UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
1201 NE Lloyd Boulevard, Suite 1100
PORTLAND, OREGON 97232-1274

March 14, 2019

FINDING OF NO SIGNIFICANT IMPACT

BACKGROUND

Proposed Action:

The proposed action is for the National Marine Fisheries Service (NMFS) to approve three Snake River steelhead fishing plans under NMFS' Endangered Species Act (ESA) 4(d) Rules. Details associated with this proposed action can be found in the attached Environmental Assessment.

Alternatives Evaluated in the Environmental Assessment:

- Alternative 1 (No Action) – Do Not Make a Determination under the 4(d) Rule or Tribal 4(d) Rule
- Alternative 2 (Proposed Action) – Make a Determination that the Submitted Fishery Management and Evaluation Plans (FMEPs) and Tribal Resource Management Plans (TRMP) Meet the Requirements of the 4(d) Rule and Tribal 4(d) Rule, Respectively.
- Alternative 3 (Implement Additional Conservation Measures) – Make a Determination that Revised FMEPs with Additional Conservation Measures and a Revised TRMP that Maintains Status Quo Fisheries Meet the Requirements of the 4(d) Rule and Tribal 4(d) Rule, Respectively
- Alternative 4 (Close Steelhead Fisheries in Snake River Basin) – Make a Determination that the Submitted FMEPs and TRMP Do Not Meet the Requirements of the 4(d) Rule and Tribal 4(d) Rule, Respectively
- Alternative 5 (Increased Allowable Impact Rates) – Make a Determination that Revised FMEPs and TRMP with Increased Allowable Impact Rates when Natural-origin Steelhead Abundance Exceeds Minimum Abundance Thresholds (MAT) Meet the Requirements of the 4(d) Rule and Tribal 4(d) Rule, Respectively

Selected Alternative

NMFS is selecting Alternative 2, under which NMFS would make a determination that the submitted FMEPs and TRMP Meet the Requirements of the ESA 4(d) Rule and Tribal 4(d) Rule, Respectively.

Related Consultations:
NMFS' Endangered Species Act (ESA) consultation on this proposed action concluded that the action is not likely to jeopardize the continued existence of the Snake River spring/summer Chinook Salmon evolutionarily significant unit (ESU), Snake River fall Chinook Salmon ESU, Snake River Steelhead distinct population segment (DPS), Middle Columbia River Steelhead

DPS, or the Snake River Sockeye Salmon ESU, or destroy or adversely modify their designated critical habitat (NMFS 2019).

NMFS' Magnuson-Stevens Act Essential Fish Habitat (EFH) consultation concluded that the proposed action would not adversely affect designated EFH for Chinook or coho salmon (NMFS 2019).

The U.S. Fish and Wildlife Service's (USFWS) ESA consultation on this proposed action concluded that the action will not jeopardize the survival and recovery of bull trout under its authority and will not adversely modify bull trout critical habitat (USFWS 2019).

SIGNIFICANCE CRITERIA REVIEW

The Council on Environmental Quality (CEQ) regulations state that the determination of significance using an analysis of effects requires examination of both context and intensity, and lists ten criteria for intensity (40 CFR 1508.27). In addition, the Companion Manual for National Oceanic and Atmospheric Administration Administrative Order 216-6A provides sixteen "intensity" criteria, the same ten as the CEQ Regulations and six additional, for determining whether the impacts of a proposed action are significant. Each criterion is discussed below with respect to the proposed action and considered individually as well as in combination with the others.

Context is defined as including the entire human context, as well as the national, regional and local significance of the effects. Here, the context of the action is a fishery that takes place within a long-standing regional harvest framework, the *U.S. v. Oregon* Management Agreement. This agreement, established through treaties and enforced through federal district court orders beginning in 1969, sets out the boundaries for a sharing of the harvest between the states in the Columbia River basin and the Tribes with treaty rights to harvest salmon and steelhead. The fisheries here represent the continued implementation of those treaties, and their impacts consist primarily of the impacts to the harvested species as they occur in the Snake River basin and the impacts to the Tribes and non-tribal citizens of Idaho, Washington, and Oregon.

The context in which NMFS has made its significance determination is informed by the recent *U.S. v. Oregon* Environmental Impact Statement (EIS) issued in 2018. Because the EIS was completed one year ago and considered all potential impacts associated with Columbia River salmon and steelhead fisheries, this review has incorporated the *US v. Oregon* EIS and focused its analysis on specific elements not fully considered earlier, as well as any new information regarding the human environment.

1. Can the proposed action reasonably be expected to cause both beneficial and adverse impacts that overall may result in a significant effect, even if the effect will be beneficial?

> The impacts of the proposed action on the biological, physical, and human components of the environment are described in Section 4 of the Environmental Assessment. The proposed action is not expected to increase recreational fishing effort for steelhead in the Snake River Basin or alter the spatial and/or temporal distribution of current recreational

fishing effort for steelhead. The proposed action is expected to increase Tribal fishing effort for steelhead in the Snake River Basin over time and could also increase the spatial and temporal distribution of current Tribal fishing effort for steelhead. This increase is part of a new comprehensive management plan determined to confer adequate protection to the biological component of the environment. The proposed action is not reasonably expected to cause beneficial or adverse impacts that result in a significant effect overall because its scope is limited to fishing activities in a limited number of specific locations in the project area. In addition, these activities are monitored and controlled by regulations that minimize negative impacts on the biological and physical components of the environment while promoting benefits to the human component of the environment.

2. Can the proposed action reasonably be expected to significantly affect public health or safety?

The proposed action is not reasonably expected to significantly affect public health or safety because the proposed fisheries are not associated with any known health hazards directly or indirectly. There is a certain amount of safety risk associated with any fisheries because participants are in contact with the river and sometimes inclement weather conditions. However, participation in the proposed fisheries is limited to state-licensed fishermen and to enrolled Tribal members and poses no risk to public safety in general.

3. Can the proposed action reasonably be expected to result in significant impacts to unique characteristics of the geographic area, such as proximity to historic or cultural resources, park lands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas?

The proposed action is not expected to result in significant impacts to unique characteristics of the geographic area, such as proximity to historic or cultural resources, park lands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas because it does not involve the construction of any new infrastructure. Designated critical habitat for the ESA-listed species is within the affected area; however, NMFS and USFWS found that the proposed action is not likely to destroy or adversely modify designated critical habitat or adversely affect designated EFH (NMFS 2019; USFWS 2019).

4. Are the proposed action's effects on the quality of the human environment likely to be highly controversial?

NMFS is unaware of any indication that the proposal to continue implementing these ongoing fisheries under the *US v. Oregon* framework is highly controversial. In response to making the Idaho Department of Fish and Game's (IDFG's) FMEP available for public comment, 31 letters expressed some level of disagreement with the proposal and more than 1,000 expressed support for continuing the fisheries. There is minimal disagreement among experts regarding NMFS' methodology for assessing the impacts of the fisheries, and no other federal, state or Tribal agency has objected to the proposal. The entities expressing disagreement with the proposal have raised their concerns about the adequacy of protections for wild steelhead populations.[1] NMFS agrees that these are important concerns and has endeavored to address them in the Environmental Assessment. Because several salmon and steelhead species are ESA-listed as threatened or endangered, NMFS has examined those impacts in greater detail in its Biological Opinion on the proposed action.

5. Are the proposed action's effects on the human environment likely to be highly uncertain or involve unique or unknown risks?

The proposed action's effects on the human environment are not likely to be highly uncertain or involve unique or unknown risks. Although there are some uncertainties involved in the ongoing operation of fisheries, such as gaps in available data regarding salmon and steelhead populations, NMFS does possess sufficient information to understand the risks posed by these long-standing programs and the various limiting factors (such as related hatchery production), and the proposed fisheries include explicit steps to monitor and evaluate these uncertainties in a manner that allows timely adjustments to minimize or avoid adverse impacts. The Environmental Assessment also addresses questions raised in comments on the IDFG FMEP regarding whether NMFS adopted the correct methodology for determining the mortality rate for steelhead resulting from the proposed action. Additional information on the mortality rate is found in NMFS' biological opinion. The proposed fisheries are similar to other fisheries occurring in many areas of the Pacific Northwest, and the effects are well known. No unique or unknown risks have been identified specific to this project area and the resources potentially affected by this action.

6. Can the proposed action reasonably be expected to establish a precedent for future actions with significant effects or represent a decision in principle about a future consideration?

This action is not expected to establish a precedent for future factions with significant effects or represent a decision in principle about a future action because the proposed hatchery programs are similar in nature and scope to other fishing actions reviewed by NMFS over the past twenty years. This includes basin-specific FMEPs similar to the proposed action as well as the *U.S. v. Oregon* and *U.S. v. Washington* agreements which have been reviewed and which promulgate larger-scale fishing plans in the Columbia Basin and Puget Sound, respectively. As discussed above, the proposed action is a subset of the harvest framework encompassed by the *U.S. v. Oregon* agreement, for which NMFS recently prepared an EIS in 2018.

Like other similar fisheries that have already been reviewed, implementation monitoring is a key element of the proposed action, which would inform co-managers of the effects of the action. The proposed hatchery programs would support precedence already set for monitoring and adaptive management, which reduces any risk of significant effects occurring now or in the future.

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[1] NMFS notes that the parties expressing concern raised legal issues in their comment letters and in a notice of intent to sue the State of Idaho. The Environmental Assessment does not attempt to resolve legal issue; its purpose is to determine whether the impacts of the proposed action are significant and warrant the preparation of an EIS.

7. Is the proposed action related to other actions that when considered together will have individually insignificant but cumulatively significant impacts?

The proposed action, when considered with other actions, is not expected to have individually insignificant but cumulatively significant impacts. The cumulative impacts of the proposed action have been considered in the attached Environmental Assessment and associated biological opinions (NMFS 2019; USFWS 2019). This includes the cumulative impacts of climate change, which will likely alter salmon and steelhead habitat in the affected geographic area by both degrading conditions in areas susceptible to increased temperature or reduced flow and by emphasizing the importance of higher elevation habitat. The take of ESA-listed species will be limited to a maximum level considered to result in a no-jeopardy ESA determination when considering all existing conditions, all other permits, and other actions affecting these species. The proposed hatchery programs are coordinated with monitoring so that fish managers can respond to changes in the status of affected listed species. If the cumulative effects of management efforts fail to provide for recovery of listed species, adjustments would likely be proposed to many of the activities affecting the species (e.g., harvest, hatchery, and hydropower operations).

8. Can the proposed action reasonably be expected to adversely affect districts, sites, highways, structures, or objects listed in or eligible for listing in the National Register of Historic Places or may cause loss or destruction of significant scientific, cultural, or historical resources?

The proposed action is not expected to adversely affect districts, sites, highway structures, or objects listed in or eligible for listing in the National Register of Historic Places. Similarly, the proposed action is not expected to cause loss or destruction of significant scientific, cultural, or historical resources because no construction is proposed and fishing access points have already been established. Fishery monitoring activities are in place to assess impacts upon implementation of the proposed action, and fishery regulations are enforced by the fishery managers (NMFS 2019).

9. Can the proposed action reasonably be expected to have a significant impact on endangered or threatened species, or their critical habitat as defined under the Endangered Species Act of 1973?

NMFS' ESA consultation on this proposed action concluded that the action is not likely to jeopardize the continued existence of the Snake River spring/summer Chinook Salmon ESU, Snake River fall Chinook Salmon ESU, Snake River Steelhead DPS, Middle Columbia River Steelhead DPS, or the Snake River Sockeye Salmon ESU, or destroy or adversely modify their designated critical habitat (NMFS 2019).

The USFWS' ESA consultation on this proposed action concluded that the action will not jeopardize the survival and recovery of bull trout and will not adversely modify bull trout critical habitat (USFWS 2019).

In addition, the proposed action is not expected to have an impact on marine mammals such as the endangered Southern Resident killer whale (SRKW) or its critical habitat because all fisheries would occur in the Snake River Basin, which is ~400 miles from the Pacific Ocean. In addition, steelhead are not a primary prey of SRKW (NMFS 2016).

One comment notes that the proposed action will affect designated critical habitat for salmon, steelhead, and bull trout. However, as discussed in the Environmental Assessment and associated biological opinions, the impacts to critical habitat resulting from the action are minimal.

10. Can the proposed action reasonably be expected to threaten a violation of federal, state, or local law or requirements imposed for environmental protection?

The proposed action is not expected to threaten a violation of federal, state, or local law or requirements imposed for environmental protection. There is no new construction or modification being proposed to land or water, and ESA impacts are being accounted for in the associated biological opinions (NMFS 2019; USFWS 2019).

11. Can the proposed action reasonably be expected to adversely affect stocks of marine mammals as defined in the Marine Mammal Protection Act?

As described in #9, the proposed action is not expected to impact marine mammals as defined under the Marine Mammal Protection Act, such as pinnipeds, because treaty and non-treaty fisheries described in the proposed action would occur ~400 miles from the Pacific Ocean after salmon and steelhead migrate through the range of marine mammals and are available to them as prey.

12. Can the proposed action reasonably be expected to adversely affect managed fish species?

The proposed action has the potential to affect several managed fish species such as salmon, steelhead, bull trout, rainbow trout, and brook trout. Effects of the proposed action on ESA-listed managed fish species are discussed under #9. Impacts on non-listed managed fish species are expected to be low to negligible as described in Section 4.2 of the Environmental Assessment.

13. Can the proposed action reasonably be expected to adversely affect essential fish habitat as defined under the Magnuson-Stevens Fishery Conservation and Management Act?

The project area includes designated EFH for both Chinook and coho salmon. NMFS' Magnuson-Stevens Fishery Conservation and Management Act EFH consultation concluded that the proposed action would not adversely affect designated EFH for these species (NMFS 2019). EFH has not been identified for steelhead or sockeye salmon. No other species' EFH would be expected to be impacted because there is no other EFH in the project area.

14. Can the proposed action reasonably be expected to adversely affect vulnerable marine or coastal ecosystems, including but not limited to, deep coral ecosystems?

The proposed action would have no impact or negligible adverse impacts on vulnerable marine or coastal ecosystems because the proposed fisheries do not occur in the ocean, coastal habitats, or deep coral ecosystems.

15. Can the proposed action reasonably be expected to adversely affect biodiversity or ecosystem functioning (e.g., benthic productivity, predator-prey relationships, etc.)?

The proposed action is not expected to have a substantial impact on biodiversity or ecosystem functioning. Although salmon and steelhead interact with other species through predator/prey interactions, they would not be expected to affect biodiversity because the number of salmon and steelhead affected in the proposed fisheries would only represent a small portion of the total number of predator or prey species within the affected area.

16. Can the proposed action reasonably be expected to result in the introduction or spread of a nonindigenous species?

The proposed action includes management of fishery activities only and would not introduce species (indigenous or nonindigenous) to a new area. Fishing activities are not likely to introduce or spread any non-indigenous species any more than other ongoing activities such as hiking, camping, tourist activities, fishing for non-listed species, and forestry practices. The gear used in these fisheries (tackle and boats, etc.) are not expected to be brought in from outside the basin in any great number, and the states have in place check stations and other mechanisms, independent of the proposed activities, that would reduce transfer from out-of-basin locations of any non-indigenous species to levels no different from other activities not part of the proposed action.

DETERMINATION

In view of the information presented in this document and the analysis contained in the supporting Environmental Assessment prepared for NMFS' determinations under the ESA Section 4(d) Rule for the Snake River Steelhead Fishery FMEPs and TRMP, it is hereby determined that the approval of the FMEPs and TRMP will not significantly impact the quality of the human environment as described above and in the supporting Environmental Assessment. Accordingly, preparation of an environmental impact statement for this action is not necessary.

Barry A. Thom — 3/14/2019

Barry A. Thom
Regional Administrator

Date

REFERENCES

NMFS. 2016. Southern Resident Killer Whales (Orcinus orca) 5-Year Review: Summary and Evaluation. December 2016. NMFS, West Coast Region, Seattle, Washington. 74p.

NMFS. 2019. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. Recreational and Tribal Treaty Steelhead Fisheries in the Snake River Basin. NMFS Consultation No.: WCR-2018-10283. 131p.

USFWS. 2019. Biological Opinion for the National Marine Fisheries Service Authorization of Recreational and Tribal Treaty Fisheries in the Snake River Basin. 01EIFW00-2019-F-0234. February 11, 2019. 76p.

Cover Sheet

Final Environmental Assessment

Title of Environmental Review: Snake River Basin Steelhead Fisheries

Distinct Population Segments: Snake River Steelhead DPS

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Legal Mandate: Endangered Species Act of 1973, as amended and implemented – 50 CFR Part 223

Location of Proposed Activities: Snake River Basin in Washington, Oregon, and Idaho. The Snake River is a tributary to the Columbia River.

Activity Considered: The proposed management plans describe steelhead fisheries and associated activities in the Snake River Basin

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1. PURPOSE OF AND NEED FOR THE PROPOSED ACTION

1.1. Background

NOAA's National Marine Fisheries Service (NMFS) is the lead agency for administering the Endangered Species Act (ESA) as it relates to ESA-listed salmon and steelhead. On July 10, 2000, NMFS issued a final rule pursuant to ESA section 4(d) (4(d) Rule), adopting regulations necessary and advisable to conserve threatened species (50 CFR 223.203). NMFS also issued a parallel ESA 4(d) Rule for Tribal Plans (i.e., the Tribal 4(d) Rule) (65 FR 111, January 3, 2000). The 4(d) Rules apply the take prohibitions in section 9(a)(1) of the ESA to salmon and steelhead listed as threatened, and sets forth specific circumstances when the take prohibitions would not apply, known as 4(d) limits. There are 13 limits in the 4(d) rule. Limit 4 is for Fishery Management and Evaluation Plans (FMEPs) developed by the state fishery agencies.

Additional information about the 4(d) rule, exemptions, and scientific concepts that NMFS uses to evaluate programs can be found at Westcoast Region Fisheries.

NMFS has received three FMEPs and a Tribal Resource Management Plan (TRMP) for Snake River Basin steelhead fisheries. Idaho Department of Fish and Game (IDFG), Oregon Department of Fish and Wildlife (ODFW), and Washington Department of Fish and Wildlife (WDFW) submitted their FMEPs under Limit 4 of the 4(d) Rule, and the Nez Perce Tribe (NPT) submitted their TRMP under the Tribal 4(d) rule.

The Snake River is a tributary to the Columbia River, and fisheries in the Columbia River are managed subject to provisions of United States v. Oregon (*U.S. v. Oregon*) under the continuing jurisdiction of the Federal court. The case now styled *U.S. v. Oregon* is the outgrowth of the consolidation of two cases filed in 1968, *Sohappy v. Smith*, No. 68-409 (D. Or.), and *U.S. v. Oregon*, No. 68-513 (D. Or.). These cases were first brought in 1968 to enforce the reserved treaty fishing rights of the Confederated Tribes of the Warm Springs Reservation of Oregon, the Confederated Tribes of the Umatilla Indian Reservation, the Nez Perce Tribe, and the Confederated Tribes and Bands of the Yakama Nation (collectively, "Columbia River Treaty Tribes"). The United States brought the case to define the Columbia River Treaty Tribes' right to take fish "at all usual and accustomed places" on the Columbia River and its tributaries. At the time the original complaint was filed, the Columbia River Treaty Tribes were limited to approximately 16% of the annual salmon harvest, based on 1960-1968 averages.

In the intervening decades, the courts have established several key principles. First, that the language of the treaties provided that the tribes retain the right to take fish at all usual and accustomed fishing places "in common with the citizens of the United States [or citizens of the territory]," reserved 50% of the harvestable fish destined for the tribes' traditional fishing places. Second, that the state may only regulate treaty fishing when reasonable and necessary for conservation. The conservation necessity applies when reasonable regulation of non-Indian activities is insufficient to meet the conservation purpose, the regulations are the least restrictive possible, the regulations do not discriminate against Indians, and voluntary tribal measures are not adequate.

The most recent *U.S. v. Oregon* Management Agreement was signed in 2018 after completion of ESA section 7 consultation and a Final Environmental Impact Statement (FEIS) (NMFS 2017c). In considering this proposed action, NMFS has determined that this Environmental Assessment (EA) shall tier itself to and fully incorporate the *U.S. v. Oregon* FEIS. This is appropriate due to the relationship of the actions. The proposed action here is fully consistent with the programmatic alternative adopted in the *U.S. v. Oregon* FEIS's record of decision. The *U.S. v. Oregon* FEIS considered all potential impacts associated with Columbia River salmon and steelhead fisheries, and while it is a recent document, this assessment will build upon the impacts considered in the *U.S. v. Oregon* FEIS and explore any additional impacts, particularly site-specific ones, beyond those previously considered. By tiering this Assessment to the *U.S. v. Oregon* FEIS, NMFS is able to narrow the scope of the analysis here to more efficiently execute our NEPA responsibilities.

