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 Eight Scientific Research Permits Affecting Seven Salmonid Species in the Interior Columbia River Basin Beginning in 2018

NMFS Consultation Number: WCR-2018-9183

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

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 Fall 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.**
Snake River Sockeye Salmon (*O. nerka*)	**Endangered**	**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 Conducted By: National Marine Fisheries Service, Northwest Region

Issued By: FOR Chris E Yates
Barry A. Thom
Regional Administrator

Date: April 16, 2018

Administrative record number: 151422WCR2018PR00051

Contents

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 eight 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 eight applications to conduct scientific research in the Pacific Northwest. Five of the applications are to renew previously approved work, three are for entirely new work, and one is a request to modify 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***
1124 – 6R	The Idaho Department of Fish and Game (IDFG)
1134 – 7R	The Columbia River Inter-Tribal Fish Commission (CRITFC)
13380 – 3R	The Northwest Fisheries Science Center (NWFSC)
14283 – 3R	Environmental Assessment Services (EAS)
16979 – 2R	Washington Department of Fish and Wildlife (WDFW)
20713	NWFSC
21432	Cramer Fish Sciences
21571	U.S. Geological Survey (USGS)

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). In all, five of the applications are requests to renew research that has been previously approved; in four of the cases, the research has been previously approved at least twice. The other renewal has been approved once before and the request for a modified permit is minor modification. The new requests are for work that has never been done before—even under other authorizations. As noted on the cover page, the affected species are upper Columbia River (UCR) spring Chinook, UCR steelhead, Snake River (SR) spr/sum Chinook, SR fall Chinook, SR sockeye, 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 20713) in the form of an application on October 16th, 2017; the other applications came in over the following three 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 52884 (11/15/17); 83 FR 2145 (1/16/2018); 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 those periods closed, we initiated consultation on February 16, 2018. The full consultation histories for the eight 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 eight 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]

In addition to this biological opinion, we are writing a separate biological opinion to cover species from the lower Columbia River and portions of western Washington and Oregon. That opinion (WCR-2017-8556) will evaluate some of the take proposed in the applications for Permits 20713 and 21432. We will only issue those permits after all the analyses are complete and we have signed all the controlling biological opinions.

Permit 1124 – 6R

The IDFG is seeking to renew for five years a permit under which they have been conducting six research projects in the Snake River basin for nearly 20 years. The permit would continue to cover the following actions: One general fish population inventory; one project designed to monitor fish health throughout the state; two projects looking at natural and hatchery Chinook salmon production (in which sockeye may rarely be captured); one project monitoring natural steelhead; and one project centering on monitoring sockeye salmon recovery in Idaho. Much of the work being conducted under these projects is covered by other ESA authorizations; the work contemplated here is only that portion of the research that may affect sockeye salmon. The purposes of the research are therefore to monitor listed salmonid health, help guide sockeye salmon recovery operations, and to rescue sockeye salmon imperiled by circumstances such as being trapped by low flows. The benefits to the salmon would come in the form of information to help guide resource managers in restoring the listed fish and, as stated, in directly rescuing

[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").

them from peril. The fish would be captured by various methods–screw traps, electrofishing, hook-and-line-angling, mid-water trawl–and most captured fish would immediately be released. The researchers propose to intentionally kill some of the juvenile sockeye for genetic analysis, but in all other cases the researchers do not intend to kill any of the captured fish—though a few may die as an inadvertent result of the research.

Permit 1134 – 7R

The Columbia River Inter-Tribal Fish Commission (CRITFC) is seeking to renew for five years a permit under which they have been conducting research for nearly 20 years. The permit would continue covering five study projects that, among them, would annually take adult and juvenile threatened SR spring/summer Chinook salmon and adult and juvenile threatened SR steelhead in the Snake River basin. There have been some changes in the research over the last ten years; nonetheless, the projects proposed are largely continuations of ongoing research. They are: Project 1—Adult Spring/summer and Fall Chinook Salmon and Summer Steelhead Ground and Aerial Spawning Ground Surveys; Project 2—Cryopreservation of Spring/summer Chinook Salmon and Summer Steelhead Gametes; Project 3—Adult Chinook Salmon Abundance Monitoring Using Video Weirs, Acoustic Imaging, and passive integrated transponder (PIT) tag Detectors in the South Fork Salmon River; Project 4—Snorkel, Seine, fyke net, Minnow Trap, and Electrofishing Surveys and Collection of Juvenile Chinook Salmon and Steelhead; and Project 5—Juvenile Anadromous Salmonid Emigration Studies Using Rotary Screw Traps. Under these tasks, listed adult and juvenile salmon would be variously (1) observed/harassed during fish population and production monitoring surveys; (2) captured (using seines, trawls, traps, hook-and-line angling equipment, and electrofishing equipment) and anesthetized; (3) sampled for biological information and tissue samples, (4) PIT-tagged or tagged with other identifiers, (5) and released.

The research has many purposes and would benefit listed salmon and steelhead in different ways. However, in general, the studies are part of ongoing efforts to monitor the status of listed species in the Snake River basin and to use those data to inform decisions about land- and fisheries management actions and to help prioritize and plan recovery measures for the listed species. Under the proposal, the studies would continue to benefit listed species by generating population abundance estimates, allowing comparisons to be made between naturally reproducing populations and those being supplemented with hatchery fish, and helping preserve listed salmon and steelhead genetic diversity. The CRITFC researchers do not intend to kill any of the fish being captured, but a small percentage may die as a result of the research activities.

Permit 13380 – 3R

The NWFSC is seeking to renew for five years a permit that currently allows them to annually take natural juvenile SR spring/summer Chinook salmon and SR steelhead in the Salmon River subbasin in Idaho. This research has been in progress for over ten years and is designed to assess three alternative methods of nutrient enhancement (Salmon carcasses, carcass analogues, and nutrient pellets) on biological communities in Columbia River tributaries. In general, the purpose of the research is to learn how salmonids acquire nutrients from the carcasses of dead spawners and test three methods of using those nutrients to increase growth and survival among naturally produced salmonids. The research would benefit the fish by helping managers use nutrient enhancement techniques to recover listed salmonid populations. Moreover, managers would gain a broader understanding of the role marine-derived nutrients play in ecosystem health as a whole. This, in turn, would help inform management decisions and actions intended to help salmon recovery in the future.

Under the proposed research, the fish would variously be (a) captured (using seines, nets, traps, and possibly, electrofishing equipment) and anesthetized; (b) measured, weighed and fin-clipped; (c) held for a time in enclosures in the stream from which they are captured; and (d) released. A number of the captured fish would also be intentionally killed so the researchers may conduct stable isotope, otolith, and diet analyses with the purpose of linking growth and survival to habitat conditions. It is also likely that a small percentage of the fish being captured would unintentionally be killed during the process; in such instances, any unintentional mortalities would be used in place of any fish that would otherwise be lethally taken. In addition, tissue samples would be taken from adult carcasses.

Permit 14283 – 3R

Environmental Assessment Services (EAS) is seeking to renew for five years a permit that currently allows them to annually take listed fish in the mid- and upper Columbia River in support of the U.S. Department of Energy's Hanford Site Cleanup Mission and regulatory drivers under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The research would take place in four areas the Columbia River waters extending from McNary Dam to a point upstream of Wanapum Dam. The researchers are targeting non-listed resident fish but may also capture UCR steelhead and Chinook, MCR steelhead, SR fall Chinook, SR spr/sum Chinook, and SR Steelhead. The research would benefit listed fish by helping monitor and reduce contamination from the Hanford Nuclear Reservation. The researchers would capture the fish using electrofishing, hook and line, and long-line techniques. Any captured listed fish would immediately be released. The researchers do not propose to kill any listed fish but a small number may inadvertently be killed by the activities.

Permit 16979 – 2R

The Washington Department of Fish and Wildlife (WDFW) is seeking a five-year permit to collect data on UCR Chinook and steelhead abundance, status, distribution, diversity, species/ecological interactions, and behavior in the Columbia River from its confluence with the Yakima River upstream to Chief Joseph Dam. The research would benefit fish by helping managers (a) understand the distribution and proportion of hatchery and natural origin steelhead, and Chinook in UCR tributaries, (b) understand the influences of other biotic and abiotic factors with respect to recovering listed species, (c) understand the potential effects of proposed land use practices, (d) determine appropriate regulatory and habitat protection measures in the areas where land use actions are planned, (e) project the impacts of potential hydraulic projects, and (f) evaluate the effectiveness of local forest practices and instream habitat improvement projects in terms of their ability to protect and enhance listed salmonid populations.

The researchers would capture fish via a wide variety of means (snorkeling, dip netting, seining, using electrofishing equipment, traps and weirs, and barbless hook-and-line sampling). The captured fish would be variously tissue sampled, measured, tagged, allowed to recover, and released. The researchers do not intend to kill any of the fish being captured, but a small percentage of them may inadvertently be killed as a result of the proposed activities.

Permit 20713

The Northwest Fisheries Science Center (NWFSC) is seeking a permit for two years that would allow them to take juveniles for all the species considered in this opinion. The purpose of the study is to measure contaminant levels in juvenile UWR Chinook salmon in the lower Willamette River (Oregon), a Superfund site with high levels of pollutants, and to evaluate associations between toxins in fish tissues and fish growth and immune response. The permit would expire on December 31, 2019. Study results would support an ongoing Natural Resource Damage Assessment. In addition, the data would be used in Chinook salmon life cycle models to compare how chemical pollution affects UWR Chinook salmon populations relative to other stressors.

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

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

Permit 21432

Cramer Fish Sciences is seeking a research permit for two years that would allow them to take juvenile LCR Chinook, LCR coho, LCR steelhead, and MCR steelhead in the Klickitat, Wind, and White Salmon River subbasins (Washington). The purpose of the research is to determine fish occupancy in stream reaches in lands owned by SDS Lumber Company. The permit would expire on December 31, 2019. The researchers would compare results of the electrofishing surveys with e-DNA studies done in the same stream reaches, which would provide information on the utility of eDNA analysis for determining fish occupancy. The research would benefit listed fish by affording them protections if they are found in streams that previously were assessed as non-fish bearing.

Cramer Fish Sciences proposes to capture fish using single-pass backpack electrofishing, identify fish while they are held briefly in hand-held dip nets, and immediately return the fish to the site of their capture. The researchers do not propose to kill any fish but a small number may die as an unintended result of research activities.

Permit 21571

The United States Geological Survey (USGS) is seeking a five-year permit to conduct research on migration survival among middle Columbia River steelhead in the Yakima River system in Washington State. The research would look at how well the listed fish are surviving passage through various reaches of the Yakima River. The research would benefit the listed fish by helping managers understand what survival risks the young salmonids face when migrating downriver in the Yakima system. The managers would then be able to use that information to take actions designed to increase fish survival. The USGS researchers would capture juvenile MCR steelhead and tag them with acoustic and PIT tags. They would then use PIT tag detectors and acoustic receivers to follow the fish as they move downstream. The researchers would also use boat electrofishing equipment to count predators in several reaches, but they would not use that equipment to capture any listed animals for handling, and adult steelhead would be avoided in all cases. The researchers do not intend to kill any listed animals, but a small number may die as an inadvertent result of the planned 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 because those fish are considered surplus to recovery needs (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 are 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 ESA-listed species considered in this opinion, and aquatic habitat at large, is climate change. Climate change is likely to play an increasingly important role in determining the abundance and distribution of ESA-listed species, and the conservation value of designated critical habitats, in the Pacific Northwest. These changes will not be spatially homogeneous across the Pacific Northwest. The largest hydrologic responses are expected to occur in basins with significant snow accumulation, where warming decreases snow pack, increases winter flows, and advances the timing of spring melt (Mote et al. 2014, Mote et al. 2016). Rain-dominated watersheds and those with significant contributions from groundwater may be less sensitive to predicted changes in climate (Tague et al. 2013, Mote et al. 2014).

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

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

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

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

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

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

The adaptive ability of these threatened and endangered species is depressed due to reductions in population size, habitat quantity and diversity, and loss of behavioral and genetic variation.

Without these natural sources of resilience, systematic changes in local and regional climatic conditions due to anthropogenic global climate change will likely reduce long-term viability and sustainability of populations in many of these ESUs (NWFSC 2015). New stressors generated by climate change, or existing stressors with effects that have been amplified by climate change, may also have synergistic impacts on species and ecosystems (Doney et al. 2012). These conditions will possibly intensify the climate change stressors inhibiting recovery of listed species in the future

2.2.2 Status of the Species

For Pacific salmon and steelhead, NMFS commonly uses four parameters to assess the viability of the populations that, together, constitute the species: spatial structure, diversity, abundance, and productivity (McElhany et al. 2000). These "viable salmonid population" (VSP) criteria therefore encompass the species' "reproduction, numbers, or distribution" as described in 50 CFR 402.02. 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, but the most pertinent are the Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest and the various recovery plans cited in the tables that follow. These documents and other relevant information may be found at http://www.westcoast.fisheries.noaa.gov; the discussions they contain are summarized in the tables below. For the purposes of our later analysis, all the species considered here require functioning habitat and adequate spatial structure, abundance, productivity, and diversity to ensure their survival and recovery in the wild.

