

Artificial Propagation Program	Run	Location (State)
Tucannon River *	Summer	Tucannon River (Washington)
Dworshak NFH/Clearwater FH	Summer	South Fork Clearwater River (Idaho)
Dworshak NFH	Summer	Clearwater R/North Fk Clearwater R (Idaho)
Dworshak NFH	Summer	Lolo Creek-Clearwater River (Idaho)
East Fork Salmon River	Summer	East Fork Salmon River (Idaho)
Little Sheep Creek/Imnaha River Hatchery (ODFW stock # 29) *	Summer	Imnaha River (Oregon)

* Denotes programs that were listed as part of the 1999 listing of the DPS

Structure and Diversity

SR steelhead are distributed throughout the Snake River drainage system, including tributaries in southwest Washington, eastern Oregon and north/central Idaho (NMFS 1996). Steelhead migrate a substantial distance from the ocean (up to 1,500 km) and use high elevation tributaries (typically 1,000-2,000 meters above sea level) for spawning and juvenile rearing. Steelhead occupy habitat that is considerably warmer and drier (on an annual basis) than other steelhead DPSs. Steelhead are generally classified as summer-run, based on their adult run timing patterns. Summer steelhead enter the Columbia River from late June to October. After holding over the winter, summer steelhead spawn during the following spring (March to May). Managers classify up-river summer steelhead runs into two groups based primarily on ocean age and adult size upon return to the Columbia River. A-run steelhead are predominately age-1 ocean fish while B-run steelhead are larger, predominated by age-2 ocean fish.

With the exception of the Tucannon River and some small tributaries to the mainstem Snake River, the tributary habitat used by SR steelhead is above Lower Granite Dam. Major groupings of populations and subpopulations can be found in the Grande Ronde River system, the Imnaha River drainage, the Clearwater River drainages, the South Fork Salmon River, the smaller mainstem tributaries before the confluence of the mainstem Snake River, the Middle Fork Salmon River, the Lemhi and Pahsimeroi Rivers, and the upper Salmon River tributaries.

Almost all artificial production of steelhead in the Snake River steelhead DPS has been associated with two major mitigation initiatives—the Lower Snake River Compensation Program (LSRCP) and the mitigation program for Dworshak Dam on the North Fork Clearwater River. The LSRCP is administered by the USFWS and was established as compensation for losses incurred as a result of the construction and operation of the four lower Snake River hydroelectric dams. Production under this initiative generally began in the mid-1980s. The Dworshak mitigation program provides artificial production as compensation for the loss of access to the North Fork Clearwater, a major historical production area. Dworshak Hatchery, completed in

1969, is the focus for that production. In all, hatchery releases in some 17 subbasins—covering nearly 60 different stocks of SR steelhead—total an average of over 10 million smolts a year (Good et al. 2005).

Table 13. MPGs, populations, and scores for the key elements (A&P, diversity, and SS/D) used to determine current overall viability risk for SRB steelhead (Ford 2011; NMFS 2011b, NWFSC 2015). Risk ratings included very low (VL), low (L), moderate (M), high (H), and very high (VH). Maintained (MT) population status indicates that the population does not meet the criteria for a viable population but does support ecological functions and preserve options for recovery of the DPS.

Major Population Group	Spawning Populations (Watershed)	A&P	Diversity	Integrated SS/D	Overall Viability Risk*
Lower Snake River	Tucannon River	**	M	M	H
	Asotin Creek	**	M	M	MT
Grande Ronde River	Lower Grande Ronde	**	M	M	Not rated
	Joseph Creek	VL	L	L	Highly viable
	Upper Grande Ronde	M	M	M	MT
	Wallowa River	**	L	L	H
Clearwater River	Lower Clearwater	M	L	L	MT
	South Fork Clearwater	H	M	M	H
	Lolo Creek	H	M	M	H
	Selway River	H	L	L	H
	Lochsa River	H	L	L	H
Salmon River	Little Salmon River	**	M	M	MT
	South Fork Salmon	**	L	L	H
	Secesh River	**	L	L	H
	Chamberlain Creek	**	L	L	H
	Lower MF Salmon	**	L	L	H
	Upper MF Salmon	**	L	L	H
	Panther Creek	**	M	H	H
	North Fork Salmon	**	M	M	MT
	Lemhi River	**	M	M	MT
	Pahsimeroi River	**	M	M	MT
	East Fork Salmon	**	M	M	MT
	Upper Main Salmon	**	M	M	MT
Imnaha	Imnaha River	M	M	M	MT

* There is uncertainty in these ratings due to a lack of population-specific data.

** Insufficient data.

Abundance

Although no direct historical estimates of production from the Snake River basin are available, the basin is believed to have supported more than half the total steelhead production from the Columbia River basin (Mallet 1974). There are some historical estimates of returns to portions of the drainage. Lewiston Dam, on the lower Clearwater River, began operation in 1927. Counts of steelhead passing through the adult fish ladder at the dam reached 40,000– 60,000 in the early 1960s (Cichosz et al. 2001). Based on relative drainage areas, the Salmon River basin likely supported substantial production as well. In the early 1960s, returns to the Grande Ronde and Imnaha Rivers may have exceeded 15,000 and 4,000 steelhead per year, respectively. Extrapolations from tag-recapture data indicate that the natural steelhead return to the Tucannon River may have exceeded 3,000 adults in the mid-1950s (Thompson et al. 1958).

The longest consistent indicator of steelhead abundance in the Snake River basin is derived from counts of natural-origin steelhead at the uppermost dam on the lower Snake River (Lower Granite Dam). According to these estimates, the abundance of natural-origin steelhead at the uppermost dam on the Snake River has declined from a 4-year average of 58,300 in 1964 to a 4-year average of 8,300 ending in 1998. In general, steelhead abundance declined sharply in the early 1970s, rebuilt modestly from the mid-1970s through the 1980s, and declined again during the 1990s. The 2001 count at Ice Harbor Dam was 255,726 with Lower Granite reporting 262,558 (both counts include hatchery fish and differ slightly from the PCSRF numbers, below). Numbers of natural steelhead increased to about 47,700 at Lower Granite in 2001 (FPC 2002). With a few exceptions, annual estimates of steelhead returns to specific production areas within the Snake River are not available. Annual estimates of returns are available for the Tucannon River, sections of the Grande Ronde River system, and the Imnaha River. A recent geometric mean abundance in the Tucannon River was lower than it was in the last status review. Returns to the other areas were generally higher than they were in the early 1990s (NMFS 2003). In 2001, only one population—Joseph Creek—was known to meet or exceed its interim target. The other eight were either at fractions of the interim target or were unknown. Overall, however, from the year 2004 through the year 2009, the five-year average return to the ESU was 162,323 adult fish (Ford 2011); of these, approximately 90% were of hatchery origin (PCSRF 2007). That recent upward trend has generally continued and the most recent four-year rolling geometric mean we have for this DPS is 195,721 returns over Ice Harbor Dam from 2009 through 2012 (University of Washington 2013).

The figures just quoted demonstrate that there is some degree of variability in the various sources for returning adult numbers. As a result, it is sometimes difficult to take all the various factors into account (survey types, data gaps, various dam counts, hatchery vs. wild components, etc.) and clearly and accurately determine what the returns actually are. Nonetheless, the figures we believe to be the most likely to represent the actual returns come from the U.S. v. Oregon Technical Advisory Committee (TAC) numbers derived from dam counts and complied by the WDFW (WDFW 2013). These numbers are widely used throughout the region for management purposes (particularly in setting harvest quotas), and at this point represent the very best available scientific and technical knowledge to which we have access. The most recent year for which these numbers have been calculated and published is 2014. That year, the SR steelhead total return to Lower Granite Dam was 43,803 natural adults (AMIP). And the most recent four-year average for those returns was 33,340. Given that these fish constitute approximately 10% of the total run, it signifies that the total return for 2014 was 438,000 fish and the 2011-2014 average was 333,400.

Juvenile abundance estimates are published each spring in an annual memorandum estimating percentage of listed Pacific salmon and steelhead smolts arriving at various locations in the Columbia River basin. The averages of the five most recent projections for the SR steelhead juvenile outmigration are displayed below.

Table 14. Recent Five-Year Average Projected Outmigrations for SR Steelhead (Dey 2012; Zabel 2013; Zabel 2014; Zabel 2015, Zabel 2016).

Origin	Outmigration
Natural	890,596
Listed Hatchery: Adipose Clipped	3,370,663
Listed Hatchery: Intact Adipose	833,108

The natural abundance number should be viewed with caution, however, as it only addresses one of several juvenile life stages. Moreover, deriving any juvenile abundance estimate is complicated by a host of variables, including the facts that: (1) spawner counts and associated sex ratios and fecundity estimates can vary widely between years; (2) multiple juvenile age classes (fry, parr, smolt) are present yet comparable data sets may not exist for all of them; (3) it is very difficult to distinguish between non-listed juvenile rainbow trout and listed juvenile steelhead; and (4) survival rates between life stages are poorly understood and subject to a multitude of natural and human-induced variables (e.g., predation, floods, fishing, etc.).

Productivity

We only have good productivity data for two SR steelhead populations: Joseph Creek and the upper Grand Ronde River. Data for longer term trend analyses for the populations begin with estimates from the early 1970s and extend through 2009. The average trend over the full time period was a negative 1 to 5% per year for the Upper Grande Ronde and a positive 4% per year for Joseph Creek across the range of long term trend metrics (Ford 2011, NWFSC 2015). Estimates of annual spawning escapements into the Upper Grande Ronde River (dam counts) fluctuated around lower levels for a prolonged period except for a peak in the mid-1980s and an increase in the most recent two years for which we have data. Estimated escapements in Joseph Creek were generally lower in the 1970s, and fluctuated around higher levels after also peaking in the mid-1980s. The aggregate Lower Granite Dam abundance estimates are available for years going back to the 1986- 87 cycle. The general trend in returns derived from those counts has been slightly positive across all groups for the last few years: that is, from 1995 through 2008, the trends for all spawners range from 0.98 to 1.11—depending on hatchery efficiency (Ford 2011, NWFSC 2015). This trend has been slowly but steadily increasing since at least 1987. However, the fraction of hatchery spawners has also been increasing that entire time and, as noted, that trend remains an issue of concern.

Limiting factors

SR steelhead occupy the Snake River basin (including many tributary habitats) from its confluence with the Columbia River upstream to the Hells Canyon complex of dams. The area is generally a mix of dry forest, upland steppe, and semi-arid grassland. Streams tend to lose much of their flow through percolation and evaporation, and only the larger rivers that lie below the water table contain substantial flows year round. Extended dry intervals are very common in the Snake River Plateau. In addition, much of this DPS's habitat has been affected by logging, mining, water withdrawals, and hydropower development. As a result of these activities and tribal and recreation harvest, the main limiting factors for this DPS are (NMFS 2011b; NMFS 2011c):

- Adverse effects related to the mainstem Columbia River hydropower system
- Impaired tributary fish passage
- Degradation of d floodplain connectivity and function, channel structure and complexity, riparian areas and large woody debris recruitment, stream flow, and water quality
- Increased water temperature
- Harvest-related effects, particularly for B-run steelhead
- Predation
- Genetic diversity effects from out-of-population hatchery releases

Status Summary

Several factors—both population- and habitat-related have caused this DPS to decline to the point that it is likely to become endangered in the foreseeable future. While there have been some improvements in the species' status in recent years (particularly since the lows of the early 1990s), it is not enough to prevent them from continuing to be threatened. In general, almost all of the populations in this DPS are considered to be at low to moderate risk for factors relating to spatial structure and diversity, and moderate to high risk for factors relating to abundance and productivity. And only one population out of 24 (Joseph Creek) is known to have exceeded the ICTRT's viability criterion for returning spawners.

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. 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).

For salmon and steelhead, NMFS ranked watersheds within designated critical habitat at the scale of the fifth-field hydrologic unit code (HUC_5) in terms of the conservation value they provide to each listed species they support.[3] The conservation rankings are high, medium, or low. To determine the conservation value of each watershed to species viability, NMFS's critical habitat analytical review teams (CHARTs) 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 (NOAA Fisheries 2005). Thus, even a location that has poor quality of 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 if it serves another important role (*e.g.*, obligate area for migration to upstream spawning areas).

The physical or biological features of freshwater spawning and incubation sites, include water flow, quality and temperature conditions and suitable substrate for spawning and incubation, as well as migratory access for adults and juveniles (Tables 15 and 16). These features are essential to conservation because without them the species cannot successfully spawn and produce offspring. The physical or biological features of freshwater migration corridors associated with spawning and incubation sites include water flow, quality and temperature conditions supporting larval and adult mobility, abundant prey items supporting larval feeding after yolk sac depletion, and free passage (no obstructions) for adults and juveniles. These features are essential to conservation because they allow adult fish to swim upstream to reach spawning areas and they allow larval fish to proceed downstream and reach the ocean.

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[3] 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 noted previously, the designations of critical habitat for species used the terms primary constituent element or essential features. The new critical habitat regulations (81 FR 7414) replace this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a ‘‘destruction or adverse modification’’ analysis, which is the same regardless of whether the original designation identified primary constituent elements, physical or biological features, or essential features. In this biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

Table 15. The physical or biological features (formerly primary constituent elements (PCEs)) of critical habitats designated for UCR Chinook and Steelhead, MCR Steelhead, and SR steelhead, and corresponding species life history events.

Physical or Biological Features		**Species Life History Event**
Site Type	**Site Attribute**	
Freshwater spawning	Substrate Water quality Water quantity	Adult spawning Embryo incubation Alevin growth and development
Freshwater rearing	Floodplain connectivity Forage Natural cover Water quality Water quantity	Fry emergence from gravel Fry/parr/smolt growth and development
Freshwater migration	Free of artificial obstruction Natural cover Water quality Water quantity	Adult sexual maturation Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration
Estuarine areas	Forage Free of artificial obstruction Natural cover Salinity Water quality Water quantity	Adult sexual maturation and “reverse smoltification” Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration
Nearshore marine areas	Forage Free of artificial obstruction Natural cover Water quantity Water quality	Adult growth and sexual maturation Adult spawning migration Nearshore juvenile rearing

Table 16. Essential features of critical habitats designated for SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, and SR sockeye salmon, and corresponding species life history events.

Physical or Biological Features		**Species Life History Event**
Site	**Site Attribute**	
Spawning and juvenile rearing areas	Access (sockeye) Cover/shelter Food (juvenile rearing) Riparian vegetation Space (Chinook, coho) Spawning gravel Water quality Water temp (sockeye) Water quantity	Adult spawning Embryo incubation Alevin growth and development Fry emergence from gravel Fry/parr/smolt growth and development
Adult and juvenile migration corridors	Cover/shelter Food (juvenile) Riparian vegetation Safe passage Space Substrate Water quality Water quantity Water temperature Water velocity	Adult sexual maturation Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration
Areas for growth and development to adulthood	Ocean areas – not identified	Nearshore juvenile rearing Subadult rearing Adult growth and sexual maturation Adult spawning migration

CHART Salmon and Steelhead Critical Habitat Assessments

The CHART for each recovery domain assessed biological information pertaining to occupied by listed salmon and steelhead, determine whether those areas contained PBFs (formerly PCEs) essential for the conservation of those species and whether unoccupied areas existed within the historical range of the listed salmon and steelhead that are also essential for conservation. The CHARTs assigned a 0 to 3 point score for the PBFs in each HUC_5 watershed for:

Factor 1. Quantity,
Factor 2. Quality – Current Condition,
Factor 3. Quality – Potential Condition,
Factor 4. Support of Rarity Importance,
Factor 5. Support of Abundant Populations, and

Factor 6. Support of Spawning/Rearing.

Thus, the quality of habitat in a given watershed was characterized by the scores for Factor 2 (quality – current condition), which considers the existing condition of the quality of PBFs in the HUC_5 watershed; and Factor 3 (quality – potential condition), which considers the likelihood of achieving PBF potential in the HUC_5 watershed, either naturally or through active conservation/restoration, given known limiting factors, likely biophysical responses, and feasibility.

When critical habitat was designated throughout the interior Columbia (IC) River recovery domain, it included the Snake River Basin, for SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, UCR spring-run Chinook salmon, SR sockeye salmon, MCR steelhead, UCR steelhead, and SRB steelhead. Major tributaries in the Oregon portion of the IC recovery domain include the Deschutes, John Day, Umatilla, Walla Walla, Grande Ronde, and Imnaha rivers.

Habitat quality in tributary streams in the IC recovery domain varies from excellent in wilderness and roadless areas to poor in areas subject to heavy agricultural and urban development (Wissmar *et al.* 1994; NMFS 2009b). Critical habitat throughout much of the IC recovery domain has been degraded by intense agriculture, alteration of stream morphology (*i.e*., channel modifications and diking), riparian vegetation disturbance, wetland draining and conversion, livestock grazing, dredging, road construction and maintenance, logging, mining, and urbanization. Reduced summer stream flows, impaired water quality, and reduced habitat complexity are common problems for critical habitat in developed areas.