1.2. Description of the Proposed Action

The Federal action evaluated in this EA is NMFS's proposed approval of the submitted FMEPs and TRMP under the 4(d) Rules. The submitted FMEPs and TRMP include measures intended for the conservation of ESA-listed salmonids, consistent with recovery objectives. The proposed action would result in the implementation of fisheries as described in the FMEPs and TRMP[1] (Table 1). The proposed fisheries are the same as continued operation of the present Snake River steelhead fisheries except as follows:

- The proposed fisheries would be managed to reduce impacts on natural-origin steelhead if abundance falls below a Critical Abundance Threshold.
- The Tribal steelhead fishery harvest has been limited and the levels of harvest of these fish will increase over time to allow for meaningful exercise of their treaty fishing rights and to access the treaty harvest share.
- All Snake River steelhead fisheries (i.e., recreational and tribal) would be managed under one natural-origin framework as described in Section 1.2.1 and the submitted TRMP.
- Monitoring and evaluations would occur to ensure implementation of the fisheries is as intended and that assumptions of effects remain valid.

Under the proposed action, the Tribal steelhead fishery would grow over time through improved access and ability to fish at all "usual and accustomed" fishing places. Tribes would not bear a disproportionate level of conservation burden, and a fair share of the harvestable fish would

[1] NMFS's ESA review of TRMPs does not itself permit the operation of the described fishery. The Unites States' treaties with Indian tribes are the supreme law of the land, and thus, NMFS cannot make judicially binding determinations regarding the nature and extent of tribal treaty rights. Such determinations are the province of Federal courts. NMFS's role is solely limited to making a determination as to whether a fishery would be likely to appreciably reduce the survival and recovery of ESA-listed fish.

accrue to the tribal fishery. This would enable the tribes to implement ceremonial, subsistence, and commercial fisheries.

Table 1. Ongoing and proposed fisheries.

Fishery	Manager	Location	Timing	Gear
Recreational mark-selective steelhead[1, 2]	IDFG	Mainstem Snake River	August 1-April 30	Barbless hook; bait, lure, jig allowed
		Lower Mainstem Clearwater River	July 1-April 30	
		Mainstem and middle fork Clearwater River	July 1-April 30	
		North Fork Clearwater River	July 1-April 30	
		South fork Clearwater River	July 1-April 30	
		Lower mainstem Salmon River	August 1-April 30	
		Middle mainstem Salmon River	August 1-March 31	
		Upper mainstem Salmon River	August 1-April 30	
		Little Salmon River	August 1-May 15	
		Non-anadromous waters; upstream of Hells Canyon Dam, and Boise and Payette Rivers	October 15-May 30	
Recreational mark-selective steelhead	ODFW	Grande Ronde and Imnaha Rivers	September 1-April 30	Barbed and barbless hook: bait, lure, jig allowed
		Mainstem Snake River	September 1-April 30	
Recreational mark-selective steelhead	WDFW	Mainstem Snake River	August 1-March 31	Barbless hook; bait, lure, jig allowed
		Tucannon River	August 1-March 31	
		Grande Ronde River	August 1-April 15	
Treaty steelhead	NPT	Clearwater, Salmon, Grande Ronde, Imnaha and Tucannon River Subbasins and Snake River mainstem	Late August-April	Hook, gillnet, spear, seine, weir, dipnet, gaff, other traditional gear

[1] For IDFG's steelhead fishery this period covers both catch-and-release and ad-clipped (hatchery) retention fishing.
[2] Only hatchery-origin steelhead, with a clipped adipose fin as evidence by a healed scar may be harvested during open steelhead seasons. Steelhead without a clipped adipose fin as evidenced by a healed scar must be immediately released unharmed.

1.2.1. Natural-origin Framework for Steelhead Fisheries

Historically, management of recreational steelhead fisheries in the mainstem Snake River, Clearwater, and Salmon River Basins has been managed to limit impacts to a percentage of the estimated natural-origin abundance of the combined DPS. In the Grande Ronde and Imnaha, the steelhead fishery has been managed to limit impacts to a percentage of the steelhead abundance in that MPG. In the Tucannon River, the steelhead fishery has been managed to limit impacts to a percentage of the abundance of the Tucannon population (Figure 1).

Under the proposed action, incidental mortality of adult natural-origin steelhead associated with all fisheries in the project area (i.e., including impacts from the spring-summer and fall Chinook salmon, and coho salmon fisheries) would be limited by the fixed impact rates at the MPG level shown in Table 2. For some MPGs, the total allowable impact rates in the comprehensive framework are higher than what has occurred on average over the last five years. These higher rates would not be expected to be reached in the near-term, but they would allow the tribal parties to grow their steelhead fisheries over time so they could meaningfully exercise their treaty fishing rights. The new comprehensive framework would also allow the states and tribes to manage their steelhead fisheries with a higher level of precision in the Snake River mainstem and tributaries.

Table 2. Proposed adult natural-origin steelhead maximum lethal impact rates on Snake River steelhead that pass Ice Harbor Dam from all fisheries in the Snake River Basin.

MPG	Proposed maximum natural-origin lethal impact rate of steelhead that pass Ice Harbor Dam (%)	2011 - 2016 average observed natural-origin lethal impact rate of steelhead that passed Ice Harbor Dam (%)
Lower Snake	5	1.3
Clearwater	10	4.0
Grande Ronde	10	3.7
Imnaha	5	4.5
Salmon	10	3.1

In addition, the comprehensive natural-origin framework incorporates a critical abundance threshold that was designed to provide additional protections to natural-origin steelhead when abundance fall below a certain level. If MPG abundances at Ice Harbor Dam are at or below the aggregated critical abundance threshold (CAT)[2] as defined in (Table 3), fishery managers would work with NMFS to determine what additional measures would be incorporated to reduce encounters of natural-origin steelhead. The magnitude of the management change will depend on how many consecutive years of low abundance have been observed and/or are forecasted. For example, in the first year of forecasted low abundance, fishery managers may institute a change such as a decrease in bag limits, but in the second consecutive year of forecasted low abundance, fishery managers may decrease bag limits and prohibit fishing in certain areas.

Table 3. Critical Abundance Thresholds by MPG for Snake River steelhead.

MPG	Minimum Abundance Threshold	Critical-Abundance Threshold[1]
Lower Snake	1500	450
Clearwater	5000	1500
Grande Ronde	4000	1200
Imnaha	1000	300
Salmon	9,500	2850

[1] When natural-origin abundance at Ice Harbor Dam is predicted to be below this threshold for a specific MPG, fishery managers will work with NMFS to determine what management measures will be incorporated to limit impacts on the MPG.

1.3. Purpose and Need

The purpose and need for the proposed action is three-fold: (1) to meet the Federal government's tribal treaty rights and trust and fiduciary responsibilities; (2) to support fishing opportunities in the Oregon, Washington, and Idaho waters of the Snake River Basin; and (3) to work collaboratively with co-managers to protect and conserve ESA-listed and non-listed species.

NMFS has an obligation to administer the provisions of the ESA and to protect ESA-listed species. NMFS also have a Federal trust responsibility to the treaty Indian tribes, as well as a duty to support the fishing rights reserved in their treaties as defined by the Federal courts. Thus, NMFS seeks to harmonize the effects of fishery programs with the provision for tribal harvest. Because of the Federal government's trust responsibility to the tribes, NMFS is committed to considering the tribal co-managers' judgment and expertise regarding conservation of trust resources.

[2] The CAT for each MPG is 30% of the aggregated MPG minimum abundance threshold (MAT) value. MAT values are the number of spawners necessary for maintaining genetic characteristics and spatial structure in a population. Abundance levels relative to CAT are determined at Lower Granite Dam using Genetic Stock Identification (GSI) to estimate the proportion of the run from each steelhead MPG. The fishery managers propose to use the GSI proportions from the most recent running five-year average.

1.4. Project Area

The project area includes the entire Snake River mainstem up to Hells Canyon Dam, plus the Tucannon River, Grande Ronde River, Imhaha River, Clearwater River, and Salmon River Subbasins (Figure 1).

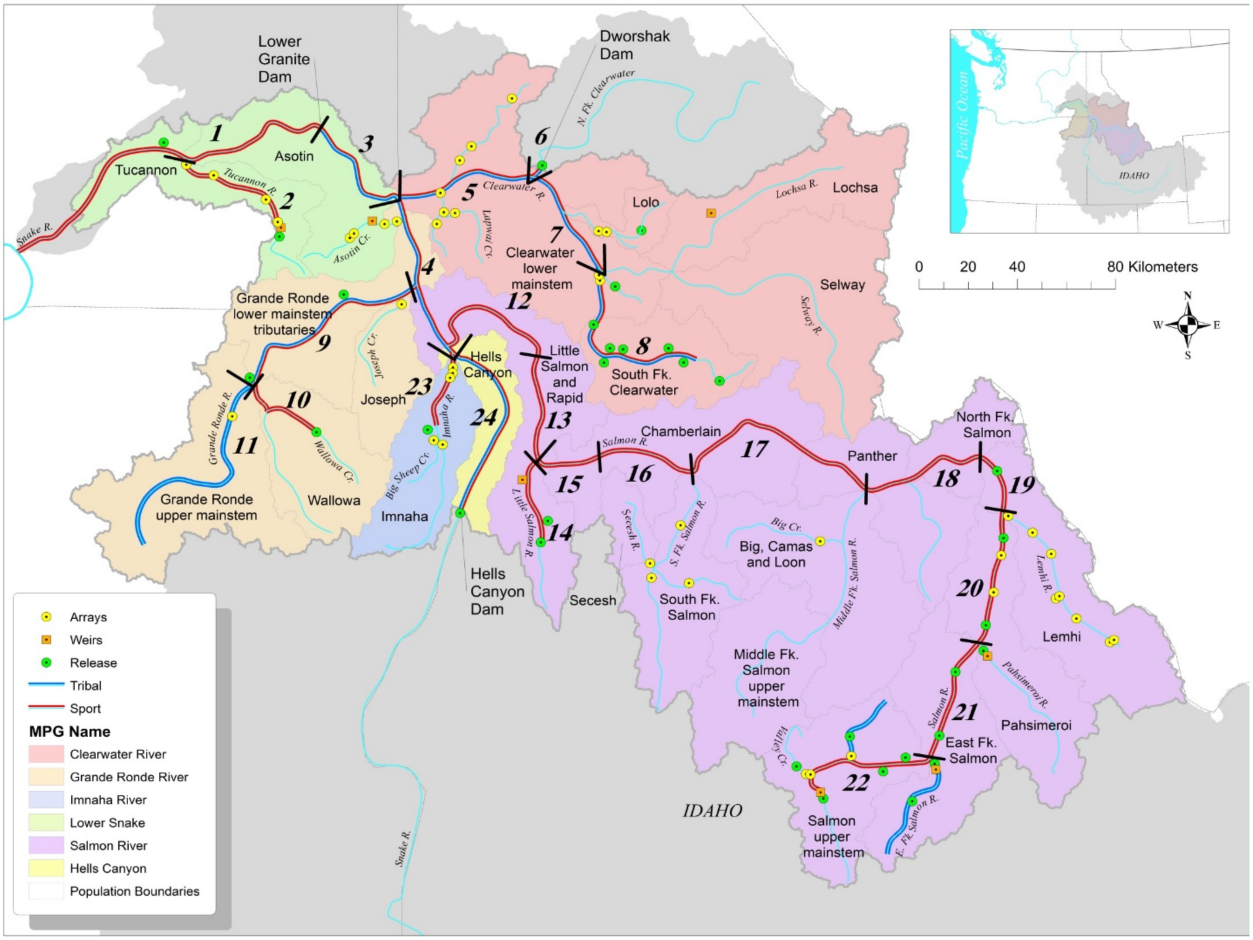

Figure 1. Project area (courtesy of Eric Stark, IDFG)

1.5. Relationship to Other Plans and Policies

Other plans, regulations, agreements, treaties, laws, and Secretarial and Executive Orders also affect fisheries activities in the Snake River Basin and their effects on resources in the project area. These are summarized below to provide additional context for the following evaluation of the Snake River Basin FMEPs and TRMP and their effects on the environment.

1.5.1. Secretarial Order 3206 – American Indian Tribal Rights, Federal-Tribal Trust Responsibilities and the ESA

Secretarial Order 3206, American Indian Tribal Rights, Federal-Tribal Trust Responsibilities and the ESA, issued by the secretaries of the Departments of Interior and Commerce, clarifies the responsibilities of the agencies, bureaus, and offices of the departments when actions taken under the ESA and its implementing regulations affect, or may affect, Indian lands, tribal trust resources, or the exercise of American Indian tribal rights as they are defined in the order.

Secretarial Order 3206 acknowledges the trust responsibility and treaty obligations of the United States towards tribes and tribal members, as well as its government-to-government relationship when corresponding with tribes. Under the order, NMFS and the U.S. Fish and Wildlife Service (Services) "will carry out their responsibilities under the [ESA] in a manner that harmonizes the Federal trust responsibility to tribes, tribal sovereignty, and statutory missions of the [Services], and that strives to ensure that Indian tribes do not bear a disproportionate burden for the conservation of listed species, so as to avoid or minimize the potential for conflict and confrontation."

More specifically, the Services shall, among other things, do the following:

- Work directly with Indian tribes on a government-to-government basis to promote healthy ecosystems (Sec. 5, Principle 1)
- Recognize that Indian lands are not subject to the same controls as Federal public lands (Sec. 5, Principle 2)
- Assist Indian tribes in developing and expanding tribal programs so that healthy ecosystems are promoted and conservation restrictions are unnecessary (Sec. 5, Principle 3)
- In cases that involve the potential for incidental take under the ESA, the Services will analyze and determine whether conservation restrictions meet the following standard:
    - the restriction is reasonable and necessary for conservation of the species at issue;
    - the conservation purpose of the restriction cannot be achieved by reasonable regulation of non-Indian activities;
    - the measure is the least restrictive alternative available to achieve the required conservation purpose;
    - the restriction does not discriminate against Indian activities, either as stated or applied; and
    - voluntary tribal measures are not adequate to achieve the necessary conservation purpose
    - be sensitive to Indian culture, religion, and spirituality (Sec. 5, Principle 4)

1.5.2. Federal Trust Responsibility

The United States government has a trust or special relationship with Indian Tribes. The unique and distinctive political relationship between the United States and Indian Tribes is defined by treaties, statutes, executive orders, judicial decisions, federal agency policies, and agreements. It differentiates tribes from other entities that deal with, or are affected by, the Federal government.

Executive Order 13175, Consultation and Coordination with Indian Tribal Governments, requires each Federal agency to establish procedures for meaningful consultation and coordination with tribal officials in the development of Federal policies that have tribal implications. The Department of Commerce (DOC) Administrative Order (DAO) 218-8 and the "Tribal Consultation and Coordination Policy of the U.S. Department of Commerce" together constitute DOC's "Tribal Consultation Policy". When working with our Native American tribal partners, NMFS enacts this policy outlined in our NOAA tribal consultation handbook: "NOAA Procedures for Government-to-Government Consultation with Federally Recognized Indian Tribes and Alaska Native Corporations."

1.5.3. *U.S. v. Oregon*

The court in *U.S. v. Oregon* (302 F.Supp. 899, 1978) ruled that state regulatory power over Indian fishing is limited because the 1855 treaties between the United States and the Nez Perce, Umatilla, Warm Springs, and Yakama Tribes preserved the tribes' right to fish at all usual and accustomed places, whether on or off reservation. Because of this decision, fisheries in the Columbia River are governed through the Columbia River Fish Management Agreement () which was carefully negotiated by the Federal and state governments and the involved treaty Indian tribes. The most recent Management Agreement, entered as a court order in 2018 and set to expire on December 31, 2027, provides the current framework for managing fisheries and hatchery programs in much of the Columbia River Basin. The agreement includes a list of hatchery programs with stipulated production levels, and a list of tribal and non-tribal salmonid fisheries in the Columbia River Basin, including designated off-channel sites that are intended to: (1) ensure fair sharing of harvestable fish between tribal and non-tribal fisheries in accordance with Treaty fishing rights standards and *U.S. v. Oregon*, and (2) be responsive to the needs of ESA-listed species. For more details about the history of the Management Agreement, see the 2018 *U.S. v. Oregon* Management Agreement FEIS in Section 1.6.1 (NMFS 2017c). The FMEPs and TRMP would be implemented and enforced by the same fishery managers that are parties to the *U.S. v. Oregon* Agreement.

2. ALTERNATIVES INCLUDING THE PROPOSED ACTION

Five alternatives are considered in this EA: (1) NMFS would not make a determination under the 4(d) Rule or Tribal 4(d) Rule, (2) NMFS would make a determination that the submitted FMEPs and TRMP meet the requirements of the 4(d) Rule and Tribal 4(d) Rule, respectively, (3) NMFS would make a determination that revised FMEP with additional conservation measures meet the requirements of the 4(d) Rule and that the modified TRMP[3] meets the requirement of the Tribal 4(d) Rule, (4) NMFS would make a determination that the submitted FMEPs and TRMP do not meet the requirements of the 4(d) Rule and Tribal 4(d) Rule, respectively, and (5) Make a Determination that Revised FMEPs and TRMP with increased harvest rates when natural-origin steelhead abundance exceeds MAT meet the requirements of the 4(d) Rule and Tribal 4(d) Rule, respectively. No other alternatives that would meet the purpose and need were identified that would be appreciably different from the four alternatives described below.

2.1. Alternative 1 (No Action) – Do Not Make a Determination under the 4(d) Rule or Tribal 4(d) Rule

Under Alternative 1, NMFS would not make determinations under the 4(d) Rule or Tribal 4(d) Rule and the parties would not manage their steelhead fisheries jointly under one overarching management framework that limits the combined impacts of the Snake River steelhead fisheries. NMFS recognizes the possibility that the No-action alternative could result in closure of steelhead fisheries in the Snake River basin. However, this is not NMFS' best estimate of what would occur, and discontinuation is the subject of Alternative 4. Under the No-action alternative, there would be uncoordinated harvest among the fishing parties. Because each fishing party would manage their fishery independently, it is difficult to predict the total level of fishing that would occur under this alternative. Therefore, NMFS will assume that the states and tribes would continue to implement their steelhead fisheries as under baseline conditions. Under the No-action alternative, the majority of the steelhead fisheries in the Snake River Basin would not have ESA take coverage.

Table 1 provides a list and, location, timing and allowed gear use for status quo steelhead fisheries. The IDFG, ODFW, and WDFW implement mark-selective fisheries for steelhead, where only adipose-clipped hatchery-origin fish may be retained. Fish with an intact adipose fin must be released. The NPT implements non-selective steelhead fisheries where all steelhead landed can be kept. Figure 1 includes areas in Idaho, southeast Washington, and northeast Oregon open to state-managed steelhead recreational fisheries. Figure 1 does not include all harvest areas as they relate to the NPT's 1855 Reservation and usual and accustomed fishing areas. Fisheries for the NPT may include other locations.

State-managed steelhead fisheries listed in Table 1 have been ongoing for decades and tribal fisheries since time immemorial. Impacts on natural-origin Snake River steelhead associated with these fisheries have likely decreased from historical impacts with the advent of mark-selective fisheries.

[3] Because tribal fisheries under Alternative 3 would be managed according to the harvest rates at the MPG levels in Table 4, this alternative does not meet the purpose and need. However, since this Alternative 3 considers reduced impacts from status quo and from the proposed action, we are including it for analysis since it addresses some concerns from interested citizen groups regarding current and proposed levels of effort for the Snake River steelhead fishery.

The state-managed recreational fisheries currently use bag limits of two (IDFG) or three (WDFW and ODFW) hatchery-origin steelhead per day. The use of bait is generally allowed in state regulations (Table 1). However, like many other aspects of fisheries, the use of bait is occasionally restricted to reduce impacts on natural-origin steelhead.

IDFG, ODFW, WDFW, and NPT each manage steelhead fisheries independently under their own jurisdiction. However, more recently, the fishery managers have increased their coordination through their participation on the Snake Basin Steelhead Run Reconstruction group. This group generates an annual report using a model to estimate the mortality of steelhead due to fisheries in each reach of the Snake River and its tributaries (Figure 1) (Copeland et al. 2015; Copeland et al. 2013; Copeland et al. 2014; Stark et al. 2016). This represents the best available information at the MPG level for assessing mortality of steelhead attributable to Snake River fisheries.

2.2. Alternative 2 (Proposed Action) – Make a Determination that the Submitted FMEPs and TRMP Meet the Requirements of the 4(d) Rule and Tribal 4(d) Rule, Respectively.

Under this alternative, NMFS would make a determination that the submitted FMEPs and TRMP meet the requirements of the 4(d) Rule and Tribal 4(d) Rule, and steelhead fisheries in the Snake River basin would be implemented as described in the FMEPs and TRMP.

As described in Section 1.2, the proposed fisheries are the same as continued operation of the present Snake River steelhead fisheries except as follows:

- The proposed fisheries would be managed to reduce impacts on natural-origin steelhead if abundance falls below a Critical Abundance Threshold.
- The Tribal steelhead fishery harvest has been limited and the levels of harvest of these fish will increase over time to allow for meaningful exercise of their treaty fishing rights and to access the treaty harvest share.
- All Snake River steelhead fisheries (i.e., recreational and tribal) would be managed under one natural-origin framework as described in Section 1.2.1 and the submitted TRMP.
- Monitoring and evaluations would occur to ensure implementation of the fisheries is as intended and that assumptions of effects remain valid.