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

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Upper Columbia River spring-run Chinook salmon	Endangered 6/28/05	Upper Columbia Salmon Recovery Board 2007	NWFSC 2015	This ESU comprises four independent populations. Three are at high risk and one is functionally extirpated. Current estimates of natural origin spawner abundance increased relative to the levels observed in the prior review for all three extant populations, and productivities were higher for the Wenatchee and Entiat populations and unchanged for the Methow population. However, abundance and productivity remained well below the viable thresholds called for in the Upper Columbia Recovery Plan for all three populations.	• Effects related to hydropower system in the mainstem Columbia River • Degraded freshwater habitat • Degraded estuarine and nearshore marine habitat • Hatchery-related effects • Persistence of non-native (exotic) fish species • Harvest in Columbia River fisheries
Upper Columbia River steelhead	Threatened 1/5/06	Upper Columbia Salmon Recovery Board 2007	NWFSC 2015	This DPS comprises four independent populations. Three populations are at high risk of extinction while 1 population is at moderate risk. Upper Columbia River steelhead populations have increased relative to the low levels observed in the 1990s, but natural origin abundance and productivity remain well below viability thresholds for three out of the four populations. The status of the Wenatchee River steelhead population continued to improve based on the additional year's information available for the most recent review. The abundance and productivity viability rating for the Wenatchee River exceeds the minimum threshold for 5% extinction risk. However, the overall DPS status remains unchanged from the prior review, remaining at high risk driven by low abundance and productivity relative to viability objectives and diversity concerns.	• Adverse effects related to the mainstem Columbia River hydropower system • Impaired tributary fish passage • Degraded floodplain connectivity and function, channel structure and complexity, riparian areas, large woody debris recruitment, stream flow, and water quality • Hatchery-related effects • Predation and competition • Harvest-related effects
Middle Columbia River steelhead	Threatened 1/5/06	NMFS 2009	NWFSC 2015	This DPS comprises 17 extant populations. The DPS does not currently include steelhead that are designated as part of an experimental	• Degraded freshwater habitat • Mainstem Columbia River hydropower-related impacts

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
				population above the Pelton Round Butte Hydroelectric Project. Returns to the Yakima River basin and to the Umatilla and Walla Walla Rivers have been higher over the most recent brood cycle, while natural origin returns to the John Day River have decreased. There have been improvements in the viability ratings for some of the component populations, but the DPS is not currently meeting the viability criteria in the MCR steelhead recovery plan. In general, the majority of population level viability ratings remained unchanged from prior reviews for each major population group within the DPS.	• Degraded estuarine and nearshore marine habitat • Hatchery-related effects • Harvest-related effects • Effects of predation, competition, and disease
Snake River spring/summer-run Chinook salmon	Threatened 6/28/05	NMFS 2016 (draft)	NWFSC 2015	This ESU comprises 28 extant and four extirpated populations. All expect one extant population (Chamberlin Creek) are at high risk. Natural origin abundance has increased over the levels reported in the prior review for most populations in this ESU, although the increases were not substantial enough to change viability ratings. Relatively high ocean survivals in recent years were a major factor in recent abundance patterns. While there have been improvements in abundance and productivity in several populations relative to prior reviews, those changes have not been sufficient to warrant a change in ESU status.	• Degraded freshwater habitat • Effects related to the hydropower system in the mainstem Columbia River, • Altered flows and degraded water quality • Harvest-related effects • Predation
Snake River fall-run Chinook salmon	Threatened 6/28/05	NMFS 2015a (draft)	NWFSC 2015	This ESU has one extant population. Historically, large populations of fall Chinook salmon spawned in the Snake River upstream of the Hells Canyon Dam complex. The extant population is at moderate risk for both diversity and spatial structure and abundance and productivity. The overall viability rating for this population is 'viable.' Overall, the status of Snake River fall Chinook salmon has clearly improved compared to the time of listing and compared to prior status reviews. The single	• Degraded floodplain connectivity and function • Harvest-related effects • Loss of access to historical habitat above Hells Canyon and other Snake River dams • Impacts from mainstem Columbia River and Snake River hydropower systems • Hatchery-related effects • Degraded estuarine and nearshore habitat.

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
				extant population in the ESU is currently meeting the criteria for a rating of 'viable' developed by the ICTRT, but the ESU as a whole is not meeting the recovery goals described in the recovery plan for the species, which require the single population to be "highly viable with high certainty" and/or will require reintroduction of a viable population above the Hells Canyon Dam complex.	
Snake River basin steelhead	Threatened 1/5/06	NMFS 2016 (draft)	NWFSC 2015	This DPS comprises 24 populations. Two populations are at high risk, 15 populations are rated as maintained, 3 populations are rated between high risk and maintained, 2 populations are at moderate risk, 1 population is viable, and 1 population is highly viable. Four out of the five MPGs are not meeting the specific objectives in the draft recovery plan based on the updated status information available for this review, and the status of many individual populations remains uncertain A great deal of uncertainty still remains regarding the relative proportion of hatchery fish in natural spawning areas near major hatchery release sites within individual populations.	• Adverse effects related to the mainstem Columbia River hydropower system • Impaired tributary fish passage • Degraded freshwater habitat • Increased water temperature • Harvest-related effects, particularly for B-run steelhead • Predation • Genetic diversity effects from out-of-population hatchery releases
Snake River sockeye salmon	Endangered 6/28/05	NMFS 2015b	NWFSC 2015	This single population ESU is at very high risk dues to small population size. There is high risk across all four basic risk measures. Although the captive brood program has been successful in providing substantial numbers of hatchery produced fish for use in supplementation efforts, substantial increases in survival rates across all life history stages must occur to re-establish sustainable natural production In terms of natural production, the Snake River Sockeye ESU remains at extremely high risk although there has been substantial progress on the first phase of the proposed recovery approach – developing a hatchery based	• Effects related to the hydropower system in the mainstem Columbia River • Reduced water quality and elevated temperatures in the Salmon River • Water quantity • Predation

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
				program to amplify and conserve the stock to facilitate reintroductions.	

A great deal more information on the status of the species listed above can be found in the various documents referenced in the table and text above. For the purposes of our later analysis, however, the information presented above needs to be augmented by 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. 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 four-year averages of the return numbers (dam counts) for the species considered in this opinion. These two sets of abundance data are displayed in the following two tables.

Table 3. Recent Five-Year Average Projected Outmigrations for Columbia Basin Salmonids (Zabel 2013, Zabel 2014, Zabel 2015, Zabel 2016, Zabel 2017).

ESU/DPS	Origin	Outmigration
UCR Chinook	Natural	474,383
UCR Chinook	Listed Hatchery: Adipose Clipped	614,420
UCR Chinook	Listed Hatchery: Intact Adipose	384,079
UCR Steelhead	Natural	176,213
UCR Steelhead	Listed Hatchery: Adipose Clipped	642,307
UCR Steelhead	Listed Hatchery: Intact Adipose	159,702
MCR Steelhead	Natural	417,218
MCR Steelhead	Listed Hatchery: Adipose Clipped	360,184
MCR Steelhead	Listed Hatchery: Intact Adipose	93,680
SR Spr/sum Chinook	Natural	1,383,142
SR Spr/sum Chinook	Listed Hatchery: Adipose Clipped	4,453,059
SR Spr/sum Chinook	Listed Hatchery: Intact Adipose	1,001,592
SR Fall Chinook	Natural	585,720
SR Fall Chinook	Listed Hatchery: Adipose Clipped	2,707,553
SR Fall Chinook	Listed Hatchery: Intact Adipose	2,878,985
SR Steelhead	Natural	804,571
SR Steelhead	Listed Hatchery: Adipose Clipped	3,345,005
SR Steelhead	Listed Hatchery: Intact Adipose	749,088

ESU/DPS	Origin	Outmigration
SR Sockeye	Natural	19,735
SR Sockeye	Listed Hatchery: Adipose Clipped	191,246

Table 4. Recent Four-Year Adult Return Averages and the Percentages of their Natural Component for the Species Considered in this Opinion as of 2017. (AMIP 2018)

ESU/Species	Recent Four-Year Average Return*	Natural Fish Returns	Percent of the Return Made up of Natural Fish	Point Where Returns Were Measured
UCR Chinook	9,966	3,488	35%	Priest Rapids Dam
UCR Steelhead	15,730	3,618	23%	Priest Rapids Dam
MCR Steelhead	10,269	9,242**	91%	Prosser Dam
SR Spr/sum Chinook	22,280	18,270	82%	Lower Granite Dam (and Tucannon R.)
SR Fall Chinook	109,354	12,029	11%	Lower Granite Dam
SR Steelhead	292,890	29,289	10%	Lower Granite Dam
SR Sockeye	712		Essentially all part of a captive broodstock program	Stanley Basin, ID

*The total return was calculated by expanding the known natural returns by the known percentages of natural vs. hatchery origin fish (NWFSC 2015).
**The Yakima R. MPG makes up approximately 1/3 of the return to the MCR steelhead DPS as a whole, the Prosser Dam count average was therefore expanded to give total natural returns.

2.2.3 Status of the Critical Habitat

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

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

A summary of the status of critical habitats, considered in this opinion is provided in Table 5, below.

Table 5. Critical habitat, designation date, federal register citation, and status summary for critical habitat considered in this opinion

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
Upper Columbia River spring-run Chinook salmon	9/02/05 70 FR 52630	Critical habitat encompasses four subbasins in Washington containing 15 occupied watersheds, as well as the Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some, or high, potential for improvement. We rated conservation value of HUC5 watersheds as high for 10 watersheds, and medium for five watersheds. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Upper Columbia River steelhead	9/02/05 70 FR 52630	Critical habitat encompasses 10 subbasins in Washington containing 31 occupied watersheds, as well as the Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 20 watersheds, medium for eight watersheds, and low for three watersheds.
Middle Columbia River steelhead	9/02/05 70 FR 52630	Critical habitat encompasses 15 subbasins in Oregon and Washington containing 111 occupied watersheds, as well as the Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of occupied HUC5 watersheds as high for 80 watersheds, medium for 24 watersheds, and low for 9 watersheds.
Snake River spring/summer-run Chinook salmon	10/25/99 64 FR 57399	Critical habitat consists of river reaches of the Columbia, Snake, and Salmon rivers, and all tributaries of the Snake and Salmon rivers (except the Clearwater River) presently or historically accessible to this ESU (except reaches above impassable natural falls and Hells Canyon Dam). Habitat quality in tributary streams varies from excellent in wilderness and roadless areas, to poor in areas subject to heavy agricultural and urban development (Wissmar et al. 1994). Reduced summer stream flows, impaired water quality, and reduced habitat complexity are common problems. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Snake River fall-run Chinook salmon	10/25/99 64 FR 57399	Critical habitat consists of river reaches of the Columbia, Snake, and Salmon rivers, and all tributaries of the Snake and Salmon rivers presently or historically accessible to this ESU (except reaches above impassable natural falls, and Dworshak and Hells Canyon dams). Habitat quality in tributary streams varies from excellent in wilderness and roadless areas, to poor in areas subject to heavy agricultural and urban development (Wissmar et al. 1994). Reduced summer stream flows, impaired water quality, and reduced habitat complexity are common problems. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Snake River basin steelhead	9/02/05 70 FR 52630	Critical habitat encompasses 25 subbasins in Oregon, Washington, and Idaho. Habitat quality in tributary streams varies from excellent in wilderness and roadless areas, to poor in areas subject to heavy agricultural and urban development (Wissmar et al. 1994). Reduced summer stream flows, impaired water quality, and reduced habitat

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
		complexity are common problems. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Snake River sockeye salmon	10/25/99 64 FR 57399	Critical habitat consists of river reaches of the Columbia, Snake, and Salmon rivers; Alturas Lake Creek; Valley Creek; and Stanley, Redfish, Yellow Belly, Pettit and Alturas lakes (including their inlet and outlet creeks). Water quality in all five lakes generally is adequate for juvenile sockeye salmon, although zooplankton numbers vary considerably. Some reaches of the Salmon River and tributaries exhibit temporary elevated water temperatures and sediment loads that could restrict sockeye salmon production and survival (NMFS 2015b). Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.

As noted previously, the PCEs mentioned in the table above are now termed "PBFs." Those features relevant to the listed species in this opinion are displayed in the following two tables.

Table 6. 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 7. 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

The relevance of these features to the effects that may be generated by the proposed permits is found in the effects section (2.4).

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. Some of the rest of the research would take place in widely distributed mainstem habitat. 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 of the interior Columbia River basin. 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. In addition, there is one geographically distant outlier that must be included in the action area: that portion of the Puget Sound and Strait of Juan de Fuca 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 total action area under consideration covers a large percentage of the listed species' ranges (see Section 2.3), the effects of these past activities on the species themselves (i.e., on their abundance, productivity, etc.) are described in a general way in the species and critical habitat status sections that precede this section (see Section 2.2).

For some of the work being contemplated here, the impacts that previous Federal, state, and private activities in the action area have had on the species are indistinguishable from those effects summarized below and in the previous section on the species' rangewide status. The same is true with respect to the species' habitat: for some of the work contemplated, the environmental baseline is the result of these activities' rangewide effects on the PBFs that are essential to the conservation of the species.

However, for some of the work (that with a more limited geographic scope), the action area can be narrowed for a more specific analysis—and in those instances, the relevant local status information will be taken into account for both species and critical habitat.