Migratory habitat quality in this area has been severely affected by the development and operation of the FCRPS dams and reservoirs in the mainstem Columbia River, Bureau of Reclamation tributary projects, and privately owned dams in the Snake and Upper Columbia River basins. For example, construction of Hells Canyon Dam eliminated access to several likely production areas in Oregon and Idaho, including the Burnt, Powder, Weiser, Payette, Malheur, Owyhee, and Boise river basins (Good *et al.* 2005), and Grand Coulee and Chief Joseph dams completely block anadromous fish passage on the upper mainstem Columbia River.

Hydroelectric development modified natural flow regimes, resulting in higher water temperatures, changes in fish community structure leading to increased rates of piscivorous and avian predation on juvenile salmon and steelhead, and delayed migration for both adult and juveniles. Physical features of dams such as turbines also kill migrating fish. In-river survival is inversely related to the number of hydropower projects encountered by emigrating juveniles. Similarly, development and operation of extensive irrigation systems and dams for water withdrawal and storage in tributaries have altered hydrological cycles.

A series of large regulating dams on the middle and upper Deschutes River affect flow and block access to upstream habitat, and have extirpated one or more populations from the Cascades Eastern Slope major population. Also, operation and maintenance of large water reclamation systems such as the Umatilla Basin and Yakima Projects have significantly modified flow regimes and degraded water quality and physical habitat in this domain.

Many stream reaches designated as critical habitat in the IC recovery domain are over-allocated, with more allocated water rights than existing streamflow. Withdrawal of water, particularly during low-flow periods that commonly overlap with agricultural withdrawals, often increases summer stream temperatures, blocks fish migration, strands fish, and alters sediment transport (Spence *et al.* 1996). Reduced tributary stream flow has been identified as a major limiting factor for all listed salmon and steelhead species in this recovery domain except SR fall-run Chinook salmon and SR sockeye salmon (NMFS 2011e).

Many stream reaches designated as critical habitat are listed on the state of Oregon's Clean Water Act section 303(d) list for water temperature. Many areas that were historically suitable rearing and spawning habitat are now unsuitable due to high summer stream temperatures. Removal of riparian vegetation, alteration of natural stream morphology, and withdrawal of water all contribute to elevated stream temperatures. Contaminants such as insecticides and herbicides from agricultural runoff and heavy metals from mine waste are common in some areas of critical habitat.

The IC recovery domain is a very large and diverse area. The CHART determined that few watersheds with PCEs (now PBFs) for Chinook salmon or steelhead are in good to excellent condition with no potential for improvement. Overall, most IC recovery domain watersheds are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some or high potential for improvement. In Washington, the Upper Methow, Lost, White, and Chiwawa watersheds are in good-to-excellent condition with no potential for improvement. In Oregon, only the Lower Deschutes, Minam, Wenaha, and Upper and Lower Imnaha Rivers HUC_5 watersheds are in good-to-excellent condition with no potential for improvement. In Idaho, a number of watersheds with PCEs for steelhead (Upper Middle Salmon, Upper Salmon/Pahsimeroi, Middle Fork Salmon, Little Salmon, Selway, and Lochsa rivers) are in good-to-excellent condition with no potential for improvement. Additionally, several Lower Snake River HUC_5watersheds in the Hells Canyon area, straddling Oregon and Idaho, are in good-to-excellent condition with little to no potential for improvement (Table 17).

Table 17. **Interior Columbia Recovery Domain:** Current and potential quality of HUC_5 watersheds identified as supporting historically independent populations of ESA-listed Chinook salmon (CK) and steelhead (ST) (NOAA Fisheries 2005). Watersheds are ranked primarily by "current quality" and secondly by their "potential for restoration."

Current PBF Condition	Potential PBF Condition
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name and HUC_5 Code(s)	Listed Species	Current Quality	Restoration Potential
Upper Columbia # 1702000xxx			
White (101), Chiwawa (102), Lost (801) & Upper Methow (802) rivers	CK/ST	3	3
Upper Chewuch (803) & Twisp rivers (805)	CK/ST	3	2
Lower Chewuch River (804); Middle (806) & Lower (807) Methow rivers	CK/ST	2	2
Salmon Creek (603) & Okanogan River/Omak Creek (604)	ST	2	2
Upper Columbia/Swamp Creek (505)	CK/ST	2	1
Foster Creek (503) & Jordan/Tumwater (504)	CK/ST	1	1
Upper (601) & Lower (602) Okanogan River; Okanogan River/Bonaparte Creek (605); Lower Similkameen River (704); & Lower Lake Chelan (903)	ST	1	1
Unoccupied habitat in Sinlahekin Creek (703)	ST Conservation Value "Possibly High"		
Upper Columbia #1702001xxx			
Entiat River (001); Nason/Tumwater (103); & Lower Wenatchee River (105)	CK/ST	2	2
Lake Entiat (002)	CK/ST	2	1
Columbia River/Lynch Coulee (003); Sand Hollow (004); Yakima/Hansen Creek (604), Middle Columbia/Priest Rapids (605), & Columbia River/Zintel Canyon (606)	ST	2	1
Icicle/Chumstick (104)	CK/ST	1	2
Lower Crab Creek (509)	ST	1	2
Rattlesnake Creek (204)	ST	0	1
Yakima #1703000xxx			
Upper (101) & Middle (102) Yakima rivers; Teanaway (103) & Little Naches (201) rivers; Naches River/Rattlesnake Creek (202); & Ahtanum (301) & Upper Toppenish (303) & Satus (305) creeks	ST	2	2
Umtanum/Wenas (104); Naches River/Tieton River (203); Upper Lower Yakima River (302); & Lower Toppenish Creek (304)	ST	1	2
Yakima River/Spring Creek (306)	ST	1	1
Lower Snake River #1706010xxx			

Current PBF Condition	**Potential PBF Condition**
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name and HUC5 Code(s)	**Listed Species**	**Current Quality**	**Restoration Potential**
Snake River/Granite (101), Getta (102), & Divide (104) creeks; Upper (201) & Lower (205) Imnaha River; Snake River/Rogersburg (301); Minam (505) & Wenaha (603) rivers	ST	3	3
Grande Ronde River/Rondowa (601)	ST	3	2
Big (203) & Little (204) Sheep creeks; Asotin River (302); Catherine Creek (405); Lostine River (502); Bear Creek (504); & Upper (706) & Lower (707) Tucannon River	ST	2	3
Middle Imnaha River (202); Snake River/Captain John Creek (303); Upper Grande Ronde River (401); Meadow (402); Beaver (403); Indian (409), Lookingglass (410) & Cabin (411) creeks; Lower Wallowa River (506); Mud (602), Chesnimnus (604) & Upper Joseph (605) creeks	ST	2	2
Ladd Creek (406); Phillips/Willow Creek (408); Upper (501) & Middle (503) Wallowa rivers; & Lower Grande Ronde River/Menatche Creek (607)	ST	1	3
Five Points (404); Lower Joseph (606) & Deadman (703) creeks	ST	1	2
Tucannon/Alpowa Creek (701)	ST	1	1
Mill Creek (407)	ST	0	3
Pataha Creek (705)	ST	0	2
Snake River/Steptoe Canyon (702) & Penawawa Creek (708)	ST	0	1
Flat Creek (704) & Lower Palouse River (808)	ST	0	0
Upper Salmon and Pahsimeroi #1706020xxx			
Germania (111) & Warm Springs (114) creeks; Lower Pahsimeroi River (201); Alturas Lake (120), Redfish Lake (121), Upper Valley (123) & West Fork Yankee (126) creeks	ST	3	3
Basin Creek (124)	ST	3	2
Salmon River/Challis (101); East Fork Salmon River/McDonald Creek (105); Herd Creek (108); Upper East Fork Salmon River (110); Salmon River/Big Casino (115), Fisher (117) & Fourth of July (118) creeks; Upper Salmon River (119); Valley Creek/Iron Creek (122); & Morgan Creek (132)	ST	2	3
Salmon River/Bayhorse Creek (104); Salmon River/Slate Creek (113); Upper Yankee Fork (127) & Squaw Creek (128); Pahsimeroi River/Falls Creek (202)	ST	2	2
Yankee Fork/Jordan Creek (125)	ST	1	3
Salmon River/Kinnikinnick Creek (112); Garden Creek (129); Challis Creek/Mill Creek (130); & Patterson Creek (203)	ST	1	2
Road Creek (107)	ST	1	1
Unoccupied habitat in Hawley (410), Eighteenmile (411) & Big Timber (413) creeks	Conservation Value for ST “Possibly High”		

Current PBF Condition	**Potential PBF Condition**
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name and HUC5 Code(s)	**Listed Species**	**Current Quality**	**Restoration Potential**
Middle Salmon, Panther and Lemhi #1706020xxx			
Salmon River/Colson (301), Pine (303) & Moose (305) creeks; Indian (304) & Carmen (308) creeks, North Fork Salmon River (306); & Texas Creek (412)	ST	3	3
Deep Creek (318)	ST	3	2
Salmon River/Cow Creek (312) & Hat (313), Iron (314), Upper Panther (315), Moyer (316) & Woodtick (317) creeks; Lemhi River/Whimpey Creek (402); Hayden (414), Big Eight Mile (408), & Canyon (408) creeks	ST	2	3
Salmon River/Tower (307) & Twelvemile (311) creeks; Lemhi River/Kenney Creek (403); Lemhi River/McDevitt (405), Lemhi River/Yearian Creek (406); & Peterson Creek (407)	ST	2	2
Owl (302) & Napias (319) creeks	ST	2	1
Salmon River/Jesse Creek (309); Panther Creek/Trail Creek (322); & Lemhi River/Bohannon Creek (401)	ST	1	3
Salmon River/Williams Creek (310)	ST	1	2
Agency Creek (404)	ST	1	1
Panther Creek/Spring Creek (320) & Clear Creek (323)	ST	0	3
Big Deer Creek (321)	ST	0	1
Mid-Salmon-Chamberlain, South Fork, Lower, and Middle Fork Salmon #1706020xxx			
Lower (501), Upper (503) & Little (504) Loon creeks; Warm Springs (502); Rapid River (505); Middle Fork Salmon River/Soldier (507) & Lower Marble Creek (513); & Sulphur (509), Pistol (510), Indian (511) & Upper Marble (512) creeks; Lower Middle Fork Salmon River (601); Wilson (602), Upper Camas (604), Rush (610), Monumental (611), Beaver (614), Big Ramey (615) & Lower Big (617) creeks; Middle Fork Salmon River/Brush (603) & Sheep (609) creeks; Big Creek/Little Marble (612); Crooked (616), Sheep (704), Bargamin (709), Sabe (711), Horse (714), Cottonwood (716) & Upper Chamberlain Creek (718); Salmon River/Hot Springs (712); Salmon River/Kitchen Creek (715); Lower Chamberlain/McCalla Creek (717); & Slate Creek (911)	ST	3	3
Marsh (506); Bear Valley (508) Yellow Jacket (604); West Fork Camas (607) & Lower Camas (608) creeks; & Salmon River/Disappointment Creek (713) & White Bird Creek (908)	ST	2	3
Upper Big Creek (613); Salmon River/Fall (701), California (703), Trout (708), Crooked (705) & Warren (719) creeks; Lower South Fork Salmon River (801); South Fork Salmon River/Cabin (809), Blackmare (810) & Fitsum (812) creeks; Lower Johnson Creek (805); & Lower (813), Middle (814) & Upper Secesh (815) rivers; Salmon	ST	2	2

Current PBF Condition	Potential PBF Condition
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name and HUC5 Code(s)	Listed Species	Current Quality	Restoration Potential
River/China (901), Cottonwood (904), McKenzie (909), John Day (912) & Lake (913) creeks; Eagle (902), Deer (903), Skookumchuck (910), French (915) & Partridge (916) creeks			
Wind River (702), Salmon River/Rabbit (706) & Rattlesnake (710) creeks; & Big Mallard Creek (707); Burnt Log (806), Upper Johnson (807) & Buckhorn (811) creeks; Salmon River/Deep (905), Hammer (907) & Van (914) creeks	ST	2	1
Silver Creek (605)	ST	1	3
Lower (803) & Upper (804) East Fork South Fork Salmon River; Rock (906) & Rice (917) creeks	ST	1	2
Little Salmon #176021xxx			
Rapid River (005)	ST	3	3
Hazard Creek (003	ST	3	2
Boulder Creek (004)	ST	2	3
Lower Little Salmon River (001) & Little Salmon River/Hard Creek (002)	ST	2	2
Selway, Lochsa and Clearwater #1706030xxx			
Selway River/Pettibone (101) & Gardner (103) creeks; Bear (102), White Cap (104), Indian (105), Burnt Knob (107), Running (108) & Goat (109) creeks; & Upper Selway River (106); Gedney (202), Upper Three Links (204), Rhoda (205), North Fork Moose (207), Upper East Fork Moose (209) & Martin (210) creeks; Upper (211), Middle (212) & Lower Meadow (213) creeks; Selway River/Three Links Creek (203); & East Fork Moose Creek/Trout Creek (208); Fish (302), Storm (309), Warm Springs (311), Fish Lake (312), Boulder (313) & Old Man (314) creeks; Lochsa River/Stanley (303) & Squaw (304) creeks; Lower Crooked (305), Upper Crooked (306) & Brushy (307) forks; Lower (308), Upper (310) White Sands, Ten Mile (509) & John's (510) creeks	ST	3	3
Selway River/Goddard Creek (201); O'Hara Creek (214) Newsome (505) creeks; American (506), Red (507) & Crooked (508) rivers	ST	2	3
Lower Lochsa River (301); Middle Fork Clearwater River/Maggie Creek (401); South Fork Clearwater River/Meadow (502) & Leggett creeks; Mill (511), Big Bear (604), Upper Big Bear (605), Musselshell (617), Eldorado (619) & Mission (629) creeks, Potlatch River/Pine Creek (606); & Upper Potlatch River (607); Lower (615), Middle (616) & Upper (618) Lolo creeks	ST	2	2
South Fork Clearwater River/Peasley Creek (502)	ST	2	1
Upper Orofino Creek (613)	ST	2	0
Clear Creek (402)	ST	1	3

Current PBF Condition	Potential PBF Condition
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name and HUC$_5$ Code(s)	Listed Species	Current Quality	Restoration Potential
Three Mile (512), Cottonwood (513), Big Canyon (610), Little Canyon (611) & Jim Ford (614) creeks; Potlatch River/Middle Potlatch Creek (603); Clearwater River/Bedrock (608), Jack's (609) Lower Lawyer (623), Middle Lawyer (624), Cottonwood (627) & Upper Lapwai (628) creeks; & Upper (630) & Lower (631) Sweetwater creeks	ST	1	2
Lower Clearwater River (601) & Clearwater River/Lower Potlatch River (602), Fivemile Creek (620), Sixmile Creek (621) and Tom Taha (622) creeks	ST	1	1
Mid-Columbia #1707010xxx			
Wood Gulch (112); Rock Creek (113); Upper Walla Walla (201), Upper Touchet (203), & Upper Umatilla (301) rivers; Meacham (302) & Birch (306) creeks; Upper (601) & Middle (602) Klickitat River	ST	2	2
Glade (105) & Mill (202) creeks; Lower Klickitat River (604); Mosier Creek (505); White Salmon River (509); Middle Columbia/Grays Creek (512)	ST	2	1
Little White Salmon River (510)	ST	2	0
Middle Touchet River (204); McKay Creek (305); Little Klickitat River (603); Fifteenmile (502) & Fivemile (503) creeks	ST	1	2
Alder (110) & Pine (111) creeks; Lower Touchet River (207), Cottonwood (208), Pine (209) & Dry (210) creeks; Lower Walla Walla River (211); Umatilla River/Mission Creek (303) Wildhorse Creek (304); Umatilla River/Alkali Canyon (307); Lower Butter Creek (310); Upper Middle Columbia/Hood (501); Middle Columbia/Mill Creek (504)	ST	1	1
Stage Gulch (308) & Lower Umatilla River (313)	ST	0	1
John Day #170702xxx			
Middle (103) & Lower (105) South Fork John Day rivers; Murderers (104) & Canyon (107) creeks; Upper John Day (106) & Upper North Fork John Day (201) rivers; & Desolation Creek (204)	ST	2	2
North Fork John Day/Big Creek (203); Cottonwood Creek (209) & Lower NF John Day River (210)	ST	2	1
Strawberry (108), Beech (109), Laycock (110), Fields (111), Mountain (113) & Rock (114) creeks; Upper Middle John Day River (112); Granite (202) & Wall (208) creeks; Upper (205) & Lower (206) Camas creeks; North Fork John Day/Potamus Creek (207); Upper Middle Fork John Day River (301) & Camp (302), Big (303) & Long (304) creeks; Bridge (403) & Upper Rock (411) creeks; & Pine Hollow (407)	ST	1	2
John Day/Johnson Creek (115); Lower Middle Fork John Day River	ST	1	1

Current PBF Condition	Potential PBF Condition
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name and HUC5 Code(s)	Listed Species	Current Quality	Restoration Potential
(305); Lower John Day River/Kahler Creek (401), Service (402) & Muddy (404) creeks; Lower John Day River/Clarno (405); Butte (406), Thirtymile (408) & Lower Rock (412) creeks; Lower John Day River/Ferry (409) & Scott (410) canyons; & Lower John Day River/McDonald Ferry (414)			
Deschutes #1707030xxx			
Lower Deschutes River (612)	ST	3	3
Middle Deschutes River (607)	ST	3	2
Upper Deschutes River (603)	ST	2	1
Mill Creek (605) & Warm Springs River (606)	ST	2	1
Bakeoven (608) & Buck Hollow (611) creeks; Upper (701) & Lower (705) Trout Creek	ST	1	2
Beaver (605) & Antelope (702) creeks	ST	1	1
White River (610) & Mud Springs Creek (704)	ST	1	0
Unoccupied habitat in Deschutes River/McKenzie Canyon (107) & Haystack (311); Squaw Creek (108); Lower Metolius River (110), Headwaters Deschutes River (601)	ST Conservation Value “Possibly High”		

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). The action area for the proposed activities encompasses some research that would take place in widely distributed headwater sites in Oregon, Washington, and Idaho. As a result, some of the proposed activities are so wide-ranging that the action area for this opinion potentially includes a great deal of each listed species' freshwater ranges (including some streams that may be randomly chosen from year to year), thus we cannot describe the action area with a great deal of specificity. Nonetheless, where it is possible to narrow the area of a given permit's scope, the effects analysis (Section 2.4) takes that limited geographic scope into account when determining the proposed actions' impacts on the species and their critical habitat.