Table 1 provides a list and, location, timing and allowed gear that would be used for proposed steelhead fisheries. Similar to Alternative 1, the IDFG, ODFW, and WDFW would implement mark-selective fisheries for steelhead, where only adipose-clipped hatchery-origin fish would be retained. Fish with an intact adipose fin would be released. The NPT would implement non-selective steelhead fisheries where all steelhead landed could be kept. Figure 1 includes areas in Idaho, southeast Washington, and northeast Oregon open to state-managed steelhead recreational fisheries. Figure 1 does not include all harvest areas as they relate to the NPT’s 1855 Reservation and usual and accustomed fishing areas. Fisheries for the NPT may include other locations.

The incidental mortality of adult natural-origin steelhead associated with all fisheries in the project area (i.e., including impacts from the spring-summer and fall Chinook salmon, and coho salmon fisheries) would be limited by the impact rates at the MPG level shown in Table 2. For some MPGs, the total allowable impact rates in the comprehensive framework would be higher than what has occurred on average over the last five years (Table 4). These higher rates would not be expected to be reached in the near-term, but they would allow the tribal parties to grow their steelhead fisheries over time so they could meaningfully exercise their treaty fishing rights. As described in Section 1.2.1, the new comprehensive framework would also allow the states and tribes to manage their fisheries with a higher level of precision in the Snake River mainstem, Clearwater, and Salmon Rivers. That is, if needed, they would be able to adjust fishing regulations to provide additional protections to a specific MPG.

Table 4. Comparison of incidental mortality of adult natural-origin steelhead that pass Ice Harbor Dam between Alternative 1 and Alternative 2.

MPG	2011-2016 Ave. Percent Mortality of Adults at Ice Harbor Dam under Alternative 1	Maximum Percent Mortality of Adults at Ice Harbor Dam under Alternative 2
Lower Snake	1.3	5.0
Clearwater	4.0	10.0
Grande Ronde	3.7	10.0
Imnaha	4.5	5
Salmon	3.1	10

If MPG abundances at Ice Harbor Dam are at or below their aggregated critical abundance threshold (CAT)[4] as defined in (Table 3), fishery managers will work with NMFS to determine what measures will be incorporated to reduce encounters of wild steelhead. The magnitude of the management change will depend on how many consecutive years of low abundance have been observed/and or are forecasted. For example, in the first year of forecasted low abundance, fishery managers may institute a change such as a decrease in bag limits, but in the second consecutive year of forecasted low abundance, fishery managers may decrease bag limits and prohibit fishing in certain areas.

[4] The CAT for each MPG is 30% of the aggregated MPG minimum abundance threshold (MAT) value as apportioned for each MPG determined by the average GSI proportions from the most recent 5-year running average at Lower Granite Dam.

2.3. Alternative 3 (Implement Additional Conservation Measures) – Make a Determination that Revised FMEPs with Additional Conservation Measures and a Revised TRMP that Maintains Status Quo Fisheries Meet the Requirements of the 4(d) Rule and Tribal 4(d) Rule, Respectively.

Under Alternative 3, NMFS would make a determination that revised FMEPs with additional conservation measures meet the requirements of the 4(d) Rule and that the modified TRMP to maintain status-quo fisheries meets the requirement of the Tribal 4(d) Rule. There are a number of potential conservation measures that could be added to the proposed FMEPs, e.g., further reduce bag limits, prohibit all use of bait, prohibit fishing from floating devices, extend barbless hook requirements, prevent wild steelhead from being removed from the water, reduce the fishing season. There are an infinite number of possibilities for how these conservation measures could be implemented, but for the purposes of analysis, NMFS will evaluate one potential scenario for how Alternative 3 could be implemented.

Under Alternative 3, NMFS will evaluate the effects of a scenario under which tribal fisheries would continue to be managed as under Alternative 1 and state-managed recreational fisheries would be reduced to the fall season only, eliminating the spring season when compared to the Alternative 1. As a result, fewer natural-origin steelhead would be encountered in the shorter-timed recreational steelhead fisheries.

As illustrated in Figure 2, spring season fishing effort was equivalent to 40 percent of the total yearly effort for IDFG's steelhead fishery (Hebdon 2018). We assume that a 40 percent reduction in yearly effort would result in approximately a 40 percent reduction in yearly incidental impacts on natural-origin steelhead. We also assume that seasonal fishing patterns described by IDFG (IDFG 2018b) also hold for WDFW and ODFW fisheries. Under these assumptions, Alternative 3 would result in a reduction in recreational fishing effort and incidental mortality of natural-origin steelhead in the project area by around 40 percent (Table 5). NMFS did not speculate as to whether the fall-only fishery would result in changes in angler behavior (e.g., more anglers would fish with greater frequency in the fall). For the purpose of analysis, we assume this shift does not happen. Tribal fisheries would continue to harvest only a small percentage of the total harvest under Alternative 3.

Because tribal fisheries under Alternative 3 would remain as currently occurring, this alternative would not meet the purpose and need because it would not allow the tribes to meaningfully exercise their treaty fishing rights. Tribal fisheries would remain limited in nature, and they may not be able to grow their fisheries over time to access their "usual and accustomed" fishing places and harvest share. However, we have decided to include it in our analysis for information purposes because Alternative 3 would have reduced impacts relative to Alternative 1 and Alternative 2. In addition, it incorporates some of the conservation measures suggested by an interested citizen group in a letter they submitted to IDFG (WFC 2018).

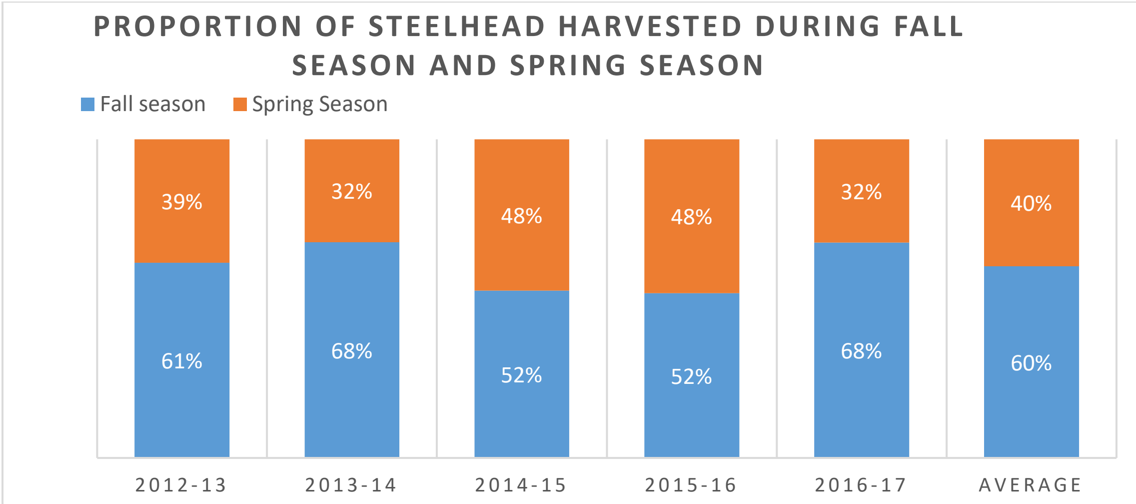

Figure 2. Proportion of steelhead harvested during fall season versus spring season in Idaho's fishery.

Table 5. Expected impact rates under Alternative 3

MPG	Average Ice Harbor Dam Return	Average Impact Rate per MPG Under Alternative 1	Expected Average Impact Rate per MPG Under Alternative 3
Lower Snake	8,018	1.3%	0.7%
Clearwater	8,402	4.0%	2.3%
Grande Ronde	8,230	3.7%	1.9%
Imnaha	2,584	4.5%	2.3%
Salmon	12,203	3.1%	1.7%

2.4. Alternative 4 (Close Steelhead Fisheries in Snake River Basin) – Make a Determination that the Submitted FMEPs and TRMP Do Not Meet the Requirements of the 4(d) Rule and Tribal 4(d) Rule, Respectively.

Under this alternative, NMFS would make a determination that the submitted FMEPs and TRMP do not meet the requirements of the 4(d) Rule and Tribal 4(d) Rule, and for the purposes of this EA, we will assume that all Snake River basin steelhead fisheries would be closed (recreational and tribal). Under Alternative 4, it is assumed that NMFS would reinitiate ESA consultation with WDFW regarding their currently authorized steelhead FMEP and that fisheries in Washington's

State portion of the Snake River would cease. This alternative would not meet our purpose and need for action because this alternative would not (1) meet the Federal government's tribal treaty rights and trust responsibilities or (2) support meaningful steelhead fishing opportunities in the in the Oregon, Washington, and Idaho waters of the Snake River basin. Further, it would result in a higher proportion of hatchery-origin fish on the spawning grounds, which could increase genetic risks to many ESA-listed populations. Tribal fisheries would be responsible for the conservation burden for steelhead and would not allow the tribes to meaningfully exercise their treaty fishing rights. They would not be able to grow their fisheries over time to access their "usual and accustomed" fishing places and harvest share. However, NMFS supports analysis of this alternative to assist with a full understanding of potential effects on the human environment under various management scenarios, including those that do not achieve all of our objectives.

2.5. Alternative 5 (Increased Allowable Impact Rates) – Make a Determination that Revised FMEPs and TRMP with Increased Allowable Impact Rates when Natural-origin Steelhead Abundance Exceeds MAT Meet the Requirements of the 4(d) Rule and Tribal 4(d) Rule, Respectively.

Under Alternative 5, NMFS would make a determination that modified FMEPs and TRMP with increased harvest rates when natural-origin steelhead abundance exceeds MAT meet the criteria of the 4(d) Rule and Tribal 4(d) Rule, respectively. Under Alternative 5, compared to Alternative 1, a higher total allowable impact rate would be allowed when steelhead abundance is high, i.e., abundance at Ice Harbor Dam is predicted to be above the aggregated MAT (Table 6) for a specific MPG.

There are a number of possibilities for how Alternative 5 could be implemented, but for the purposes of analysis, NMFS will evaluate one potential scenario. Under Alternative 5, IDFG, ODFW, WDFW, and NPT would manage consistent with the comprehensive natural-origin frameworks described in Section 1.2.1 when populations were below the aggregated MAT. However, when abundance was forecast to exceed the aggregated MAT for each MPG, the fishery managers would harvest 35% of the steelhead that exceeded the aggregated MAT for each MPG in addition to the fixed rate [(0.35*(forecasted abundance – MAT)) + (fixed rate*forecasted abundance)]. For example, for a return of 1750 adult steelhead to the Lower Snake MPG, the number of natural-origin fish impacted lethally would be:

Number impacted = (1500*0.05) + (0.35*(1750-1500))

Number impacted =		Step A	+	Step B
163	=	75 fish	+	88 fish

This equates to a loss of 163 fish from this MPG.

Identical to Alternative 2, under Alternative 5, IDFG, ODFW, WDFW, and NPT would work with NMFS to determine which fisheries modifications would be implemented to limit impacts on an MPG if expected run size on any given year is below the aggregated CAT for each MPG. The degree of management change will depend on how many consecutive years of low abundance have been observed/and or are forecasted. For example, in the first year of forecasted low abundance, fishery managers may institute a change such as a decrease in bag limits, but in the second consecutive year of forecasted low abundance, fishery managers may decrease bag limits and prohibit fishing in certain areas.

Table 6. Harvest rate schedule for adult natural-origin steelhead impact rates for fisheries in the Snake River Basin under Alternative 5.

MPG	Aggregated Minimum Abundance Threshold (MAT)	Proposed natural-origin lethal impact rate (%)	Step
Lower Snake	<1,500	5	A
	>1,500	A+ 35 percent of the margin[1]	B
Clearwater	<5,000	10	A
	>5,000	A+ 35 percent of the margin	B
Grande Ronde	<4,000	10	A
	>4,000	A+ 35 percent of the margin	B
Imnaha	<1,000	5	A
	>1,000	A+ 35 percent of the margin	B
Salmon	<9,500	10	A
	>9,500	A+ 35 percent of the margin	B

1 NMFS defines "of the margin" as the number of fish that exceed the aggregated MAT.

3. AFFECTED ENVIRONMENT

In this section, status quo conditions are described for resources that may be affected by the proposed action: wildlife, fish, vegetation, economics, cultural resources, and environmental justice. This section builds and expands on the affected environment section found in the *U.S. v Oregon* FEIS (NMFS 2017c).

The proposed action does not include any form of construction or demolition to bridges, dams, hydroelectric facilities, or other related infrastructure. Therefore, no effects are expected on river transportation, river navigation, or historical properties (Section 106 of the National Historic Preservation Act). No detectable effects on water quality would be expected outside of effects on marine-derived nutrients, which are described within Section 3.2, Fish. The proposed action and its alternatives are not expected to have any detectable effect on Greenhouse Gas Emissions. Southern resident killer whales are not in the project area and would not be affected by the proposed action or its alternatives.

3.1. Wildlife

There are numerous species of birds, mammals, and invertebrates in the project area. Wildlife species in the project are have the potential to be affected by fishermen through their presence, noise, and boat use. In addition, wildlife species have the potential to be affected by steelhead fisheries if they are a primary prey or predator of steelhead. A comprehensive list of wildlife species found in the Snake River Basin is provided in Section 3.4 of the *U.S. v. Oregon* FEIS (NMFS 2017c) and Section 3.5 of the Mitchell Act FEIS (NMFS 2014b). Relevant information is summarized below:

- Canada lynx (*Lynx canadensis*) maintain large home ranges and are highly mobile. They may occasionally travel through the fishing areas, but they are not expected to be affected by steelhead fisheries because lynx primarily eat hare. Because they are highly mobile, they would be able to easily avoid fishermen.
- Wolverines (*Gulo gulo luscus*) are also highly mobile and may travel through areas associated with proposed fisheries, but they are not expected to be affected by steelhead fisheries because wolverines eat carrion and small or medium sized animals such as voles, squirrels, and hares. Because they are highly mobile, they would be able to easily avoid fishermen.
- Northern Idaho ground squirrel (*Urocitellus brunneus*). Fisheries in the Upper Salmon River are within the range of the Norther Idaho ground squirrel, but squirrels are neither predators nor prey of steelhead. In addition, because they are highly mobile, they would be able to easily avoid fishermen.
- River otters (*Lontra canadensis*) and mink (*Neovison vison*) occur throughout the project area and may consume steelhead
- Steelhead predators include the bald eagle (*Haliaeetus leucocephalus*), golden eagle (*Aquila chrysaetos*), and possibly osprey (*Pandion haliaetus*).

3.2. Fish

The following sections describe baseline conditions for fish species within the project area. Since 1991, NMFS has identified 12 ESUs and DPSs of Columbia River Basin salmon and Columbia River Basin steelhead as requiring protection under the ESA. The following ESA-listed fish species may be impacted by the proposed fisheries:

- Snake River spring-summer Chinook salmon

- Snake River Fall Chinook salmon
- Snake River steelhead
- Middle Columbia steelhead
- Snake River sockeye salmon
- Bull trout

Baseline conditions for these ESA-listed species are found in Section 3.2.1 through Section 3.2.6.

NMFS has determined the range-wide status of critical habitat for ESA-listed species by examining the condition of its physical and biological features (PBFs) that were identified when critical habitat was designated. These features are essential to the conservation of the listed species because they support one or more of the species' life stages. An example of some PBFs are listed below. These are often similar among listed salmon and steelhead; specific differences can be found in the critical habitat designation for each species.

(1) Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development;

(2) Freshwater rearing sites with: (i) Water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; (ii) Water quality and forage supporting juvenile development; and (iii) Natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks;

(3) Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival;

(4) Estuarine areas free of obstruction and excessive predation with: (i) Water quality, water quantity, salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; (ii) Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels; and (iii) Juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation;

(5) Near-shore marine areas free of obstruction and excessive predation with: (i) Water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and (ii) Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels;

(6) Offshore marine areas with water-quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.

3.2.1. Snake River Spring/Summer Chinook Salmon

On June 3, 1992, NMFS listed the Snake River spring/summer-run Chinook Salmon ESU as a threatened species (57 FR 23458). More recently, the threatened status was reaffirmed on June 28, 2005 (70 FR 37160) and on April 14, 2014 (79 FR 20802). Critical habitat was originally designated on December 28, 1993 (58 FR 68543) but updated most recently on October 25, 1999 (65 FR 57399).

The Snake River spring/summer-run Chinook Salmon ESU includes 32 naturally spawning populations of spring/summer-run Chinook salmon in the mainstem Snake River and the Tucannon River, Grande Ronde River, Imnaha River, and Salmon River subbasins, as well as 10 artificial propagation programs (Jones Jr. 2015; NWFSC 2015). However, inside the geographic range of the ESU, there are a total of 19 hatchery spring/summer-run Chinook salmon programs currently operational (Jones Jr. 2015). As explained above, genetic resources can be housed in a hatchery program but for a detailed description of how NMFS evaluates and determines whether to include hatchery fish in an ESU or DPS, see NMFS (2005). Table 7 lists the natural and hatchery populations included (or excluded) in the ESU.

Table 7. Snake River spring/summer-run Chinook Salmon ESU description and MPGs (Jones Jr. 2015; NWFSC 2015).

ESU Description	
Threatened	Listed under ESA in 1992; updated in 2014.
5 major population groups	32 historical populations (4 extirpated)
Major Population Group	***Extant Populations***
Lower Snake River	Tucannon River
Grande Ronde/Imnaha River	Wenaha, Lostine/Wallowa, Minam, Catherine Creek, Upper Grande Ronde, Imnaha
South Fork Salmon River	Secesh, East Fork/Johnson Creek, South Fork Salmon River Mainstem, Little Salmon River
Middle Fork	Bear Valley, Marsh Creek, Sulphur Creek, Loon Creek, Camas Creek, Big Creek, Chamberlain Creek, Lower Middle Fork (MF) Salmon, Upper MF Salmon

ESU Description	
Upper Salmon	Lower Salmon Mainstem, Lemhi River, Pahsimeroi River, Upper Salmon Mainstem, East Fork Salmon, Valley Creek, Yankee Fork, North Fork Salmon
Artificial production	
Hatchery programs included in ESU (10)	Tucannon River Spr/Sum, Lostine River Spr/Sum, Catherine Creek Spr/Sum, Lookingglass Hatchery Reintroduction Spr/Sum, Upper Grande Ronde Spr/Sum, Imnaha River Spr/Sum, McCall Hatchery summer, Johnson Creek Artificial Propagation Enhancement summer, Pahsimeroi Hatchery summer, Sawtooth Hatchery spring.
Hatchery programs not included in ESU (8)	South Fork Chinook Eggbox spring, Panther Creek summer, Yankee Fork SBT spring, Rapid River Hatchery spring, Dworshak NFH spring, Kooskia spring, Clearwater Hatchery spring, Nez Perce Tribal Hatchery spring.

Twenty eight historical populations (four extirpated) within five MPGs comprise the Snake River spring/summer-run Chinook Salmon ESU. The natural populations are aggregated into the five extant MPGs based on genetic, environmental, and life-history characteristics. Figure 3 shows a map of the current ESU and the MPGs within the ESU.

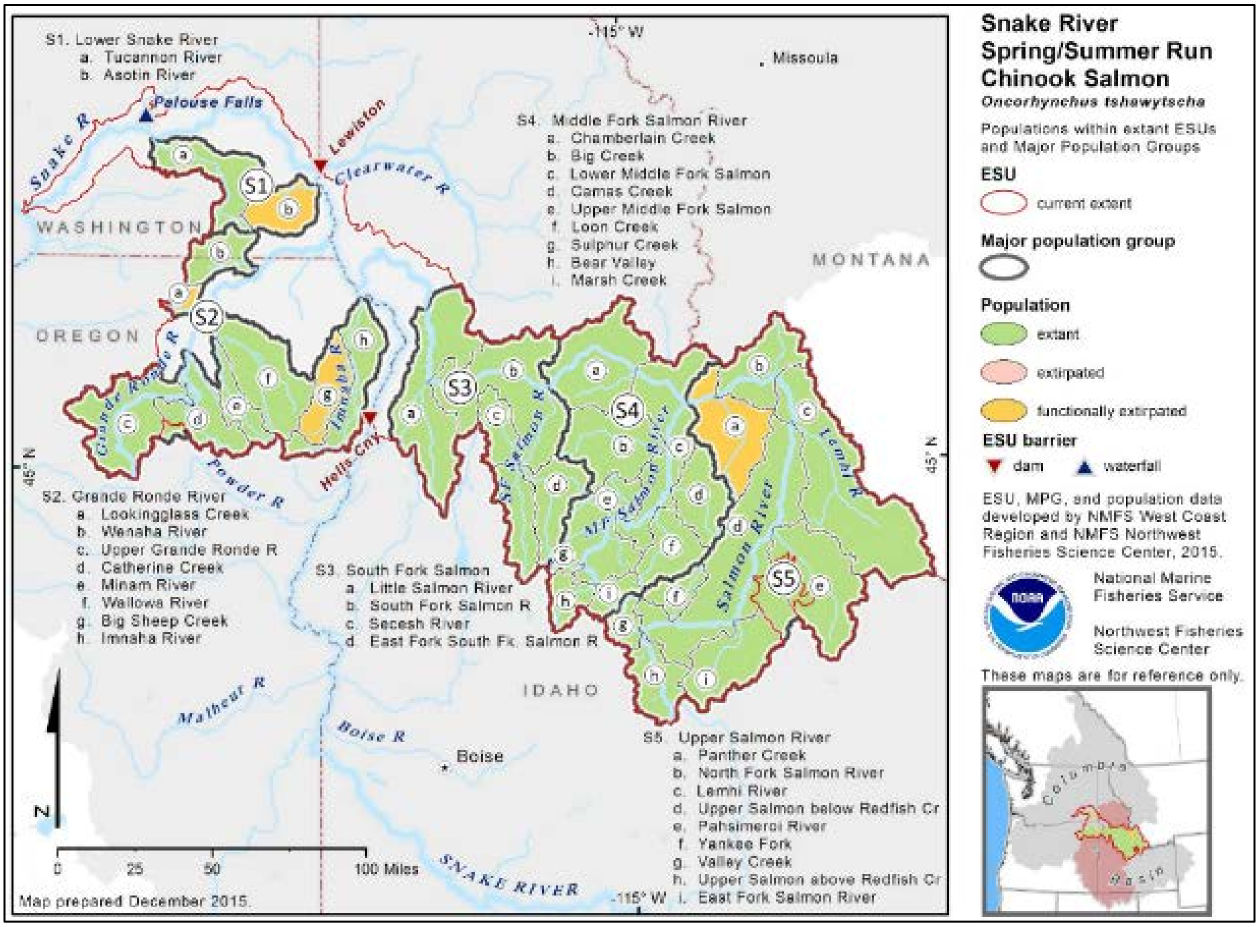

Figure 3. Snake River spring/summer-run Chinook Salmon ESU spawning and rearing areas, illustrating natural populations and MPGs (NWFSC 2015).