Summary for all Listed Species

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

As a general matter, all the species considered in this opinion have at least some biological requirements that are not being met in the action area. The listed species are still experiencing the impact of a variety of past and ongoing Federal, state, and private activities in the action area and that impact is expressed in the limiting factors described above and in Table 2—all of which, in combination, are currently keeping the species from recovering and actively preventing them from having all their biological requirement met in the action area.

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 December 31, 2017, several dozen section 10(a)(1)(A) scientific research permits are in force in the Pacific Northwest and they authorize all the species considered here to be taken by a variety of means—and some individuals of each species to be killed. In addition, NMFS has also re-authorized three state scientific research programs under ESA section 4(d) for

Oregon, Washington, and Idaho and all three programs take and sometimes kill individuals of the species considered in this opinion. 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, 2017.

Table 8. Take Authorized for Research on Listed Species as of December 31, 2017.

	Origin	*Adults Handled*	*Adults Killed*	*Juveniles Handled*	*Juveniles Killed*
UCR Chinook	Natural	578	13	32,712	810
	Listed Hatchery: Adipose Clip	413	10	2,669	84
	Listed Hatchery: Intact Adipose	564	15	12,132	311
UCR Steelhead	Natural	593	9	67,913	1,525
	Listed Hatchery: Adipose Clip	756	20	14,863	398
	Listed Hatchery: Intact Adipose	342	9	13,150	346
MCR Steelhead	Natural	2,564	34	155,109	2,600
	Listed Hatchery: Adipose Clip	850	9	21,326	647
	Listed Hatchery: Intact Adipose	225	12	15663	327
SR s/s Chinook	Natural	8,734	56	1,4948,78	11,931
	Listed Hatchery: Adipose Clip	2,588	13	87,273	1,039
	Listed Hatchery: Intact Adipose	3,580	11	71,496	562
SR Fall Chinook	Natural	271	7	2,495	93
	Listed Hatchery: Adipose Clip	242	6	1,250	62
	Listed Hatchery: Intact Adipose	210	3	576	15
SR Steelhead	Natural	1,0086	126	470,667	5,958
	Listed Hatchery: Adipose Clip	3,020	52	79,275	898
	Listed Hatchery: Intact Adipose	2,580	38	50,013	589
SR Sockeye*	Natural	273	8	13,950	827
				425	256

*The adult take for sockeye salmon represents both natural fish and adults generated by the captive broodstock program (which constitute the vast majority of the adult returns).

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 total number of fish they request and kill about 15% of the numbers authorized to be killed.) Second, we purposefully inflate our take and mortality estimates for each proposed study to account for the effects of potential accidental deaths. Therefore it is very likely that far fewer fish—especially juveniles—would be killed under any given research project than the researchers are permitted.

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. As noted earlier, we do not expect there to be any effects arising from activities that are interrelated or interdependent with the permit activities. Nor do we expect there the permit activities to have any negative indirect effects on listed species or their critical habitat.

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; (3) marking the captured fish with various types of tags and marks; and (4) sacrificing some of the captured fish for genetic and other studies. 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 appreciable effect 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 their 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 2003). 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.

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 , 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 2000) 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, 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.

Sacrifice (Intentionally Killing)

In some instances, it is necessary to kill a captured fish in order to gather whatever data a study is designed to produce. In such cases, determining effect is a very straightforward process: the sacrificed fish, if they are juveniles, are forever removed from the gene pool and the effect of their deaths is weighed in the context that the effect on their listed unit and, where possible, their local population. If the fish are adults, the effect depends upon whether they are killed before or after they have a chance to spawn. If they are killed after they spawn, there is very little overall effect. Essentially, it amounts to removing the nutrients their bodies would have provided to the spawning grounds. If they are killed before they spawn, not only are they removed from the population, but so are all their potential progeny. Thus, killing pre-spawned adults has the greatest potential to affect the listed species. Because of this, NMFS only very rarely allows pre-spawned adults to be sacrificed. And, in almost every instance where it is allowed, the adults are stripped of sperm and eggs so their progeny can be raised in a controlled environment such as a hatchery—thereby greatly decreasing the potential harm posed by sacrificing the adults. As a general rule, adults are not sacrificed for scientific purposes and so such activity is considered in this opinion.

2.5.3 Species-specific Effects of Each Permit

As noted above, the analysis process described above hinges primarily on two sets of data that are laid out earlier in Tables 3 and 4. The first set is NMFS's estimate of how many juvenile fish from each listed species 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 (some of them are being re-analyzed in this opinion). All the analyses relating to juvenile take in this section and the next use as their denominators the five-year average outmigration estimates in Table 3. The second set of data is drawn from a tracking sheet developed for the Federal Columbia River Power System's adaptive Management and Implementation Plan (AMIP). It is made up of individual fish counts at various dams on the Columbia, Snake and Yakima Rivers and it is generally used to help track the status of all fish passing through the hydropower system. In this analysis, we use it to gauge the effects that the proposed permits may have on the returning adult components of each of the listed species considered in this opinion.

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

Permit 1124 – 6R

As stated previously, Permit 1124 has been in existence for nearly 20 years. It covers a suite of projects (described above) that have the potential to take all listed salmonid species in the Snake River basin except SR fall Chinook salmon. The programs would largely involve collecting, handling, marking/tagging, and tissue sampling juvenile salmon. The most commonly used collection procedures would be screw traps, hook and line fishing, electrofishing and (in the

Stanley Basin lakes) mid-water trawl. Most juveniles caught would be anesthetized, counted, sampled for length and released. In addition, a smaller number of juvenile fish would be PIT-tagged. Adult salmon may be trapped at weirs. Some sockeye will be killed during mid-water trawl operations in the Stanley Basin lakes—this portion of the research is considered critical for estimating sockeye abundance (population recovery monitoring) and gathering genetic information. Some sockeye salmon (adult and juvenile) will also be transported in specially equipped trucks. This activity would be carried out by IDFG staff and would typically take up to 15 minutes for juveniles and up to 30 minutes for adults (but usually less).

In all cases, the welfare of each fish is a primary concern for staff, and all necessary precautions are taken to ensure their health and survival. Individuals participating in research activities receive the proper training before being allowed to participate in Department research programs and all researchers would follow well-established protocols for electrofishing, handling, tagging and, in general, interacting with listed salmonids. The researchers are requesting the following of take:

Table 9. Requested SR Sockeye take for Permit 1124 – 6R (C=Capture, H=Handle, T=Tag, TP=Transport, TS= Tissue Sample, IK=Intentionally kill, R=Release)

ESU/Species	Life Stage	Origin	Take Activity	Requested Take	Unintentional Mortality
SR Sockeye Salmon	Adult	Natural	C/H/T/TS/R	75	2*
SR Sockeye Salmon	Adult	Natural	C/TS/TP	50	1
SR Sockeye Salmon	Juvenile	Natural	C/H/TS/TP	3,000	60
SR Sockeye Salmon	Juvenile	Natural	IK	250	N/A
SR Sockeye Salmon	Juvenile	Natural	C/H/R	50	2
SR Sockeye Salmon	Juvenile	Hatchery Ad-Clip	IK	250	N/A
SR spr/sum Chinook	Adult	Natural	C/H/R	15	0
SR spr/sum Chinook	Juvenile	Natural	C/H/T/TS/R	11,000	110
SR spr/sum Chinook	Juvenile	Natural	C/H/R	17,200	172
SR spr/sum Chinook	Juvenile	Hatchery Ad-Clip	C/H/T/TS/R	500	5
SR steelhead	Adult	Natural	C/H/R	5	0
SR steelhead	Juvenile	Natural	C/H/T/TS/R	2300	23
SR steelhead	Juvenile	Natural	C/H/R	1100	11

*In this and all other instances where unintentional mortality is listed, the numbers come out of the requested take and are not added to it. So for example, the two SR sockeye adults in the Unintentional Mortality column in the first row of the table above would come out of the requested 75 fish found in the fifth column—not be added to it.

Because the majority of the fish that would be captured are expected to recover with no permanent detrimental effects on their fitness, 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 expected for these species (and their components) found in Table 3 and the recent average adult returns found in Table 4.

This signifies that the researchers would kill, at most, the following percentages of the listed unit:

Table 10. Maximum Percentages of the 2013 - 2017 Average Outmigration and Recent 4-year Adult Returns that Permit 1124 – 6R Could Kill.

ESU/Species	Life Stage	Origin	% Mortalities
SR Sockeye	Adult	Natural	0.4%
SR Sockeye	Juvenile	Natural	1.6%
SR Sockeye	Juvenile	Hatchery: Ad-Clip	0.13%
SR spr/sum Chinook	Adult	Natural	0%
SR spr/sum Chinook	Juvenile	Natural	0.02%
SR spr/sum Chinook	Juvenile	Hatchery: Ad-Clip	0.0001%
SR Steelhead	Adult	Natural	0%
SR Steelhead	Juvenile	Natural	0.004%

There are two important caveats associated with the mortality numbers given above (particularly for sockeye salmon). First, many of the fish that listed as “natural” above would, in actuality, probably be hatchery fish (of which there are approximately 10 times as many). They are considered “natural” for the purposes of this analysis in order to lay out the worst-case scenario associated with the research. Second, these truly are worst-case numbers. Over the last 10 years, the IDFG researchers have killed only a fraction of the fish they have been allotted. For sockeye, that fraction has consistently been less than 20% of the permitted mortalities. For the other species (that have generally been handled under other authorizations), the mortality rates were similarly low. We nonetheless examine the higher possible mortality levels because it is hoped that the sockeye populations (as well as the other salmonids) will continue to expand and, if that happens, the researchers would be likely to encounter more fish in the later years of the permit.

SR Sockeye salmon: Because there is currently only one population for this ESU, the number of fish that may be killed would have no essentially effect on spatial structure or diversity. However, the possible losses of both juveniles and adults do have the potential to affect abundance and therefore productivity. Both of these effects are small (and research has never been identified as a limiting factor for sockeye or any other salmonid), but they should still be viewed with some caution. One ameliorating factor for the adult component is that the researchers have killed no adults in the last 10 years the activities have been permitted, so it is probable that there will actually be no real adverse effect on adults. In addition, and as noted above, the chances are that the researchers will not even kill one-fifth of the allotted juveniles, so the actual effect is probably more on the order of a 0.3% mortality rate. Still, if the researchers were to kill every fish they are permitted, that small effect must be considered. But it must be considered in the context of the work's purpose—and that purpose is largely to monitor the effectiveness of a program that is specifically designed to help the sockeye survive and recover. The research proposed here supports sockeye management actions that have been underway in the in the Stanley basin for more than 25 years. In general, those actions have been (1) to develop captive broodstocks from Redfish Lake Sockeye salmon, culture broodstocks, and produce progeny for reintroduction; (2) to determine the contribution hatchery-produced Sockeye salmon make toward avoiding population extinction and increasing population abundance; (3) to describe O. nerka population characteristics for Sawtooth Basin lakes in relation to carrying capacity and broodstock program reintroduction efforts; and (4) to use genetic analysis to discern the origin of wild and broodstock Sockeye salmon to provide maximum effectiveness in their utilization within the broodstock program. The research therefore supports critical sockeye recovery efforts, and while the proposed activities would have a small, short-term impact on abundance and productivity, their larger purpose is actually to recover sockeye salmon. Though it is not certain, it is possible that without this research and the actions it supports, the sockeye might already have gone extinct.

SR steelhead and spr/sum Chinook: First, the proposed research would kill no adult Chinook or steelhead. Second, the impacts on the juvenile components would be very small, and even though they would be restricted to portions of the upper Salmon River subbasin, their magnitude is such that they are unlikely to affect spatial structure or diversity to any meaningful degree. The research would however have small effects on abundance and productivity, and those effects would be concentrated by their limited geographic scope. But even if those effects were magnified by a factor of 10 to account for the local impact (and the upper Salmon River produces more than $1/10^{th}$ of both the listed natural SR steelhead and Chinook), they would still be very small: for spr/sum Chinook the local impact would be on the order of two juvenile fish out of every thousand, and for steelhead it would be four juvenile fish out of every ten-thousand. Therefore the effect in both cases is a very small reduction in abundance even at the local level and an even smaller reduction at the species level.

And even those small effects must be considered in the context of the work being performed: in all cases the work is designed to benefit the listed fish by monitoring population status and the effectiveness of various recovery and mitigation actions. The end goal is to better inform management decisions and thereby protect both the listed fish and the habitats upon which they depend.

Permit 1134 – 7R

As stated previously, Permit 1134 has been in existence for many years and currently allows CRITFC to annually take adult and juvenile threatened SR fall Chinook salmon; adult and juvenile threatened SR spring/summer Chinook salmon (natural and artificially propagated); and adult and juvenile threatened SR steelhead at many locations in the Snake River basin. The renewal would allow them to continue the same activities they have been pursuing for the last five years but with significant reductions in the amount of take they are requesting

Under the renewed permit, CRITFC would continue the five projects in which they are currently engaged (see Proposed Action), but there is no take associated with the spawning ground surveys they would conduct under Study 1 and nor would there be any measurable habitat effects. Project 1 involves only aerial and ground surveys, so while some harassment may occur, it would be very short-lived and would involve no physical contact. Under Project 1, the researchers may also examine and take tissue samples from an indeterminate number of carcasses found during the surveys—another practice that would not measurably harm listed species and arguably would benefit them (if, for example, pathogens were to be found, managers would be able to make an early and effective response to the threat). Therefore the discussion of the effects likely to be associated with permit will be divided into sections pertaining to each of the other projects that do have a potential to harm listed fish.