The action area is thus spread out over a great deal across the landscape. It is also discontinuous. That is, there are large areas in between the various actions' locations where listed salmonids do exist, but where they would not be affected to any degree by any of the proposed activities. Also, there is one geographically distant outlier that must be included in the action area: that portion of the Puget Sound inhabited by southern resident killer whales. As noted earlier, the proposed actions could affect the killer whales' prey base (Chinook salmon) and so it is possible that some of the actions' effects could be felt as far as hundreds of miles away from where the actual 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 very small sites. For example, the researchers might electrofish a few hundred feet of river, deploy a beach seine covering only a few hundred square feet of stream, or operate a screw trap in a few tens of square feet of habitat. All of the actions would take place in designated critical habitat.

2.4 Environmental Baseline

The "environmental baseline" includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02). The environmental baseline for this opinion is therefore the result of the impacts that many activities (summarized below) have had on the various listed species' survival and recovery. It is also the result of the effects that climate change has had in the region (see Section 2.2.1 for discussion). Because the action area under consideration covers a large percentage of the listed species' ranges (see Section 2.3), the effects of these past activities on the species themselves (i.e., on their abundance, productivity, etc.) are largely described in the species status sections that precede this section (see Section 2.2). That is, for some of the work being contemplated here, the impacts of activities in the action area are indistinguishable from those effects described in the previous section on the species' rangewide status. Thus, with respect to the species' habitat, the environmental baseline is the combination of these effects on the PBFs that are essential to the conservation of the species. However, in those instances where the action area can be narrowed for a more specific analysis, the baseline in those areas will be taken fully into account.

2.4.1 Summary for all Listed Species

Factors Limiting Recovery

The best scientific information presently available demonstrates that a multitude of factors, past, present, and some ongoing, have contributed to the decline of west coast salmonids. NMFS' status reviews, Technical Recovery Team publications, and recovery plans for the listed species considered in this opinion identify several factors that have caused them to decline, as well as those that prevent them from recovering (many of which are the same). These factors are generally associated with (a) habitat degradation caused by human development (including hydropower development); (b) recreational, commercial, and tribal salmonid harvest; and (c) hatchery practices. Table 18 is a summary of the major factors limiting recovery of the species considered in this opinion; more details can also be found in the individual discussions of the species' status.

Table 18. Major Factors Limiting Recovery. (Adapted from NOAA, NMFS, 2005 Report to Congress: Pacific Coast Salmon Recovery Fund FY 2000-2004, Good et al. 2005, Ford 2011, NWFSC 2015)

Species	High Temp	Excess Sediment	Blocked Passage	Habitat Loss	Degraded Channels	Impaired Floodplain	Reduced Streamflow	Hatchery Impacts	Harvest-Related Effects	Hydropower Mortality
UCR Chinook	●		●	●	●	●	●		●	●
UCR Steelhead	●	●		●	●	●	●	●		●
MCR Steelhead	●	●	●		●		●			●
SR Spr/sum Chinook	●	●			●	●		●	●	●
SR Steelhead	●	●			●	●	●	●		●

For detailed information on how various factors have degraded PCEs in the Columbia River basin please see any of the following: NMFS 1991, NMFS 1997, NMFS 1998a, NMFS 2000a, NMFS 2002, NMFS 2003, NMFS 2000d, Good et al. 2005, Ford 2011, NWFSC 2015).

Research Effects

Although it has never been identified as a factor for decline or a threat preventing recovery, scientific research has the potential to affect the species' survival and recovery by killing listed salmonids. As of 2017, several dozen section 10(a)(1)(A) scientific research permits are in force in the Pacific Northwest that authorize lethal and non-lethal listed species take. In addition, NMFS has also re-authorized three state scientific research programs under ESA section 4(d) (for Oregon, Washington, and Idaho). The table below displays the total take NMFS has authorized for the ongoing research under ESA sections 4(d) and 10(a)(1)(A), as of December 31, 2016.

Table 19. Take Authorized for Research on Relevant Listed Species at the beginning of 2017.

	Origin	***Adults Handled***	***Adults Killed***	***Juveniles Handled***	***Juveniles Killed***
UCR Chinook	Natural	618	15	25,966	677
	Listed Hatchery: Adipose Clip	297	7	2,467	82
	Listed Hatchery: Intact Adipose	414	12	11,274	281
UCR Steelhead	Natural	654	10	47,381	1,163
	Listed Hatchery: Adipose Clip	10	17	15,069	409
	Listed Hatchery: Intact Adipose	252	7	12,701	331
MCR Steelhead	Natural	4,151	38	176,025	3,166
	Listed Hatchery: Adipose Clip	903	10	26,388	760
	Listed Hatchery: Intact Adipose	424	12	17,294	367
SR s/s Chinook	Natural	9,780	67	1,341,690	10,640
	Listed Hatchery: Adipose Clip	1,640	11	142,388	1,562

	Listed Hatchery: Intact Adipose	3,653	10	82,983	720
SR Steelhead	Natural	12,374	126	416,593	4,440
	Listed Hatchery: Adipose Clip	4,731	58	28,764	390
	Listed Hatchery: Intact Adipose	3,830	187	37,938	465

Actual take levels associated with these activities are almost certain to be a good deal lower than the permitted levels. There are two reasons for this. First, most researchers do not handle the full number of outmigrants (or adults) they are allowed. (Our research tracking system reveals that researchers, on average, end up taking only about 37% of the number of fish they request and kill about 15% of the numbers authorized.) Second, we purposefully inflate our mortality estimates for each proposed study to account for the effects of potential accidental deaths. Therefore very likely that far fewer fish—especially juveniles—would be killed under any given research project than the researchers are allotted.

2.5 Effects of the Action

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

2.5.1 Effects on Critical Habitat

Full descriptions of effects of the proposed activities are found in the next section. As a general rule, the activities would be (1) conducting electrofishing surveys; (2) capturing fish with angling gear (barbless artificial bait and flies), traps, and nets of various types; and (3) marking the captured fish with various types of tags and marks. All of these techniques are minimally intrusive in terms of their effect on habitat because they would involve very little, if any, disturbance of streambeds or adjacent riparian zones. Thus none of the activities would measurably affect any habitat PBF listed earlier. Moreover, the proposed activities are all of short duration.

2.5.2 Effects on Listed Salmon and Steelhead

As noted above, the proposed research activities would have no measurable effects on the listed salmonids' habitat. The actions are therefore not likely to measurably affect any of the listed salmonid species considered here by reducing their habitat's ability to contribute to their survival and recovery.

The primary effect of the proposed research on the listed species would be in the form of capturing and handling the fish. Capturing, handling, and releasing fish generally leads to stress and other short-term, sub-lethal effects, but the fish do sometimes die from such treatment. The following subsections describe the types of activities being proposed. Each is described in terms broad enough to apply to all the relevant permits. The activities would be carried out by trained professionals using established protocols. The effects of the activities have been well documented and are discussed in detail below. No researcher would receive a permit unless the activities (e.g., electrofishing) incorporate NMFS' uniform, pre-established set of mitigation measures—described in Section 1.3 of this opinion as "Common Elements among the Proposed Actions." They are incorporated (where relevant) into every permit as part of the conditions to which any researcher must adhere.

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 (Section 1.3), would not be walked on. Harassment is the primary form of take associated with these observation activities, and no injuries or 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.

Capture/handling

Any physical handling or psychological disturbance is known to be stressful to fish (Sharpe et al. 1998). The primary contributing factors to stress and death from handling are excessive doses of anesthetic, differences in water temperatures (between the river and wherever the fish are held), dissolved oxygen conditions, the amount of time that fish are held 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 that are transferred to holding tanks can experience trauma if care is not taken in the transfer process, and fish can experience stress and injury from overcrowding in traps if the traps are not emptied regularly. High levels of stress can both immediately debilitate individuals and over a longer period, increase their vulnerability to physical and biological challenges (Sharpe et al. 1998). Debris built up at traps can also kill or injure fish unless the traps are monitored and cleared regularly. The permit conditions identified earlier in subsection 1.3 contain measures that mitigate these and other factors that commonly lead to stress and trauma from handling, and thus minimize the harmful effects. When these measures are followed, fish typically recover fairly rapidly from handling.

Screw trapping

Smolt, rotary screw (and other out-migration) traps, are generally used to obtain information on natural population abundance and productivity. On average, they achieve a sample efficiency of four to 20% of the emigrating population from a river or stream--depending on river size. Although under some conditions traps may achieve a higher efficiency for a relatively short period of time (NMFS 2003b). Based on years of sampling at hundreds of locations under hundreds of scientific research authorizations, we would expect the mortality rates for fish captured at rotary screw type traps to be one percent or less.

The trapping, capturing, or collecting and handling of juvenile fish using traps is likely to cause some stress on listed fish. However, fish typically recover rapidly from handling procedures. The primary factors that contribute to stress and mortality from handling are excessive doses of anesthetic, differences in water temperature, dissolved oxygen conditions, the amount of time that fish are held out of water, and physical trauma. Stress on salmonids increases rapidly from handling if the water temperature exceeds 64.4 degrees F (18 degrees C) or if dissolved oxygen is below saturation. Additionally, stress can occur if there are more than a few degrees difference in water temperature between the stream/river and the holding tank.

The potential for unexpected injuries or mortalities among listed fish is reduced in a number of ways. These can be found in the individual study protocols and in the permit conditions stated earlier. In general, screw traps are checked at least daily and usually fish are handled in the morning. This ensures that the water temperature is at its daily minimum when fish are handled. Also, fish may not be handled if the water temperature exceeds 69.8 degrees Fahrenheit (21 degrees C). Great care must be taken when transferring fish from the trap to holding areas and the most benign methods available are used—often this means using sanctuary nets when transferring fish to holding containers to avoid potential injuries. The investigators' hands must be wet before and during fish handling. Appropriate anesthetics must be used to calm fish subjected to collection of biological data. Captured fish must be allowed to fully recover before being released back into the stream and would be released only in slow water areas. And often, several other stringent criteria are applied on a case-by case basis: safety protocols vary by river velocity and trap placement, the number of times the traps are checked varies by water and air temperatures, the number of people working at a given site varies by the number of outmigrants expected, etc. All of these protocols and more are used to make sure the mortality rates stay at one percent or lower.

Angling

Fish that are caught with hook and line and released alive may still die as a result of injuries and stress they experience during capture and handling. The likelihood of killing a fish varies widely, based on a number of factors including the type of hook used (barbed vs barbless), the type of bait used (natural vs artificial), the water temperature, anatomical hooking location, the species, and the care with which the fish is released (level of air exposure and length of time for hook removal).

The available information assessing hook and release mortality of adult steelhead suggests that hook and release mortality with barbless hooks and artificial bait is low. Nelson et al (2005) reported an average mortality of 3.6% for adult steelhead that were captured using barbless hooks and radio tagged in the Chilliwack River, BC. The authors also note that there was likely some tag loss and the actual mortality might be lower. Hooton (1987) found catch and release mortality of adult winter steelhead to average 3.4% (127 mortalities of 3,715 steelhead caught) when using barbed and barbless hooks, bait, and artificial lures. Among 336 steelhead captured on various combinations of popular terminal gear in the Keogh River, the mortality of the combined sample was 5.1%. Natural bait had slightly higher mortality (5.6%) than did artificial lures (3.8%), and barbed hooks (7.3%) had higher mortality than barbless hooks (2.9%). Hooton (1987) concluded that catching and releasing adult steelhead was an effective mechanism for maintaining angling opportunity without negatively impacting stock recruitment. Reingold (1975) showed that adult steelhead hooked, played to exhaustion, and then released returned to their target spawning stream at the same rate as steelhead not hooked and played to exhaustion. Pettit (1977) found that egg viability of hatchery steelhead was not negatively affected by catch-and-release of pre-spawning adult female steelhead. Bruesewitz (1995) found, on average, fewer than 13% of harvested summer and winter steelhead in Washington streams were hooked in critical areas (tongue, esophagus, gills, eye). The highest percentage (17.8%) of critical area hookings occurred when using bait and treble hooks in winter steelhead fisheries.

The referenced studies were conducted when water temperatures were relatively cool, and primarily involve winter-run steelhead. Catch and release mortality of steelhead is likely to be higher if the activity occurs during warm water conditions. In a study conducted on the catch and release mortality of steelhead in a California river, Taylor and Barnhart (1999) reported over 80% of the observed mortalities occurred at stream temperatures greater than 21 degrees C. Catch and release mortality during periods of elevated water temperature are likely to result in post-release mortality rates greater than reported by Nelson et al (2005) or (Hooton (1987) because of warmer water and that fact that summer fish have an extended freshwater residence that makes them more likely to be caught. As a result, NOAA Fisheries expects steelhead hook and release mortality to be in the lower range discussed above.

Juvenile steelhead occupy many waters that are also occupied by resident trout species and it is not possible to visually separate juvenile steelhead from similarly-sized, stream-resident, rainbow trout. Because juvenile steelhead and stream-resident rainbow trout are the same species, are similar in size, and have the same food habits and habitat preferences, it is reasonable to assume that catch-and-release mortality studies on stream-resident trout are similar for juvenile steelhead. Where angling for trout is permitted, catch-and-release fishing with prohibition of use of bait reduces juvenile steelhead mortality more than any other angling regulatory change. Artificial lures or flies tend to superficially hook fish, allowing expedited hook removal with minimal opportunity for damage to vital organs or tissue (Muoneke and Childress, 1994). Many studies have shown trout mortality to be higher when using bait than when angling with artificial lures and/or flies (Taylor and White 1992; Schill and Scarpella 1995; Muoneke and Childress 1994; Mongillo 1984; Wydoski 1977; Schisler and Bergersen 1996). Wydoski (1977) showed the average mortality of trout, when using bait, to be more than four times greater than the mortality associated with using artificial lures and flies. Taylor and White (1992) showed average mortality of trout to be 31.4% when using bait versus 4.9 and 3.8% for lures and flies, respectively. Schisler and Bergersen (1996) reported average mortality of trout caught on passively fished bait to be higher (32%) than mortality from actively fished bait (21%). Mortality of fish caught on artificial flies was only 3.9%. In the compendium of studies reviewed by Mongillo (1984), mortality of trout caught and released using artificial lures and single barbless hooks was often reported at less than 2%.

Most studies have found a notable difference in the mortality of fish associated with using barbed versus barbless hooks (Huhn and Arlinghuas 2011; Bartholomew and Bohnsack 2005; Taylor and White 1992; Mongillo 1984; Wydoski 1977). Researchers have generally concluded that barbless hooks result in less tissue damage, they are easier to remove, and because they are easier to remove the handling time is shorter. In summary, catch-and-release mortality of steelhead is generally lowest when researchers are restricted to use of artificial flies and lures. As a result, all steelhead sampling via angling must be carried out using barbless artificial flies and lures.

Only a few reports are available that provide empirical evidence showing what the catch and release mortality is for Chinook salmon in freshwater. The ODFW has conducted studies of hooking mortality incidental to the recreational fishery for Chinook salmon in the Willamette River. A study of the recreational fishery estimates a per-capture hook-and-release mortality for wild spring Chinook in Willamette River fisheries of 8.6% (Schroeder et al. 2000), which is similar to a mortality of 7.6% reported by Bendock and Alexandersdottir (1993) in the Kenai River, Alaska.

A second study on hooking mortality in the Willamette River, Oregon, involved a carefully controlled experimental fishery, and mortality was estimated at 12.2% (Lindsay et al. 2004). In hooking mortality studies, hooking location, gear type, and unhook time is important in determining the mortality of released fish. Fish hooked in the jaw or tongue suffered lower mortality (2.3 and 17.8% in Lindsay et al. (2004)) compared to fish hooked in the gills or esophagus (81.6 and 67.3%). Numerous studies have reported that deep hooking is more likely to result from using bait (e.g. eggs, prawns, or ghost shrimp) than lures (Lindsay et al 2004; …..). One theory is that bait tends to be passively fished and the fish is more likely to swallow bait than a lure. Passive angling techniques (e.g. drift fishing) are often associated with higher hooking mortality rates for salmon while active angling techniques (e.g. trolling) are often associated with lower hooking mortality rates (Rogers et al 1999).