Abundance, Productivity, Spatial Structure, and Diversity

Status of the species is determined based on the abundance, productivity, spatial structure, and diversity of its constituent natural populations. Best available information indicates that Snake River spring/summer-run Chinook Salmon ESU remains at high overall risk, with the exception of one population (Chamberlain Creek). NMFS has finalized recovery plans for the Snake River drainage, organized around a subset of management unit plans corresponding to state boundaries.

The recovery plans developed by NMFS incorporated viability criteria recommended by the Interior Columbia River Technical Recovery Team (ICTRT). The population level goals are based on a set of metrics used to assess the viability of a salmon population – abundance, productivity, spatial structure, and diversity (McElhany et al. 2000). The ICTRT approach calls for comparing estimates of current natural-origin abundance and productivity against predefined viability curves (NWFSC 2015). Achieving recovery (i.e., delisting the species) of each ESU via sufficient improvement in the abundance, productivity, spatial structure, and diversity is the longer-term goal of the recovery plan. Table 8 shows the most recent metrics for the Snake River spring/summer-run Chinook Salmon ESU.

NMFS most recent status review found that natural-origin abundance has increased over the levels reported in the prior status review (Ford et al. 2011) for most populations in this ESU, although the increases were not substantial enough to change viability ratings. Relatively high ocean survivals in the years preceding the most recent review were a major factor in recent abundance patterns. Ten natural populations increased in both abundance and productivity, seven increased in abundance while their updated productivity estimates decreased, and two populations decreased in abundance and increased in productivity. One population, Loon Creek, decreased in both abundance and productivity. Overall, all but one population in this ESU remains at high risk for abundance and productivity and there is a considerable range in the relative improvements to life cycle survivals or limiting life stage capacities required to attain viable status.

Spatial structure ratings remain unchanged or stable with low or moderate risk levels for the majority of the populations in the ESU (Table 8). Four populations from three MPGs (Catherine Creek and Upper Grande Ronde of the Grande Ronde/Imnaha MPG, Lemhi River of the Upper Salmon River MPG, and Lower MF Mainstem of the MF MPG) remain at high risk for spatial structure loss. Three of the four extant MPGs in this ESU have populations that are undergoing active supplementation with local broodstock hatchery programs. In most cases, those programs evolved from mitigation efforts and include some form of sliding scale management guidelines that limit hatchery contribution to natural spawning based on the abundance of natural-origin fish returning to spawn – the more natural-origin fish that return the fewer hatchery fish that are needed to spawn naturally. Sliding-scale management is designed to maximize hatchery benefits in low abundance years and reduce hatchery risks at higher spawning levels. Efforts to evaluate key assumptions and impacts are underway for several programs (NWFSC 2015).

Table 8. Measures of viability and overall viability rating for Snake River spring/summer-run Chinook salmon populations[1] (NWFSC 2015).

Population	Abundance/Productivity Metrics				Spatial Structure and Diversity Metrics			Overall Viability Rating
	ICTRT Minimum Threshold	Natural Spawning Abundance	ICTRT Productivity	Integrated A/P Risk	Natural Processes Risk	Diversity Risk	Integrated SS/D Risk	
Lower Snake River MPG								
Tucannon River	750	↑ 267 (.19	↓ .69 (.23)	High	Low	Moderate	Moderate	HIGH RISK
Asotin Creek	500	extirpated						extirpated
Grande Ronde/Imnaha MPG								
Wenaha River	750	↓ 399 (.12)	↑ .93 (.21)	High	Low	Moderate	Moderate	HIGH RISK
Lostine/Wallowa R.	1,000	↑ 332 (.24)	↑ .98 (.12)	High	Low	Moderate	Moderate	HIGH RISK
Lookingglass R. (ext)	500	extirpated						extirpated
Minam R.	750	↑ 475 (.12)	↑ .94 (18)	High(M)	Low	Moderate	Moderate	HIGH RISK
Catherine Creek	1,000	↑ 110 (.31)	↑ .95 (.15)	High	Moderate	Moderate	Moderate	HIGH RISK
Upper Gr. Ronde R.	1,000	↑ 43 (.26)	↑ .59 (.28)	High	High	Moderate	High	HIGH RISK
Imnaha River	750	↑ 328 (.21)	↑ 1.20 (.09)	High (M)	Low	Moderate	Moderate	HIGH RISK
South Fork MPG								
South Fork Mainstem	1,000	↑ 791 (.18)	↓ 1.21 (.20)	High (M)	Low	Moderate	Moderate	HIGH RISK
Secesh River	750	↑ 472 (.18)	○ 1.25 (.20	High(M)	Low	Low	Low	HIGH RISK
East F./Johnson Cr.	1,000	↑ 208 (.24)	↓ 1.15 (.20)	High	Low	Low	Low	HIGH RISK
Little Salmon River	750	Insf. data			Low	Low	Low	HIGH RISK
Middle Fork MPG								
Chamberlain Creek	750	↑ 641 (.17)	↓ 2.26 (.45)	Moderate	Low	Low	Low	Maintained
Big Creek	1,000	↑ 164 (.23)	↓ 1.10 (.21)	High	Very Low	Moderate	Moderate	HIGH RISK
Loon Creek	500	↓ 54 (.10)	↓ .98 (.40)	High	Low	Moderate	Moderate	HIGH RISK
Camas Creek	500	↑ 38 (.20)	↓ .80 (.29)	High	Low	Moderate	Moderate	HIGH RISK
Lower Mainstem MF	500	Insf. data	Insf.data	-	Moderate	Moderate	Moderate	HIGH RISK
Upper Mainstem MF	750	↑ 71 (.18)	↓ 0.50 (.72)	High	Low	Moderate	Moderate	HIGH RISK
Sulphur Creek	500	↑ 67 (.99)	↑ .92 (.26)	High	Low	Moderate	Moderate	HIGH RISK
Marsh Creek	500	↑ 253 (.27)	↓ 1.21 (.24)	High	Low	Low	Low	HIGH RISK
Bear Valley Creek	750	↑ 474 (.27	↓ 1.37 (.17)	High(M)	Very Low	Low	Low	HIGH RISK

Upper Salmon River MPG									
Salmon Lower Main	2,000	↓ 108 (.18)	↑ 1.18 (.17)	High	Low	Low	Low	HIGH RISK
Salmon Upper Main	1,000	↑ 411 (.14)	↑ 1.22 (.19)	High (M)	Low	Low	Low	HIGH RISK
Pahsimeroi River	1,000	↑ 267 (.16)	↑ 1.37 (.20)	High (M)	Moderate	High	High	HIGH RISK
Lemhi River	2,000	↑ 143 (.23)	↑ 1.30 (.23)	High	High	High	High	HIGH RISK
Valley Creek	500	↑ 121 (.20)	↑ 1.45 (.15)	High	Low	Moderate	Moderate	HIGH RISK
Salmon East Fork	1,000	↑ 347 (.22)	↑ 1.08 (.28)	High	Low	High	high	HIGH RISK
Yankee Fork	500	↑ 44 (.45)	↓ .72 (.39)	High	Moderate	High	High	HIGH RISK
North Fork	500	Insf. data	Insf. data		Low	Low	Low	HIGH RISK
Panther Creek (ext)	750	Insf. data	Insf. data					extirpated

[1]Comparison of updated status summary vs. recovery plan viability objectives; upwards arrow=improved since prior review. Downwards arrow=decreased since prior review. Oval=no change. Shaded populations are the most likely combinations within each MPG to be improved to viable status. Current abundance and productivity estimates are expressed as geometric means (standard error). Extirpated populations were not evaluated as indicated by the blank cells (NWFSC 2015).

3.2.2. Snake River Fall Chinook Salmon

On June 3, 1992, NMFS listed the Snake River fall-run Chinook Salmon ESU as a threatened species (57 FR 23458). More recently, the threatened status was reaffirmed on June 28, 2005 (70 FR 37160) and on April 14, 2014 (79 FR 20802). Critical habitat was designated on December 28, 1993 (58 FR 68543).

The Snake River fall-run Chinook Salmon ESU includes naturally spawned fish in the lower mainstem of the Snake River and the lower reaches of several of the associated major tributaries including the Tucannon, the Grande Ronde, Clearwater, Salmon, and Imnaha Rivers, along with 4 artificial propagation programs (Jones Jr. 2015; NWFSC 2015). None of the hatchery programs are excluded from the ESU. As explained above by NMFS (2005), genetic resources can be housed in a hatchery program but for a detailed description of how NMFS evaluates and determines whether to include hatchery fish in an ESU or DPS, see (NMFS 2005). Table 9 lists the natural and hatchery populations included in the ESU.

Table 9. Snake River Fall-Run Chinook Salmon ESU description and MPGs (Jones Jr. 2015; NWFSC 2015).

ESU Description	
Threatened	Listed under ESA in 1992; updated in 2014
1 major population groups	2 historical populations (1 extirpated)
Major Population Group	***Extant Population***
Snake River	Lower Snake River
Artificial production	
Hatchery programs included in ESU (4)	Lyons Ferry NFH fall, Acclimation Ponds Program fall, Nez Perce Tribal Hatchery fall, Idaho Power fall.
Hatchery programs not included in ESU (0)	Not applicable

Two historical populations (1 extirpated) within one MPG comprise the Snake River fall-run Chinook Salmon ESU. The extant natural population spawns and rears in the mainstem Snake River and its tributaries below Hells Canyon Dam. Figure 4 shows a map of the ESU area. The decline of this ESU was due to heavy fishing pressure beginning in the 1890s and loss of habitat with the construction of Swan Falls Dam in 1901 and the Hells Canyon Complex from 1958 to

1967, which extirpated one of the historical populations. Hatcheries mitigating for losses caused by the dams have played a major role in the production of Snake River fall-run Chinook salmon since the 1980s (NMFS 2012b). Since the species were originally listed in 1992, fishery impacts have been reduced in both ocean and river fisheries. Total exploitation rate has been relatively stable in the range of 40% to 50% since the mid-1990s (NWFSC 2015).

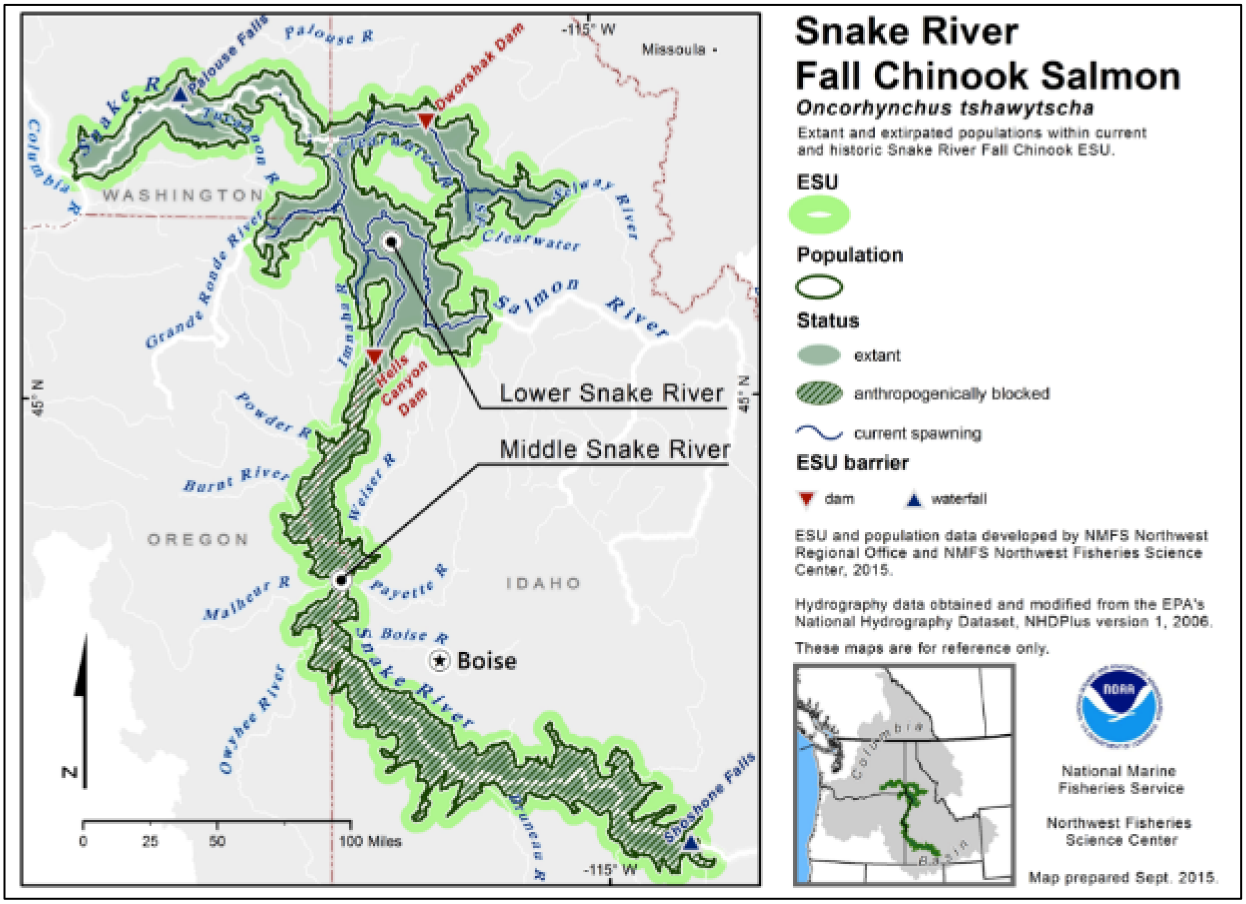

Figure 4. Map of the Snake River Fall-Run Chinook Salmon ESU's spawning and rearing areas, illustrating populations and MPGs (NWFSC 2015).

Snake River fall-run Chinook salmon spawning and rearing occurs primarily in larger mainstem rivers, such as the Salmon, Snake, and Clearwater Rivers. Historically, the primary fall-run Chinook salmon spawning areas were located on the upper mainstem Snake River (Connor et al. 2005). Now, a series of Snake River mainstem dams block access to the Upper Snake River and about 85% of ESU's spawning and rearing habitat. Swan Falls Dam, constructed in 1901, was the first barrier to upstream migration in the Snake River, followed by the Hells Canyon Complex beginning with Brownlee Dam in 1958, Oxbow Dam in 1961, and Hells Canyon Dam in 1967. The ESU is also impacted by eight mainstem dams (four on the Columbia River and four in the lower Snake River). Natural spawning is currently limited to the Snake River from the upper end of Lower Granite Dam to Hells Canyon Dam; the lower reaches of the Imnaha, Grande Ronde, Clearwater, Salmon, and Tucannon Rivers; and small areas in the tailraces of the Lower Snake River hydroelectric dams (Good et al. 2005).

Some fall-run Chinook salmon also spawn in smaller streams such as the Potlatch River, and Asotin and Alpowa Creeks and they may be spawning elsewhere. The vast majority of spawning today occurs upstream of Lower Granite Dam, with the largest concentration of spawning sites in the mainstem Snake River (about 60%) and in the Clearwater River, downstream from Lolo Creek (about 30%) (NMFS 2012b).

Abundance, Productivity, Spatial Structure, and Diversity

Status of the species is determined based on the abundance, productivity, spatial structure, and diversity of its constituent natural populations. Best available information indicates that the Snake River fall-run Chinook Salmon ESU remains at threatened status (NWFSC 2015).

The recently released NMFS Snake River fall-run Chinook Recovery Plan (NMFS 2017a) proposes that a single population recovery scenario could be possible given the unique spatial complexity of the Lower Mainstem Snake River fall-run Chinook salmon population; the recovery plan notes that such a scenario could be possible if major spawning areas supporting the bulk of natural returns are operating consistent with long-term diversity objectives in the proposed plan. Under this single population scenario, the requirements for a sufficient combination of natural abundance and productivity could be based on a combination of total population natural abundance and relatively high production from one or more major spawning areas with relatively low hatchery contributions to spawning, i.e., low hatchery influence for at least one major natural spawning production area.

The overall current risk rating for the Lower Mainstem Snake River fall-run Chinook salmon population is viable. The overall risk rating is based on a low risk rating for abundance/productivity (A/P) and a moderate risk rating for spatial structure/diversity (SS/D). The geometric mean natural-origin fish abundance obtained from the most recent 10 years of annual spawner escapement estimates is 6,418 fish. While natural-origin spawning levels are above the 4,200 minimum abundance threshold for recovery, and estimated productivity is also high, neither measure is high enough to achieve the very low risk rating needed for recovery of a one-population ESU (NWFSC 2015). The most recent status review used the ICTRT simple 20-year recruits per spawner (R/S) method to estimate the current productivity for this population (1990-2009 brood years) and determined it was 1.5. Given remaining uncertainty and the current level of variability, the point estimate of current productivity would need to meet or exceed 1.70 to be rated at very low risk.

For spatial structure/diversity, the moderate risk rating was driven by changes in major life-history patterns, shifts in phenotypic traits, and high levels of genetic homogeneity detected in samples from natural-origin returns. In particular, the rating reflects the relatively high proportion of within-population hatchery spawners in all major spawning areas and the lingering effects of previous high levels of out-of-ESU strays. In addition, the potential for selective pressure imposed by current hydropower operations and cumulative harvest impacts contribute to the current rating level (NWFSC 2015).

3.2.3. Snake River Steelhead

On August 18, 1997, NMFS listed the Snake River Steelhead DPS as a threatened species (62 FR 43937). The threatened status was reaffirmed in 2006 and most recently on April 14, 2014 (79 FR 20802). Critical habitat for the DPS was designated on September 2, 2005 (70 FR 52769).

The Snake River Steelhead DPS includes all naturally spawned anadromous *O. mykiss* originating below natural and manmade impassable barriers in streams in the Snake River Basin of southeast Washington, northeast Oregon, and Idaho (Figure 5) (NWFSC 2015). Twenty four extant historical populations within six MGPs comprise the Snake River Basin Steelhead DPS. Inside the geographic range of the DPS, 12 hatchery steelhead programs are currently operational. Five of these artificial programs are included in the DPS (Table 10) (Jones Jr. 2015). For a detailed description of how NMFS evaluates and determines whether to include hatchery fish in an ESU or DPS, see NMFS (2005).

Table 10. Snake River Basin Steelhead DPS description and MPGs (Jones Jr. 2015; NMFS 2012b; NWFSC 2015).

DPS Description	
Threatened	Listed under ESA as threatened in 1997; updated in 2014.
6 major population groups	26 historical populations (2 extirpated)
Major Population Group (Extant)	***Extant Populations***
Grande Ronde	Joseph Creek, Upper Mainstem, Lower Mainstem, Wallowa River
Imnaha River	Imnaha River
Clearwater	Lower Mainstem River, North Fork Clearwater, Lolo Creek, Lochsa River, Selway River, South Fork Clearwater
Salmon River	Little Salmon/Rapid, Chamberlain Creek, Secesh River, South Fork Salmon, Panther Creek, Lower MF, Upper MF, North

DPS Description	
	Fork, Lemhi River, Pahsimeroi River, East Fork Salmon, Upper Mainstem
Lower Snake	Tucannon River, Asotin Creek
Hells Canyon Tributaries	Extirpated
Artificial production	
Hatchery programs included in DPS (5)	Tucannon River summer, Little Sheep Creek summer, EF Salmon River Natural A, Dworshak NFH B, SF Clearwater (Clearwater Hatchery) B, Salmon River B
Hatchery programs not included in DPS (7)	Lyons Ferry NFH summer, Wallowa Hatchery summer, Hells Canyon A, Pahsimeroi Hatchery A, Upper Salmon River A, Streamside Incubator Project A and B, Little Salmon River A

Snake River steelhead exhibit two distinct morphological forms, identified as “A-Index” and “B-Index” fish, which are distinguished by differences in body size, run timing, and length of ocean residence. B-Index fish predominantly reside in the ocean for 2 years, while A-Index steelhead typically reside in the ocean for 1-year (NMFS 2017b). As a result of different ocean residence times, B-Index steelhead are generally larger than A-Index fish. The smaller size of A-Index adults allows them to spawn in smaller headwater streams and tributaries. The differences in the two fish stocks represent an important component of phenotypic and genetic diversity of the Snake River Basin Steelhead DPS through the asynchronous timing of ocean residence, segregation of spawning in larger and smaller streams, and possible differences in the habitats of the fish in the ocean (NMFS 2012b).