Project 2—Cryopreservation of Spr/sum Chinook Salmon and Summer Steelhead Gametes

Under this project, CRITFC would annually collect spr/sum Chinook and steelhead gametes throughout the Snake River basin. The fish would be collected by various methods—dipnet, hand, seine, angling, and at already-established screw traps and hatchery weirs. Once captured, the fish would be tissue sampled (a fin punch and/or a scale taken), examined, and measured. At that point, no females would be handled further and all would be allowed to escape immediately back to the stream. The males would be anesthetized (anywhere from 30 seconds to two minutes), their abdomens wiped dry, and sperm samples would be taken. They would then be placed in a pool area of the stream and assisted until they recover. The sperm samples would be preserved in liquid nitrogen tanks and transported to the University of Idaho and Washington State University.

The amount of take CRITFC is requesting for Project 2 is found in the following table.

Table 11. Requested Take by ESU, Life Stage, Origin, and Activity for Project 2 of Permit 1134 – 7R (C=Capture, H=Handle, T=Tag, TS=tissue sample, M=Mark, R=Release.)

ESU/Species	Life Stage	Origin	Take Activity	Requested Take	Unintentional Mortality
SR Spr/sum Chinook	Adult	Natural	C/H/T/TS/M/R	500	2
SR Spr/sum Chinook	Adult	Hatchery Non-Ad-Clipped	C/H/TS/M/R	178	1
SR Steelhead	Adult	Natural	C/H/TS/M/R	200	5

Because the majority of the fish that would be captured are expected to recover with no permanent detrimental effects on their fitness, the most meaningful measure of the effects of the proposed action is seen in the number of listed fish the researchers would be permitted 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 3 and the recent average adult returns found in Table 4.

This signifies that the researchers would kill, at most, the following percentages of the listed unit:

Table 12. The maximum Percentages of the Retuning adults (recent 4-year average) Project 2 of Permit 1134 – 7R could kill.

ESU/Species	Life Stage	Origin	% Mortalities
SR Spr/sum Chinook	Adult	Natural	0.01%
SR Spr/sum Chinook	Adult	Hatchery: Non-ad-clip	0.004%
SR Steelhead	Adult	Natural	0.02%

It should be noted that in the more than 15 years this project has previously been permitted, it has resulted in only *one* dead steelhead and no dead Chinook, so it is likely that no fish will actually be killed during the proposed activities—especially given that in most years this research is not even conducted. Nonetheless, if all the potential deaths were to occur (and comparing the mortalities to the returns in Table 4), it would mean approximately 0.01% of the most recent four-year average of the retuning natural spr/sum Chinook may be killed along with 0.004% of the (four-year average) of the returning hatchery fish. In addition, as many as 0.02% of the returning natural SR steelhead adults may be killed. However, the losses just described could come from any one of several tributary streams in the Snake River basin. It is therefore impossible to say that any given population among more than a dozen would be affected any more than any other. Thus, given the losses' small magnitude and the fact that they are spread out over the listed units, the negative effects of the research are likely to be nearly negligible with respect to abundance and productivity and completely negligible with respect to structure and diversity—especially in view of the fact that the research is designed to preserve listed SR Chinook and steelhead diversity and, eventually, help recover them.

Project 3—Adult Chinook Salmon and Summer Steelhead Abundance Monitoring Using Video, Sonar Applications, and PIT-Tag Detectors

This project primarily involves observation only and therefore its effects have largely negligible (and have been analyzed that way previously). However, the CRITFC is also seeking to take 75 adult steelhead kelts in two locations--Lolo and Newsome Creeks. (They would conduct observations at a few stations in the basin.) The steelhead would come from a mix of natural and hatchery fish and they would simply be captured, handled, and released. One may be killed, but because that would be a fish that had already spawned, it would be extremely unlikely to survive in any case—and it is effectively impossible that it would return to spawn again in either Lolo or Newsome Creeks. The reason for the capture is that the researchers have determined there is likelihood that the fish would become trapped in picket weirs. The captured fish would be released from the weir and set free just downstream from the trap locations. Because only one spawned-out fish that would almost certainly die in any case may be killed as a result of being captured, there would be a negligible effect on every VSP parameter at both the population and species levels.

Project 4—Snorkel, Seine, Minnow Traps, and Electrofishing Surveys and Collection of Juvenile Chinook Salmon and Steelhead

Under Project 4, CRITFC annually collects and PIT-tags juvenile SR Chinook and steelhead. The researchers would use the capture methods listed above. The captured fish would be anesthetized, measured and weighed, scale and/or other tissue samples would be taken in most instances, and many of the fish would be PIT-tagged. Once these operations are complete, the fish would be allowed to recover and move back into the stream. The amounts of requested take are displayed in the following table. (They also intend to observe a number of fish, but as stated previously, any negative effects associated with observation are unmeasurably small and some benefit would be derived.)

Table 13. Requested Take by ESU, Life Stage, and Activity for Project 4 of Permit 1134 – 7R. (C=Capture, H=Handle, T=Tag, TS=tissue sample, M=Mark, R=Release.)

ESU/Species	Life Stage	Origin	Take Activity	Requested Take	Unintentional Mortality
SR Spr/Sum Chinook	Juvenile	Natural	C/H/R	2365	10
SR Spr/Sum Chinook	Juvenile	Natural	C/H/T/TS/M/R	1200	12
SR Spr/Sum Chinook	Juvenile	Hatchery Non-Ad-Clipped	C/H/R	715	3
SR Spr/Sum Chinook	Juvenile	Hatchery Non-Ad-Clipped	C/H/T/M/R	715	7
SR Steelhead	Juvenile	Natural	C/H/R	8000	250
SR Steelhead	Juvenile	Natural	C/H/T/M/TS/R	1250	13
SR Steelhead	Juvenile	Hatchery Non-Ad-Clipped	C/H/R	3500	90

Because the majority of the fish that would be captured are expected to recover with no permanent detrimental fitness effects, the most meaningful measure of the effects of the proposed action is seen in the maximum number of listed fish the action could 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 3. This signifies that the research might kill the following percentages of the outmigrants' three-year averages.

Table 14. Maximum Percentages of the 2013-2017 Outmigration Average Project 4 of Permit 1134 – 7R Could Kill.

ESU/Species	Life Stage	Origin	% Mortalities
SR Spr/Sum Chinook	Juvenile	Natural	0.002%
SR Spr/Sum Chinook	Juvenile	Hatchery Non-Ad-Clipped	0.0001%
SR Steelhead	Juvenile	Natural	0.03%
SR Steelhead	Juvenile	Hatchery Non-Ad-Clipped	0.01%

These losses are extremely small and, as a result, there would be a very small impact on abundance and productivity (at most, three ten-thousandths of the outmigrating non-ad clipped hatchery steelhead could be killed), but there would be no appreciable impact on structure or diversity for either the spr/sum Chinook or the steelhead. Moreover, the slight negative effect would be offset to some extent by the benefits of this research, which supports a number of basinwide fish- and habitat restoration programs and would help managers monitor trends in listed salmonid population structures over time. In addition, it is likely that the take numbers—particularly for the natural fish (both steelhead and Chinook) would actually be lower than those allotted. There are two reasons for this: first, in the many years this permit has been in operation, the researchers have never reached the amount of take there were allotted; second, the number of natural fish that may be taken is purposefully over-estimated to account for the fact that much of the research would be conducted in areas where there is less influence from hatchery fish. And finally, because the research would be place in at least five of the major subbasins that are tributary to the Snake River (and would vary in intensity from year to year), it is impossible to clearly differentiate the impacts by population—so it is necessary to gauge them in the context of each species as a whole.

Project 5—Juvenile Anadromous Salmonid Emigration Studies Using Rotary Screw Traps.

Under Project 5, CRITFC researchers would annually trap, anesthetize, examine, measure, and PIT-tag SR spr/sum Chinook and steelhead at several rotary screw traps in the upper Snake River Basin. Some of the captured fish would be marked and returned upstream to check trap efficiency. Some adults may be captured during the operations, but they would immediately be released. The amounts of take being requested under Project 5 are displayed in the following table.

Table 15. Requested Take by ESU, Life Stage, and Activity for Project 5 of Permit 1134 – 7R (C=Capture, H=Handle, T=Tag, M=Mark, R=Release.)

ESU/Species	Life Stage	Origin	Take Activity	Requested Take	Unintentional Mortality
SR Spr/sum Chinook	Adult	Natural	C/H/R	90	1
SR Spr/sum Chinook	Juvenile	Natural	C/H/R	225,000	1000
SR Spr/sum Chinook	Juvenile	Natural	C/H/T/M/R	40,000	350
SR Spr/sum Chinook	Juvenile	Hatchery Ad-Clipped	C/H/R	60,000	600
SR Spr/sum Chinook	Juvenile	Hatchery Non-Ad-Clipped	C/H/R	21,000	105
SR Spr/sum Chinook	Juvenile	Hatchery Non-Ad-Clipped	C/H/T/M/R	3,500	21

ESU/Species	Life Stage	Origin	Take Activity	Requested Take	Unintentional Mortality
SR Steelhead	Adult	Natural	C/H/R	160	1
SR Steelhead	Juvenile	Natural	C/H/R	60,000	250
SR Steelhead	Juvenile	Natural	C/H/T/M/R	12,000	112
SR Steelhead	Juvenile	Hatchery Ad-Clipped	C/H/R	50,000	500
SR Steelhead	Juvenile	Hatchery Non-Ad-Clipped	C/H/R	7,250	25
SR Steelhead	Juvenile	Hatchery Non-Ad-Clipped	C/H/T/M/R	1,350	8

Because the majority of the fish that would be captured are expected to recover with no permanent detrimental effects on their fitness, the most meaningful measure of the effects of the proposed action is seen in the maximum number of listed fish the action may kill. To determine the effect of these losses, it is necessary to compare them to the total outmigrant numbers expected for these species (and their components) found in Table 3. This signifies that the Research may kill the following percentages of the outmigrants.

Table 16. Maximum Percentages of the 2013-2107 Outmigration and Recent Return Average that Project 5 of Permit 1134 – 7R Could Kill

ESU/Species	Life Stage	Origin	% Mortalities
SR Spr/sum Chinook	Adult	Natural	0.005%
SR Spr/sum Chinook	Juvenile	Natural	0.01%
SR Spr/sum Chinook	Juvenile	Hatchery Ad-Clipped	0.01%
SR Spr/sum Chinook	Juvenile	Hatchery Non-Ad-Clipped	0.01%
SR Steelhead	Adult	Natural	0.003%
SR Steelhead	Juvenile	Natural	0.04%
SR Steelhead	Juvenile	Hatchery Ad-Clipped	0.01%
SR Steelhead	Juvenile	Hatchery Non-Ad-Clipped	0.004%

Only once in the past nearly 20 years have the researchers taken (or killed) even half the numbers of fish that have been allotted by Permit 1134, and that year was one in which there was an anomalously low estimate for fall Chinook (an estimate that was later corrected upwards and they are no longer requesting to take fall Chinook in any case). Further, the total levels of take contemplated in this action are in most instances actually a great deal lower than have been examined in previous opinions, and in no case are they higher. This means that the CRITFC has reduced its request to levels below those already considered not to jeopardize the species and they have in all cases taken far fewer fish than authorized in previous years. As the tables above demonstrate, these levels of take translate to low level of mortality. Thus, there would be a very small impact on abundance and productivity for both steelhead and spr/sum Chinook, but—because the effects would be spread out over the majority of the populations that make up the two species—there would be no appreciable impact on structure or diversity. In addition, the work would shift to some degree among populations from year to year—thereby decreasing even further the chance that structure or diversity would be affected for either species. And any negative effect to be generated by these operations would be offset to some degree by the fact that the screw trap and PIT-tagging operations provide managers from several states and Federal agencies with critical information about the yearly outmigration and the status of the various species. River and dam operations, land use planning, restoration efforts, and other scientific research projects depend upon the information generated by the CRITFC researchers under this permit, and they have done so for many years.

13380 – 3R

As previously noted, Permit 13380 – 2R is a continuation of work that has been conducted in the basin for well over ten years. Under it, the researchers would annually capture, anesthetize, measure, release, and kill SR spr/sum Chinook salmon and SR steelhead while evaluating the effects of marine-derived nutrients on salmonid populations in 25 streams of the Salmon River subbasin in Idaho. In most instances, the researchers would crowd the fish toward a net, remove them by dip net, or electroshocking methods, anesthetize and measure them, use gastric lavage to sample stomach contents form some them, mark them, allow them to recover, and release them. A small number of the fish would be killed for stable isotope, otolith, and diet analysis. In all cases, fish that are killed by other permitted activities would be used in place of any fish the researcher would kill on purpose. .

Table 17. Requested Take by ESU, Life Stage, Origin, and Activity for Permit 13380 – 2R. (C=Capture, H=Handle, T=Tag, M= Mark, TS=Tissue sample, R=Release, GL=Gastric Lavage, IK=Intentionally kill.)