Catch and release fishing does not seem to have an effect on migration. Lindsay et al. (2004) noted that “hooked fish were recaptured at various sites at about the same frequency as control fish”. Bendock and Alex (1993) found that most of their tagged fish later turned up on the spawning grounds. Cowen et al (2007) found little evidence of an adverse effect on spawning success for Chinook.

Not all of the fish that are hooked are subsequently landed. We were unable to find any studies that measured the effect of hooking and losing a fish. However, it is reasonable to assume that nonlanded morality would be negligible, as fish lost off the hook are unlikely to be deeply hooked and would have little or no wound and bleeding (Cowen et al 2007).

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

Electrofishing

Electrofishing is a process by which an electrical current is passed through water, stunning fish and thus making them easier to capture. It can cause a suite of effects ranging from simple harassment to actually killing the fish (adults and juveniles) in an area where it is occurring. The amount of unintentional mortality attributable to electrofishing may vary depending on the equipment used, the settings on the equipment, water conditions, 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. The long-term effects electrofishing has on both juvenile and adult salmonids are not well understood, but long experience with electrofishing indicates that most impacts occur at the time of sampling and are of relatively short duration.

The effects electrofishing may have on the species in this opinion would be limited to the direct and indirect effects of exposure to an electric field, capture by netting, holding captured fish in aerated tanks, and the effects of handling associated with transferring the fish back to the river (see the previous subsection for more detail on capturing and handling effects). 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 intercept a smaller head-to-tail electrical potential 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 MCR 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 (Snyder 1992 and 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 (Ainslie *et al.* 1998, Dalbey *et al.* 1996). 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).

NMFS's electrofishing guidelines (NMFS 2000c) will be followed in all surveys employing electrofishing equipment. 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. Electrofishing is used only when other survey methods are not feasible. All areas for stream and special needs surveys 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 or pulsed DC units will be used, and the equipment will be regularly maintained to ensure proper operating condition. Voltage, pulse width, and rate will be kept at minimal levels and water conductivity will be tested at the start of every electrofishing session so those minimal levels can be determined. When such low settings are used, shocked fish normally revive instantaneously. Fish requiring revivification will receive immediate, adequate care.

The preceding discussion focused on the effects of using a backpack unit for electrofishing and the ways those effects will be mitigated. It should be noted, however, that 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 thereby take steps to avoid them. Because of its greater potential to harm fish, and because NMFS has not published appropriate guidelines, boat electrofishing has not been given a general authorization under NMFS' ESA section 4(d) rules. In any case, all researchers intending to use boat electrofishing will use all means at their disposal to ensure that a minimum number of fish are harmed.

Tagging/marking

Techniques such as PIT-tagging (passive integrated transponder 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 NMFS' pre-established mitigation measures (Section 1.3), 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 fish are taken from, recover in, and are released to cold water of high quality and in a carefully controlled, sanitary environment.

The 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 does not generally increase the likelihood of mortality because researchers recover CWTs from salmon that have been taken during the course of commercial and recreational harvest (and are therefore already dead).

Another primary method for tagging fish is to implant them with radio tags. There are two main ways to accomplish this, with differing 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 (Nielson 1992), but could interfere greatly with feeding and fitness in general if done before that time. 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 radio 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 (Nielson 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 radio tags often die at higher rates than fish tagged by other means because radio 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 radio tagging to a minimum by following the conditions given earlier in this opinion, as well as by meeting any other permit-specific requirements.

Fin clipping is the process of removing part or all of one or more fins to alter a fish's appearance and thus make it identifiable. When entire fins are removed, they are not expected 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. Stolte (1973) showed that adipose- and pelvic-fin-clipped coho salmon fingerlings have a 100% recovery rate. Recovery rates are generally 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.

Regardless, any time researchers clip or remove fins, it is necessary that the fish be handled. Therefore, the same safe and sanitary conditions required for tagging operations also apply to clipping activities.

2.5.3 Species-specific Effects of Each Permit

The analysis process described above hinges primarily on two sets of data. The first set is NMFS's estimate of how many juvenile fish from each of the species considered here outmigrate every year. Our Science Center produces these estimates every year and the numbers are largely drawn from activities that have received research permits and authorizations in the region for well over a decade. All the analyses relating to juvenile take in this section and the next use as their denominators the five-year average outmigration estimates in the table below (these same data are also presented in the various species' status sections).

Table 20. Recent Five-Year Average Projected Outmigrations for Columbia Basin Salmonids (Dey 2012; Zabel 2013; Zabel 2014; Zabel 2015, Zabel 2016).

ESU/DPS	Origin	Outmigration
UCR Chinook	Natural	521,802
UCR Chinook	Listed Hatchery: Adipose Clipped	507,920
UCR Chinook	Listed Hatchery: Intact Adipose	592,379
UCR Steelhead	Natural	245,890
UCR Steelhead	Listed Hatchery: Adipose Clipped	631,207
UCR Steelhead	Listed Hatchery: Intact Adipose	143,502
MCR Steelhead	Natural	448,242
MCR Steelhead	Listed Hatchery: Adipose Clipped	347,853
MCR Steelhead	Listed Hatchery: Intact Adipose	202,573
SR Spr/sum Chinook	Natural	1,397,403
SR Spr/sum Chinook	Listed Hatchery: Adipose Clipped	4,288,088
SR Spr/sum Chinook	Listed Hatchery: Intact Adipose	1,115,848

ESU/DPS	Origin	Outmigration
SR Steelhead	Natural	890,596
SR Steelhead	Listed Hatchery: Adipose Clipped	3,370,663
SR Steelhead	Listed Hatchery: Intact Adipose	833,108

The second set of data is used to gauge the effects the proposed activities may have on adults. These data are derived from the most recent five-year averages of the return numbers found in the individual species status sections. The following table summarizes the most recent four-year adult return averages for which we have data.

Table 21. Recent Four-Year Adult Return Averages and the Percentages of their Natural Component for the Species Considered in this Opinion (see individual status sections for more detail).

ESU/Species	Recent Four-Year Average Return	Natural Fish Returns	Percent of the Return Made up of Natural Fish
UCR Chinook	9,075	3,170	35%
UCR Steelhead	19,179	4,410	23%
MCR Steelhead	18,782	17,232	91%
SR Spr/sum Chinook	28,596	23,449	82%
SR Steelhead	333,400	33,340	10%

In conducting the following analyses, we have tied the effects of each proposed action to its impacts on individual populations (or population groups) wherever it was possible to do so. In some instances, the nature of the project (i.e., it is broadly distributed or situated in mainstem habitat) was such that the take could not reliably be assigned to any population or group of populations. In those cases, the effects of the action are measured in terms of how they are expected to affect each species at the species scale, rather than at the population scale.

Permit 1379 – 7R

Under Permit 1379 – 7R, CRITFC would continue work they have been doing in the Columbia River basin for nearly two decades. As stated previously, Permit 1379 has been in existence for many years and currently allows CRITFC to annually take adult and juvenile SR fall Chinook, SR spring/summer Chinook, and UCR spring Chinook; adult and juvenile SR and UCR steelhead; and adult SR sockeye salmon at Bonneville and Tumwater Dam, in the Wenatchee River, and in the Hanford reach of the Columbia River. Many of the fish would simply be captured, handled, and released, but some would be anesthetized as well.

The amount of take being requested is in the table below, and “Ad-Clip” indicates that these animals are hatchery fish that have had their adipose fins clipped. As noted before, there are no take prohibitions on such fish (and therefore they will not appear in any permit), but they are still listed under the ESA and the effects of taking them must therefore be evaluated.

Table 22. Requested Take by ESU, Life Stage, Origin, and Activity for Permit 1379-7R (C=Capture, H=Handle, R=Release)

ESU/Species	Life Stage	Origin	Take Activity	Requested Take	Unintentional Mortality
UCR Chinook	Adult	Natural	C/H/R	81	0
UCR Chinook	Juvenile	natural	C/H/R	205	6
UCR Chinook	Juvenile	Hatchery: Ad-Clip	C/H/R	136	3
UCR Steelhead	Adult	Natural	C/H/R	81	0
UCR Steelhead	Juvenile	Natural	C/H/R	35	2
UCR Steelhead	Juvenile	Hatchery: Ad-Clip	C/H/R	9	1

*In this and all other instances where unintentional mortality is listed, the numbers *come out* of the requested take they are not added to it. So for example, the six UCR Chinook juveniles in the Unintentional Mortality column in the table above would be six of the requested 205 fish found in the fifth column.

Because the vast majority of the fish that would be captured are expected to recover with no ill effects, the true effects of the proposed action are best seen in the context of the fish that the action is likely to kill. To determine the effect of these losses, it is necessary to compare them to the total outmigrant numbers expected for these species (and their components) found in Table 20. (There is no reason to compare the adult losses to recent returns because no adults are expected to be killed.) This signifies that the research may kill the following percentages of the last five years’ average projected outmigrations for UCR Chinook and steelhead.

Table 23. Percentage of the 2012 - 2016 Average Outmigration and Recent 5-year Adult Returns Likely to be Killed by Activities Conducted Under Permit 1379 – 7R.

ESU/Species	Life Stage	Origin	% Mortalities
UCR Chinook	Juvenile	Natural	0.001%
UCR Chinook	Juvenile	Hatchery: Ad-Clip	0.0001%
UCR Steelhead	Juvenile	Natural	0.0008%
UCR Steelhead	Juvenile	Hatchery	0.0001%

This signifies that the research would have only very small impacts on any species' abundance (and therefore productivity) and no measureable impact on structure or diversity. This is especially true given that the research would take place in such a way that the researchers could intercept fish from any portion of the ESU. Thus, even this small amount of harm cannot be ascribed to any given population. But even these minor effects are in actuality probably even smaller than displayed: in the many years this permit has been in effect, the researchers have always killed far fewer fish than they have been allotted—in two recent years, they have killed none.

Permit 13381 – 2R

Under Permit 13381 – 2R, the NWFSC would continue research in the Salmon River subbasin that they have been conducting for well over a decade under a previous version of this permit and under an earlier permit of a different number (1406). The researchers would use seines, dipnets, and electrofishing equipment to capture the fish. Most fish would simply be released, but a substantial fraction would be handled, measured, tissue-sampled, and given a PIT-tag. The researchers would work primarily in multiple streams tributary to the Salmon River in Idaho, but they would also capture some fish at Little Goose Dam or Lower Granite Dam on the Snake River.

Table 24. Requested Take by ESU, Life Stage, Origin, and Activity for Permit 13381 – 2R (C=Capture, H=Handle, T=Tag, TS= Tissue Sample, R=Release)

ESU/Species	Life Stage	Origin	Take Activity	Requested Take	Unintentional Mortality
SR spr/sum Chinook	Juvenile	Natural	C,H,R	9,000	180

ESU/Species	Life Stage	Origin	Take Activity	Requested Take	Unintentional Mortality
SR spr/sum Chinook	Juvenile	Natural	C,H,T,TS,R	22,700	430
SR Steelhead	Juvenile	Natural	C,H,R	7,000	140
SR Steelhead	Juvenile	Natural	C,H,T,TS,R	4,000	80

Because the vast majority of the fish that would be captured are expected to recover from their handling, tagging, etc. with no ill effects, the true impacts of the proposed action are best seen in the context of the fish that the action is likely to kill. To determine the effect of these losses, it is necessary to compare them to the total outmigrant numbers expected for these species (and their components) found in Table 20. This signifies that the research may kill the following percentages of the last five years' average projected outmigrations.

Table 25. Percentage of the 2011-2016 Average Outmigration Likely to be Killed by Activities Conducted Under Permit 13381 – 2R.

ESU/Species	Life Stage	Origin	% Mortalities
SR spr/sum Chinook	Juvenile	Natural	0.04%
SR Steelhead	Juvenile	Natural	0.02%

Thus the research would kill, at most, 0.04% of the outmigrating natural spr/sum Chinook and 0.02% of the natural steelhead. These effects would be somewhat magnified by the fact that most of the fish would come the Salmon River subbasin (approximately 1,700 of the 31,700 spr/sum Chinook, though, would be collected at little Goose Damn—so those fish could come from anywhere in the ESU). The effects would be evenly distributed over at least 13 streams during every field season—and the collection sites would likely change slightly from year to year—so it is unlikely that any particular population would suffer a disproportionate amount of loss. Given, though, that the collections would be restricted to only a portion of the DPS's range, the local effects in the Salmon River subbasin would indeed by slightly higher than the percentages in the table above would suggest. Yet, even if those impacts were doubled—and the Salmon River produces more than half the SR spr/sum Chinook and SR steelhead—they would still represent only very small reductions in abundance and productivity (0.08% to 0.04% for salmon and steelhead, respectively) and no measureable impact on structure or diversity. And once again, those impacts would be well-distributed throughput the subbasin so no individual population would be affected to a greater degree than any other.

Lastly, the NWFSC has been reporting on this research for a number of years. Those reports show that even in the most impactful season for this permit in the last nine years (2011), the researchers killed far fewer fish than they were allotted: around 25% for spr/sum Chinook and even less than that for steelhead. This would tend to indicate that the effect this permit may have in any given year is likely to be a good deal smaller than the numbers displayed in the tables above. And, too, even that small effect would be offset by the information generated from the research and that will very likely have a strong positive effect in helping recover the listed fish by helping budget water releases at the Columbia River dams and gathering data on early life stage behavior and response.

Permit 13382 – 3R

Under Permit 13382 – 3R, the NWFSC would continue work they have been conducting under various authorizations for more than two decades in Idaho, SE Washington, and NE Oregon. The work is essentially identical to work that has been previously analyzed three times and approved for the last 15 years or so. For most of the study, the NWFSC would capture juvenile fish using seines and electrofishing equipment, anesthetize, measure, and tissue-sample (fin clip) a portion of them, allow them to recover from the anesthetic, and release them back to their capture sites. They would also sample some fish that are handled under other permits for hatchery operations.

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

The researchers are requesting the following levels of take.

Table 26. Requested Take by ESU, Life Stage, Origin, and Activity for Permit 13382 – 3R (C=Capture, H=Handle, T=Tag, R=Release)

ESU/Species	Life Stage	Origin	Take Activity	Requested Take	Unintentional Mortality
SR Spr/sum Chinook	Juvenile	Natural	C/H/R	319	7
SR Spr/sum Chinook	Juvenile	Natural	C/H/T/R	1,050	16
SR Spr/sum Chinook	Juvenile	Hatchery: Ad-Clip	C/H/R	1,033	20
SR Spr/sum Chinook	Juvenile	Hatchery: Ad-Clip	C/H/T/R	3,400	51
SR Spr/sum Chinook	Juvenile	Hatchery: Intact Adipose	C/H/R	168	3
SR Spr/sum Chinook	Juvenile	Hatchery: Intact Adipose	C/H/T/R	550	8
SR Steelhead	Juvenile	Natural	C/H/R	340	7
SR Steelhead	Juvenile	Natural	C/H/T/R	553	11
SR Steelhead	Juvenile	Hatchery: Ad-Clip	C/H/R	1,320	26
SR Steelhead	Juvenile	Hatchery: Ad-Clip	C/H/T/R	2,144	43
SR Steelhead	Juvenile	Hatchery: Intact Adipose	C/H/R	340	7
SR Steelhead	Juvenile	Hatchery: Intact Adipose	C/H/T/R	553	11

Because nearly all the fish that would be captured under this permit are expected to recover with no ill effects, the true effects of the proposed action are best seen in the context of the fish that the action is likely to kill. To determine the effect of these losses, it is necessary to compare them to the total outmigrant numbers expected for these species (and their components) found in Table 20. This signifies that the research may kill the following percentages of the last five years' average projected outmigrations for the relevant species.

Table 27. Percentage of the 2012 - 2016 Average Outmigration Likely to be Killed by Permit 13382 – 3R.

ESU/Species	Life Stage	Origin	% Mortalities
SR Spr/Sum Chinook Salmon	Juvenile	Natural	0.002%
SR Spr/Sum Chinook Salmon	Juvenile	Hatchery: Ad-Clip	0.002%
SR Spr/Sum Chinook Salmon	Juvenile	Hatchery: Intact Adipose	0.001%
SR Steelhead	Juvenile	Natural	0.002%
SR Steelhead	Juvenile	Hatchery: Ad-Clip	0.002%
SR Steelhead	Juvenile	Hatchery: Intact Adipose	0.002%

Thus the researchers would in all cases kill (at most) two-thousandths of a percent of any component of the steelhead or spr/sum Chinook outmigrations. And because that take would be spread out over tributaries in three states and vary locations from year to year, it is impossible to assign that take to any grouping smaller than the entire listing units themselves and therefore no individual smaller unit (i.e., population) would suffer a disproportionate amount of the likely effects.

In addition, if the past is any indication, the likely effects would probably be even smaller than those displayed: over the past 14 years, the applicants have nearly invariably taken far fewer fish than they were allotted and, in all years, they killed fewer fish as well. So it is probable that they will continue take and kill fewer fish than they are permitted. But even if they were to take all the fish contemplated in the tables above, the losses would still be very small and would only be seen as slight reductions in abundance and productivity and would not measurably affect diversity or structure. Another thing to consider is the fact that the researchers have for years been providing important information about hatchery effects in the Snake River basin—information that has been used for years to inform a range of management decisions.