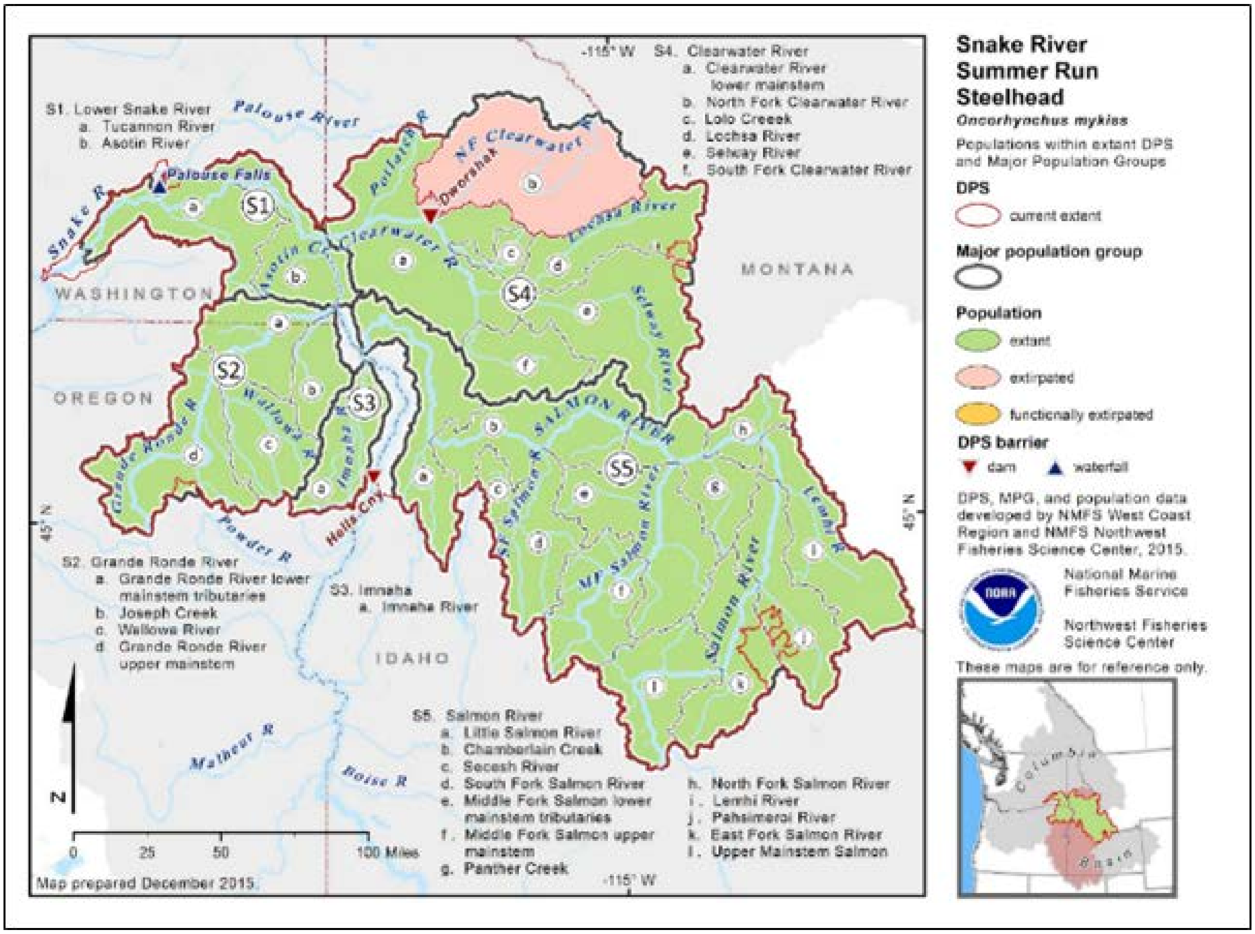

Figure 5. Map of the Snake River Basin Steelhead DPS's spawning and rearing areas, illustrating natural populations and MPGs (NWFSC 2015).

Like all salmonid species, steelhead are cold-water fish (Magnuson et al. 1979) that survive in a relatively narrow range of temperatures, which limits the species distribution in fresh water to northern latitudes and higher elevations. Snake River Basin steelhead migrate a substantial distance from the ocean (up to 930 miles) and occupy habitat that is considerably warmer and drier (on an annual basis) than steelhead of other DPSs. Adult Snake River steelhead return to the Snake River Basin from late summer through fall, where they hold in larger rivers for several months before moving upstream into smaller tributaries, and are generally classified as summer-run (NMFS 2012b; NMFS 2013a).

Steelhead live primarily off stored energy during the holding period, with little or no active feeding (Laufle et al. 1986; Shapovalov and Taft 1954). Adult dispersal toward spawning areas varies with elevation, with the majority of adults dispersing into tributaries from March through May, with earlier dispersal at lower elevations, and later dispersal at higher elevations. Spawning begins shortly after fish reach spawning areas, which is typically during a rising hydrograph and prior to peak flows (NMFS 2012b; Thurow 1987).

Abundance, Productivity, Spatial Structure, and Diversity

Status of the species is determined based on the abundance, productivity, spatial structure, and diversity of its constituent natural populations. Best available information indicates that the Snake River Steelhead DPS, ranges from moderate to high risk and remains at threatened status (NWFSC 2015). A great deal of uncertainty remains regarding the relative proportion of hatchery-origin fish in natural spawning areas near major hatchery release sites.

Direct counts of steelhead abundance by population are generally not available for Snake River steelhead due to difficulties conducting surveys in much of their range when steelhead move into their spawning tributaries. However, most populations are thought to be maintained, meaning they exist at levels providing ecological and evolutionary function to the DPS as a whole (ICTRT 2007; NWFSC 2015). For those populations where information is known, productivity is above replacement (i.e., when the number of offspring are equivalent to the number of parents, or 1) and abundance is close to or exceeds the MAT values, which are the values required for the population to meet the full range of criteria for a viable salmonid population. These values were derived by assuming a replacement rate of 1, and considering available spawning habitat (ICTRT 2007). Information on the distribution of natural returns among stock groups and populations indicates that differences in abundance/productivity status among populations may be more related to habitat conditions such as geography or elevation rather than the morphological forms of A-run versus B-run (NWFSC 2015).

The ICTRT viability criteria adopted in the Snake River Management Unit Recovery Plans include spatial explicit criteria and metrics for both spatial structure and diversity. With one exception, spatial structure ratings for all of the Snake River Basin steelhead populations were low or very low risk, given the evidence for distribution of natural production with populations. The exception was the Panther Creek population, which was given a high risk rating for spatial structure based on the lack of spawning in the upper sections. No new information was provided for the 2015 status update that would change those ratings Table 11(NWFSC 2015).

Updated information is available for two important factors that contribute to rating diversity risk under the ICTRT approach: hatchery spawner fractions and the life history diversity. Hatchery straying appears to be relatively low. At present, direct estimates of hatchery returns based on PBT analysis are available for the run assessed at Lower Granite Dam and at the hatchery rack (IDFG 2015). Furthermore, information from the Genetic Stock Identification (GSI) assessment sampling provide an opportunity to evaluate the relative contribution of B-Index returns within each stock group. No population fell exclusively into the B-Index size category, although there were clear differences among population groups in the relative contributions of the larger B-Index life history type (NWFSC 2015).

Table 11. Major Population Groups, populations, and scores for the key elements (A/P, diversity, and SS/D) used to determine current overall viability risk for the Snake River Basin Steelhead DPS (NWFSC 2015).[1]

Major Population Groups	Spawning Populations (Watershed)	A/P	Diversity	Integrated SS/D	Overall Viability Risk*
Lower Snake River	Tucannon River	**	M	M	H??
	Asotin Creek	**	M	M	MT?/(H??)
Grande Ronde River	Lower Grande Ronde	**	M	M	MT
	Joseph Creek	VL	L	L	Highly viable
	Upper Grande Ronde	M	M	M	Viable
	Wallowa River	**	L	L	Moderate?
Clearwater River	Lower Clearwater	M	L	L	MT
	South Fork Clearwater	H	M	M	MT/H?
	Lolo Creek	H	M	M	MT/H?
	Selway River	H	L	L	MT?
	Lochsa River	H	L	L	MT?
Salmon River	Little Salmon River	**	M	M	MT?
	South Fork Salmon	**	L	L	MT?
	Secesh River	**	L	L	MT?
	Chamberlain Creek	**	L	L	MT?
	Lower MF Salmon	**	L	L	MT?
	Upper MF Salmon	**	L	L	MT?
	Panther Creek	**	M	H	H?
	North Fork Salmon	**	M	M	MT?
	Lemhi River	**	M	M	MT?

	Pahsimeroi River	**	M	M	MT?
	East Fork Salmon	**	M	M	MT?
	Upper Main Salmon	**	M	M	MT?
Imnaha River	Imnaha River	M	M	M	Moderate?

[1] Risk ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH). Maintained (MT) population status indicates that the population does not meet the criteria for a viable population but does support ecological functions and preserve options for recovery of the DPS (NWFSC 2015).
* There is uncertainty in these ratings due to a lack of population-specific data.
** Insufficient data.

3.2.4. Middle Columbia River Steelhead

On March 25, 1999, NMFS listed the Middle Columbia River (MCR) Steelhead DPS as a threatened species (64 FR 14517). The threatened status was reaffirmed in 2006 and most recently on April 14, 2014 (79 FR 20802). Critical habitat for the MCR steelhead was designated on September 2, 2005 (70 FR 52808).

The MCR Steelhead DPS includes naturally spawning anadromous *O. mykiss* originating from below natural and manmade impassable barriers from the Columbia River and its tributaries upstream of the Wind River (Washington) and Hood River (Oregon) to and including the Yakima River, excluding the Upper Columbia River tributaries (upstream of Priest Rapids Dam) and the Snake River Figure 6. Four MPGs, composed of 20 historical populations (2 extirpated), comprise the MCR Steelhead DPS. Inside the geographic range of the DPS, 10 hatchery steelhead programs are currently operating. Seven of these artificial programs are included in the DPS (Table 12). As explained by NMFS (2005), genetic resources can be housed in a hatchery program. For a detailed description of how NMFS evaluates and determines whether to include hatchery fish in an ESU or DPS, see NMFS (2005).

Table 12. MCR Steelhead DPS description and MPGs (Jones Jr. 2015; NWFSC 2015).

DPS Description	
Threatened	Listed under ESA as threatened in 1999; updated in 2014.
4 major population groups	20 historical populations (3 extirpated)
Major Population Group	***Extant Populations***
Cascades Eastern Slope Tributaries	Deschutes River Eastside, Deschutes River Westside, Fifteenmile Creek*, Klickitat River*, Rock Creek*

DPS Description	
John Day River	John Day River Lower Mainstem Tributaries, John Day River Upper Mainstem Tributaries, MF John Day River, NF John Day River, SF John Day River
Yakima River	Naches River, Satus Creek, Toppenish Creek, Yakima River Upstream Mainstem
Umatilla/Walla Walla Rivers	Touchet River, Umatilla River, Walla Walla River
Artificial production	
Hatchery programs included in DPS (7)	Touchet River Endemic summer, Yakima River Kelt Reconditioning summer (in Satus Creek, Toppenish Creek, Naches River, and Upper Yakima River), Umatilla River summer, Deschutes River summer
Hatchery programs not included in DPS (3)	Lyons Ferry NFH summer (on station and Walla Walla River Releases), Skamania Stock Release summer, Skamania Stock Release winter

* These populations are winter steelhead populations. All other populations are summer steelhead populations.

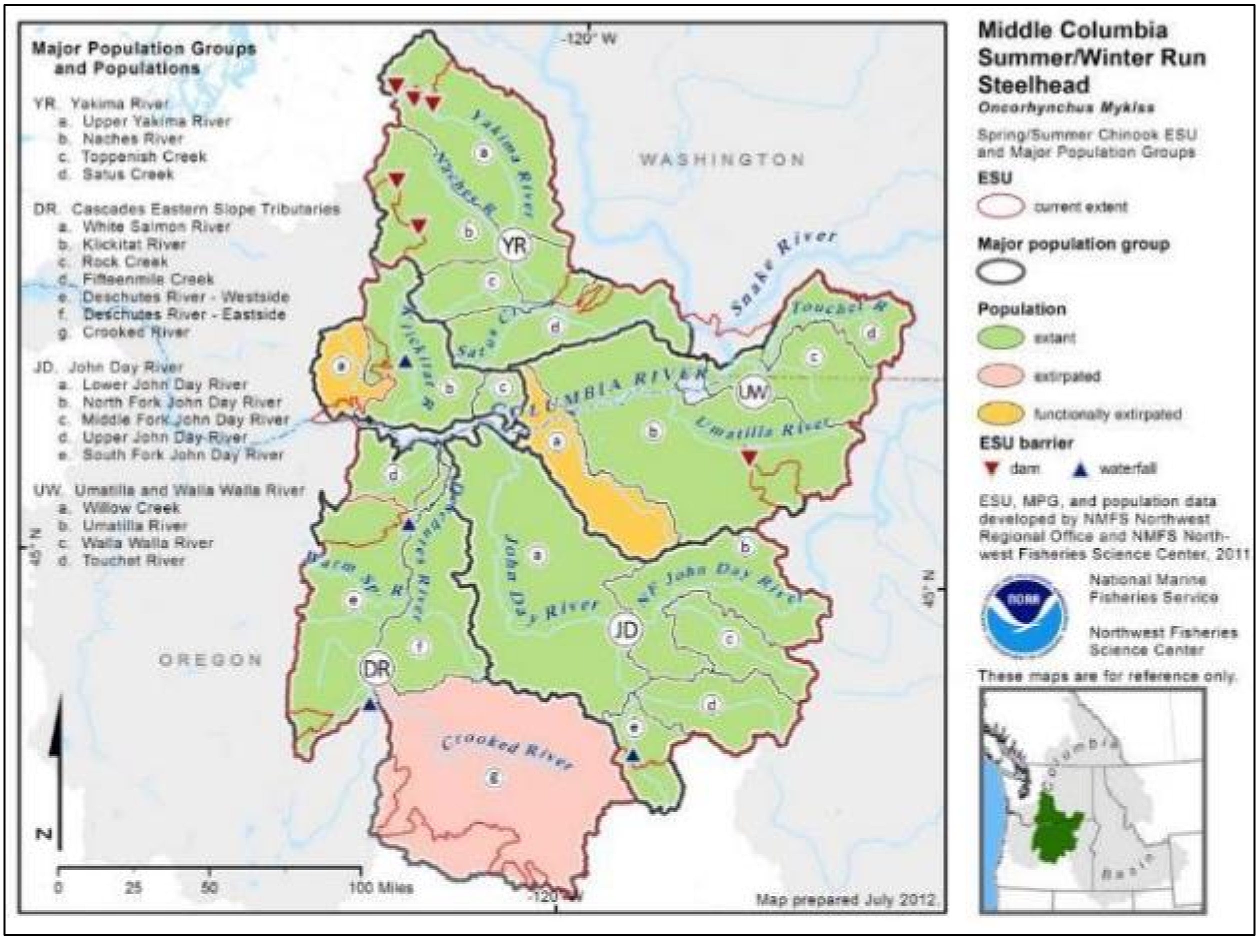

Figure 6. Map of the MCR Steelhead DPS's spawning and rearing areas, illustrating populations and MPGs (NWFSC 2015).

Abundance, Productivity, Spatial Structure, and Diversity

Status of the species is determined based on the abundance, productivity, spatial structure, and diversity of its constituent natural populations. Best available information indicates that the species, in this case the MCR Steelhead DPS, is at moderate risk and remains at threatened status. The most recent status update (NWFSC 2015) used updated abundance and hatchery contribution estimates provided by regional fishery managers to inform the analysis on this DPS. However, this DPS has been noted as difficult to evaluate in several of the reviews for reasons such as: the wide variation in abundance for individual natural populations across the DPS, chronically high levels of hatchery strays into the Deschutes River, and a lack of consistent information on annual spawning escapements in some tributaries (NWFSC 2015).

The Middle Columbia Recovery Plan identifies a set of most likely scenarios to meet the ICTRT recommendations for low risk populations at the MPG level. In addition, the management unit plans generally call for achieving moderate risk ratings (maintained status) across the remaining extant populations in each MPG. Table 13 shows the most recent abundance, productivity, spatial structure, and diversity metrics for the 17 populations in the DPS. Overall viability ratings for the populations in the MCR Steelhead DPS remained generally unchanged from the prior five year review. One population, Fifteenmile Creek, shifted downward from viable to maintained status as a result of a decrease in natural-origin abundance to below its ICTRT minimum abundance threshold. The Toppenish River population (in the Yakima MPG) dropped in both estimated abundance and productivity, but the combination remained above the 5% viability curve, and, therefore, its overall rating remained as viable. The majority of the populations showed increases in estimates of productivity (NWFSC 2015).

Table 13. Summary of MCR Steelhead DPS status relative to the ICTRT viability criteria, grouped by MPG (NWFSC 2015)1.

Population	Abundance/Productivity Metrics				Spatial Structure and Diversity Metrics			Overall Viability Rating
	ICTRT Minimum Threshold	Natural Spawning Abundance	ICTRT Productivity	Integrated A/P Risk	Natural Processes Risk	Diversity Risk	Integrated SS/D Risk	
Eastern Cascades MPG								
Fifteen Mile Creek	500	↓ 356 (.16)	↑ 1.84 (.19)	Moderate	Very Low	Low	Low	Maintained
Deschutes (Westside)	1,500 (1,000)	↑ 634 (.13)	↑ 1.16 (.15)	High	Low	Moderate	Moderate	High Risk
Deschutes (Eastside)	1,000	↓ 1,749 (.05)	↑ 2.52 (.24)	Low	Low	Moderate	Moderate	Viable
Klickitat River	1,000			Moderate	Low	Moderate	Moderate	Maintained
Rock Creek	500				Moderate	Moderate	Moderate	High Risk
Crooked River (ext)	2,000							Extirpated
White Salmon R.(ext)	500							Extirpated.
Yakima River MPG								
Satus Creek	1,000 (500)	↑ 1127 (.17)	↑ 1.93 (.12)	Low	Low	Moderate	Moderate	Viable
Toppenish Creek	500	↓ 516 (.14)	↓ 2.52 (.19)	Low	Low	Moderate	Moderate	Viable
Naches River	1,500	↑ 1,244 (.16)	↑ 1.83 (.10)	Moderate	Low	Moderate	Moderate	Moderate
Upper Yakima River	1,500	↑ 246 (.18)	↑ 1.87 (.10)	Moderate	Moderate	High	High	High Risk
John Day River MPG								
Lower John Day Tribs	2,250	↓ 1,270 (.22)	↓ 2.67 (.19)	Moderate	Very Low	Moderate	Moderate	Maintained
Middle Fork John Day	1,000	↑ 1,736 (.41)	↑ 3.66 (.26)	Low	Low	Moderate	Moderate	Viable
North Fork John Day	1,000	↑ 1,896 (.19)	↓ 2.48 (.23)	Very Low	Very Low	Low	Low	Highly Viable
South Fork John Day	500	↑ 697 (.27)	↑ 2.01 (.21)	Low	Very Low	Moderate	Moderate	Viable
Upper John Day	1,000	↑ 641 (.21)	1.32 (.18)	Moderate	Very Low	Moderate	Moderate	Maintained
Umatilla/Walla Walla MPG								
Umatilla River	1,500	↑ 2,379 (.11)	○ 1.20 (.32)	Moderate	Moderate	Moderate	Moderate	Maintained
Walla Walla River	1,000	↓ 877 (.13)	↑ 1.65 (.11)	Moderate	Moderate	Moderate	Moderate	Maintained
Touchet River	1,000	↓ 382 (.12)	↑ 1.25 (.11)	High	Low	Moderate	Moderate	High Risk

[1]Comparison of updated status summary vs. recovery plan viability objectives; upwards arrow=improved since prior review. Downwards arrow=decreased since prior review. Oval=no change. Shaded populations are the most likely combinations within each MPG to be improved to viable status. Current abundance and productivity estimates are expressed as geometric means (standard error) (NWFSC 2015).