ESU/Species	Life Stage	Origin	Take Activity	Requested Take	Unintentional Mortality
SR Spr/sum Chinook	Juvenile	Natural	C/M/T/TS/GL/R	1,000	30
SR Spr/sum Chinook	Juvenile	Natural	IK	150	N/A

ESU/Species	Life Stage	Origin	Take Activity	Requested Take	Unintentional Mortality
SR Spr/sum Chinook	Adult (Carcass)	Natural	TS	50	N/A
SR Steelhead	Juvenile	Natural	C/H/M/TS/GL/R	1000	30
SR Steelhead	Juvenile	Natural	IK	150	N/A

Because the majority (97%) of the fish that would be captured (and not intentionally killed) are expected to recover with no permanent detrimental fitness 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 displayed in Table 3. This signifies that the research could potentially kill the following percentages of the outmigrating natural spr/sum Chinook salmon and steelhead:

Table 18. Maximum Percentages of the Average Estimated 2013-2017 Outmigration that Permit 13380 – 3R Could Kill.

ESU/Species	**Life Stage**	Origin	**% Mortalities**
SR Spr/sum Chinook	Juvenile	Natural	0.01%
SR Steelhead	Juvenile	Natural	0.02%

As the tables above demonstrate, the proposed amounts of take would have very small effects on both listed species. It is true that those effects would be concentrated in the Salmon River subbasin in Idaho (and therefore magnified), but since they will be spread out over at least 25 different streams and shift around form year to year, the effects are still attenuated enough that it is unlikely that any single population would suffer a disproportionate degree of impact. In general, though, because the populations in the Salmon River subbasin account for most of the both the spr/sum Chinook and steelhead production, it is possible that the effects would be locally magnified by as much as 30-50%, but again, those effects would be spread out across many individual populations.

However, there are three reasons why the impacts are almost certainly not as high as those displayed. First, because unintentional mortalities would be used in place of any intentional mortalities, as many as 20% of the mortalities may be double-counted and the actual take would be correspondingly lower than stated. Second, in the last 10 years this work has been conducted, the researchers have generally killed something on the order of 10% of the fish they have been allotted. As a result, they have reduced the numbers of fish they would kill on purpose by about 75% for Chinook and 80% for steelhead. So if their take numbers remain about where they have been for years, this would signify that the actual lethal take levels are likely to be something on the order of 50% of the levels displayed above. Third, the future the levels are likely to decrease even more substantially because the researchers are starting to substitute tissue samples (fin clips) for the take that is now necessary to gather the data they need.

Thus, while the research would have some small impact on both species' abundance and productivity (and likely no appreciable effect on structure or diversity), the numbers of fish that may be killed are 75% smaller (or more) than numbers previously determined in earlier versions of the permit analysis to not jeopardize the species. Further, the actual impacts would, for the reasons stated above, almost certainly be a good deal lower than even those stated in. But even in the worst case scenario the effects would still be (a) very small, (b) restricted to reductions in abundance and productivity, (c) spread out over at least 25 different salmonid-producing streams and many of populations, and (d) offset to some degree by the information to be gained. And in all likelihood the effects would continue to decrease—as they have over the last 10 years.

14283 – 3R

Permit 14823 - 3R would allow the researchers from EAS to annually take listed species during the course of their work to characterize the ongoing off-site effects of the Hanford Nuclear Reservation. They would use boat electrofishing and hook and line fishing to sample various non-listed fishes in the Columbia River from Wanapum Dam downstream to McNary Dam. They would seek to avoid listed species, but some listed individuals may accidentally be encountered during the activities. All captured listed fish would be immediately released back to the river after a minimum of handling. No measurements would be taken.

They are requesting the following amounts of take.

Table 19. Requested Take by ESU, Life Stage, Origin, and Activity for Permit 14283 – 3R (C=Capture, H=Handle, R=Release)

ESU/Species	Life Stage	Origin	Take Activity	Requested Take	Unintentional Mortality
UCR Chinook	Adult	Natural	C/H/R	6	0
UCR Chinook	Juvenile	Natural	C/H/R	5	1
UCR Steelhead	Adult	Natural	C/H/R	6	0
UCR Steelhead	Juvenile	Natural	C/H/R	5	1
MCR Steelhead	Adult	Natural	C/H/R	6	0
MCR Steelhead	Juvenile	Natural	C/H/R	5	1

Because the majority of the fish that would be captured are expected to recover with no permanent detrimental fitness effects, the most meaningful measure of the effects of the proposed action is seen in the maximum number of listed fish the action may kill. To determine the effect of these losses, it is necessary to compare them to the total outmigrant numbers displayed in Table 3. This signifies that the research may kill the following percentages of the outmigrating natural spr/sum Chinook salmon and steelhead:

Table 20. Maximum Percentages of the Average Estimated 2013-2017 Outmigration that Permit 14283 – 3R Could Kill.

ESU/Species	Life Stage	Origin	% Mortalities
UCR Chinook	Juvenile	Natural	0.0002%
UCR Steelhead	Juvenile	Natural	0.0006%
MCR Steelhead	Juvenile	Natural	0.0002%

As the table above demonstrates, the proposed research would have no essentially no effect on adults and almost no effect on juvenile UCR Chinook and steelhead and MCR steelhead. In fact, the effect would be as near to zero as it is possible to get, and in all likelihood it actually would be zero because over the last five years the researchers have actually killed no listed fish from any of the species. But even if the researchers actually killed all three of the juveniles they would be permitted, they would be sampling in the Columbia River mainstem, so even these small losses cannot be tied to any particular population of any species. Thus, the negative impact of the research would be nearly negligible at both the population and the species levels, and it would have only the smallest potential to affect abundance and productivity. There would be no appreciable impact at all on structure or diversity for any of the listed species. And even this (nearly zero) adverse effect would be offset to some degree by the fact that the research is designed to help salmon and steelhead by guiding monitoring and eventually helping to ameliorate the continued negative effects coming from the Hanford Nuclear Reservation.

16979 – 2R

Under Permit 16979, the WDFW would continue work that has been conducted sporadically under other authorities and previous permits for a number of years in Washington. The researchers may capture fish via dip netting, seining, snerding (using snorkelers to herd fish into a seine), electrofishing equipment, traps and weirs, and barbless hook-and-line sampling techniques. The captured fish may be tissue sampled (DNA and scales), measured, and tagged

(PIT and radio-telemetry), allowed to recover, and released. No fish would intentionally be killed and with the exception of radio-telemetry studies, all adult fish encountered will be allowed to escape without being captured. The researchers are requesting the following levels of take.

Table 21. Requested Take by ESU, Life Stage, Origin, and Activity for Permit 16979 -2R (C=Capture, H=Handle, T=Tag, M=Mark, TS=Tissue Sample, R=Release)

ESU/Species	Life Stage	Origin	Take Activity	Requested Take	Unintentional Mortality*
UCR Spr. Chinook	Adult	Natural	C/H/T/M/TS/R	100	2
UCR Spr. Chinook	Adult	Hatchery: Ad-Clipped	C/H/T/M/TS/R	150	3
UCR Spr. Chinook	Adult	Hatchery: Intact Adipose	C/H/T/M/TS/R	150	3
UCR Spr. Chinook	Juvenile	Natural	C/H/T/M/TS/R	10,000	200
UCR Spr. Chinook	Juvenile	Hatchery: Ad-Clipped	C/H/T/M/TS/R	1,000	20
UCR Spr. Chinook	Juvenile	Hatchery: Intact Adipose	C/H/T/M/TS/R	1,000	20
UCR Steelhead	Adult	Natural	C/H/T/M/TS/R	100	2
UCR Steelhead	Adult	Hatchery: Ad-Clipped	C/H/T/M/TS/R	200	4
UCR Steelhead	Adult	Hatchery: Intact Adipose	C/H/T/M/TS/R	90	2
UCR Steelhead	Juvenile	Natural	C/H/T/M/TS/R	30,000	600
UCR Steelhead	Juvenile	Hatchery: Ad-Clipped	C/H/T/M/TS/R	1,000	30
UCR Steelhead	Juvenile	Hatchery: Intact Adipose	C/H/T/M/TS/R	1,000	30

Because the majority (>97% in all cases) of the fish that would be captured are expected to recover with no permanent detrimental fitness 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 these species (and their components). This signifies that the research may kill the following maximum percentages of the outmigrants and adult returns.

Table 22. Maximum Percentages of the Recent Average Outmigration and Recent Return Average that Permit 16979 – 2R Could Kill.

ESU/Species	Life Stage	Origin	% Mortalities
UCR Spr. Chinook	Adult	Natural	0.05%
UCR Spr. Chinook	Adult	Hatchery: Ad-Clipped*	0.03%
UCR Spr. Chinook	Adult	Hatchery: Intact Adipose*	0.03%
UCR Spr. Chinook	Juvenile	Natural	0.04%
UCR Spr. Chinook	Juvenile	Hatchery: Ad-Clipped	0.005%
UCR Spr. Chinook	Juvenile	Hatchery: Intact Adipose	0.008%
UCR Steelhead	Adult	Natural	0.05%
UCR Steelhead	Adult	Hatchery: Ad-Clipped*	0.02%
UCR Steelhead	Adult	Hatchery: Intact Adipose*	0.01%
UCR Steelhead	Juvenile	Natural	0.09%
UCR Steelhead	Juvenile	Hatchery: Ad-Clipped	0.005%
UCR Steelhead	Juvenile	Hatchery: Intact Adipose	0.02%

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

Thus, the maximum effect of the research would be that the equivalent of nine juvenile natural steelhead out of ten thousand may annually be killed under the permit. In addition, the equivalent of five adult natural UCR spring Chinook and five adult natural steelhead out of ten thousand would be allowed to be killed in any given year. All other effects would be smaller than that, and some would be orders of magnitude smaller. Moreover, because the research would be spread out across both the species' entire ranges upstream from the Yakima River, no individual population would be likely to experience a disproportionately large percentage of the negative impacts. Given these factors, it is likely that the research would have a small effect on the species' abundance and productivity, but no appreciable effect on structure or diversity. The impacts, however, would likely be smaller than those examined. The numbers displayed are absolute maxima, and in all likelihood would never be reached in a given season. Over the past five years during which the WDFW has conducted similar research, they have in all instances taken and killed far fewer fish than they were allotted and in some seasons, they have not operated at all.

Nonetheless, the impacts could be as high as those laid out, and given that an endangered species is involved, the yearly research operations will be monitored carefully and a special condition will be placed in the authorizing permit to require that the WDFW make a mid-year check-in with NMFS's Northwest region just to be sure the research is proceeding as expected with regard to its effects. So the effects, while small, will be monitored especially carefully to be sure that they remains so. It is also important to keep in mind that the data from the research would be used to conduct critical status monitoring and would help direct habitat restoration and other salmonid recovery actions throughout the species' ranges.

Permit 20713

Under Permit 20713, the NWFSC would conduct work that may cause them to take a small number of juvenile fish from every listed species considered in this opinion. The researchers propose to intentionally kill natural-origin juvenile Chinook salmon that are between 50 and 80 mm in fork length using a lethal dose of MS-222. The target for contaminant analysis is natural-origin UWR Chinook, but juvenile Chinook salmon from other ESUs in the Columbia River basin may be killed as well because juveniles from different ESUs cannot be distinguished visually. Hatchery-origin Chinook salmon with intact adipose fins could also be killed because they cannot be distinguished from wild fish in the field. In addition, a few individuals from other ESU/DPSs could be killed unintentionally due to capture and handling during seining surveys. However, given the fork length restriction mentioned, many of the outmigrating Chinook smolts from the Snake and Columbia Rivers would be too large and would thus be immediately released. The NWFSC researchers used past survey data from the Lower Willamette and Columbia rivers to predict the proportions of Chinook salmon and other species that they would be likely to capture during their surveys and to plan the timing of their surveys to target UWR Chinook outmigrants. They are seeking the following amounts of take

Table 23. Requested Take by ESU, Life Stage, Origin, and Activity for Permit 20713 (C=Capture, H=Handle, R=Release, IK=Intentionally Kill)

ESU/Species	Life Stage	Origin	Take Activity	Requested Take	Unintentional Mortality
UCR Chinook	Juvenile	Natural	IK	15	N/A
UCR Chinook	Juvenile	Listed hatchery: ad-clip	C/H/R	12	2
UCR Steelhead	Juvenile	Natural	C/H/R	2	1
UCR Steelhead	Juvenile	Listed hatchery: ad-clip	C/H/R	2	1
MCR Steelhead	Juvenile	Natural	C/H/R	2	1
MCR Steelhead	Juvenile	Listed hatchery: ad-clip	C/H/R	2	1

ESU/Species	Life Stage	Origin	Take Activity	Requested Take	Unintentional Mortality
SR spr/sum Chinook	Juvenile	Natural	IK	2	N/A
SR spr/sum Chinook	Juvenile	Listed hatchery: ad-clip	C/H/R	2	1
SR Fall Chinook	Juvenile	Natural	IK	4	N/A
SR Fall Chinook	Juvenile	Listed hatchery: ad-clip	C/H/R	2	1
SR Steelhead	Juvenile	Natural	C/H/R	2	1
SR Steelhead	Juvenile	Listed hatchery: ad-clip	C/H/R	2	1
SR Sockeye	Juvenile	Natural	C/H/R	5	1

Most of the captured fish that are not killed during the course of the research are expected to fully recover with no lasting detrimental effects on their fitness. Therefore, the true impact of this work is seen in the number of fish it may kill. To determine the effect of these losses, it is necessary to compare them to the total outmigrant numbers and returns expected for these species (and their components). This signifies that the research could kill, at a maximum, kill the following percentages of the most recent five-year outmigration averages.