Permit 17222 – 2R

Under Permit 17222 – 2R, researchers from the CTWSRO would use seines to capture unlisted Chinook salmon in the Deschutes River. The researchers would be operating at times when they are unlikely to encounter any listed MCR steelhead, but some would still likely be caught as a consequence of the work. All captured steelhead would be released immediately with a minimum of handling. The researchers are requesting to take 100 juvenile natural MCR steelhead and 100 juvenile hatchery MCR steelhead that have had their adipose fins clipped. Of these, as many as three hatchery and three natural fish may be killed.

This would signify that the research may kill, at most, 0.0007% of the species' natural outmigrants and 0.0009% of the adipose-clipped hatchery component. However, these effects would be magnified by the fact that the fish that may be taken would not come from the species a whole, but only from the Deschutes River populations. Given that the Deschutes River produces approximately 18% of the fish returning to the DPS (see status section), the local effects are likely to be something on the order of five times as large as they are for the species as a whole. That would mean that as much as 0.0035% of the natural component of MCR steelhead in the Deschutes and 0.0045% of the hatchery component may be killed by the research. These effects on abundance and productivity are still nearly zero and the effects on structure and diversity are still unmeasurably small. Moreover, in the last five years this research has been underway, the CTWSRO researchers have never killed any MCR steelhead at all. Therefore the effects just listed are unlikely to even occur.

But even if the researchers were to kill the total number of fish they have requested, these losses must be placed come in the context of an effort to generate information that would be used to characterize population and habitat health in the Deschutes River—data that would inform resource management and recovery planning decisions in future years.

Permit 17306 – 2R

Under Permit 17306 – 2R the ODFW would continue work they have been doing for decades but for which they now require a permit because MCR steelhead have been reintroduced to the upper Deschutes River. The researchers would use a variety of means to capture the fish (seines, traps, electrofishing, hook-and-line) and about 40% of the time would simply measure and release the fish. In their screw trap operations, the fish would also be sampled and tagged or marked. No adults would be targeted and, in all instances, they would be released as soon as possible. In no case would the researchers conduct electrofishing for adults, and if any are encountered during the boat electrofishing operations, the equipment would immediately be turned off and the fish allowed to escape. The researchers are requesting the following levels of take.

Table 28. Requested Take by ESU, Life Stage, Origin, and Activity for Permit 17306 – 2R (C=Capture, H=Handle, T=Tag, TS=tissue sample, M=Mark, R=Release.)

ESU/Species	Life Stage	Origin	Take Activity	Requested Take	Unintentional Mortality
MCR Steelhead	Adult	Natural	C/H/R	80	1
MCR Steelhead	Adult	Hatchery: Intact Adipose	C/H/R	80	1
MCR Steelhead	Juvenile	Natural	C/H/R	3,260	68
MCR Steelhead	Juvenile	Hatchery: Intact Adipose	C/H/R	3,260	68
MCR Steelhead	Juvenile	Natural	C/H/TS/M/R	5,000	50
MCR Steelhead	Juvenile	Hatchery: Intact Adipose	C/H/TS/M/R	5,000	50

Because the majority of the fish that would be captured are expected to recover with no permanent ill effects, the most meaningful measure of the effects of the proposed action is seen in the number of listed fish the action is likely to kill. To determine the effect of these losses, it is necessary to compare them to the total outmigrant numbers and returns expected for this species (and its components). This signifies that the research could potentially kill the following percentages of the outmigrants and adult returns.

Table 29. Percentage of the Recent Average Outmigration and Recent Return Average Likely to be Killed by Permit 17306.

ESU/Species	Life Stage	Origin	% Mortalities
MCR Steelhead	Adult	Natural	0.006%
MCR Steelhead	Adult	Hatchery: Intact Adipose*	0.06%
MCR Steelhead	Juvenile	Natural	0.02%
MCR Steelhead	Juvenile	Hatchery: Intact Adipose	0.06%

*The hatchery return components are not broken out by whether or not the fish have had their adipose fins removed, so the percentage above is derived by using the entire hatchery return figure as the denominator.

Thus the effects of the research on MCR steelhead would be very small and would likely only affect abundance and to some extent productivity. It should be noted, however, that the effects would be concentrated on the Deschutes River population that has been reintroduced above Pelton and Roundbutte Dams, so they would be magnified at the local level. At the moment, the only fish that have been reintroduced are unfed hatchery fry. The most recent outplanting of hatchery fry was 415,000 fish. That means that the effect of the take would be to kill something on the order of 0.03% of the fish that may inhabit the system. For natural fish, the effect may be slightly larger, but this effect has thus far not been evident and would likely remain unapparent for the next few years. It is hoped that in future years fisheries managers would be able to pass 100 (or more) returning steelhead above the Pelton and Round Butte Dams on the Deschutes River. These fish could produce something on the order of 12,500 smolts (estimating 50 females, 2,500 eggs each, 5% survival to smolthood) and therefore the research may kill, at most 0.9% of those possible progeny—but that is leaving aside the continued influx of hatchery fry which would reduce the overall effect by orders of magnitude. Thus the research would have a very small effect on the local outmigrations' abundances (and therefore productivity) and a negligible effect on the DPS as a whole; neither structure nor diversity is likely to be affected at either level.

The effect on the adult returns is very small, but it is actually most likely to be zero. Given that the researchers could not electrofish for adults and that in all other cases the adults would be avoided, the chances are very good that no adults at all would be killed. In fact, none have even been encountered in the last four years the research has been undertaken. But even if the two adults were to be killed, the effect on the natural population would be nearly negligible and the effect on the hatchery fish would be small enough that it would not constitute a hazard for the population.

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

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

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

In developing this biological opinion, we considered several efforts being made at the local, tribal, state, and national levels to conserve listed salmonids—primarily the final recovery plans for the fish in the middle and upper Columbia River and Snake River and efforts laid out in the 2011 and 2015 status review updates for Pacific salmon and steelhead listed under the Endangered Species Act (Ford 2011, NWFSC 2015). The result of those reviews was that salmon take—particularly associated with research, monitoring, and habitat restoration—is likely to continue to increase in the region for the foreseeable future. However, as noted above, all actions falling in those categories would also have to undergo consultation (like that documented in this opinion) before they are allowed to proceed.

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

We can, however, make some generalizations based on population trends. The action area contemplated here is in the State of Idaho and the eastern portions of Oregon and Washington. According to the U.S. Census bureau, the State of Idaho's population has been increasing at about 1% per year over the last several years, but that increase has largely been confined to the State's urban areas. The rural population—the areas where the proposed actions would take place--saw a 14% decrease in population between 1990 and 2012 (Idaho Statesman Journal 2013). This signifies that in the action areas, if this trend continues, there is likely to be a reduction in competing demands for resources such as water. Also, it is likely that streamside development will decrease. However, given the overall increase in population, recreation demand for resources such as the fish themselves may go up—albeit slowly.

The situation is similar for Eastern Oregon and Washington. Both states have seen population increases (between 0.5% and 1.5% per year for Oregon between 2000 and 2010 (Portland State University 2014), and overall 12% for Washington between 2000 and 2010, but the last four-year trend for the rural areas of Eastern Oregon has been relatively flat (Oregon Employment Department 2013) and, though Eastern Washington has also seen some population increase, it has largely been restricted to the population centers rather than the rural areas (Washington Office of Financial management 2012). This signifies that, as with Idaho above, there is little likelihood that there will be increasing competing demands for primary resources like water, but recreational demand for the species themselves will probably increase along with the human population.

One final thing to take into account when considering cumulative effects is the time period over which the activity would operate. The permits here would be good for a maximum of five years and the effects on listed species abundance they generate could continue for up to four years after that, though they would decrease in each succeeding year. We are unaware of any major non-Federal activity that could affect listed salmonids and is certain to occur in the action area during that time frame.

2.7 Integration and Synthesis of Effect

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

Aside from the considerations listed above, these assessments are also made in consideration of the other research that has been authorized and that may affect the various listed species. The reasons we integrate the proposed take in the permits considered here with the take from other research authorizations are that they are similar in nature and we have good information on what the effects are, and thus it is possible to determine the overall effect of all research in the region on the species considered here. The following three tables therefore (a) combine the proposed take for all the permits considered in this opinion for all components of each species (Table 30), (b) add the take proposed by the researchers in this opinion to the take that has already been authorized in the region (Table 31), and then (c) compare those totals to the estimated annual abundance of each species under consideration (Table 32).

Table 30. Total Requested Take and Mortalities for All Permits and Percentages of the Listed Units by Age Class and Origin.

ESU/DPS	Life Stage	Origin (Component)	Requested Take	% of Component Taken	Requested Mortality	% of Component Killed
UCR Chinook	Adult	Natural	81	2.5%	0	0%
UCR Chinook	Adult	Hatchery	81	1.3%	0	0%
UCR Chinook	Juvenile	Natural	205	0.04%	6	0.001%
UCR Chinook	Juvenile	Adipose-clipped	136	0.03%	3	0.0006%
UCR Steelhead	Adult	Natural	81	1.8%	0	0%
UCR Steelhead	Juvenile	Natural	35	0.01%	2	0.0008%
UCR Steelhead	Juvenile	Adipose-clipped	9	0.001%	1	0.0001%
MCR Steelhead	Adult	Natural	80	0.46%	1	0.005%
MCR Steelhead	Adult	Hatchery	80	5.1%	1	0.06%
MCR Steelhead	Juvenile	Natural	8360	1.8%	121	0.02%
MCR Steelhead	Juvenile	Adipose-clipped	100	0.03%	3	0.0009%
MCR Steelhead	Juvenile	Intact Adipose	8260	4.0%	118	0.06%
SR Spr/sum Chinook	Juvenile	Natural	33069	2.3%	633	0.04%
SR Spr/sum Chinook	Juvenile	Adipose-clipped	13433	0.3%	54	0.001%
SR Spr/sum Chinook	Juvenile	Intact Adipose	718	0.06%	11	0.001%
SR Steelhead	Juvenile	Natural	11000	1.2%	220	0.02%
SR Steelhead	Juvenile	Adipose-clipped	2464	0.07%	69	0.002%
SR Steelhead	Juvenile	Intact Adipose	893	0.1%	18	0.002%

Thus the activities contemplated in this opinion may kill—in combination and at most—as much as 0.06% of the fish from any component of any listed species; that component is juvenile hatchery MCR steelhead with an intact adipose fin.

In all other instances found in the table above, the effect is (at most) about two-thirds of that and in most cases the effect is one or more orders of magnitude smaller. These figures are probably much lower in actuality, but before engaging in that discussion, it is necessary to add all the take considered in this opinion to the rest of the research take that has been authorized in the interior Columbia River basin.

Table 31. Total Take and Mortalities for All Proposed Permits and All Baseline Research Take that has Already Been Authorized.

	Origin	*Adults Handled*	*Adults Killed*	*Juveniles Handled*	*Juveniles Killed*
UCR Chinook	Natural	618	15	25,966	677
	Listed Hatchery: Adipose Clip	297	7	2,467	82
	Listed Hatchery: Intact Adipose	414	12	11,274	281
UCR Steelhead	Natural	654	10	47,381	1,163
	Listed Hatchery: Adipose Clip	10	17	15,069	409
	Listed Hatchery: Intact Adipose	252	7	12,701	331
MCR Steelhead	Natural	4,151	38	176,025	3,166
	Listed Hatchery: Adipose Clip	903	10	26,388	760
	Listed Hatchery: Intact Adipose	424	12	17,294	367
SR s/s Chinook	Natural	9,780	67	1,341,690	10,640
	Listed Hatchery: Adipose Clip	1,640	11	142,388	1,562
	Listed Hatchery: Intact Adipose	3,653	10	82,983	720
SR Steelhead	Natural	12,374	126	416,593	4,440
	Listed Hatchery: Adipose Clip	4,731	58	28,764	390
	Listed Hatchery: Intact Adipose	3,830	187	37,938	465

This signifies that all the research previously authorized for the species considered here—in combination with the proposed actions in this opinion—would have the following impacts in terms of the fish that may be killed.

Table 32. Percentage of Abundance that may be Lost among the Listed Species for All Previously Authorized Research and the All the Permit Actions Analyzed in this Opinion.

	*Origin**	*Adults Killed*	*Percentage of Abundance*	*Juveniles Killed*	*Percentage of Abundance*
UCR Chinook	Natural	15	0.47%	677	0.13%
	Listed Hatchery: Adipose Clip	7	0.37%	82	0.02%
	Listed Hatchery: Intact Adipose	12	See Note.	281	0.05%
	Total for the listed Unit	**34**	**0.37%**	**1,040**	**0.06%**
UCR Steelhead	Natural	10	0.22%	1,163	0.47%
	Listed Hatchery: Adipose Clip	17	0.16%	409	0.06%
	Listed Hatchery: Intact Adipose	7	See Note.	331	0.02%
	Total for the listed Unit	**34**	**0.18%**	**1,903**	**0.19%**
MCR Steelhead	Natural	38	0.22%	3,166	0.70%
	Listed Hatchery: Adipose Clip	10	1.4%	760	0.22%
	Listed Hatchery: Intact Adipose	12	See Note.	367	0.18%
	Total for the listed Unit	**60**	**0.32%**	**4293**	**0.43%**
SR spr/sum Chinook	Natural	67	0.28%	10,640	0.76%
	Listed Hatchery: Adipose Clip	11	0.41%	1,562	0.04%
	Listed Hatchery: Intact Adipose	10	See Note.	720	0.06%
	Total for the listed Unit	**87**	**0.30%**	**12,922**	**0.19%**
SR Steelhead	Natural	126	0.38%	4,440	0.49%
	Listed Hatchery: Adipose Clip	58	0.08%	390	0.01%
	Listed Hatchery: Intact Adipose	187	See Note.	465	0.05%
	Total for the listed Unit	**371**	**0.11%**	**5,295**	**0.10%**

*For adults, the ad-clipped and non-ad-clipped hatchery percentages are combined (and displayed in the "Listed Hatchery Adipose Clip" lines) because we lack data on the percentage breakdown among those components.

First, please note that the numbers in Table 31 and the percentages in Table 32 are actually identical to the amount of baseline take that has previously been authorized (see Table 22). The reason for this is that because every proposed permit in this opinion is a renewal and all the proposed take in this opinion has already been evaluated and accounted for in the baseline for a number of years—some of it, multiple times.

The consequence of this is that this is only the second opinion since NMFS started granting research permits and authorizations in the interior Columbia River basin (about 25 years ago) in which the actual impact on listed fish has not increased.

Because the majority of the fish that researchers capture and release are expected to recover shortly after handling with no long-term ill effects, the most meaningful effect of the action we consider here is the potential number of dead fish from each species. As the table above illustrates, the dead fish from all the permits in this opinion *and* all the previously authorized research would at most amount to a few tenths of a percent of each species' total abundance. Thus the research, even the total for the entire program, would likely have only very small negative effects on any of the species considered here. It is appropriate to look at the reductions across the entire listed units because the effects of the combined research program are well-distributed across each of the species' ranges. The exceptions to this—permits for which the effects would be mostly limited to only a portion of the species' ranges—are documented above in the effects section.

Juvenile Fish

As the tables above (30-32) illustrate, in most instances, the research—even in total—would have only very small effects on any species' juvenile abundance (and therefore productivity) and no discernible effect on structure or diversity because the effects would be spread out across each entire species. One possible exception to this is the 0.76% of the natural juvenile SR spr/sum Chinook that the research program may kill in total. While it should be noted that this figure actually represents no increase in the baseline take, it is still means that as many as seven juvenile natural fish out of every thousand may be killed every year by the research efforts in the basin. However, this minor effect has repeatedly been determined to not jeopardize the species, the information being generated is used in critical status monitoring and recovery efforts and, again, the take contemplated in this opinion does not add even one fish to the amounts previously permitted for research in the basin. Also, in the more than ten years that the primary permits taking these fish has been in effect (Permits 1127, Permit 1134, and Permit 1339—the first held by the Shoshone-Bannock, the other two held by the Nez Perce Tribes) the researchers have never killed more than 70% of fish they were allotted, and in most years the total mortalities were far less than 50% of the permitted amounts. And finally, when the losses are considered in the context of the entire listed unit instead of simply the natural component, the mortality rate is actually 0.19% in even the most pessimistic scenario—which, though not negligible, is still a very small impact.

The situation is similar for juvenile, natural UCR steelhead. The mortality rate there is 0.47%, which, again, represents no increase over what has previously been analyzed and permitted. As with the SR spr/sum Chinook, effects of approximately that magnitude have repeatedly been determined to not jeopardize the species, and the research being conducted serves a critical function in monitoring the species' status. Furthermore, the researchers under the permit with the most take for this species (Permit 1480-3R, held by the USGS) have never in at least the last eight years even approached the actual number of mortalities they were allotted, and in most cases the mortality rate has been on the order of 20% or less of the total allowable mortalities. And, too, the total take for the listed unit falls to 0.19% when the activities are considered in the context of the species as a whole.