Overall, there have been improvements in the viability ratings for many populations, but the MCR Steelhead DPS, as a whole, is not currently meeting the viability criteria (adopted from the

ICTRT) in the Middle Columbia Steelhead Recovery Plan. In addition, several factors cited by the 2005 BRT remain as concerns or key uncertainties. Natural-origin returns to the majority of the population in two of the four MPGs in this DPS increased modestly relative to the levels reported in the previous five year review. Abundance estimates for two of three populations with sufficient data in the remaining two MPGs (Eastside Cascades and Walla Walla and Umatilla Rivers) were marginally lower. Natural-origin spawning estimates are highly variable relative to minimum abundance thresholds across the populations in the DPS. In general, the majority of the population level viability ratings remained unchanged from prior reviews for each MPG within the DPS.

3.2.5. Snake River Sockeye Salmon

On April 5, 1991, NMFS listed the Snake River Sockeye Salmon ESU as an endangered species (56 FR 14055) under the Endangered Species Act (ESA). This listing was affirmed in 2005 (70 FR 37160), and again on April 14, 2014 (79 FR 20802). Critical habitat was designated on December 28, 1993 (58 FR 68543) and reaffirmed on September 2, 2005.

The ESU includes naturally spawned anadromous and residual sockeye salmon originating from the Snake River Basin in Idaho, as well as artificially propagated sockeye salmon from the Redfish Lake captive propagation program (Jones Jr. 2015)(Figure 7)(Table 14).

Table 14. Snake River Sockeye Salmon ESU description and MPG (Jones Jr. 2015; NMFS 2015a).

ESU Description	
Threatened	Listed under ESA in 1991; updated in 2014.
1 major population group	5 historical populations (4 extirpated)
Major Population Group	***Extant Population***
Sawtooth Valley Sockeye	Redfish Lake
Artificial production	
Hatchery programs included in ESU (1)	Redfish Lake Captive Broodstock
Hatchery programs not included in ESU (0)	Not applicable

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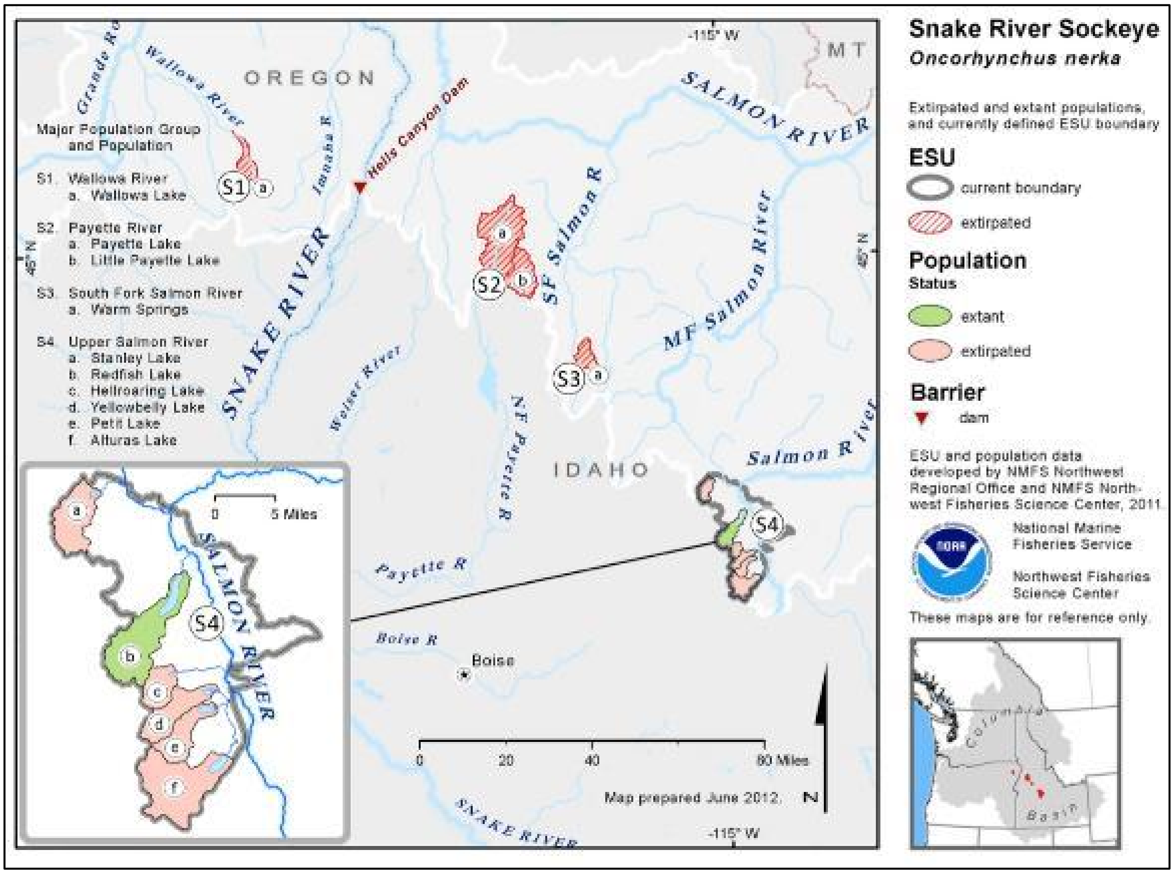

Figure 7. **Map of the Snake River Sockeye Salmon ESU's spawning and rearing areas, illustrating populations and MPGs (NWFSC 2015).**

Abundance, Productivity, Spatial Structure, and Diversity

Status of the species is determined based on the abundance, productivity, spatial structure, and diversity of its constituent natural populations. Best available information indicates that the Snake River Sockeye Salmon ESU is at high risk and remains at endangered status. Although the endangered Snake River Sockeye Salmon ESU has a long way to go before it will meet the biological viability criteria (i.e., indication that the ESU is self-sustaining and naturally producing), annual returns of sockeye salmon through 2013 show that more fish are returning than before initiation of the captive broodstock program which began soon after the initial ESA listing (Table 15). Between 1999 and 2007, more than 355 adults returned from the ocean from captive brood releases – almost 20 times the number of natural-origin fish that returned in the 1990s. Though this total is primarily due to large returns in the year 2000. Adult returns in the last six years have ranged from a high of 1,579 fish in 2014 (including 453 natural-origin fish) to a low of 257 adults in 2012 (including 52 natural-origin fish). Sockeye salmon returns to Alturas

Lake ranged from one fish in 2002 to 14 fish in 2010. No fish returned to Alturas Lake in 2012, 2013, or 2014 (NWFSC 2015).

Table 15. Hatchery- and natural-origin sockeye salmon returns to Sawtooth Valley, 1999-2018 (IDFG, in prep.; NMFS 2015a)Christine Kozfkay, IDFG, personal communication, March 4, 2019). .

Return Year	Total Return	Natural Return	Hatchery Return	Alturas Returns[1]	Observed Not Trapped
1999	7	0	7	0	0
2000	257	10	233	0	14
2001	26	4	19	0	3
2002	22	6	9	1	7
2003	3	0	2	0	1
2004	27	4	20	0	3
2005	6	2	4	0	0
2006	3	1	2	0	0
2007	4	3	1	0	0
2008	646	140	456	1	50
2009	832	86	730	2	16
2010	1,355	178	1,144	14	33
2011	1,117	145	954	2	18
2012	257	52	190	0	15
2013	272	79	191	0	2
2014	1,579	453	1,062	0	63
2015[2]	91	14	77	0	0
2016	574	33	539	0	24
2017	176	11	151	0	14
2018	14	13	100	0	1

[1] These fish were assigned as sockeye salmon returns to Alturas Lake and are

Return Year	Total Return	Natural Return	Hatcher y Return	Alturas Returns[1]	Observed Not Trapped

included in the natural return numbers.
[2] In 2015, 56 fish swam in and 35 Snake Basin origin fish were transported from Granite.

The large increases in returning adults in recent years reflect improved downstream and ocean survivals, as well as increases in juvenile production, starting in the early 1990s. Although total sockeye salmon returns to the Sawtooth Valley in recent years have been high enough to allow for some level of natural spawning in Redfish Lake, the hatchery program remains at its initial phase with a priority on genetic conservation and building sufficient returns to support sustained outplanting and recolonization of the species historic range (NMFS 2015a; NWFSC 2015).

Furthermore, there is evidence that the historical Snake River Sockeye Salmon ESU included a range of life history patterns, with spawning populations present in several of the small lakes in the Sawtooth Basin (NMFS 2015a). Historical production from Redfish Lake was likely associated with a lake shoal spawning life history pattern although there may have also been some level of spawning in Fish Hook Creek (NMFS 2015a; NWFSC 2015). In NMFS' 2011 status review update for Pacific salmon and steelhead listed under the ESA (Ford et al. 2011), it was not possible to quantify the viability ratings for Snake River sockeye salmon. Ford et al. (2011) determined that the Snake River sockeye salmon captive broodstock-based program has made substantial progress in reducing extinction risk, but that natural production levels of anadromous returns remain extremely low for this species (NMFS 2012b).

In the most recent 2015 status update, NMFS determined that at this stage of the recovery efforts, the ESU remains at high risk for both spatial structure and diversity (NWFSC 2015). At present, anadromous returns are dominated by production from the captive spawning component. The ongoing reintroduction program is still in the phase of building sufficient returns to allow for large scale reintroduction into Redfish Lake, the initial target for restoring natural program (NMFS 2015a). There is some evidence of very low levels of early timed returns in some recent years from out-migrating naturally produced Alturas Lake smolts. At this stage of the recovery efforts, the ESU remains rated at high risk for spatial structure, diversity, abundance, and productivity (NWFSC 2015).

3.2.6. Bull trout

The USFWS listed bull trout (*Salvelinus confluentus*) as threatened under the ESA in June 1998 (63 FR 31647). The USFWS published a proposed critical habitat rule on January 14, 2010 (75 FR 2260) and a final rule on October 18, 2010 (75 FR 63898), effective November 17, 2010. The designation involved the species' coterminous range within the Coastal, Klamath, Mid-

Columbia, Columbia Headwaters, Upper Snake, and St. Mary recovery units. Rangewide, the Service designated reservoirs/lakes and stream/shoreline miles in 32 critical habitat units (CHU) as bull trout critical habitat. Designated bull trout critical habitat is of two primary use types: (1) spawning and rearing; and (2) foraging, migrating, and overwintering.

Bull trout are members of the family Salmonidae and are char native to Washington, Oregon, Idaho, Nevada, Montana and western Canada. Compared to other salmonids, bull trout have more specific habitat requirements that appear to influence their distribution and abundance. They need cold water to survive, so they are seldom found in waters where temperatures exceed 59 to 64 degrees (F). They also require stable stream channels, clean spawning and rearing gravel, complex and diverse cover, and unblocked migratory corridors.

The Mid-Columbia Recovery Unit (RU) is located within eastern Washington, eastern Oregon, and portions of central Idaho. The Mid-Columbia RU is divided into four geographic regions: Lower Mid-Columbia, Upper Mid-Columbia, Lower Snake, and Mid-Snake Geographic Regions. The Mid-Columbia RU contains 24 occupied core areas comprising 142 local populations, two historically occupied core areas, one research needs area, and seven Foraging Migration and Overwinter habitats (USFWS 2015a). The Upper Snake RU is located in central Idaho, northern Nevada, and eastern Oregon. The Upper Snake RU is divided into seven geographic regions: Salmon River, Boise River, Payette River, Little Lost River, Malheur River, Jarbidge River, and Weiser River. The Upper Snake RU contains 22 core areas and 207 local populations, with almost 60 percent being present in the Salmon River Region (USFWS 2015b).

The current condition of the bull trout in the project area is attributed to the adverse effects of climate change, agricultural practices (e.g., irrigation, water withdrawals, livestock grazing), fish passage (e.g. dams, culverts), nonnative species, forest management practices, and mining. Conservation measures or recovery actions implemented include road removal, channel restoration, mine reclamation, improved grazing management, removal of fish barriers, and in-stream flow requirements (USFWS 2015a).

3.2.7. Coho Salmon

Upriver coho are native to the Snake River Basin, but were extirpated in 1986. Programs for reintroduction of upriver coho in the Snake River Basin are currently underway. For fishery management, there are two primary geographic groups of Columbia River coho; Lower River and upriver coho salmon. Bonneville Dam in the mainstem Columbia River divides the Lower Columbia River coho and upriver coho. Substantial hatchery coho salmon production occurs above Bonneville Dam (upriver coho). Coho salmon returns to the Snake River basin can be estimated by annual adult counts at Lower Granite Dam and run reconstructions. Lower Granite Dam counts indicate peak Coho salmon escapement in recent history was 18,651 adult fish in 2014. The 2013-2017 average for adult returns is 6,824 adult fish (range 2,454 to 18,651 fish) (Nez Perce Tribe 2018).

3.2.8. Other Fish Species

Approximately 60 other species of fish live in the Snake River and its tributaries. About one-half are native species, primarily of the families Salmonidae (e.g., rainbow trout, brook trout, whitefish), Catastomidae (e.g., suckers), Cyprinidae (e.g., northern pikeminnow), and Cottidae (e.g., sculpins). Fish from these families may be encountered and a few may be incidentally taken in steelhead fisheries.

The other native fish are not likely to be encountered in steelhead fisheries, but may interact with salmon and steelhead ecologically through predator or prey relationships. For example, White sturgeon (*Acipenser transmontanus*) occur in the mainstems of the Snake and Salmon Rivers, but are rarely encountered in steelhead fisheries because the gear and fishing methods for sturgeon are different than for steelhead. Margined sculpin (*Cottus marginatus*) prey on eggs and on juvenile salmon and steelhead. Other species, such as leopard dace (*Rhinichthys falcatus*) and Umatilla dace (*Rhinichthys 49ommunit*), may serve as prey for steelhead. These species are not likely to be encountered in steelhead fisheries.

The Snake River Basin also supports at least 25 introduced species, primarily representing the taxonomic families Percidae, Centrarchidae, and Ictaluridae. Most of the introduced species are considered game fish by IDFG (Simpson and Wallace 1978). Introduced species such as smallmouth bass (*Micropterus dolomieu*) and largemouth bass (*Micropterus salmoides*), would not likely be harvested in proposed fisheries due to differences in fishing gear requirements and habitat preferences for these species.

3.3. Vegetation

Fisheries can affect vegetation when new angler access points are created. Angler may clear away or trample vegetation to gain better river access. The magnitude of the effect depends on the relative abundance of fishermen per unit of area; high abundances will likely lead to greater effects. However, fishermen typically access riverbanks through well-established access points.

ESA-listed plants in the project area include Spalding’s catchfly (*Silene spaldingii*) and MacFarlane’s four o’clock (*Mirabilis macfarlanei*), both listed as threatened under the ESA. While these plants are in the project area, they occur primarily in bunchgrass grasslands, sagebrush-steppe, open pine communities, steep river canyon grassland habitats, or mesic, alkaline habitats in the project area. Access points for steelhead fishing occur away from these habitats. Therefore, there is little or no likelihood of anglers encountering listed plants or their habitats (Spalding’s catchfly and MacFarlane’s four o’clock) while fishing in the project area.

3.4. Socioeconomics

The *U.S. v. Oregon* FEIS describes status quo conditions for harvest and related economic values for commercial (tribal and non-tribal) and recreational fisheries on the Columbia River, and the contribution of these fisheries to affected regional economies. This section summarizes socioeconomic information found in Section 3.5 of the *U.S. v. Oregon* FEIS.

Recreational fisheries contribute to local economies through the purchase of fishing-related goods and supplies, and by the retention of local services, such as outfitter and guiding services. Sectors particularly affected by recreational fishing activities include food services, eating and drinking establishments, lodging, recreation services, and fueling stations. Expenditures on fishing-related goods and services by fishermen contribute to both local and non-local businesses.

According to information in the Mitchell Act FEIS (NMFS 2014b), about 52 percent (161,397 fish) of the annual average recreational harvest between 2002 and 2009 of salmon and steelhead in the Columbia River basin (311,252 fish) occurred in the Lower Columbia River and tributaries. The recreational fisheries above Bonneville Dam, which account for the remainder of the harvest, are geographically widespread throughout the many tributaries in the upper Columbia River and Snake River, and are socially important.

Salmon and steelhead play a significant role in the ceremonial and subsistence cultural practices among Indian tribes in the project area. This important cultural resource may be affected by the alternatives analyzed in this EIS. Salmon and steelhead have always been and will continue to be a core symbol and foundation of tribal identity, health, individual identity, culture, spirituality, religion, emotional well-being, and economy.

Salmon evoke sharing, gifts from nature, responsibility to the resource, and connection to the land and water. They represent the ability of Indian cultures to endure; they facilitate the transmission of tribal fishing culture to younger members, who are taught from an early age to fish and to understand their responsibility to the salmon and its habitat. The struggle to affirm and maintain the right to fish has made salmon an even more evocative symbol of tribal identity.

Salmon remain central in what is known as the first foods. The salmon was the first food to appear in early spring. First salmon ceremonies focus on thanking the fish for returning and assuring the entire community of a successful harvest. These ceremonies also draw attention to the responsibility Indian people have for providing a clean, welcoming, habitat for the returning fish. Family bands gathered along the Columbia River at their favorite or traditional fishing sites to catch and dry enough salmon to use for the year ahead.

The tribes strive to keep at least some subsistence fisheries open the entire year and regard subsistence fishing as an extremely important way for tribal people to provide food for themselves. Even during commercial fisheries, a certain portion of the catch is normally retained for subsistence use. While not all tribal members currently participate in fisheries, those who fish typically share fish with family and friends. Sharing and informal distribution of fish help to bind the community in a system of relationships and obligations. Tribal subsistence harvest can also be used for trade or barter among tribes.

The early history of non-Indian use of fishery resources in the Columbia River Basin is described in Craig and Hacker (1940). Due to the importance of recreational fisheries, the USFWS and NMFS jointly issued the "The Policy for Conserving Species Listed or Proposed for Listing Under the Endangered Species Act While Providing and Enhancing Recreational Fisheries Opportunities" on June 3, 1996 (61 FR 27978), which was issued pursuant to the Presidential Executive Order 12962, issued on June 7, 1995. That order requires Federal agencies, to the extent permitted by law, and where practical and in cooperation with States and the tribes, to improve the quality, function, productivity, and distribution of aquatic resources for increased recreational fishing opportunity. Among other actions, the order requires all Federal agencies to aggressively work to promote compatibility and reduce conflict between administration of the ESA and recreational fisheries.

One of the top economic boosters for Idaho's economy is hunting and recreational fishing, with the two outdoor activities bringing in roughly $1.02 billion in 2011[5]. According to the National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (Reference), recreational fisheries in Idaho contributed approximately $548 million in retail sales, and $230 million in wages and salaries for 7,252 jobs in 2011. According to the Clearwater County Board of Commissioners, if we use the number of day trips reported by anglers in north central Idaho and the estimated spending per day per angler in 2011, steelhead fishing would produce $31,781,152 in economic activity in the Clearwater River communities alone (Ebert 2018). Similarly, in Washington State[6], fishermen, hunters and wildlife watchers contribute more than $6.7 billion a year to the state's economy, with recreational fisheries contributing $1.1 billion per year. In Oregon State[7], residents and visitors spent $2.5 billion in fishing, hunting and wildlife viewing activities and equipment.

3.5. Environmental Justice

In 1994, the President issued Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority and Low-Income Populations*. Environmental justice is defined as "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies." Environmental justice analysis considers whether adverse human health or environment effects of a program would be disproportionately borne by minority and low-income populations, often referred to as the environmental justice communities of concern. Fisheries, such as those that are the subject of this EA, have the potential to affect the extent of fish available for subsistence and economic purposes for minority and low-income populations.

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[5] Idaho sportsmen & women brochure

[6] Washington State report on recreational fishing

[7] Fishing, Hunting, Wildlife Viewing in Oregon

This EIS incorporates the same methodology as Section 3.7.1 of the *U.S. v. Oregon* FEIS for defining low income and minority thresholds for counties. An environmental justice county is one whose minority or low-income population was meaningfully greater than the state in which the county is located.

Fifteen (out of seventeen) counties in the project area qualify as communities of concern; two qualify based on minority population threshold, five qualify based on minority population and low-income thresholds and nine qualifies as low-income threshold only (Through treaties, the United States made commitments to protect tribes' rights to take fish. These rights are of enormous cultural and societal importance to the tribes; thus, impacts to commercial, subsistence, and recreational harvest opportunities are examined for any effect on tribal and low-income harvest. All tribes identified in the Project Area are considered environmental justice communities of concern and, accordingly, tribal effects are a specific focus of the environmental justice analysis. Although individual tribes may not meet environmental justice analysis criteria for minority or low-income populations, they are regarded as affected groups for environmental justice purposes, as defined by USEPA guidance (EPA 1998). Only two counties (Valley County in Idaho and Garfield County in Washington did not meet any criteria to be considered a community of concern (Table 16).

Table 16. Summary of environmental justice communities of concern analysis. Bold text indicates the county meets the criteria for low income community, italicized text indicates it meets the criteria for minority community, and bold italicized text indicates it meets both criteria.