Table 24.   Maximum Percentages of the Recent Average Outmigration and Recent Return Average that Permit 20713 Could Kill.

ESU/Species	Life Stage	Origin	% Mortalities
UCR Chinook	Juvenile	Natural	0.003%
UCR Chinook	Juvenile	Listed hatchery: ad-clip	0.0003%
UCR Steelhead	Juvenile	Natural	0.0006%
UCR Steelhead	Juvenile	Listed hatchery: ad-clip	0.0001%
MCR Steelhead	Juvenile	Natural	0.0002%
MCR Steelhead	Juvenile	Listed hatchery: ad-clip	0.0003%
SR spr/sum Chinook	Juvenile	Natural	0.0001%
SR spr/sum Chinook	Juvenile	Listed hatchery: ad-clip	0.00002%
SR Fall Chinook	Juvenile	Natural	0.0007%
SR Fall Chinook	Juvenile	Listed hatchery: ad-clip	0.00003%

ESU/Species	Life Stage	Origin	% Mortalities
SR Steelhead	Juvenile	Natural	0.0001%
SR Steelhead	Juvenile	Listed hatchery: ad-clip	0.00002%
SR Sockeye	Juvenile	Natural	0.005%

Research associated with Permit 20713 would thus have a very small impact on abundance and productivity and no measureable impact on spatial structure or diversity for all the listed species displayed above. In most cases, the loss is as close to zero as it is possible to get, but even where the researchers would kill more than one fish, the effects are vanishingly small—on the order of three to five juvenile fish out of 100,000 (for UCR Chinook and SR sockeye). In addition, because the work would be conducted near the mouth of the Willamette River, none of the losses displayed above can be attributed to any populations from any of the listed species and the effects would therefore be spread out over the entirety of each listed unit. And, too, the take estimates above are absolute maxima. It is very likely that no juvenile fish would be killed at all during the capture, handle, and release portions of the work. For that kind of activity, we typically see mortality rates that are less than 1%. So the single dead individuals from each of those take lines in Table 23, above, are added simply as a precautionary measure: if the researchers were to accidentally (and anomalously) kill, for example, a single adipose-clipped hatchery-origin SR steelhead, the work would be able to continue. Moreover, given the location of the research, we would expect that in most years the researchers would not even encounter any listed fish from the interior Columbia basin. We fully expect that killing even one of these animals would be a rare event.

But even if the researchers were to kill all the juvenile fish the permit would allow, those small losses must still be placed in the context of the information to be gained. Results from this study would benefit listed species by supporting an ongoing Natural Resource Damage Assessment. In addition, the data would be used in Chinook salmon life cycle models to compare how chemical pollution affects UWR Chinook salmon populations relative to other stressors.

Permit 21432

Cramer Fish Sciences requested to take juvenile listed MCR steelhead by single-pass backpack electrofishing in the Klickitat, Wind, and White Salmon River subbasins. In all cases, the fish would simply be captured, swiftly removed from the electrofishing field, and returned immediately to the stream at their point of capture. In most cases, if even one fish is observed during these operations, that portion of the survey would be deemed complete and the electrofishing crew would move on to another survey unit. However, some selected stream reaches may be surveyed twice to compare the results with non-invasive techniques such as observation and environmental DNA (eDNA) sampling. It is hoped that in the future this study and others like it will be able to use such techniques to get the information they need and will eventually require no listed species take at all.

The researchers are seeking the following amounts of take

Table 25. Requested Take by ESU, Life Stage, Origin, and Activity for Permit 21432 (C=Capture, H=Handle, R=Release)

ESU/Species	Life Stage	Origin	Take Activity	Requested Take	Unintentional Mortality
MCR Steelhead	Juvenile	Natural	C/H/R	210	6
MCR Steelhead	Juvenile	Listed hatchery: ad-clip	C/H/R	30	3

Nearly all captured fish are expected to fully recover with no lasting detrimental effects on their fitness. Therefore, the true impact of this work is evaluated by the number of fish the research will kill. To determine the effect of these losses, it is necessary to compare them to the total outmigrant numbers and returns expected for these species (and their components). This signifies that the research could, at a maximum, kill the following percentages of the most recent five-year outmigration averages.

Table 26. Maximum Percentages of the Recent Average Outmigration and Recent Return Average that Permit 21432 Could Kill.

ESU/Species	Life Stage	Origin	% Mortalities
MCR Steelhead	Juvenile	Natural	0.001%
MCR Steelhead	Juvenile	Listed hatchery: ad-clip	0.0008%

Research associated with Permit 21432 would thus have a negligible impact on MCR steelhead abundance, and productivity and no appreciable effect on their spatial structure or diversity. However, these small losses would actually be magnified somewhat by the fact that they would be concentrated in the Wind, Klickitat, and White Salmon River subbasins. We do not know how many MCR steelhead are produced in these subbasins, but even if the effect were multiplied by a factor of 10, that would still mean that the worst possible impact would equate to the loss of one juvenile fish out of every ten thousand. Moreover, in most years, we fully expect that the effect would not reach the levels displayed above. There are several reasons for this. First, the researchers are concentrating their work in areas where fish are not expected to be present at all. Second, as noted above, the researchers would in most cases stop surveying as soon as a single fish is found. And third, while this is new research, the permit holders have held other permits in the past and have never reached, let alone exceeded the amounts of take they were allotted.

But even if the researchers were to have the maximum permitted impact, the study must still be placed in the context of the information it would generate. We expect that his work would benefit listed fish by affording them new protections if they are found in streams that were previously assessed to be non-fish-bearing. The study also would provide valuable information about the utility of using less-invasive e-DNA survey techniques in place of traditional electrofishing surveys to provide information on fish occupancy.

Permit 21571

Under Permit 21571, the USGS would conduct a series of studies designed to estimate smolt survival in relation to a number of factors in the Yakima River, Washington. In general, those factors are reach-specific survival, migration route choice, predator effects, and other biotic and abiotic variables. This new work would be compared to similar work being conducted on non-listed Chinook salmon in the Yakima River with the goal of determining whether the Chinook studies can serve as surrogates for steelhead studies in the future. As noted previously, the researchers would use a variety of tags and capture methods to monitor the fishes' survival. The researchers would handle all listed fish with care, allow them to recover before returning them to the river, and follow well-established guidelines and protocols for all capture, handling and tagging procedures (e.g., NMFS's electrofishing guidelines). Adult fish will be avoided if at all possible.

The researchers are requesting the following amounts of take:

Table 27. Requested Take by ESU, Life Stage, Origin, and Activity for Permit 21571 (C=Capture, H=Handle, M=Mark, T=Tag, TS=Tissue Sample, R=Release)

ESU/Species	Life Stage	Origin	Take Activity	Requested Take	Unintentional Mortality
MCR Steelhead	Adult*	Natural	C/H/R	26	0
MCR Steelhead	Juvenile	Natural	C/H/M/T/TS/R	350	11
MCR Steelhead	Juvenile	Natural	C/H/R	335	7

*In this instance, nearly all the adults that may be encountered (23 out of 26) are expected to be kelts—fish that have already spawned and are not likely to spawn again.

Because the majority (~97% or more in all cases) of the fish that would be captured are expected to recover with no permanent detrimental fitness effects, the most meaningful measure of the effects of the proposed action is evaluated by the number of listed fish the researchers would be permitted to kill. To determine the effect of these losses, it is necessary to compare them to the total outmigrant numbers displayed in Table 3. This signifies that the research could, at a maximum, kill the following percentage of the outmigrating natural spr/sum Chinook salmon and steelhead:

Table 28. Maximum Percentage of the Average Estimated 2013-2017 MCR Steelhead Outmigration that Permit 21571 Could Kill.

ESU/Species	Life Stage	Origin	% Mortalities
MCR Steelhead	Juvenile	Natural	0.004%

As the table above shows, the effect of the proposed permit actions would be a very small one by any measure. There would be a slight reduction in abundance (and therefore productivity), but because so few fish would be killed, the effects on spatial structure and diversity would be negligible. However, because the fish would all come from the Yakima River major population group (MPG), the effect of the losses would be magnified somewhat at the local level. The Yakima River produces approximately 1/3 of the natural MCR steelhead in the DPS, so at the local level, the effect may be as much as three times as high as that displayed above—or 0.012% of the Yakima River MPG. This equates to about one juvenile fish out of every ten thousand, which is still a very small effect and unlikely to have any impact in the species' structure or diversity. Moreover, that loss must be placed in the context of the information the research is designed to generate regarding outmigrant survival in the Yakima River. For many years, there has been a data gap regarding sources of juvenile MCR steelhead mortality in the Yakima River, and this work is designed to fill that gap and thereby inform future management decisions for the benefit of the MCR steelhead in the basin.

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 many state, tribal, and local governments have developed plans and initiatives to benefit listed fish, they must be applied and sustained in a comprehensive way before NMFS can consider them "reasonably foreseeable" in its analysis of cumulative effects.

We can, however, make some generalizations based on population trends. 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 a recent 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, 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 that would result from 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 29), (b) add the take proposed by the researchers in this opinion to the take that has already been authorized in the region (Table 30), and then (c) compare those totals to the estimated annual abundance of each species under consideration (Table 31).

Table 29. Total Requested Take and Mortalities for All Permits and Percentages of the Listed Units by Age Class and Origin.

ESU/DPS	Life Stage	Origin (Com-ponent)	Requested Take	% of Component Taken	Requested Mortality	% of Component Killed
UCR Chinook	Adult	Natural	106	0.3%	2	0.06%
UCR Chinook	Adult	Hatchery	300	4.6%	6	0.09%
UCR Chinook	Juvenile	Natural	10,200	2.1%	216	0.04%
UCR Chinook	Juvenile	Adipose-clipped	1,012	0.2%	22	0.003%
UCR Chinook	Juvenile	Intact Adipose	1,000	0.3%	20	0.005%
UCR Steelhead	Adult	Natural	106	2.9%	2	0.05%
UCR Steelhead	Adult	Hatchery	290	0.8%	6	0.05%
UCR Steelhead	Juvenile	Natural	30,007	17.0%	602	0.34%
UCR Steelhead	Juvenile	Adipose-clipped	1,002	0.15%	31	0.005%
UCR Steelhead	Juvenile	Intact Adipose	1,000	0.63%	30	0.02%
MCR Steelhead	Adult	Natural	32	0.35%	0	0.0%
MCR Steelhead	Adult	Hatchery	0	0.0%	0	0.0%
MCR Steelhead	Juvenile	Natural	902	0.21%	26	0.006%
MCR Steelhead	Juvenile	Adipose-clipped	32	0.009%	4	0.001%
MCR Steelhead	Juvenile	Intact Adipose	0	0.0%	0	0.0%
SR Spr/sum Chinook	Adult	Natural	805	4.4%	8	0.04%
SR Spr/sum Chinook	Adult	Hatchery	178	0.80%	1	0.004%
SR Spr/sum Chinook	Juvenile	Natural	297,917	21.5%	1,836	0.13%

ESU/DPS	Life Stage	Origin (Com-ponent)	Requested Take	% of Component Taken	Requested Mortality	% of Component Killed
SR Spr/sum Chinook	Juvenile	Adipose-clipped	60,502	1.3%	606	0.01%
SR Spr/sum Chinook	Juvenile	Intact Adipose	24,500	2.4%	126	0.01%
SR Fall Chinook	Juvenile	Natural	4	0.0007%	4	0.0007%
SR Fall Chinook	Juvenile	Adipose-clipped	2	0.00007%	1	0.00004%
SR Steelhead	Adult	Natural	440	1.5%	7	0.02%
SR Steelhead	Juvenile	Natural	85,802	10.7%	740	0.92%
SR Steelhead	Juvenile	Adipose-clipped	50,002	1.5%	501	0.01%
SR Steelhead	Juvenile	Intact Adipose	12100	1.6%	123	0.02%
SR Sockeye	Adult	Natural	125	17.5%	3	0.42%
SR Sockeye	Juvenile	Natural	3305	16.7%	313	1.6%
SR Sockeye	Juvenile	Adipose-clipped	250	0.13%	250	0.13%

Thus the activities contemplated in this opinion may kill—in combination and at most—as much as 1.6% of the fish from any component of any listed species; that component is juvenile natural sockeye salmon.