Another figure requiring a closer view is the 0.70% of the natural MCR steelhead juveniles that may be killed by research activities in the basin. This number represents a very small effect that has been previously found to not jeopardize the species, and the actions considered in this opinion would add no juvenile natural fish to the baseline. It should also be noted that the two largest authorizations for taking this species (held by the Oregon Department of Fish and Wildlife and the Washington Department of fish and Wildlife--ongoing, various authorization numbers) have over the last four years generally not taken more than a third of the allotted number of natural, juvenile MCR steelhead—and in most cases the take amounts have actually been fractions of that. And here again, the research being conducted in the basin adds critical knowledge about the species' status—knowledge that we are required to have every five years to perform status reviews for this (or any) listed species. And, when the total take is placed in the context of the species as a whole, the effect is 0.43%.

The 0.49% of the natural SR steelhead that may be lost should also be viewed with some caution. But the same reasoning as above applies: the research being conducted under the program as a whole is integral to determining and monitoring the species' status, the amounts of previously permitted take have repeatedly been found to not jeopardize the species, the actual number of fish taken in all the permits (especially the largest) is consistently far smaller than the number permitted, and the actual impact on the listed unit as a whole is far smaller than on the natural component, coming in at 0.10%. And again, the proposed research would not add any fish to the amounts previously analyzed and permitted.

One further thing to note for the above species: all the discussed impacts are ascribed to the natural component of each listed unit, but in actuality the effects are in all cases very likely to be smaller than the displayed percentages. The reason for this is that when in doubt—in those instances where a non-clipped hatchery fish cannot be differentiated from a natural fish—we ask that researchers err to the side of caution and treat all fish with intact adipose fins as if they were natural fish. Given that for the UCR steelhead, unclipped hatchery fish make up 37% of the animals with intact adipose fins, it is undoubtedly the case that some unclipped fish would be taken and counted as natural fish. For MCR steelhead, that figure is 39%, and for SR steelhead, the figure is about 50%. Therefore in all cases, the natural component would in actuality be affected to a lesser degree than the percentages displayed above. It is not possible to know *how* *much* smaller the take figures would be, but that they are smaller is not in doubt. The overall percentages for the listed unit would, however, remain at the same low levels shown.

Moving from the specific to the general, it is necessary to note that for *all* the species the actual take amounts would almost certainly be a great deal smaller than what has been (or may be) authorized—particularly for juvenile fish. There are three reasons for this. First, we develop conservative estimates of juvenile abundance (described in subsection 2.2 above). Second, to account for potential accidental deaths, the researchers request more take and more mortalities than they estimate would actually occur in a given year. To illustrate this, our research tracking system reveals that on average researchers end up taking about 37% of the fish they estimate when applying for a permit and killing about 15% of the numbers they estimate. In the current context, this would mean that for the juvenile take in Table 32, above, that *actual* mortality levels would probably be nearly an order of magnitude smaller than those displayed. They would range in reality from about 0.000075% to about 0.1% for individual components and in no instance would any species as a whole experience a mortality rate greater than about 0.04%. Third, some of the fish that may be affected would be in the smolt stage, but others definitely would not be. These latter would simply be described as “juveniles,” which means they may actually be subyearlings, parr, or even fry. (As an example, several tens of thousands of the MCR steelhead juveniles in the baseline would be fry taken in various efforts.) Thus, fish grouped into the juvenile life stage represent the progeny of multiple spawning years—a much greater number of individuals (perhaps as much as an order of magnitude greater) than is represented by the smolt stage.

Therefore, we derived the already small percentages for juvenile mortalities by (a) conservatively (under)estimating the actual number of outmigrating smolts (Table 20), (b) conservatively (over)estimating the number of fish likely to be killed, and (c) treating each dead juvenile fish as part of the same year class when it is certain that at least some of them won’t be. Thus, it is highly likely that the actual numbers of juvenile salmonids the research would kill are a great deal smaller than the stated figures. But even if the worst-case scenario were to occur and all the fish that may be killed are killed in fact, the effects of even the entire program would still be very small, restricted to abundance and productivity reductions, and the new effects contemplated in this opinion (even in total) would add no increment to the effects already considered and analyzed multiple times.

Adult Fish

For the adults, the research effects are similar to those described for the juveniles. The permitted research in the interior Columbia River basin, in total, may kill a few tenths of a percent of the adult escapement for any of the listed species’ components. And, because very few adults from any species would be killed by any of the research contemplated here, all of the stated take has already been analyzed in previous opinions and been determined not to jeopardize any of the species considered here. However, killing an adult fish has a potentially a much greater effect than killing a juvenile, so it is necessary to examine more closely some of those impacts as well.

UCR Chinook: One take level to note is the 0.37% of the natural adult UCR Chinook that the research program as a whole may kill. While this figure represents no increase over the baseline take, it is still means that as many as four fish out of a thousand may be killed every year by the research efforts in the Northwest. This is a minor effect, and would not in all probability affect the species' structure or diversity, but the UCR Chinook are an endangered fish and any decrease in their abundance and productivity should be viewed with some caution. However, this effect has previously been examined with respect to the relevant permits and it was determined that the loss would not jeopardize the species. Further, at no time in the last five years has the allotted take level been reached and, in most instances, none were killed at all. In fact, the permit that allows for over half the species adult unintentional mortality—Permit 16979, held by the Washington Department of Fish and Wildlife—no UCR chinook adults have ever been killed. And again, the actions contemplated in this opinion would not exacerbate that previously analyzed effect because none of the permits would allow any adult fish of this species to be killed.

MCR Steelhead: For the MCR steelhead, the figure that stands out is the 1.4% of the adipose-clipped adults that may be killed. This seems like it could amount to a genuine effect on the species' abundance, but in fact it does not. First, the total permitted take (mortalities) is 10 fish—and that number has never been reached. Second, adipose-clipped hatchery fish are considered surplus to all species' recovery needs and, for example, are allowed to be retained in fisheries throughout the basin. As noted previously, there are no take prohibitions on them. They are listed under the ESA, so we must analyze any impacts on them, but their status is such that losses greater than 1.4% contemplated here have been repeatedly determined not to jeopardize *any* listed species—including MCR steelhead.

SR Steelhead: Another take level to note is the 0.38% of the natural adult SR Steelhead that research programs from the interior Columbia River Basin may kill. Though this figure represents no I crease in the take that has previously been permitted, it is still means that as many as four natural fish out of a thousand may be killed every year by the research efforts in the basin. However, and as noted earlier, this minor effect has repeatedly been determined to not jeopardize the species and the information being generated is used in critical status monitoring and recovery efforts. Thus, while the species' abundance and productivity would be affected to a slight degree, structure and diversity would almost certainly not see any measurable impact, and critical data on the species' status would continue to be generated. And, too, researchers under the permits with the largest numbers of permitted adult SR steelhead mortalities (Permit 1339, held by CRITFC, Permit 1134, held by the Shoshone-Bannock Tribe, and Idaho's Adult Weir program under various authorizations) have killed about 25 adult fish, in total, over the last three years.

The overall situation for adult fish is therefore effectively the same as it is for juvenile fish: the losses are very small and the estimates of adult mortalities are almost certainly much greater than the actual numbers are likely to be. As noted above, over the last several years researchers holding ESA section 10 permits have generally killed about 15% of the adult fish they were allotted. This means that even for the most-affected species above in Table 32—UCR Chinook—the actual effect would probably be something more like the removal of about 0.04% rather than the 0.37% figure displayed. Still, even in the worst case scenarios the effects are tiny, restricted to abundance and productivity reductions, and to some degree the negative effects would be offset by the information to be gained—information that in all cases would be used to protect salmon and steelhead or promote their recovery.

Thus, we expect the research activities' detrimental effects on the species' abundance and productivity, even in combination with the entirety of the research authorized in the basin, to be very small. And because that slight impact would be distributed throughout the entire listing units' ranges, it would be so attenuated as to have no appreciable effect on spatial structure or diversity. Moreover, we expect all the research actions to generate lasting benefits for the listed fish.

Critical Habitat

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

Summary

As noted in the sections on species status, no listed species currently has all its biological requirements being met. Their status is such that there must be a substantial improvement in the environmental conditions of their habitat and other factors affecting their survival if they are to begin to approach recovery. In addition, while the future impacts of cumulative effects are uncertain at this time, they are likely to continue to be negative. Nonetheless, in no case would the proposed actions exacerbate any of the negative cumulative effects discussed (habitat alterations, etc.) and in all cases the research may eventually help to limit adverse effects by increasing our knowledge about the species' requirements, habitat use, and abundance. The effects of climate change are also likely to continue to be negative. However, given the proposed actions' short time frames and limited areas, those negative effects, while somewhat unpredictable, are too small to be effectively gauged as an additional increment of harm over the time span considered in this analysis. Moreover, the actions would in no way contribute to climate change (even locally) and, in any case, many of the proposed actions would actually help monitor the effects of climate change by noting stream temperatures, flows, etc. So while we can expect both cumulative effects and climate change to continue their negative trends, it is unlikely that the proposed actions would have any additive impact to the pathways by which those effects are realized (e.g., a slight reduction in salmonid abundance would have no effect on increasing stream temperatures or continuing land development).

To this picture, it is necessary to add the increment of effect represented by the proposed actions. Our analysis shows that the proposed research activities would have slight negative effects on each species' abundance and productivity, but those reductions are so small as to have no more than a very minor effect on the species' survival and recovery. In all cases, even the worst possible effect on abundance would be far less than one percent, the activity has never been identified as a threat, and the research is designed to benefit the species' survival in the long term.

For over two decades, research and monitoring activities conducted on anadromous salmonids in the Pacific Northwest have provided resource managers with a wealth of important and useful information regarding anadromous fish populations. For example, juvenile fish trapping efforts have enabled managers to produce population inventories, PIT-tagging efforts have increased our knowledge of anadromous fish abundance, migration timing, and survival, and fish passage studies have provided an enhanced understanding of how fish behave and survive when moving past dams and through reservoirs. By issuing research authorizations—including many of those being contemplated again in this opinion—NMFS has allowed information to be acquired that has enhanced resource managers' abilities to make more effective and responsible decisions with respect to sustaining anadromous salmonid populations, mitigating adverse impacts on endangered and threatened salmon and steelhead, and implementing recovery efforts. The resulting information continues to improve our knowledge of the respective species' life histories, specific biological requirements, genetic make-up, migration timing, responses to human activities (positive and negative), and survival in the rivers and ocean. And that information, as a whole, is critical to the species' survival.

Additionally, the information being generated is, to some extent, legally mandated. While no law calls for the work being done in any particular permit or authorization, the ESA (section 4(c)(2)) requires that we examine the status of each listed species every five years and report on our findings. At that point, we must determine whether each listed species should (a) be removed from the list (b) have its status changed from threatened to endangered, or (c) have its status changed from endangered to threatened. 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.

Thus, we expect the detrimental effects on the species to be minimal and those impacts would only be seen in terms of slight reductions in juvenile and adult abundance and productivity. And because these reductions are so slight, the actions—even in combination—would have no appreciable effect on the species' diversity or structure. Moreover, we expect the actions to provide lasting benefits for the listed fish and that all habitat effects would be negligible. And finally, we expect the program as a whole and the permit actions considered here to generate information we need to fulfill our mandate under the ESA.

2.8 Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' biological opinion that the proposed permitting actions are not likely to jeopardize the continued existence of endangered UCR spring Chinook, threatened UCR steelhead, threatened SR spr/sum Chinook, threatened SR steelhead, or threatened MCR steelhead or destroy or adversely modify any of their designated critical habitat.

2.9 Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this incidental take statement.

In this instance, and for the actions considered in this opinion, there is no incidental take at all. The reason for this is that all the take contemplated in this document would be carried out under permits that allow the permit holders to *directly* take the animals in question. The actions are considered to be direct take rather than incidental take because in every case the permit holders' actual purpose is to take the animals while carrying out a lawfully permitted activity. Thus, the take cannot be considered "incidental" under the definition give above. Nonetheless, one of the purposes of an incidental take statement is to lay out the amount or extent of take beyond which individuals carrying out an action cannot go without being in possible violation of section 9 of the ESA. That purpose is fulfilled here by the amounts of direct take laid out in the effects section above and reiterated in the integration and synthesis section. 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 second paragraph of 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 (2.4) are exceeded, reinitiation of formal consultation will be required because the regulatory reinitiation triggers set out in (2) and/or (3) will have been met.

2.11 "Not Likely to Adversely Affect" Determination

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

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 are: 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 primary constituent elements (PCEs) 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.

Southern Residents 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 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 the Queen Charlotte Islands south to central California.

Southern Residents consume a variety of fish and one species of squid, but salmon, and Chinook salmon in particular, are their preferred prey (review in NMFS 2008). Ongoing and past diet studies of Southern Residents conduct sampling primarily during spring, summer and fall months in inland waters of Washington State and British Columbia (i.e., Ford and Ellis 2006; Hanson et al. 2007; Hanson et al. 2010a; ongoing research by NWFSC). Therefore, our knowledge of diet preferences is specific to inland waters. Less is known about diet preferences of Southern Residents off the Pacific Coast. There are direct observations of two SR killer whale predation events in coastal waters, and in both the prey species was identified as Columbia River Chinook (Hanson et al. 2010b). Chemical analyses also support the importance of salmon in the year-round diet of Southern Residents (Krahn et al. 2002; Krahn et al. 2007). Southern Residents' preference for Chinook salmon in inland waters, even when other species are more abundant, combined with information indicating that the killer whales consume salmon year round, makes it reasonable to expect that Southern Residents likely prefer Chinook salmon when available in coastal waters.

The proposed actions may affect Southern Residents indirectly by reducing availability of their preferred prey, Chinook salmon. As described in the effects analysis for salmonids, approximately 707 juvenile and no adult Chinook salmon may be killed during the course of the research; of these, all jjuveniles would be Chinook salmon from the upper Columba River and the Snake River. However, as the effects analysis illustrated, the juvenile losses are expected to have only very small effects on salmonid abundance and productivity and no appreciable effect on diversity or distribution.

Nonetheless, the fact that the research would take some salmonids could affect prey availability to the whales in future years throughout their range, including in the critical habitat designated in the inland waters of Washington. 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 707 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 seven adult Chinook salmon—but because that figure is derived from two different species, it is likely that the killer whales' prey base would be only reduced by a maximum of three to four adult Chinook.

In addition, the estimated Chinook mortality is likely to be much smaller than stated. First, the mortality rate estimates for most of the proposed studies are purposefully inflated to account for potential accidental deaths and it is therefore very likely that fewer salmonids will be killed by the research than stated. In fact, over the last nine years, researchers have only killed about 37% of the juvenile Chinook salmon for which they were granted lethal take authority. Thus, the actual reduction in prey available to the whales is probably closer to one fish than four.

But even if seven adults were killed, given the total quantity of prey available to SR killer whales throughout their range, this small reduction in prey (and the very low probability that any potential adult Chinook would even be intercepted by the whales), would have at most an insignificant effect on the whales' survival and recovery.

Similarly, the future loss of Chinook salmon from interior Columbia basin Chinook populations could affect the prey PCE of designated critical habitat for killer whales. As described above, however, and considering the conservative estimate of seven Chinook salmon adult equivalents that could be taken by the proposed actions (fish that are unlikely ever to be found in the Puget Sound in any case), and the total amount of prey available in critical habitat, the reduction would be so small that it would not affect the conservation value of the critical habitat in any meaningful or measurable way.

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

3.0 MAGNUSON-STEVENS 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 on the habitat effects analysis performed above and descriptions of EFH for Pacific coast salmon contained in the fishery management plans developed by the Pacific Fishery Management Council and approved by the Secretary of Commerce.

In this instance, because no adverse effects on habitat are expected, no effects on EFH are anticipated either. As the biological opinion above states, 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 discountable in terms of their effects, short- or long-term, on any habitat parameter important to the fish.

The action agencies must reinitiate EFH consultation if plans for these actions are substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for the EFH conservation recommendations (50 CFR Section 600.920(k)).

4.0 DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

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

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this consultation are the applicants and funding/action agencies listed on the first page. The agencies, applicants, and the American public will benefit from the consultation.

Individual copies were made available to the applicants. This opinion 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 NOAA Fisheries in accordance with relevant information technology security policies, and standards set out in Appendix III, "Security of Automated Information Resources," Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

4.3 Objectivity:

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01 et seq., and the MSA implementing regulations regarding EFH, 50 CFR 600.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this opinion and EFH consultation 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.

LITERATURE CITED

Ainslie, B.J., J.R. Post, and A.J. Paul. 1998. Effects of pulsed and continuous DC electrofishing on juvenile rainbow trout. North American Journal of Fisheries Management 18: 905-918.

Allen, R.L., and T.K. Meekin. 1973. An evaluation of the Priest Rapids Chinook salmon spawning channel, 1963-1971. Washington Department of Fisheries, Technical Report 11: 1-52, Olympia, Washington.

Bartholomew, A., Bohnsack, J.A., 2005.Areview of catch-and-release angling mortality with implications for no-take reserves. Reviews in Fish Biology and Fisheries 15, 129–154.

Becker, D.C. 1970. Temperature, timing, and seaward migration of juvenile Chinook salmon from the central Columbia River. Battelle Northwest Laboratories, AEC Research and Development Report, Richland, Washington.