State, County	Total Population (2017 estimates)	Percent Non White	Percent Indian	Percent Hispanic	Poverty Rate Percent	Per Capita Income $ (2016)
Idaho						
Statewide Reference Area	1,716,943	18.0	1.7	12.5	14.4	$24,280.00
Adams County	4,147	8.1	1.3	3.8	**14.6**	$22,741.00
Clearwater County	8,546	9.6	*2.3*	4.1	13.1	$21,316.00
Custer County	4,172	8.2	0.9	4.8	**20.6**	$23,624.00
Idaho County	16,369	9.1	*3.1*	3.5	**16.1**	$19,524.00
Latah County	39,333	11.1	0.9	4.3	**22.4**	$22,717.00
Lemhi County	7,875	6.5	1.2	3.2	**16.9**	$21,953.00
Lewis County	3,887	15.4	*6.5*	4.4	**15.9**	$22,589.00
Nez Perce County	40,385	13.0	*6.0*	3.6	13.6	$25,179.00

State, County	Total Population (2017 estimates)	Percent Non White	Percent Indian	Percent Hispanic	Poverty Rate Percent	Per Capita Income $ (2016)
Valley County	10,687	7.9	1.2	4.7	14.0	$28,133.00
Oregon						
Statewide Reference Area	4,142776	24.2	1.8	12.4	13.3	$28,822.00
Union County	26,222	11.3	1.3	4.8	**18.6**	$25,458.00
Wallowa County	7,051	6.9	0.9	3.0	**14.6**	$24,956.00
Washington						
Statewide Reference Area	7,405,743	31.3	1.9	12.7	11.3	$32,999.00
Asotin County	22,535	9.5	1.8	4.0	**14.5**	$25,760.00
Benton County	198,171	29.6	1.2	*21.9*	**12.8**	$29,529.00
Columbia County	4,047	14.9	1.7	8.3	**14.8**	$26,536.00
Franklin County	91,125	*59.7*	1.7	*53.3*	**16.4**	$20,997.00
Garfield County	2,210	10.2	0.6	5.7	11.3	$23,313.00
Walla Walla County	60,563	28.1	1.4	*21.3*	**16.5**	$24,736.00
Whitman County	49,046	21.3	0.8	6.4	**30.0**	$20,957.00

Source: U.S. Census Bureau, 2012-2016 American Community Survey[8], Table B17001: Poverty Status in the Past 12 Months by Sex and Age; Table B19301: Per Capita Income in the Past 12 Months (in 2016 Inflation Adjusted Dollars).

The following Indian tribes are located within the project area and/or may rely on steelhead fisheries in the Snake River Basin upstream from Ice Harbor Dam for cultural and subsistence purposes:

- Nez Perce Tribe
- Confederated Tribes of the Umatilla Indian Reservation
- Shoshone-Bannock Tribes

[8] U.S. Census Bureau FactFinder. Accessed October 2018

Present day tribal reservations may encompass a fraction of a tribe's previously occupied territory; therefore, tribes have the right to take fish at all usual and accustomed places in accordance with applicable treaties. For example, the combined amount of tribal reservation land for the NPT reservation consists of 770,000 acres, but the tribes' aboriginal lands and ceded areas encompass 13 million acres (CRITFC 1994).

3.5.1. Nez Perce Tribe

The NPT has lived in and held historical and cultural ties to the greater Columbia River Basin, even though the Nez Perce Tribe Reservation is located in north-central Idaho (Figure 8). The Tribe has several fishing locations spread throughout most of the Columbia and Snake River basins[9].

Under the guidance of the 1855 Treaty, the NPT co-manages fisheries resources throughout the project area through the Tribe's Department of Fisheries Resources Management Program. The Tribe works and coordinates with state, Federal, and Tribal entities while monitoring fish resources within the region. Tribal members also fish on the Clearwater River, which runs through the Nez Perce Indian Reservation, on the Selway River in the Clearwater River Subbasin, on the Salmon River Subbasin, tributaries to the Snake River in Southeast Washington and Northeast Oregon, and on the Columbia River outside of the project area. Presently, NPT steelhead fisheries are limited in scope.

3.5.2. Confederated Tribes of Umatilla Indian Reservation

The CTUIR includes the Umatilla, Walla Walla, and Cayuse tribes[10]. These tribes have long depended on the abundant fisheries in the Columbia Plateau, historically living around the confluence of the Yakima, Snake, and Walla Walla Rivers. The Cayuse lived "…south of and between the Nez Perces and Wallah-Wallahs, extending from the Des Chutes or Wawanui river to the eastern side of the Blue Mountains. It [their country] is almost entirely in Oregon, a small part only, upon the upper Wallah-Wallah River, lying within Washington Territory." [11] The Umatilla tribes traveled over vast areas to take advantage of salmon and steelhead runs, traditionally fishing the Columbia and Snake Rivers, and the Imnaha, Tucannon, Walla Walla, Grande Ronde, Umatilla, John Day, Burnt, and Powder Rivers of northeastern Oregon and southeastern Washington (USBOR 1988).

Tribal members typically harvest spring, summer, and fall Chinook salmon and steelhead in the Columbia River and its tributaries located in southeastern Washington and northeastern Oregon. The CTUIR has co-management responsibilities of fishery activities within the Columbia, Snake, Walla Walla, Tucannon, and Grande Ronde Rivers.

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[9] Overview of the Nez Perce Tribe. Accessed February, 2019
[10] Overview of the Confederated Tribes of the Umatilla Indian Reservarion. Accessed February, 2019
[11] History of CTUIR Accessed February, 2019.

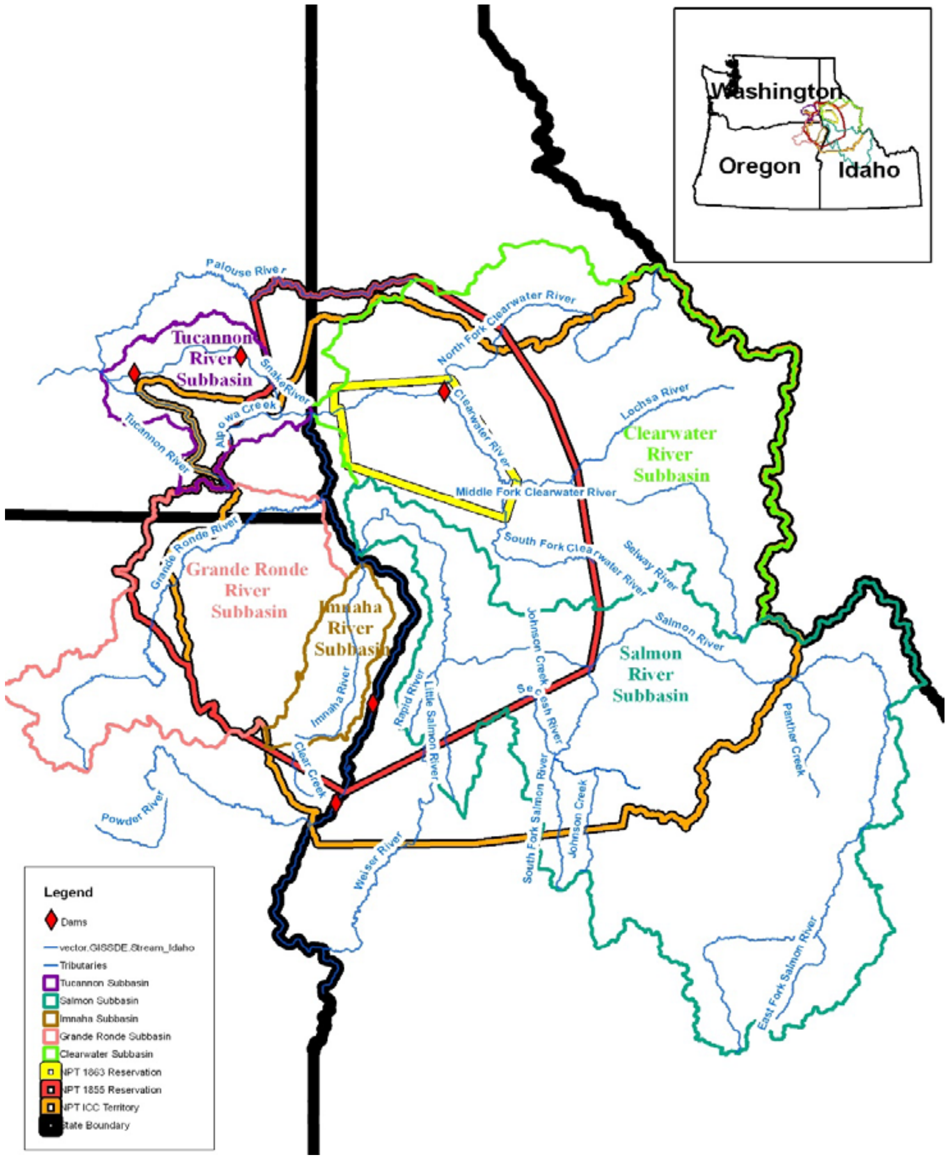

Figure 8. The Snake River Basin and its harvest areas as they relate to the Nez Perce Tribe's 1855 Reservation and usual and accustomed fishing areas.

3.5.3. Shoshone-Bannock Tribes

The Shoshone-Bannock Tribes (SBT) consist of the Northern Shoshone and the Bannock Bands. In 1868, the Shoshone and Bannock Tribes were granted 1.8 million acres in southeastern Idaho under the Fort Bridger Treaty, establishing the Fort Hall Indian Reservation. Today, this reservation is home to the SBT in Idaho between the cities of Pocatello, American Falls, and

Blackfoot, and it is comprised of land in Bingham, Power, Bannock, and Caribou counties (Figure 1).

The SBT asserts that, under Article IV of the 1868 Treaty, members of the SBT harvest subsistence foods from unoccupied lands of the United States, including Steelhead. For the purposes of this evaluation, NMFS assumes that members of the SBT will primarily harvest fish in the Salmon and Snake River basins within the project area. Based on internal SBT evaluations, these harvest levels have remained minimal or near ceremonial levels throughout the project area for the past decade.

4. ENVIRONMENTAL CONSEQUENCES

This chapter describes the analysis of the direct and indirect environmental effects associated with the alternatives on the affected resources. The effects of each of the alternatives are described relative to current conditions (Section 3, Affected Environment). The relative magnitude of impacts are described using the following terms:

- Undetectable – The impact would not be detectable.
- Negligible – The impact would be at the lower levels of detection.
- Low – The impact would be slight, but detectable.
- Medium – The impact would be readily apparent.
- High – The impact would be severe.

The baseline conditions for five resources (wildlife, fish, vegetation, socioeconomics, and environmental justice) are described in Chapter 3, Affected Environment. This chapter provides an analysis of the direct and indirect environmental effects associated with the five alternatives on these five resources and builds and expands on the impacts described in the *U.S. v. Oregon* FEIS. Cumulative effects are analyzed in Chapter 5, Cumulative Effects.

4.1. Wildlife

The overall effects of the alternatives on wildlife are summarized in Table 17 and described in greater detail in Section 4.1.1 through Section 4.1.5.

Table 17. Summary of effects of the alternatives on wildlife

Resource	Alternative 1	Alternative 2 – Proposed Action	Alternative 3 – Additional Conservation Measures	Alternative 4 – Close Steelhead Fisheries	Alternative 5 – Increased Allowable Impact Rates
Wildlife	Continuation of current condition/Negligible	Negligible	Low Beneficial	Low Beneficial	Negligible

4.1.1. Alternative 1 (No Action)

Fisheries remove potential prey for wildlife and potential carcasses from the watershed. Fisheries can also result in impacts to fish and wildlife habitat through disturbance from the presence of boats, people, and noise. These activities can cause animals to temporarily depart fishing areas where boating or fishing activity occurs. Generally, the impact is short in duration and does not result in loss or injury to non-targeted animals, but when fishing activity is a sustained, significant effort and localized to a specific area, the effects from human presence could result in increased stress and energy expenditure to marine and freshwater wildlife while these animals pursue other places to forage and seek cover. These effects are limited to animals in or around fishing areas. As described in Section 3.1, the species most likely to be affected by steelhead fisheries would be river otters, mink, some invertebrate species, and predatory birds (e.g., bald eagle).

Under Alternative 1, NMFS would not make determinations under the 4(d) Rule or Tribal 4(d) Rule and the parties would not manage their steelhead fisheries jointly under one overarching management framework that limits the combined impacts of the Snake River steelhead fisheries. It is difficult to predict the total level of fishing that would occur under this alternative. Therefore, NMFS will assume that the states and tribes would continue to implement their steelhead fisheries as under current conditions. Therefore, there would be a continuation of baseline effects on wildlife as described in Section 3.1, Wildlife, resulting in negligible impacts. . In summary, the fishery would continue to remove adult steelhead, which would reduce the number of fish available to wildlife that prey or scavenge on steelhead, such as otter, mink, and eagles. Under Alternative 1, there would continue to be some disturbance to wildlife through the presence of boats and people, which may result in wildlife temporarily departing the fishing area. Overall, Alternative 1 would not result in changes to the current conditions and would result in negligible impacts to wildlife.

4.1.2. Alternative 2 (Proposed Action)

Under Alternative 2, harvest of steelhead could gradually increase over time up to the impact levels specified in Table 2 as tribes expand their steelhead fisheries. As a result, in the near term, there would likely be no difference between Alternative 2 and Alternative 1 since state recreational fisheries would be the same under both alternatives and it may take many years to expand tribal fisheries. However, over the long term, more adult steelhead would likely be removed under Alternative 2 than under Alternative 1, which would reduce the number of fish available to wildlife that prey or scavenge on steelhead, such as mink, otter, and eagles. In addition, there could be more disturbances under Alternative 2 from boats and people. However, all of these changes would be expected to be at the lower level of detection when compared to the current conditions and would, therefore, be negligible.

4.1.3. Alternative 3 (Additional Conservation Measures)

Under Alternative 3, additional conservation measures would be implemented, which would result in the removal of fewer steelhead from the ecosystem compared to Alternatives 1 and 2. As a result, more steelhead would be available to wildlife that prey or scavenge on steelhead, such as otter, mink, and eagles. In addition, there would be fewer disturbances from boats and people fishing relative to Alternatives 1 and 2. Therefore, Alternative 3 would be expected to have a low beneficial effect on wildlife species relative to the current conditions.

4.1.4. Alternative 4 (Close Steelhead Fisheries)

Under Alternative 4, steelhead fisheries would close, which would result in the removal of fewer steelhead from the ecosystem compared to Alternatives 1, 2, and 3. As a result, more steelhead would be available to wildlife that prey or scavenge on steelhead, such as otter, mink, and eagles. In addition, there would be fewer disturbances from boats and people fishing. Therefore, Alternative 4 would be expected to have a low beneficial effect on wildlife species relative to the current conditions.

4.1.5. Alternative 5 (Increased Allowable Impact Rates)

Under Alternative 5, the allowable harvest impact rate on natural-origin steelhead would increase when natural-origin abundances are high (i.e., exceed MAT). When natural-origin steelhead abundance is under MAT, harvest would occur as under Alternative 2. Therefore, effects of Alternative 5 on wildlife would be identical to Alternative 2 when natural-origin steelhead abundance is under MAT. When abundance is above MAT, there would be additional harvest of steelhead relative to both Alternative 1 and Alternative 2. Therefore, when natural-origin steelhead abundance is over MAT, there could be fewer steelhead available to wildlife that prey or scavenge on steelhead (e.g., otter, mink, and eagle) under Alternative 5 as compared to Alternatives 1, 2, 3, and 4. Similarly, when natural-origin abundance is over MAT, there may be more disturbances from boats and people fishing relative to Alternatives 1, 2, 3 and 4. However, the increases are low and the effects of Alternative 5 are considered negligible compared to the current conditions.

4.2. Fish

Fisheries can reduce fish abundance and spawning potential. Reducing fish abundance, and subsequent spawning population potential, can lead to impacts of population parameters. In addition, by targeting and reducing the abundance of certain species, fisheries can modify the trophic chain and the flows of biomass (and energy) across the ecosystem as well as remove the nutrients from the system that are contained within the fish carcasses themselves.

The overall effects of the alternatives by fish species are summarized in Table 18 and described in greater detail in Section 4.2.1 through Section 4.2.5. Because none of the alternatives would result in construction or other activities that would affect PBFs as described in Section 3.2, none of the alternatives would be expected to have more than minimal effects on critical habitat. As described in NMFS' associated biological opinion on this proposed action, direct effects through interception of adult fish as they are migrating and indirect effects on substrate, riparian vegetation, and juvenile migration are expected to be small in magnitude and transitory in time frame.

Table 18. Summary of effects of the alternatives on fish species

Resource	Alternative 1	Alternative 2 – Proposed Action	Alternative 3 – Additional Conservation Measures	Alternative 4 – Close Steelhead Fisheries	Alternative 5 – Increased Allowable Impact Rates
Snake River spring/summer Chinook salmon	Continuation of current condition/Negligible	Negligible	Negligible	Negligible	Negligible
Snake River fall Chinook salmon	Continuation of current condition/Low adverse	Low adverse	Low adverse	Low beneficial	Low adverse
Snake River steelhead	Continuation of current condition/Low adverse	Low adverse	Low beneficial	Low beneficial	Low adverse
Middle Columbia steelhead	Continuation of current condition/Negligible	Negligible	Negligible	Negligible	Negligible
Snake River sockeye salmon	Continuation of current condition/Negligible	Negligible	Negligible	Negligible	Negligible
Bull trout	Continuation of current condition/Low adverse	Low adverse	Low beneficial	Low beneficial	Low adverse
Coho salmon	Continuation of current condition/Low adverse	Low adverse	Same as Alternative 1	Low beneficial	Low adverse
Other fish species	Continuation of current condition/Negligible	Negligible	Negligible	Negligible	Negligible

4.2.1. Alternative 1 (No Action)

Under Alternative 1, NMFS would not make determinations under the 4(d) Rule or Tribal 4(d) Rule and the parties would not manage their steelhead fisheries jointly under one overarching management framework that limits the combined impacts of the Snake River steelhead fisheries. It is difficult to predict the total level of fishing that would occur under this alternative. Therefore, NMFS will assume that the states and tribes would continue to implement their steelhead fisheries as under current conditions. The effects of Alternative 1 on fish species are summarized in the sections below. For all fish species, the contribution of steelhead carcasses to the total amount of marine-derived nutrients in the Snake River Basin would be the same as under baseline conditions.

Snake River Spring/Summer Chinook Salmon ESU

Snake River spring/summer Chinook salmon enter the Snake River earlier than steelhead and are not often intercepted in Snake River steelhead fisheries. Under currently ongoing steelhead fisheries, up to 40 Snake River spring/summer Chinook salmon are encountered across 31 populations with four estimated deaths (IDFG 2018a). These impacts would be expected to continue under Alternative 1 and have a negligible impact on the long term abundance, productivity, spatial structure and diversity of the Snake River spring/summer Chinook salmon ESU because a very small percentage of the total ESU abundance would be affected.

Snake River Fall Chinook Salmon ESU

Fall Chinook salmon fishing overlaps with steelhead fisheries, and it is difficult to parse out impacts from the two fisheries. However, for the purposes of this analysis, we assume that the average incidental lethal take of Snake River Fall Chinook salmon under currently ongoing steelhead fisheries is 6.0 percent of the natural-origin fall Chinook salmon that cross Lower Granite Dam each year. The 10-year geometric mean annual spawning escapement estimate for Snake River fall Chinook salmon is 6,418, which exceeds its minimum abundance threshold for recovery by 50 percent(ICTRT 2007).. The minimum abundance threshold is the abundance level adequate for compensatory processes to operate and for maintenance of within-population spatial structure (NWFSC 2015). In addition, populations that, on average, meet or exceed their minimum abundance thresholds are resilient to environmental and anthropogenic disturbances, maintain genetic diversity, and support/provide ecosystem functions. Therefore, although the steelhead fisheries under Alternative 1 would continue to have a low adverse impact on the ESU's abundance, steelhead fisheries under Alternative 1 would not be expected to impact the productivity, diversity, or spatial structure of the ESU.

Snake River Steelhead DPS

Under Alternative 1, state-managed steelhead fisheries in the Snake River would be uncoordinated and managed independently by the three states. Table 19 provides historical information on natural-origin steelhead mortality, whether caught incidentally in mark-selective state-managed steelhead fisheries or in non-selective tribal fisheries between 2011 and 2016, retroactively converted to an MPG level using actual reported mortalities and the Snake Basin Steelhead Run Reconstruction Model[12]. NMFS cannot reliably assign certain impacts to a specific fishery when multiple fisheries are taking place in the same time and place. Therefore, estimates of the average rates of natural-origin steelhead mortalities in Snake River steelhead fisheries include impacts from other fisheries in the project area (e.g., fall Chinook salmon fisheries). Average natural-origin Snake River steelhead mortality for ongoing fisheries in the project area between 2011 and 2016 was 1,239 fish per year distributed among the five MPGs, and impact rates by MPG ranged from 1.3 percent for the Lower Snake MPG to 4.5 percent for the Imnaha MPG (Table 4)[13]. Assuming similar MPG abundances in the future, Alternative 1 would result in fishery-related mortalities of natural-origin Snake River steelhead similar to those in Table 4 and would be expected to have a low adverse impact on the spawning abundance of the Snake River steelhead DPS. Under Alternative 1, risk to spatial structure for populations in the Snake River DPS would be expected to continue to be low to very low as described in Section 3.2 because NMFS assumes fisheries would be implemented in a similar fashion as in the recent past. Because fisheries would be implemented similarly as under current conditions, there would be no anticipated change to the productivity of Snake River steelhead populations under Alternative 1.