In all other instances found in the table above, the effect is (at most) about one half 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 30. 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	399	13	32,727	810
	Listed Hatchery: Adipose Clip	396	10	2,669	84
	Listed Hatchery: Intact Adipose	470	15	12,132	301
UCR Steelhead	Natural	545	9	67,915	1,526
	Listed Hatchery: Adipose Clip	486	20	14,865	399
	Listed Hatchery: Intact Adipose	250	9	13,150	346
MCR Steelhead	Natural	2,596	34	156,011	2,626
	Listed Hatchery: Adipose Clip	850	9	21,358	651
	Listed Hatchery: Intact Adipose	225	12	15,663	327
SR spr/sum Chinook	Natural	7,167	47	1,230,780	3,631
	Listed Hatchery: Adipose Clip	1,653	9	87,275	1,040
	Listed Hatchery: Intact Adipose	3,580	11	71,496	562
SR Fall Chinook	Natural	271	7	2,499	97
	Listed Hatchery: Adipose Clip	242	6	1,252	63
	Listed Hatchery: Intact Adipose	210	3	576	26
SR Steelhead	Natural	9,856	122	405,119	4,867
	Listed Hatchery: Adipose Clip	3,020	52	79,277	899
	Listed Hatchery: Intact Adipose	2,580	38	46,613	499
SR Sockeye	Natural	125	3	13,955	828
	Listed Hatchery: Adipose Clip	14	3	425	256

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 that are permitted to be killed.

Table 31. Percent Reduction in Abundance, by life stage, Among the Listed Species for All Previously Authorized Research and the All the Permit Actions Analyzed in this Opinion.

	Origin*	***Adults Killed***	***Percentage of Adult Abundance***	***Juveniles Killed***	***Percentage of Juvenile Abundance***
UCR Chinook	Natural	13	0.37%	810	0.17%
	Listed Hatchery: Adipose Clip	10	0.38%	84	0.014%
	Listed Hatchery: Intact Adipose	15	N/A	301	0.08%
	Total for the listed Unit	**38**	**0.38%**	**1,195**	**0.081%**
UCR Steelhead	Natural	9	0.25%	1,526	0.86%
	Listed Hatchery: Adipose Clip	20	0.02%	399	0.62%
	Listed Hatchery: Intact Adipose	9	N/A	346	0.22%
	Total for the listed Unit	**38**	**0.24%**	**2,271**	**0.27%**
MCR Steelhead	Natural	34	0.37%	2,626	0.63%
	Listed Hatchery: Adipose Clip	9	2.0%	651	0.18%
	Listed Hatchery: Intact Adipose	12	N/A	327	0.35%
	Total for the listed Unit	**55**	**0.53%**	**3,604**	**0.41%**
SR spr/sum Chinook	Natural	47	0.26%	3,631	0.26%
	Listed Hatchery: Adipose Clip	9	0.50%	1,040	0.023%
	Listed Hatchery: Intact Adipose	11	N/A	562	0.056%
	Total for the listed Unit	**67**	**0.30%**	**5,232**	**0.076%**
SR Fall Chinook	Natural	7	0.06%	97	0.02%
	Listed Hatchery: Adipose Clip	6	0.009%	63	0.002%
	Listed Hatchery: Intact Adipose	3	N/A	26	0.0009%
	Total for the listed Unit	**16**	**0.015%**	**186**	**0.003%**

SR Steelhead	Natural	122	0.41%	4,867	0.60%
	Listed Hatchery: Adipose Clip	52	0.034%	899	0.027%
	Listed Hatchery: Intact Adipose	38	N/A	499	0.070%
	Total for the listed Unit	**212**	**0.072%**	**6,265**	**0.13%**
SR Sockeye	Natural	3	0.42%	828	**4.2%**
	Listed Hatchery: Adipose Clip	3	0.42%	256	**0.13%**
	Total for the listed Unit	**6**	**0.84%**	**1,084**	**0.51%**

*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 return breakdown among those components.

First, please note that the numbers in Table 30 and the percentages in Table 31 are in nearly all cases identical to or smaller than the amounts of baseline take that has previously been authorized (see Table 8). The reason for this is twofold: First, five of the eight proposed permits in this opinion are renewals and the new permits are only seeking very small amounts of take, therefore almost 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. Second, some of those renewed permits (particularly 1134 – 7R and 13380 – 3R) are requesting smaller amounts of take and mortalities than they were previously permitted. This is seen most strongly on the amounts of natural SR spr/sum Chinook and steelhead take that are being requested: SR spr/sum Chinook—hundreds of thousands fewer fish requested, thousands of mortalities fewer; SR steelhead—tens of thousands fewer fish requested, hundreds of mortalities fewer.

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 permitted impact on listed fish would see an overall decrease.

Because the majority of the fish that researchers capture and release are expected to recover shortly after handling with no long-term ill effects on their fitness, 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 in all cases amount to a few tenths of a percent of each species' total abundance (though some individual components—natural fish, etc.—would see higher degrees of effect). 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 largely be limited to only a portion of the species' ranges—are documented above in the effects section.

Juvenile Fish

As the Tables 29 - 31 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.

UCR Steelhead: The mortality rate for the natural juveniles is 0.86%, which represents an increase of only one fish over what has previously been analyzed and permitted. Thus, effects of approximately that magnitude have repeatedly been determined to not jeopardize the species in the past. Furthermore, the researchers under the two permits with the most take for this species (Permit 1480 and Permit 16979, held by the USGS and WDFW, respectively) have never in 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. Nonetheless, even if the permit holders were to take all the natural juveniles displayed above, the research being conducted serves a critical function in monitoring the species' status. As a result, it helps inform management decision throughout the species' range and provides data for (legally mandated) status reviews every five years. Finally, the total take for the listed unit falls to 0.27% when the activities are considered in the context of the species as a whole. Consequently, the effect of the program as a whole is a very small impact on abundance and productivity and the activities contemplated in this opinion would add almost nothing to that impact.

MCR steelhead: Another figure requiring a closer view is the 0.63% of the natural MCR steelhead juveniles killed by research activities in the basin. The actions considered in this opinion would add a small number of fish to that total being allotted, so the 0.63% represents a slight increase in the amount of take that has previously been found to not jeopardize the species. However, 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 even smaller fractions of the permitted amounts. 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 0.41%. So once again, even the impact of the program as a whole is a very small one on abundance and productivity and the activities analyzed here, while adding a small increment to that impact, would fill critical data gaps regarding the factors limiting the species' recovery.

SR steelhead: For the 0.60% of the natural SR steelhead permitted to be killed, 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 0.13% of the species. And once again, the proposed research represents a large reduction in the amount of baseline take, particularly for the natural component: tens of thousands fewer fish would be permitted for capture and handling and more than a thousand fewer would be allowed to be killed.

SR Sockeye: The final effect on juvenile fish requiring further scrutiny is the 4.2% mortality rate for natural sockeye salmon. As noted above, there are two important caveats associated with the mortality numbers: many of the fish that are listed as "natural" would in actuality probably be hatchery fish (of which there are 10 times as many), but they are considered "natural" for the purposes of this analysis in order to lay out the worst-case scenario associated with the research. Second, these truly are worst-case numbers. Over the last 10 years, the IDFG researchers under Permit 1124 (the main permit under which sockeye are taken) have killed less than 20% of the permitted mortalities. That is also true for the other main permit under which this species is taken: Permit 1341 is held by the Shoshone-Bannock tribes and over the last five years they have killed, in total, less than 10% of the natural juvenile sockeye they have been permitted. As a result, the total mortality rate for the program is probably on the order of 0.4% to 0.8% rather than the 4.2% displayed. And while it is true that when the juvenile mortality rates are considered in the context of the species as a whole, the rate drops to 0.51%, the potential loss of 4.2% of any component of a listed species is a number to be viewed with caution—even though, in this case (and as noted above), some fraction of that 4.2% would actually be hatchery fish rather than natural fish.

So the 4.2% figure is one that bears careful consideration. However, in this instance, it is necessary to emphasize two things: First, the take contemplated in this opinion adds only one fish to the baseline, so most of that 4.2% figure has been analyzed multiple times in the past and been found not to jeopardize the species each time. Second, the entire purpose of the permit with the most juvenile SR sockeye salmon take (Permit 1124, re-analyzed above) is to help the sockeye survive and recover. As noted previously, under that permit, the researchers support the use of captive broodstock and other methods and technology to capture, preserve, and study the few remaining sockeye salmon. It is even possible that without the research conducted under Permit 1124, the sockeye might have gone extinct; and even if that is not the case, it is inarguable that the research has been critical to the recovery the sockeye are starting to experience.

One further thing to note for the all the species above: 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. So for instance, given that for the UCR steelhead, unclipped hatchery fish make up approximately 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. As another example, that figure is 39% for MCR steelhead. Therefore in most 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 31, above, that *actual* mortality levels would probably be nearly an order of magnitude smaller than those displayed. They would range in reality from about 0.00009% to about 0.4% for individual components and in all probability, no species *as a whole* would experience an actual mortality rate greater than about 0.05%. 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, many 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 almost no increment to the effects already considered and analyzed multiple times. In fact, as a general matter, the take contemplated in this opinion would actually be a great deal less than the baseline overall.

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, will kill a few tenths of a percent of the adult escapement for any listed species. In addition, because no adults from any species will be killed by any of the new proposed research, all of the stated take has already been analyzed in previous opinions and been determined not to jeopardize any of the species considered here. In fact, adult mortalities would actually decrease for many of the species. However, killing an adult fish has a potentially 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 0.38% overall mortality rate for 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 UCR adults out of a thousand will be killed every year by the research efforts in the Northwest. This is a minor effect, and is not likely to 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. Furthermore, 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, under the permit that allows for over half the species' adult mortality rate (Permit 16979), no UCR chinook adults have actually been killed over the last five years. In addition, approximately one-third of the proposed mortalities would come from adults that have had their adipose fins clipped, so they represent a portion of the listed fish that have no take prohibitions and are considered surplus to survival and recovery needs.

MCR Steelhead: For the MCR steelhead, the figure that stands out is the 2.0% of the adult hatchery fish. While it should be noted that this figure actually represents no increase in baseline take, it still means that as many as two adult hatchery fish out of every hundred will be killed every year by the research efforts in the basin. However, 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. It should also be noted that approximately 80% of the hatchery fish in this DPS have had their adipose fins clipped, and there are no take prohibitions on this component of the species. As noted above, 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. They are listed under the ESA, so we must analyze any impacts on them, but the status of this component is such that losses greater than the approximately 1.6% contemplated here (80% of 2%) have been repeatedly determined not to jeopardize *any* listed species—including MCR steelhead. In any case, the potential loss drops to 0.53 % when all mortalities from every component are taken into account, so the effect is a small one and is offset to some degree by the critical status information the research program generates.

SR spr/sum Chinook: Under the research program as a whole, 0.50% of the adult listed hatchery spr/sum Chinook will be killed in any given year. This actually represents a decrease from the baseline take. As a result, this amount of take is less than amounts that have previously been found not to jeopardize the species—both in terms of absolute numbers and percentages... Also, approximately 80% of those fish would have had their adipose fins clipped, thus there are not take prohibitions on most of them. The effect is therefore a very small reduction in abundance and productivity that is largely concentrated in a listed component that is considered surplus to recovery needs. In addition, when the loss is considered in the context of the entire DPS, the mortality rate drops to 0.30%--a rate that would have no appreciable effect on diversity or structure and only a very minor and effect on abundance and productivity.

SR Steelhead: Another take level to note is the 0.41% of the natural adult SR Steelhead that research programs from the interior Columbia River Basin may kill. Though this figure represents an actual decrease 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. Nevertheless, even if all the permitted fish were actually to be killed, that would still represent only 0.072% reduction in the abundance of the species as a whole and even that small effect would be offset to some degree by the critical status information the research program generates.

SR sockeye: Even though the research considered in this opinion would add no adult sockeye mortalities to the baseline take, the overall program could still kill up to 0.84% of the listed unit's adult component. This amount has previously been shown not to jeopardize the sockeye, but given the sockeye's precarious status, it should still be examined. A 0.84% loss of adult sockeye salmon would have a small impact on abundance and therefore productivity, but no discernable impact on structure or diversity. (The sockeye have only one population and it is largely upheld by a number of projects associated with a long-running artificial propagation program.) Also, the mortality rate is not likely to be that high. Over the last five years, the holders of the permits with the largest amount of adult sockeye take (1124 - IDFG) have killed only one adult in total, so the likely impact in a given year is probably closer to 0.28% or less. Nonetheless, even if the entire 0.84% were to be killed, the loss in abundance would be offset to some degree by the knowledge the research program provides—and in this instance the majority of the allotted take is specifically intended to support programs whose sole purpose is to help the sockeye survive and recover.

Thus, the overall situation for adult fish is effectively the same as it is for juvenile fish: the losses are very small, the effects are only seen in reductions in abundance and productivity, and the estimates of adult mortalities are almost certainly much greater than the actual numbers are likely to be. 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 31—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 to be very small—even in combination with the entirety of the research authorized in the basin. 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 previously discussed, we do not expect the individual actions to have any appreciable effect on any listed species' critical habitat. This is true for all the proposed permit actions in combination as well: the actions' short durations, minimal intrusion, and overall lack of measureable effect signify that even when taken together they would have no discernible impact on critical habitat.