Bendock, T. and M. Alexandersdottir. 1993. Hooking mortality of Chinook salmon released in the Kenai River, Alaska. North American Journal of Fisheries Management 13:540-549.

Bell, M.C. 1986. Fisheries handbook of engineering requirements and biological criteria. U.S. Army Corps of Engineers, North Pacific Division, Portland, Oregon.

Bergman, P.K., K.B. Jefferts, H.F. Fiscus, and R.C. Hager. 1968. A preliminary evaluation of an implanted, coded wire fish tag. Washington Department of Fisheries, Fisheries Research Papers 3(1):63-84.

Bevan, D., J. Harville, P. Bergman, T. Bjornn, J. Crutchfield, P. Klingeman, and J. Litchfield. 1994. Snake Salmon Recovery Team: Final recommendations to the National Marine Fisheries Service. May 1994. Rob Jones, Recovery Plan Coordinator. (Available from National Marine Fisheries Service, 525 NE Oregon St., Suite 500, Portland, OR 97232.)

Bindoff, N.L., J. Willebrand, V. Artale, A. Cazenave, J. Gregory, S. Gulev, K. Hanawa, C. Le Quéré, S. Levitus, Y. Nojiri, C.K. Shum, L.D. Talley, and A. Unnikrishnan. 2007. Observations: Oceanic climate change and sea level. *In:* Climate Change 2007: The physical science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor, and H.L. Miller (editors).

Cambridge University Press. Cambridge, United Kingdom and New York.

Bjornn, T.C., D.R. Craddock, and D.R. Corley. 1968. Migration and survival of Redfish Lake, Idaho, sockeye salmon (*Oncorhynchus nerka*). Transactions of the American Fisheries Society 97: 360-373.

Bordner, C.E., S.I. Doroshov, D.E. Hinton, R.E. Pipkin, R.B. Fridley, and F. Haw. 1990. Evaluation of marking techniques for juvenile and adult white sturgeons reared in captivity. American Fisheries Society Symposium 7:293-303.

Bradford, M.J. 1995. Comparative review of Pacific salmon survival rates. Can. J. Fish. Aquat. Sci. 52:1327-1338.

Bruesewitz, S.L. 1995. Hook placement in steelhead. Technical Report No. AF95-01. Washington Department of Fish and Wildlife, Olympia.

Brynildson, O.M., and C.L. Brynildson. 1967. The effect of pectoral and ventral fin removal on survival and growth of wild brown trout in a Wisconsin stream. Transactions of the American Fisheries Society 96: 353-355.

Bugert, R., P. LaRiviere, D. Marbach, S. Martin, L. Ross, and D. Geist. 1990. Lower Snake River compensation plan salmon hatchery evaluation program. 1989 Annual Report to U.S. Fish and Wildlife Service (Cooperative Agreement 14-16-0001-89525).

Bugert, R. M., C. W. Hopley, C. A. Busack, and G. W. Mendel. 1995. Maintenance of stock integrity in Snake River fall Chinook salmon. In H. L. Schramm, Jr., and R. G. Piper (eds.), Uses and effects of cultured fishes in aquatic ecosystems, p. 267–276. American Fisheries Society Symposium 15 (AFS), Bethesda, MD.

Busby, P.J., T.C. Wainwright, G.J. Bryant, L.J. Lierheimer, R.S. Waples, F.W. Waknitz, and I.V. Lagomarsino. 1996. Status review of West Coast steelhead from Washington, Idaho, Oregon, and California. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-NWFSC-27, 261 p.

Cannamela, D.A. 1992. Potential impacts of releases of hatchery steelhead trout “smolts” on wild and natural juvenile Chinook and sockeye salmon. Idaho Department of Fish and Game, White Paper, Boise.

Chapman, D. W. 1986. Salmon and steelhead abundance in the Columbia River in the nineteenth century. Trans. Am. Fish. Soc. 115:662–670.

Chapman, D., C. Peven, T. Hillman, A. Giorgi, and F. Utter. 1994. Status of steelhead in the mid-Columbia River. Don Chapman Consultants, Inc., Boise, ID. 318 p. plus appendices.

Chisholm, I.M., and W.A. Hubert. 1985. Expulsion of dummy transmitters by rainbow trout. Transactions of the American Fisheries Society 114: 766-767.

Cichosz, T., D. Saul, A. Davidson, W. Warren, D. Rollins, J. Willey, T. Tate, T. Papanicolaou, and S. Juul. 2001. Clearwater subbasin summary. Draft submitted to the Northwest Power Planning Council. Online at Http://www.nwcouncil.org/fw/subbasinplanning/clearwater/plan/Default.htm [accessed November 2001].

Coble, D.W. 1967. Effects of fin-clipping on mortality and growth of yellow perch with a review of similar investigations. Journal of Wildlife Management 31: 173-180.

Conner, W.P., H.L. Burge, and R. Waitt. 2001. Snake River fall Chinook salmon early life history, condition, and growth as affected by dams. Unpublished report prepared by the U.S. Fish and Wildlife Service and University of Idaho, Moscow, ID. 4 p.

Cooney, T. 2001. Upper Columbia River steelhead and spring Chinook salmon quantitative analysis report. Part 1: Run reconstructions and preliminary analysis of extinction risks. National Marine Fisheries Service, Technical review draft. (Available from National Marine Fisheries Service, Northwest Region, Hydropower Division, 525 Oregon St., Portland, OR 97232.)

Cowen L., Nicole Trouton & Richard E. Bailey (2007) Effects of Angling on Chinook Salmon for the Nicola River, British Columbia, 1996–2002, North American Journal of Fisheries Management, 27:1, 256-267

Cramer, S.P., C.F. Willis, S.C. Vigg, J.T. Hawksworth, R. Montagne, D. Cramer, F. Shrier, C. Phillips, J. Welty, and K. Reininga. 1997. Synthesis and analysis of the Lower Columbia River Steelhead Initiative. Special Report. S.P. Cramer and Associates, Gresham, Oregon.

Dalbey, S.R., T.E. McMahon, and W. Fredenberg. 1996. Effect of electrofishing pulse shape and electrofishing-induced spinal injury on long-term growth and survival of wild rainbow trout. North American Journal of Fisheries Management 16: 560-569.

Dey, D.B.. 2012. Memorandum to James Lecky. Estimation of percentages for Listed Pacific Salmon and Steelhead Smolts Arriving at Various Locations in the Columbia River basin in 2011. Northwest Fisheries Science Center. March 6, 2012.

Dwyer, W.P., and R.G. White. 1997. Effect of electroshock on juvenile arctic grayling and Yellowstone cutthroat trout growth, 100 days after treatment. North American Journal of Fisheries Management 17: 174-177.

Feely, R.A., T. Klinger, J.A. Newton, and M. Chadsey (editors). 2012. Scientific summary of ocean acidification in Washington state marine waters. NOAA Office of Oceanic and Atmospheric Research Special Report.

Ferguson, J.W. 2010. Memorandum to James Lecky: Estimation of percentages for Listed Pacific Salmon and Steelhead Smolts Arriving at Various Locations in the Columbia River basin in 2010. Northwest Fisheries Science Center. November 9, 2010.

Fish Passage Center (FPC). 2002. Adult salmon passage counts. FPC Internet Website. <*http://www.fpc.org/adult.html*> (accessed June 13, 2002).

Fish Passage Center (FPC). 2005. Cumulative Adult Passage at Mainstem Dams Through 10/20. Weekly Report on 10/21/2005. Page 14.

Ford, M., P. Budy, C. Busack, D. Chapman, T. Cooney, T. Fisher, J. Geiselman, T. Hillman, J. Lukas, C. Peven, C. Toole, E. Weber, and P. Wilson. 1999. UCR steelhead and spring Chinook salmon population structure and biological requirements. National Marine Fisheries Service, Northwest Fisheries Science Center, Upper Columbia River Steelhead and Spring Chinook Salmon Biological Requirements Committee, Draft Report, Seattle, Washington. November 23.

Ford, M., P. Budy, C. Busack, D. Chapman, T. Cooney, T. Fisher, J. Geiselman, T. Hillman, J. Lukas, C. Peven, C. Toole, E. Weber, and P. Wilson. 2001. Final report of the Upper Columbia River Steelhead and Spring Chinook Salmon Biological Requirements Committee, March 2001. National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, WA.

Ford, M. J. (ed.). 2011. Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-113, 281 p.

Fredenberg, W. 1992. Evaluation of electrofishing-induced spinal injuries resulting from field electrofishing surveys in Montana. Montana Department of Fish, Wildlife, and Parks Report, Helena.

Fulton, L. A. 1968. Spawning areas and abundance of Chinook salmon, Oncorhynchus tshawytscha, in the Columbia River basin—past and present. U.S. Fish and Wildlife Service Spec. Sci. Rep., Fish. 571.

Good, T.P., R.S. Waples, and P. Adams (editors). 2005. Updated status of federally listed ESUs of West Coast salmon and steelhead. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-66, 598 p.

Gustafson, R.G., T.C. Wainwright, G.A. Winans, F.W. Waknitz, L.T. Parker, and R.S. Waples. 1997. Status review of sockeye salmon from Washington and Oregon. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-33, 282p.

Hanson, B., Baird, R., Ford, J., Hempelmann-Halos,J., and Van Doornik, D., Candy, J., Emmons, C., Schorr, G., Gisborne, B., Ayres, K., Wasser, S., Balcomb, K., Balcomb-Bartok, K., Sneva, J., Ford, M. 2010a. Species and stock identification of prey consumed by endangered southern resident killer whales in their summer range. Endangered Species Research. Vol. 11: 69–82, 2010. Published online March 11, 2010.

Hanson, B., Hempelmann-Halos,J., and Van Doornik, D. 2010b. Species and stock identification of scale/tissue samples from southern resident killer whale predation events collected off the Washington coast during PODs 2009 cruise on the McArthur II, March 16, 2010. Unpublished memorandum

Hart, J.L. 1973. Pacific fisheries of Canada. Fisheries Research Board of Canada Bulletin 180: 199-221.

Hart, A.C., and M.B. Dell. 1986. Early oceanic migrations and growth of juvenile Pacific salmon and steelhead trout. International North Pacific Fisheries Commission Bulletin 46: 1-105.

Hollender, B.A., and R.P. Carline. 1994. Injury to wild brook trout by backpack electrofishing. North American Journal of Fisheries Management 14: 643-649.

Hooton, R.S. 1987. Catch and release as a management strategy for steelhead in British Columbia. *In* R. Barnhart and T. Roelofs, editors. Proceedings of Catch and Release Fishing: a Decade of Experience, a National Sport Fishing Symposium. Humboldt State University, Arcata, California.

Howe, N.R., and P.R. Hoyt. 1982. Mortality of juvenile brown shrimp (*Penaeus aztecus*) associated with streamer tags. Transactions of the American Fisheries Society 111: 317-325.

Huhn D. and R. Arlinghaus. 2011. Determinants of Hooking Mortality in Freshwater Recreational Fisheries: A Quantitative Meta-Analysis. American Fisheries Society Symposium. 75: 141-170.

ICBTRT 2005 Interior Columbia River Basin Technical Recovery Team Viability Update Memo December, 2005. Attachment E.

Idaho Department of Fish and Game (IDFG). 2002. Written comments submitted to National Marine Fisheries Service regarding status review updates.

Idaho Statesman Journal, June 2, 2013: Idaho's Rural Population Continues to Shreink. Article by "Journal Staff." http://www.idahostatejournal.com/news/local/article_a16546f4-cb59-11e2-b4c2-0019bb2963f4.html

Irving J. S., and T. Bjornn. 1981. A forecast of abundance of Snake River fall Chinook salmon. Prepared for National Marine Fisheries Service, Seattle, contract no. 82-ABC-00042. (Available from Idaho Cooperative Fishery Research Unit, University of Idaho, Moscow, ID 83843.)

ISAB (Independent Scientific Advisory Board). 2007. Climate change impacts on Columbia River Basin fish and wildlife. ISAB Climate Change Report, ISAB 2007-2, Northwest Power and Conservation Council, Portland, Oregon.

Jenkins, W.E., and T.I.J. Smith. 1990. Use of PIT tags to individually identify striped bass and red drum brood stocks. American Fisheries Society Symposium 7: 341-345.

Kamler, J.F. and K.L. Pope. 2001. Nonlethal methods of examining fish stomach contents. Reviews in Fisheries Science 9(1):1-11.

Kohlhorst, D.W. 1979. Effect of first pectoral fin ray removal on survival and estimated harvest rate of white sturgeon in the Sacramento-San Joaquin estuary. California Department of Fish and Game 65: 173-177.

Light, J.T. 1987. Coastwide abundance of North American steelhead trout. (Document submitted to the annual meeting of the Int. North Pac. Fish Comm., 1987) Fisheries Research Institute Report FRI-UW_8710. Univ. Washington, Seattle, 18 p.

Lindsay, R.B., R.K. Schroeder, and K.R. Kenaston. 2004. Hooking mortality by anatomical location and its use in estimating mortality of spring Chinook salmon caught and released in a river sport fishery. North American Journal of Fisheries Management 24:367-378.

Mallet, J. 1974. Inventory of salmon and steelhead resources, habitats, use and demands. Job performance report. Proj. F-58-R-1. Idaho Department of Fish and Game, Boise.

McClure, M. M., E. E. Holmes, B. L. Sanderson, and C. E. Jordan. 2003. A large-scale, multi-species status assessment: Anadromous salmonids in the Columbia River basin. Ecol. Appl. 13(4):964–989.

McElhany, P., M. H. Ruckelshaus, M. J. Ford, T. C. Wainwright, and E. P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. U.S. Dept. Commer., NOAA Tech. Memo NMFS-NWFSC-42.

McElhany, P., T. Backman, C. Busack, S. Heppell, S. Kolmes, A. Maule, J. Myers, D. Rawding, D. Shively, A. Steel, and C. Steward. 2003. Interim report on viability criteria for Willamette and lower Columbia basin Pacific salmonids. Report from the Willamette/Lower Columbia Technical Recovery Team. (Available from Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA 98112.)

McElhaney, P., T. Backman, C. Busack, S. Kolmes, J. Myers, D. Rawding, A. Steel, C. Stewar, T. Whitesel, and C. Willis. 2004. Status evaluation of salmon and steelhead populations in the Willamette and Lower Columbia river basins. Willamette/Lower Columbia Technical Recovery Team. July 2004.

McMichael, G.A. 1993. Examination of electrofishing injury and short-term mortality in hatchery rainbow trout. North American Journal of Fisheries Management 13: 229-233.

McMichael, G.A., L. Fritts, and T.N. Pearsons, 1998. Electrofishing Injury to Stream Salmonids; Injury Assessment at the Sample, Reach, and Stream Scales. North American Journal of Fisheries Management 18:894-904.

McNeil, F.I., and E.J. Crossman. 1979. Fin clips in the evaluation of stocking programs for muskellunge (*Esox masquinongy*). Transactions of the American Fisheries Society 108: 335-343.

Mears, H.C., and R.W. Hatch. 1976. Overwinter survival of fingerling brook trout with single and multiple fin clips. Transactions of the American Fisheries Society 105: 669-674.

Meehan, W.R. and R.A. Miller. 1978. Stomach flushing: effectiveness and influence on survival and condition of juvenile salmonids. J. Fish. Res. Board Can. 35:1359-1363.

Mellas, E.J., and J.M. Haynes. 1985. Swimming performance and behavior of rainbow trout (*Salmo gairdneri*) and white perch (*Morone americana*): Effects of attaching telemetry transmitters. Canadian Journal of Fisheries and Aquatic Sciences 42: 488-493.

Mongillo, P.E. 1984. A summary of salmonid hooking mortality. Washington Department of Game, Olympia.

Moring, J.R. 1990. Marking and tagging intertidal fishes: Review of techniques. American Fisheries Society Symposium 7: 109-116.

Morrison, J. and D. Zajac. 1987. Histologic effect of coded wire tagging in chum salmon. North American Journal of Fisheries Management 7:439-441.

Mullen, J.W., A. Rockhold, and C.R. Chrisman. 1992a. Life histories and precocity of Chinook salmon in the mid-Columbia River. Prog. Fish-Cult. 54: 25-28.

Mullen, J.W., K.R. Williams, G. Rhodus, T.W. Hillman, and J.D. McIntyre. 1992b. Production and habitat of salmonids in mid-Columbia River tributary streams. U.S. Fish and Wildlife Service Monograph 1.

Muoneke, Maurice I. and Childress, W. Michael(1994)'Hooking mortality: A review for recreational fisheries',Reviews in Fisheries Science,2:2,123 — 156

Myers, J.M., R.G. Kope, G.J. Bryant, D. Teel, L.J. Lierheimer, T.C. Wainwright, W.S. Grant, F.W. Waknitz, K. Neely, S.T. Lindley, and R.S. Waples. 1998. Status review of Chinook salmon from Washington, Idaho, Oregon, and California. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-35, 443 p.

Nehlsen, W., J.E. Williams, and J.A. Lichatowich. 1991. Pacific salmon at the crossroads: stocks at risk from California, Oregon, Idaho, and Washington. Fisheries 16(2):4-21.