Summary

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

To this picture, it is necessary to add the increment of effect represented by the proposed actions. Our analysis shows that the proposed research activities would have slight negative effects on each species' abundance and productivity, but those reductions are so small as to have no more than a very minor effect on the species' survival and recovery. In all cases, even the worst possible effect on abundance 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 enhanced our 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. Though no law calls for the work being done in any particular permit or authorization, the ESA (section 4(c)(2)) requires that we examine the status of each listed species every five years and report on our findings. At that point, we must determine whether each listed species should (a) be removed from the list (b) have its status changed from threatened to endangered, or (c) have its status changed from endangered to threatened. As a result, it is legally incumbent upon us to monitor the status of every species considered here and the research program, as a whole, is one of the primary means we have of doing that.

Thus, we expect the detrimental effects on the species to be minimal and those impacts would only be seen in terms of slight reductions in juvenile and adult abundance and productivity. And because these reductions are 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 MCR steelhead, threatened SR spr/sum Chinook, threatened SR fall Chinook, threatened SR steelhead, or endangered SR sockeye, 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., Hanson et al. 2010a, Hanson et al 2010b; 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 2,614 juvenile Chinook and 17 adults may be killed during the course of the research; the adults and juveniles would come from three different listed species in the Snake and upper Columbia Rivers. As the previous effects analysis illustrated, these losses—even in total—are expected to have only very small effects on salmonid abundance and productivity and no appreciable effect on diversity or distribution.

Nonetheless, the fact that the research would take kill 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. For the adult take, this is not an issue at all because all the adult Chinook that may be killed would be killed in the interior Columbia River basin. That is, they would only be killed *after* they had already made it past the killer whales twice and were on their spawning runs, so they could not be intercepted by the whales in any case.

For the juveniles, 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 2,614 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 26 adult Chinook salmon—primarily SR spr/sum Chinook salmon. Given that the SRKW population must catch a minimum of 1,400 salmon daily to sustain their needs (Center for Whale Research 2018), this means that the research contemplated in this opinion could kill, in its entirety, 1.8% of *one day's* worth of the fish that the SRKW's need to survive. Moreover, that figure would only hold if the SRKWs could somehow intercept *all* the fish that might otherwise have grown to maturity. So even the maximum effect of a loss of 1.8% of one day's worth of SRKW food could only occur under the most extremely unlikely circumstances.

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 15% of the juvenile Chinook salmon they were permitted to kill. Thus, the actual reduction in prey available to the whales is probably closer to four fish than to 26.

But even if the equivalent of 26 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 could even be intercepted by the whales in the first place), means the research 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 PBF of designated critical habitat for killer whales. As described above, however, and considering the conservative estimate of 26 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

Abatzoglou, J.T., Rupp, D.E. and Mote, P.W. 2014. Seasonal climate variability and change in the Pacific Northwest of the United States. Journal of Climate 27(5): 2125-2142.

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.

AMIP 2018. The FCRPS Adaptive Management and Implementation Plan (AMIP) ESU-Level Abundance and Trend Tracking Spreadsheet—updated February 2018, R. Graves pers comm.

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.

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.

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.

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.

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.

Center for Whale Research. 2018. "Orcas and Salmon" page: https://www.whaleresearch.com/about-salmon

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

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.

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

Crozier, L.G., Hendry, A.P., Lawson, P.W., Quinn, T.P., Mantua, N.J., Battin, J., Shaw, R.G. and Huey, R.B., 2008. Potential responses to climate change in organisms with complex life histories: evolution and plasticity in Pacific salmon. *Evolutionary Applications* 1(2): 252-270.

Crozier, L. G., M. D. Scheuerell, and E. W. Zabel. 2011. Using Time Series Analysis to Characterize Evolutionary and Plastic Responses to Environmental Change: A Case Study of a Shift Toward Earlier Migration Date in Sockeye Salmon. *The American Naturalist* 178 (6): 755-773.

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.

Dominguez, F., E. Rivera, D. P. Lettenmaier, and C. L. Castro. 2012. Changes in Winter Precipitation Extremes for the Western United States under a Warmer Climate as Simulated by Regional Climate Models. *Geophysical Research Letters* 39(5).

Doney, S. C., M. Ruckelshaus, J. E. Duffy, J. P. Barry, F. Chan, C. A. English, H. M. Galindo, J. M. Grebmeier, A. B. Hollowed, N. Knowlton, J. Polovina, N. N. Rabalais, W. J. Sydeman, and L. D. Talley. 2012. Climate Change Impacts on Marine Ecosystems. *Annual Review of Marine Science* 4: 11-37.

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.

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.

Glick, P., J. Clough, and B. Nunley. 2007. Sea-Level Rise and Coastal Habitats in the Pacific Northwest: An analysis for Puget Sound, southwestern Washington, and northwestern Oregon. National Wildlife Federation, Seattle, WA.

Goode, J.R., Buffington, J.M., Tonina, D., Isaak, D.J., Thurow, R.F., Wenger, S., Nagel, D., Luce, C., Tetzlaff, D. and Soulsby, C., 2013. Potential effects of climate change on streambed scour and risks to salmonid survival in snow-dominated mountain basins. *Hydrological Processes* 27(5): 750-765.

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

Hockersmith, E.E., W.D. Muir, and others. 2000. Comparative performance of sham radiotagged and PIT-tagged juvenile salmon. Report to U.S. Army Corps of Engineers, Contract W66Qkz91521282, 25 p.

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.

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

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.

Intergovernmental Panel on Climate Change (IPCC). 2014. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

Isaak, D.J., Wollrab, S., Horan, D. and Chandler, G., 2012. Climate change effects on stream and river temperatures across the northwest US from 1980–2009 and implications for salmonid fishes. *Climatic Change* 113(2): 499-524.

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.

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.

Krahn, M. M., P. R. Wade, S. T. Kalinowski, M. E. Dahlheim, B. L. Taylor, M. B. Hanson, G. M. Ylitalo, R. P. Angliss, J. E. Stein, and R. S. Waples. 2002. Status review of southern resident killer whales (Orcinus orca) under the Endangered Species Act. NOAA Technical Memorandum NMFS-NWFSC-54, U.S. Department of Commerce, Seattle, Washington.

Krahn, M.M., M.B. Hanson, R.W. Baird, R.H. Boyer, D.G. Burrows, C.E. Emmons, J.K.B. Ford, L.L. Jones, D.P. Noren, P.S. Ross, G.S. Schorr, and T.K. Collier. 2007. Persistent organic pollutants and stable isotopes in biopsy samples (2004/2006) from Southern Resident killer whales. Marine Pollution Bulletin 54(12): 1903-1911.

Kunkel, K. E., L. E. Stevens, S. E. Stevens, L. Sun, E. Janssen, D. Wuebbles, K. T. Redmond, and J. G. Dobson. 2013. Regional Climate Trends and Scenarios for the U.S. National Climate Assessment: Part 6. *Climate of the Northwest U.S. NOAA Technical Report NESDIS 142-6*. 83 pp. National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Service, Washington, D.C.

Lawson, P. W., Logerwell, E. A., Mantua, N. J., Francis, R. C., & Agostini, V. N. 2004. Environmental factors influencing freshwater survival and smolt production in Pacific Northwest coho salmon (*Oncorhynchus kisutch*). *Canadian Journal of Fisheries and Aquatic Sciences* 61(3): 360-373

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.

Mantua, N., I. Tohver, and A. Hamlet. 2009. Impacts of Climate Change on Key Aspects of Freshwater Salmon Habitat in Washington State. *In* The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate, edited by M. M. Elsner,J. Littell, L. Whitely Binder, 217-253. The Climate Impacts Group, University of Washington, Seattle, Washington.

Mantua, N., I. Tohver, and A. Hamlet. 2010. Climate change impacts on streamflow extremes and summertime stream temperature and their possible consequences for freshwater salmon habitat in Washington State. *Climatic Change* 102(1): 187-223.

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.

McMahon, T.E., and G.F. Hartman. 1989. Influence of cover complexity and current velocity on winter habitat use by juvenile coho salmon (Oncorhynchus kisutch). Canadian Journal of Fisheries and Aquatic Sciences 46: 1551–1557.

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.

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.

Meyer, J.L., M.J. Sale, P.J. Mulholland, and N.L. Poff. 1999. Impacts of climate change on aquatic ecosystem functioning and health. *JAWRA Journal of the American Water Resources Association* 35(6): 1373-1386.

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.

Mote, P.W, A. K. Snover, S. Capalbo, S.D. Eigenbrode, P. Glick, J. Littell, R.R. Raymondi, and W.S. Reeder. 2014. Ch. 21: Northwest. In Climate Change Impacts in the United States: The Third National Climate Assessment, J. M. Melillo, T.C. Richmond, and G.W. Yohe, Eds., U.S. Global Change Research Program, 487-513.

Mote, P.W., D.E. Rupp, S. Li, D.J. Sharp, F. Otto, P.F. Uhe, M. Xiao, D.P. Lettenmaier, H. Cullen, and M. R. Allen. 2016. Perspectives on the cause of exceptionally low 2015 snowpack in the western United States, Geophysical Research Letters, 43, doi:10.1002/2016GLO69665

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

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

NMFS (National Marine Fisheries Service). 2003. 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. 2005. Assessment of NOAA Fisheries' critical habitat analytical review teams for 12 evolutionarily significant units of West Coast salmon and steelhead. NMFS, Protected Resources Division, Portland, Oregon.

NMFS. 2008. Recovery plan for Southern Resident killer whales (*Orcinus orca*). National Marine Fisheries Service, Northwest Region, Seattle, Washington.

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

NMFS. 2015a. Proposed ESA Recovery for Snake River Fall Chinook Salmon. West Coast Region, Protected Resources Division, Portland, OR, 97232.

NMFS. 2015b. ESA Recovery Plan for Snake River Sockeye Salmon. West Coast Region, Protected Resources Division, Portland, OR.

NMFS 2016. Proposed ESA Recovery Plan for Snake River Spring/Summer Chinook Salmon and Snake River Steelhead. West Coast Region, Protected Resources Division, Portland, OR.

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

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.

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.

Raymondi, R.R., J.E. Cuhaciyan, P. Glick, S.M. Capalbo, L.L. Houston, S.L. Shafer, and O. Grah. 2013. Water Resources: Implications of Changes in Temperature and Precipitation. *In* Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities, edited by M.M. Dalton, P.W. Mote, and A.K. Snover, 41-58. Island Press, Washington, DC.

Reeder, W.S., P.R. Ruggiero, S.L. Shafer, A.K. Snover, L.L Houston, P. Glick, J.A. Newton, and S.M Capalbo. 2013. Coasts: Complex Changes Affecting the Northwest's Diverse Shorelines. *In* Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities, edited by M.M. Dalton, P.W. Mote, and A.K. Snover, 41-58. Island Press, Washington, DC

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.

Schaller, H., P. Wilson, S. Haeseker, C. Peterosky, E. Tinus, T. Dalton, R. Woodin, E. Weber, N. Bouwes, T. Berggren, J. McCann, S. Rassk, H. Franzoni, P. McHugh. 2007. COMPARATIVE SURVIVAL STUDY (CSS) of PIT-Tagged Spring/Summer Chinook and Steelhead In the Columbia River Basin: Ten-year Retrospective Analyses Report. Project #1996-020-00, BPA Contract #s 25634, 25264, 20620. Project #1994-033-00, BPA Contract #25247.

Scheuerell, M.D., and J.G. Williams. 2005. Forecasting climate-induced changes in the survival of Snake River spring/summer Chinook salmon (Oncorhynchus tshawytscha). Fisheries Oceanography 14:448-457.Shared Strategy for Puget Sound. 2007. Puget Sound salmon recovery plan. Volume 1, recovery plan. Shared Strategy for Puget Sound. Seattle.

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.

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

Sunda, W. G., and W. J. Cai. 2012. Eutrophication induced CO2-acidification of subsurface coastal waters: interactive effects of temperature, salinity, and atmospheric p CO2. *Environmental Science & Technology*, 46(19): 10651-10659

TAC (U.S. v. Oregon Technical Advisory Committee). 2008. Biological assessment of incidental impacts on salmon species listed under the Endangered Species Act in the 2008-2017 non-Indian and treaty Indian fisheries in the Columbia River Basin.

Tague, C. L., Choate, J. S., & Grant, G. 2013. Parameterizing sub-surface drainage with geology to improve modeling streamflow responses to climate in data limited environments. Hydrology and Earth System Sciences 17(1): 341-354

Taylor, M.J., and K.R. White. 1992. A meta-analysis of hooking mortality of non-anadromous trout. North American Journal of Fisheries Management 12:760-767.

Taylor, G., and R.A. Barnhart. 1999. Mortality of angler caught and released steelhead. California Cooperative Fish and Wildlife Research Unit, Arcata.

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.

Tillmann, P., and D. Siemann. 2011. Climate Change Effects and Adaptation Approaches in Marine and Coastal Ecosystems of the North Pacific Landscape Conservation Cooperative Region. National Wildlife Federation.

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.

Wainwright, T. C., and L. A. Weitkamp. 2013. Effects of climate change on Oregon Coast coho salmon: habitat and life-cycle interactions. *Northwest Science* 87(3): 219-242.

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.

Winder, M. and D. E. Schindler. 2004. Climate change uncouples trophic interactions in an aquatic ecosystem. Ecology 85: 2100–2106

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

Zabel, R.W. 2017. Memorandum to Chris Yates. Estimation of Percentages for Listed Pacific Salmon and Steelhead Smolts Arriving at Various Locations in the Columbia River Basin in 2017. November 3, 2017.