Nelson T.C., M. L. Rosenau & N. T. Johnston (2005) Behavior and Survival of Wild and Hatchery-Origin Winter Steelhead Spawners Caught and Released in a Recreational Fishery, North American Journal of Fisheries Management, 25:3, 931-943

Nicola, S.J., and A.J. Cordone. 1973. Effects of fin removal on survival and growth of rainbow trout (Salmo gairdneri) in a natural environment. Transactions of the American Fisheries Society 102(4): 753-759.

Nielson, L. 1992. Methods of marking fish and shellfish. American Fisheries Society. Special Publication 23.

NMFS. 1991. Factors for decline: A supplement to the notice of determination for Snake River spr/sum Chinook salmon under the Endangered Species Act. NMFS, Protected Resources Division, Portland, Oregon.

NMFS. 1997. Status Review Update for West Coast Steelhead from Washington, Idaho, Oregon, and California. Prepared by the West Coast Steelhead Biological Review Team. July 7, 1997.

NMFS. 1998a. Endangered Species Act Section 7 Consultation on the Issuance and Funding of Section 10(a)(1)(A) Permits and Modifications for Scientific Research and Monitoring Involving Steelhead listed under the ESA for 1998-2002. Consultation # F/NWR/1998/00033. April 10, 1998.

NMFS. 1998b. Status Review Update for West Coast Chinook Salmon (*Oncorhynchus tshawytscha*) from Puget Sound, Lower Columbia River, Upper Willamette River, and Upper Columbia River Spring-run speciess. December 23, 1998.

NMFS. 1999. Evaluation of the status of Chinook and chum salmon and steelhead hatchery populations for speciess identified in final listing determinations. Memorandum from M. Schiewe thru U. Varanasi to W. Stelle, dated March 4, 1999.

NMFS. 2000a. Reinitiation of Consultation on the Operation of the Federal Columbia River Power System, Including the Juvenile Fish Transportation Program, and 19 Bureau of Reclamation Projects in the Columbia Basin. NMFS, Hydro Program, Portland, Oregon. Consultation # F/NWR/2001/00249. December 21, 2000.

NMFS. 2000b. White Paper: Salmon and steelhead hatcheries - the problems. NMFS, Sustainable Fisheries Division, Portland, Oregon. February 3, 2000.

NMFS. 2000c. Guidelines for Electrofishing Waters Containing Salmonids Listed under the Endangered Species Act. Protected Resources Division, NMFS, Portland, Oregon. June 2000.

NMFS. 2000d. Reinitiation of Consultation on the Operation of the Federal Columbia River Power System, Including the Juvenile Fish Transportation Program, and 19 Bureau of Reclamation Projects in the Columbia Basin. NMFS, Hydro Program, Portland, Oregon. Consultation # F/NWR/2001/00249. December 21, 2000.

NMFS. 2002. Biological Opinion on the issuance of several ESA section 10(a)(1)(A) research actions in the Middle Columbia River. August, 2002.

NMFS. 2003. Preliminary Conclusions Regarding the Updated Status of Listed Species of West Coast Salmon and Steelhead. West Coast Salmon Biological Review Team, NWFSC. Co-manager Review Draft. February, 2003.

NMFS (National Marine Fisheries Service). 2003b. Endangered Species Act - Section 7 Consultation Biological Opinion and Magnuson-Stevens Act Essential Fish Habitat Consultation on: 1) Issuance of an incidental take statement (ITS) to the USFWS; 2) Issuance of an ITS to the BPA and the Confederated Tribes and Bands of the Yakama Nation (Yakama Nation); and 3) Issuance of permit 1347 jointly to the Washington Department of Fish and Wildlife (WDFW), the Public Utility District No. 1 of Chelan County (Chelan PUD), and the Public Utility District No. 1 of Douglas County (Douglas PUD). NMFS, Portland, Oregon.

NMFS. 2009. Middle Columbia River steelhead distinct population segment ESA recovery plan. National Marine Fisheries Service, Northwest Region. Seattle.

NMFS. 2011a. Draft recovery plan for Idaho Snake River spring/summer Chinook and steelhead populations in the Snake River spring/summer Chinook salmon evolutionarily significant unit and Snake River steelhead distinct population segment. National Marine Fisheries Service. Portland, Oregon.

NMFS. 2011b. 5-year review: Summary and evaluation of Snake River sockeye, Snake River spring-summer Chinook, Snake River fall-run Chinook, Snake River Basin steelhead. National Marine Fisheries Service, Northwest Region. Portland, Oregon.

NMFS. 2011c. 2011 Report to Congress: Pacific Coastal Salmon Recovery Fund FY 2000 – 2010. National Marine Fisheries Service, Northwest Region. Portland, Oregon.

NMFS. 2014. Proposed ESA recovery plan for Snake River sockeye salmon (*Oncorhynchus nerka*). National Marine Fisheries Service, West Coast Region. Portland, Oregon.

NOAA. 1991. Final Rule, Endangered and Threatened Species: Endangered Status for Snake River Sockeye Salmon. April 22, 1992. Federal Register 57(78): 14653-14663.

NOAA. 1992. Final Rule, Endangered and Threatened Species: Threatened Status for Snake River Spr/sum Chinook Salmon and Threatened Status for Snake River Fall Chinook Salmon. April 22, 1992. Federal Register 57(78): 14653-14663.

NOAA. 1993a. Notice of Interim Policy, Endangered and Threatened Species: Interim Policy on Artificial Propagation of Pacific Salmon Under the Endangered Species Act. April 5, 1993. Federal Register 58(63): 17573-17576.

NOAA. 1993b. Final Rule, Endangered and Threatened Species: Designated Critical Habitat for Snake River Sockeye Salmon, Snake River Spr/sum Chinook Salmon, and Snake River Fall Chinook Salmon. December 28, 1993. Federal Register 58(247): 68543-68554.

NOAA. 1997. Final Rule, endangered status for upper Columbia River steelhead and threatened status for Snake River steelhead. August 18, 1997. Federal Register 62(159): 43937-43954.

NOAA. 1999. Final Rule, Endangered and Threatened Species: Threatened Status for Three Chinook Salmon Evolutionarily Significant Units (species) in Washington and Oregon, and Endangered Status for One Chinook Salmon species in Washington. March 24, 1999. Federal Register 64(56): 14308-14328.

NOAA. 2000. Final Rule, Endangered and Threatened Species: Critical Habitat for 19 Evolutionarily Significant Units of Salmon and Steelhead in Washington, Oregon, Idaho, and California. February 16, 2000. Federal Register 65(32): 7764-7787.

NOAA Fisheries. 2005. Assessment of NOAA Fisheries’ critical habitat analytical review teams for 12 evolutionarily significant units of West Coast salmon and steelhead. National Marine Fisheries Service, Protected Resources Division. Portland, Oregon.

NOAA. 2014. Salmon Population Summary Database. Queries made in March, 2014: https://www.webapps.nwfsc.noaa.gov.

Northwest Fisheries Science Center (NWFSC). 2015. Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest.

Oregon Employment Department. 2013. Eastern Oregon's Population Trends Were Mixed in 2013: Article by Jason J. Johannon. http://www.olmis.org/olmisj/ArticleReader?itemid=00008981

PCSRF. 2005. Pacific Coastal Salmon Recovery Fund 2005 Report to Congress for FY 2000-2005. U.S. Department of Commerce. National Oceanic and Atmospheric Administration. National marine Fisheries Service.

PCSRF. 2007. Pacific Coastal Salmon Recovery Fund 2006 Report to Congress for FY 2000-2006. U.S. Department of Commerce. National Oceanic and Atmospheric Administration. National marine Fisheries Service. Online at http://www.nwr.noaa.gov/Salmon-Recovery-Planning/PCSRF/Index.cfm

Peery, C.A., and T.C. Bjornn. 1991. Examination of the extent and factors affecting downstream emigration of Chinook salmon fry from spawning grounds in the upper Salmon River. Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho, Unpublished Report, Moscow.

Pettit, S.W. 1977. Comparative reproductive success of caught-and-released and unplayed hatchery female steelhead trout (*Salmo gairdneri*) from the Clearwater River, Idaho. Transactions of American Fisheries Society 106(5):431-435.

Peven, Chuck, Charlie Paulson, mark Miller, John Stevenson, and Kirk Truscott. June 29, 2011. Adult Upper Columbia River and Snake River Spring Chinook Salmon and Steelhead Survival through the Federal Columbia River Power System Hydroelectric Projects: Final Phase I Report. Colville Tribes.

Portland State University 2014. Annual Oregon Population Report. April 15, 2014. College of Urban and Public Affairs: Population Research Center. http://www.pdx.edu/prc/annual-oregon-population-report

Prentice, E.F., and D.L. Park. 1984. A study to determine the biological feasibility of a new fish tagging system. Annual Report of Research, 1983-1984. Project 83-19, Contract DE-A179-83BP11982.

Prentice, E.F., T.A. Flagg, and C.S. McCutcheon. 1987. A study to determine the biological feasibility of a new fish tagging system, 1986-1987. Bonneville Power Administration, Portland, Oregon.

Prentice, E.F., T.A. Flagg, and C.S. McCutcheon. 1990. Feasibility of using implantable passive integrated transponder (PIT) tags in salmonids. American Fisheries Society Symposium 7: 317-322.

Reingold, M. 1975. Effects of displacing, hooking, and releasing on migrating adult steelhead trout. Transactions of the American Fisheries Society 104(3):458-460.

Rondorf, D.W., and W.H. Miller. 1994. Identification of the spawning, rearing, and migratory requirements of fall Chinook salmon in the Columbia River Basin. Prepared for the U.S. Dept. of Energy, Portland, OR. 219 p.

Rub, M,W,A., L,G. Gilbreath, R.L.McComas, B.P. Sandford,D.J. Teel, and J.W. Ferguson. 2012. Estimated survival of adult spring/summer Chinook salmon from the mouth of the Columbia River to Bonneville Dam, 2010. Northwes Fisheries Science Center: Fish Ecology Division. National Marine Fisheries Service, National Oceanic and

Atmospheric Administration. 2725 Montlake Blvd. East, Seattle, Washington 98112. July 2012.

Schill, D.J., and R.L. Scarpella. 1995. Wild trout regulation studies. Annual performance report. Idaho Department of Fish and Game, Boise.

Schisler, G.J. and E.P. Bergersen. 1996. Post release hooking mortality of rainbow trout caught on scented artificial baits. North American Journal of Fisheries Management 16(3):570-578.

Schroeder, R.K., K.R. Kenaston, and R.B. Lindsay. 2000. Spring Chinook salmon in the Willamette and Sandy Rivers. October 1998 through September 1999. Annual progress report, Fish Research Project Oregon. Oregon Department of Fish and Wildlife, Portland.

Sharber, N.G., and S.W. Carothers. 1988. Influence of electrofishing pulse on spinal injuries in adult rainbow trout. North American Journal of Fisheries Management, 8: 117-122.

Sharber, N.G., S.W. Carothers, J.P. Sharber, J.C. deVos, Jr., and D.A. House. 1994. Reducing electrofishing-induced injury of rainbow trout. North American Journal of Fisheries Management 14: 340-346.

Sharpe, C.S., D.A. Thompson, H.L. Blankenship, C.B. Schreck. 1998. Effects of Routine Handling and Tagging Procedures on Physiological Stress Responses in Juvenile Chinook Salmon. The Progressive Fish-Culturist. 60(2):81-87.

Snyder, D.E. 1992. Impacts of electrofishing on fish. Report of Colorado State University, Larval Fish Laboratory to the U.S. Bureau of Reclamation, Salt Lake City, Utah, and Glen Canyon Environmental Studies Team, Flagstaff, Arizona.

Spence, B.C., G.A. Lomnicky, R.M. Hughes, and R.P. Novitzki. 1996. An ecosystem approach to salmonid conservation. ManTech Environmental Research Services, Inc. Corvallis, Oregon. National Marine Fisheries Service, Portland, Oregon.

SPS (Salmonid Population Summary Database). Database maintained by the Northwest Fisheries Science Center. Referenced queries were made on April 9th and 10th, 2014.

Stolte, L.W. 1973. Differences in survival and growth of marked and unmarked coho salmon. Progressive Fish-Culturist 35: 229-230.

Strange, C.D. and G.J. Kennedy. 1981. Stomach flushing of salmonids: a simple and effective technique for the removal of the stomach contents. Fish. Manage. 12:9-15.

Thompson, R. N., J. B. Haas, L. M. Woodall, and E. K. Holmberg. 1958. Results of tagging program to enumerate the numbers and to determine the seasonal occurrence of anadromous fish in the Snake River and its tributaries. Final report. Fish Commission of Oregon, Clackamas, OR. Contract DA-35-026-eng-20609.

Thompson, K.G., E.P. Bergersen, and R.B. Nehring. 1997. Injuries to brown trout and rainbow trout induced by capture with pulsed direct current. North American Journal of Fisheries Management 17: 141-153.

USGCRP. 2009. Global climate change impacts in the United States. U.S. Global Change Research Program. Washington, D.C. 188 p.

University of Washington. 2013. Columbia Basin Research Database – Columbia River DART (Data Access in Real time). http://www.cbr.washington.edu/dart. Queries made in March, 2013.

Upper Columbia Salmon Recovery Board. 2007. Upper Columbia spring Chinook salmon and steelhead recovery plan. Upper Columbia Salmon Recovery Board. Wenatchee, Washington.

Waples, R. S. 1991. Defenition of "Species" Under the Endangered Species Act: Application to Pacific Salmon. U.S. Department of Commerce, NOAA Technical Memorandum, NMFS, F/NWC-194. 29 pp.

Waples, R.S., O.W. Johnson, and R.P. Jones, Jr. 1991a. Status review for Snake River sockeye salmon. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-F/NWC-195, 23 p.

Waples, R.S., R.P. Jones, Jr., B.R. Beckman, and G.A. Swan. 1991b. Status review for Snake River fall Chinook salmon. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-F/NWC-201, 73p.

Washington Department of Fisheries (WDF), Washington Department of Wildlife (WDW), and Western Washington Treaty Indian Tribes (WWTIT). 1993. 1992 Washington State salmon and steelhead stock inventory (SASSI). Wash. Dep. Fish Wildlife, Olympia, 212 p. and 5 regional volumes.

WDFW (Washington Department of Fish and Wildlife). 2003. WDFW comments on draft status review dated 31 March 2003 from Bruce Sanford and Bob Leland. (Available from Washington Department of Fish and Wildlife, Fish Program, 600 Capitol Way N., Olympia, WA 98501.)

WDFW. 2013. 2013 Joint Staff Report: Stock Status And Fisheries for Fall Chinook Salmon, Coho Salmon, Chum Salmon, Summer Steelhead, and White Sturgeon. July 11, 2013.

Washington Office of Financial management. 2011. Article: Washington population growth slowed during last decade, but state is more diversified than in 2000 http://www.ofm.wa.gov/news/release/2011/110223.asp

Welch, H.E., and K.H. Mills. 1981. Marking fish by scarring soft fin rays. Canadian Journal of Fisheries and Aquatic Sciences 38: 1168-1170.

Williams, T.H., E.P. Bjorkstedt, W.G. Duffy, D. Hillemeier, G. Kautsky, T.E. Lisle, M. McCain, M. Rode, R.G. Szerlong, R.S. Schick, M.N. Goslin, and A. Agrawal. 2006. Historical population structure of coho salmon in the Southern Oregon/Northern California coasts evolutionarily significant unit. Technical Memorandum NOAA-TM-NMFS-SWFSC-390. 71 p.

Wissmar, R.C., J.E. Smith, B.A. McIntosh, H.W. Li, G.H. Reeves, and J.R. Sedell. 1994. Ecological health of river basins in forested regions of eastern Washington and Oregon. General Technical Report PNW-GTR-326, U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. Portland, Oregon.

Wydoski, R.S. 1977. Relation of hooking mortality and sublethal hooking stress to quality fishery management. Pages 43-87 *in* R.A. Barnhart and T.D. Roelofs, editors. Proceedings of a national symposium on catch-and-release fishing as a management tool. Humboldt State University, Arcata, California.

Zabel, R.W., M.D. Scheuerell, M.M. McClure, and J.G. Williams. 2006. The interplay between climate variability and density dependence in the population viability of Chinook salmon. Conservation Biology 20(1):190-200.

Zabel, R.W. 2013. Memorandum to James Lecky. Estimation of percentages for Listed Pacific Salmon and Steelhead Smolts Arriving at Various Locations in the Columbia River basin in 2012. Northwest Fisheries Science Center. January 23, 2013.

Zabel, R.W. 2014. Memorandum to Donna Wieting. Estimation of percentages for Listed Pacific Salmon and Steelhead Smolts Arriving at Various Locations in the Columbia River basin in 2014. Northwest Fisheries Science Center. November 4, 2014.

Zabel, R.W. 2015. Memorandum to Donna Wieting. Estimation of percentages for Listed Pacific Salmon and Steelhead Smolts Arriving at Various Locations in the Columbia River basin in 2015. Northwest Fisheries Science Center. October 5, 2015.

Zabel, R.W. 2016. Memorandum to Chris Yates. Corrected Estimation of percentages for Listed Pacific Salmon and Steelhead Smolts Arriving at Various Locations in the Columbia River basin in 2016. Northwest Fisheries Science Center. January 25, 2017