Table 19. Estimated average rates of natural-origin steelhead mortalities in all Snake River fisheries during 2011 and 2016 at the MPG level using the current Snake Basin Steelhead Run Reconstruction Model.

MPG	Average Natural-origin Adult Abundance at Ice Harbor Dam (2011-2016)	Ave Mortality by MPG (percent of MPG run size that cross Ice Harbor Dam)
Lower Snake	8,018	104 (1.3)
Clearwater	8,402	336 (4.0)
Grande Ronde	8,230	308 (3.7)
Imnaha	2,584	116 (4.5)
Salmon	12,203	375 (3.1)
Total for DPS	39,437	1239 (3.1)

[12] This model uses abundances at Lower Granite Dam because of the intensive sampling program operating on adult steelhead as an anchor point. Disposition of these fish within the Snake River basin was estimated by applying survival and movement probabilities. (Stark et al. 2016)

[13] For a further discussion of how NMFS has considered catch and release mortality rates, see Section 2.5.1 of the Biological Opinion, where NMFS discusses various studies that have examined mortality rates in the area and in other steelhead populations outside the Snake River DPS.

Table 20 provides estimated historical information on harvest of hatchery-origin steelhead destined for each MPG from 2011-2016. Removal of these hatchery-origin steelhead via the fisheries would continue under Alternative 1 and benefit the DPS by reducing genetic/diversity risks associated with operating Snake River steelhead hatchery programs.

Table 20. Estimated harvest of adipose-clipped, hatchery-origin steelhead from 2011-2016 destined for each major population group Source: (Stark 2018)

MPG	Average Annual Harvest	Average Ice Harbor Dam Return	Average Percent Harvested of fish that cross Ice Harbor Dam
Lower Snake	1,216	3,916	32
Clearwater	18,798	23,291	79
Grande Ronde	10,156	18,938	56
Salmon	36,727	54,454	68
Imnaha	1,108	3,367	32
Hells Canyon[3]	4,674	10,747	46
Total for DPS	72,679	114,713	63.4

[3] There are no extant natural-origin steelhead populations within this MPG.

Middle-Columbia River Steelhead DPS

In 3 of the 6 years from 2011-2016, a single natural-origin fish from the Middle Columbia Steelhead DPS was killed in Snake River Basin steelhead fisheries, based on the steelhead run reconstruction (Stark 2018). These single-digit impacts would be expected to continue under Alternative 1 and have a negligible impact on the long term abundance, productivity, spatial structure and diversity of the Middle Columbia River steelhead DPS.

Snake River Sockeye Salmon ESU

Idaho steelhead fisheries have not reported incidental take of any Snake River sockeye salmon since the 1970s (IDFG 2018b). The other steelhead fisheries in the Snake River are expected to have a similar impact. These impacts would be expected to continue under Alternative 1 and have a negligible impact on the long term abundance, productivity, spatial structure and diversity of the Snake River sockeye salmon ESU.

Bull Trout

Under the proposed fisheries, the USFWS estimates that approximately 4,000 bull trout annually would be incidentally captured during recreational and Tribal fisheries and be disturbed through handling and release (USFWS 2019). Of the total number of bull trout that would be captured and released, up to 200 bull trout annually would suffer mortality. This represents less than 1 percent of the estimated 34,327 adult bull trout in project area (USFWS 2019). Subadult bull trout are also likely to be incidentally captured during the steelhead fisheries. In Idaho, there are an estimated 1.13 million adult and subadult bull trout (High et al. 2008). Given the estimated number adult bull trout, the USFWS determined that 9 percent of the population within the project area may be incidentally captured annually during the steelhead fisheries, and 0.04 percent may suffer mortality. When subadult bull trout are included in these calculations, the percentages are much lower. For example, in the Salmon River basin High et al. (2008) estimated the abundance of adult and subadult bull trout to be 0.64 million. A similar, but slightly lower level of impact would be expected under Alternative 1 because there would be less fishing pressure than under Alternative 2 resulting in low adverse impacts to bull trout.

Coho Salmon

The 2008-2017 average number of coho salmon adults passing Lower Granite dam is 4,975 fish[14]. Incidental mortality of coho salmon in steelhead fisheries is currently low. In 2017, less than 200 coho salmon were caught by Idaho anglers in both the steelhead and coho fisheries (Don Whitney, IDFG, personal communication, December 2018). A similar level of impact would be expected under Alternative 1 because fisheries would be similar to those occurring in recent years.

Other Fish Species

As described in Section 3.2, Fish, approximately 60 other species of fish live in the Snake River and its tributaries. About one-half are native species, primarily of the families Salmonidae (e.g., rainbow trout, brook trout, whitefish), Catastomidae (e.g., suckers), Cyprinidae (e.g., northern pikeminnow), and Cottidae (e.g., sculpins). Fish from these families may be encountered and a few may be incidentally taken in steelhead fisheries under baseline conditions, but the impact on the species would be negligible because only a very small percentage of the total abundance of these species would be impacted. A similar level of impact would be expected under Alternative 1 because fisheries would be similar to those occurring in recent years.

The other native fish are not likely to be encountered in steelhead fisheries, but may interact with salmon and steelhead ecologically through predator or prey relationships. However, the effects on these species from Alternative 1 would be negligible because steelhead are not actively feeding when they return to spawn.

4.2.2. Alternative 2 (Proposed Action)

Under Alternative 2, that fishery managers in the Snake River Basin would jointly manage under an overarching framework that limits combined impacts on natural-origin steelhead in the Snake River Basin DPS. Under the combined framework, total allowable impacts would be higher than

[14] Fish Passage Center query. Accessed on October 15, 2018

total estimated impacts in recent years, which would allow the tribal fisheries to expand over time. As a result, in the near term, impacts to fish would likely be similar under Alternative 2 and Alternative 1 because state-managed recreational fisheries would not change and it would likely take many years to expand tribal fisheries. However, unlike Alternative 1, additional conservation measures would be required under Alternative 2 if an MPG falls to or below its aggregated CAT. Over the long term, there may be more fishing pressure on steelhead under Alternative 2, but only when aggregated natural-origin steelhead abundance exceeds CAT. The effects of Alternative 2 on fish species are summarized in the sections below. For all fish species, the contribution of steelhead carcasses to the total amount of marine-derived nutrients in the Snake River Basin would be similar as under baseline conditions and Alternative 1 in the near term. In the long term, Alternative 2 would be expected to result in slightly less marine-derived nutrients than under baseline conditions and Alternative 1.

Snake River Spring/Summer Chinook Salmon ESU

Snake River spring/summer Chinook salmon enter the Snake River earlier than steelhead and are not often intercepted in Snake River steelhead fisheries. Under Alternative 1, up to 40 Snake River spring/summer Chinook salmon would be encountered across 31 populations with four estimated deaths (IDFG 2018a). These impacts would be expected to be similar under Alternative 2. Therefore, like Alternative 1, Alternative 2 would be expected to have a negligible impact on the long term abundance, productivity, spatial structure and diversity of the Snake River spring/summer Chinook salmon ESU because a very small percentage of the total ESU abundance would be affected.

Snake River Fall Chinook Salmon ESU

Under Alternative 2, the steelhead fisheries would be expected to have a similar effects as under Alternative 1 because under both alternatives the steelhead fishery would be managed along with the fall Chinook fishery to limit impacts on the fall Chinook to authorized levels. Therefore, compared to Alternative 1, Alternative 2 would have a negligible effect on the Snake River Fall Chinook Salmon ESU.

Fall Chinook salmon fishing overlaps with steelhead fisheries, and it is difficult to parse out impacts from the two fisheries. However, for the purposes of this analysis, we assume that the average incidental lethal take of Snake River Fall Chinook salmon under currently ongoing steelhead fisheries is 6.0 percent of the natural-origin fall Chinook salmon that cross Lower Granite Dam each year. The 10-year geometric mean annual spawning escapement estimate for Snake River fall Chinook salmon is 6,418, which exceeds its minimum abundance threshold for recovery by 50 percent (NWFSC 2015). The minimum abundance threshold is the abundance level adequate for compensatory processes to operate and for maintenance of within-population spatial structure (ICTRT 2007). In addition, populations that, on average, meet or exceed their minimum abundance thresholds are resilient to environmental and anthropogenic disturbances, maintain genetic diversity, and support/provide ecosystem functions. Therefore, although the steelhead fisheries under Alternative 2 may increase incidental capture of fall Chinook salmon, the impact of Alternative 2 would be low and similar to Alternative 1. Steelhead fisheries under Alternative 2 would not be expected to impact the productivity, diversity, or spatial structure of the Snake River fall Chinook salmon ESU.

Snake River Steelhead DPS

As described in Section 1.2, steelhead fisheries under Alternative 2 would incorporate the following measures, which are not included under Alternative 1.

- The fisheries would be managed to reduce impacts on natural-origin steelhead if abundance falls below CAT
- The Tribal steelhead fishery would grow over time to allow for meaningful exercise of their treaty fishing rights.
- All Snake River steelhead fisheries (i.e., recreational and tribal) would be managed under one natural-origin framework as described in Section 1.2.1.

Under Alternative 2, there would be an increase in fishery-related mortalities of natural-origin Snake River steelhead relative to Alternative 1 (Table 21), which would be expected to have a low adverse impact on the abundance of the Snake River Steelhead DPS when abundance is projected to be above CAT. However, if projected abundance is below CAT, management changes would be implemented under Alternative 2 to limit impacts on natural-origin steelhead abundance, which would provide additional protections to Snake River steelhead relative to baseline conditions and Alternative 1. In addition, there would be an overall cap on total harvest of Snake River steelhead under Alternative 2. Therefore, overall, Alternative 2 would provide low beneficial effects on Snake River steelhead abundance.

Under baseline conditions, productivity for Snake Basin steelhead populations for which it can be measured is well above replacement[15] (i.e., they have productivities of 2-3) (NWFSC 2015). If multiple years of low abundances were to occur, which would be a sign that productivity may have decreased, modifications to fisheries would be made under Alternative 2 to likely reduce impacts and limit further productivity declines. Therefore, Alternative 2 is expected to have the same impact on the productivity of the Snake River steelhead populations as Alternative 1. Under Alternative 2, risk to spatial structure for populations in the Snake River DPS would be expected to continue to be low to very low as described in Section 3.2 because NMFS assumes fisheries would be implemented in a similar fashion as in the recent past.

[15] A replacement rate of 1 means that each adult spawner has a single offspring that survives to adulthood.

Table 21. Estimated average rates of natural-origin steelhead mortalities in all Snake River fisheries under Alternative 2 assuming recent abundance levels and using the current Snake Basin Steelhead Run Reconstruction Model.

MPG	Average Natural-origin Adult Abundance at Ice Harbor Dam (2011-2016)	Ave Mortality by MPG (maximum percent of MPG run size that cross Ice Harbor Dam)
Lower Snake	8,018	401 (5)
Clearwater	8,402	840 (10)
Grande Ronde	8,230	823 (10)
Imnaha	2,584	129 (5)
Salmon	12,203	122 (10)
Total for DPS	39,437	2,315 (<6)

Table 20 provides estimated historical information on harvest of hatchery-origin steelhead destined for each MPG from 2011-2016. Removal of these hatchery-origin steelhead via the fisheries would increase under Alternative 2 and provide additional benefits to the DPS by reducing genetic risks associated with operating Snake River steelhead hatchery programs.

Middle-Columbia River Steelhead DPS

In 3 of the 6 years from 2011-2016, a single natural-origin fish from the Middle Columbia Steelhead DPS was killed in Snake River Basin steelhead fisheries, based on the steelhead run reconstruction (Stark 2018). This negligible level of impact would be expected to continue under both Alternative 1 and Alternative 2 because even if the growing tribal fisheries increased impacts on Middle Columbia steelhead, the impact would still remain at the lower levels of detection. That is, even if impacts doubled under Alternative 2, this alternative would only be expected to result in the death of two fish from the Middle Columbia Steelhead DPS, which would have an negligible impact on the long term abundance, productivity, spatial structure and diversity of the Middle Columbia River steelhead DPS.

Snake River Sockeye Salmon ESU

Idaho steelhead fisheries have not reported incidental take of any Snake River sockeye salmon since the 1970s (IDFG 2018a). The other steelhead fisheries in the Snake River are also expected to have near-zero impacts. This same level of impact would be expected to continue under Alternative 2 because the fisheries would be implemented in the same time and places as under current conditions. Therefore, similar to Alternative 1, Alternative 2 would have a negligible impact on the long term abundance, productivity, spatial structure, and diversity of the Snake River sockeye salmon ESU.

Bull Trout

Under the proposed fisheries, the USFWS estimates that approximately 4,000 bull trout annually would be incidentally captured during recreational and Tribal fisheries and be disturbed through handling and release (USFWS 2019). Of the total number of bull trout that would be captured and released, up to 200 bull trout annually would suffer mortality. This represents less than 1 percent of the estimated 34,327 adult bull trout in project area. Subadult bull trout are also likely to be incidentally captured during the steelhead fisheries. In Idaho, there are an estimated 1.13 million adult and subadult bull trout (High et al. 2008). Given the estimated number adult bull trout, the USFWS determined that 9 percent of the population within the project area may be incidentally captured annually during the steelhead fisheries, and 0.04 percent may suffer mortality. When subadult bull trout are included in these calculations, the percentages are much lower. For example, in the Salmon River basin High et al. (2008) estimated the abundance of adult and subadult bull trout to be 0.64 million. Because the fisheries would impact a very low percentage of the total number of bull trout in the project area, Alternative 2 would have a low adverse effect on bull trout. This would be a similar, but slightly higher, level of impact as under Alternative 1 because fishing pressure on steelhead would be greater under Alternative 2 than under Alternative 1 except when steelhead abundance falls below CAT.

Coho Salmon

The 2008-2017 average number of coho salmon adults passing Lower Granite dam is 4,975 fish[16]. Incidental mortality of coho salmon in steelhead fisheries is low. In 2017, less than 200 coho salmon were caught by Idaho anglers in both the steelhead and coho fisheries (Don Whitney, IDFG, personal communication, December 2018). A similar, but slightly higher, level of impact would be expected under Alternative 2 because fishing pressure on steelhead would increase except when steelhead abundance falls below CAT. Therefore, similar to Alternative 1, Alternative 2 would have a low adverse effect on coho salmon in the project area.

Other Fish Species

As described in Section 3.2, Fish, approximately 60 other species of fish live in the Snake River and its tributaries. About one-half are native species, primarily of the families Salmonidae (e.g., rainbow trout, brook trout, whitefish), Catastomidae (e.g., suckers), Cyprinidae (e.g., northern pikeminnow), and Cottidae (e.g., sculpins). Fish from these families may be encountered and a few may be incidentally taken in steelhead fisheries under Alternative 2 but the impact on the species would be negligible because only a very small percentage of the total abundance of these species would be impacted. Therefore, similar to Alternative 1, the effects would be negligible.

[16] Fish Passage Center Query. Accessed on October 15, 2018

The other native fish are not likely to be encountered in steelhead fisheries, but may interact with salmon and steelhead ecologically through predator or prey relationships. Similar to Alternative 1, the effects on these species from Alternative 2 would be negligible because steelhead are not actively feeding when they return to spawn.

4.2.3. Alternative 3 (Additional Conservation Measures)

Under Alternative 3, additional conservation measures would be implemented, which would result in approximately a 40 percent reduction in yearly incidental impacts on natural-origin steelhead. The effects of Alternative 3 on fish species are summarized in the sections below. For all fish species, the contribution of steelhead carcasses to the total amount of marine-derived nutrients in the Snake River Basin would be greater under Alternative 3 than under Alternatives 1 and 2 because fewer steelhead would be removed in the fisheries.

Snake River Spring/Summer Chinook Salmon ESU

Snake River spring/summer Chinook salmon enter the Snake River earlier than steelhead and are not often intercepted in Snake River steelhead fisheries. Under Alternative 1, up to 40 Snake River spring/summer Chinook salmon would be encountered across 31 populations with four estimated deaths (IDFG 2018a). These impacts would be expected to be less under Alternative 3. However, like under Alternatives 1 and 2, Alternative 3 would have a negligible effect on the long term abundance, productivity, spatial structure, and diversity of Snake River spring/summer Chinook ESU because a very low percentage of the ESU is intercepted in steelhead fisheries.

Snake River Fall Chinook Salmon ESU

Under Alternative 3, the steelhead fisheries would be expected to have a similar effect on Snake River fall Chinook salmon as under Alternatives 1 and 2 because although the steelhead fishery would be closed during the spring under Alternative 3 fall Chinook salmon are not present in the spring (i.e., they have already spawned) so there would not be a reduction in encounters with fall Chinook under Alternative 3.

Snake River Steelhead DPS

Under Alternative 3, additional conservation measures would be implemented, which would result in approximately a 40 percent reduction in yearly incidental impacts on natural-origin steelhead, which would have a low beneficial effect on the abundance of the Snake River Steelhead DPS (Table 22).

Under baseline conditions, productivity for Snake Basin steelhead populations for which it can be measured is well above replacement (i.e., they have productivities of 2-3) (NWFSC 2015). Productivity may increase under Alternative 3 relative to Alternatives 1 and 2 because additional adult steelhead would escape to spawn.

Under Alternative 3, risk to spatial structure for populations in the Snake River DPS would be expected to continue to be low to very low as described in Section 3.2 because steelhead would continue to be well dispersed among the populations.

Table 22. Estimated average rates of natural-origin steelhead mortalities in all Snake River fisheries under Alternative 3 assuming recent abundance levels and using the current Snake Basin Steelhead Run Reconstruction Model.

MPG	Average Natural-origin Adult Abundance at Ice Harbor Dam (2011-2016)	Ave Mortality by MPG (percent of MPG run size that cross Ice Harbor Dam)
Lower Snake	8,018	56 (0.7)
Clearwater	8,402	193 (2.3)
Grande Ronde	8,230	156 (1.9)
Imnaha	2,584	59 (2.3)
Salmon	12,203	207 (1.7)
Total for DPS	39,437	671 (1.7)

Table 23 provides an estimate of harvest impacts on hatchery-origin steelhead under Alternative 3 under recent abundance levels (2011-2016). Fewer hatchery-origin steelhead would be harvested under Alternative 3 relative to Alternative 1 and 2. Therefore, the proportion of hatchery-origin fish on the spawning grounds would increase compared to Alternatives 1 and 2, which would increase genetic/diversity risk to the DPS.

Table 23 Estimated harvest of adipose-clipped, hatchery-origin steelhead from all Snake River fisheries under Alternative 3 assuming recent abundance levels

MPG	Average Annual Harvest	Average Ice Harbor Dam Return (2011-2016)	Average Percent Harvested of Fish that Cross Ice Harbor Dam
Lower Snake	730	3,916	19
Clearwater	11,279	23,291	48
Grande Ronde	6,094	18,938	32
Salmon	22,036	54,454	40
Imnaha	665	3,367	20
Hells Canyon[3]	2,804	10,747	26
Total for DPS	43,608	114,713	38

[3] There are no extant natural-origin steelhead populations within this MPG.

Middle-Columbia River Steelhead DPS

In 3 of the 6 years from 2011-2016, a single natural-origin fish from the Middle Columbia Steelhead DPS was killed in Snake River Basin steelhead fisheries, based on the steelhead run reconstruction (Stark 2018). This negligible level of impact would be expected to continue under Alternative 3 because even with the additional conservation measures implemented in Alternative 3, the Snake River steelhead fisheries still may intercept a steelhead from the Middle Columbia River Steelhead DPS. Therefore, similar to Alternatives 1 and 2, Alternative 3 would have a negligible impact on the long term abundance, productivity, spatial structure and diversity of the Middle Columbia River steelhead DPS.

Snake River Sockeye Salmon ESU

Idaho steelhead fisheries have not reported incidental take of any Snake River sockeye salmon since the 1970s (IDFG 2018a). The other steelhead fisheries in the Snake River are expected to have similar near-zero impacts. The same level of impacts would be expected to continue under Alternative 3 because fisheries would be implemented in the same places as under baseline conditions. Therefore, similar to Alternatives 1 and 2, Alternative 3 would have a negligible impact on the long term abundance, productivity, spatial structure and diversity of the Snake River sockeye salmon ESU.

Bull Trout

Under the proposed fisheries, the USFWS estimates that approximately 4,000 bull trout annually would be incidentally captured during recreational and Tribal fisheries and be disturbed through handling and release (USFWS 2019). Under Alternative 3, steelhead fisheries would be reduced by approximately 40 percent. This reduction would be expected to have a proportional effect on the incidental capture of bull trout. Therefore, steelhead fisheries under Alternative 3 would be expected to incidentally capture 2,400 bull trout annually, and an estimated 120 bull trout would suffer mortality. This represents less than 1 percent of the estimated 34,327 adult bull trout in project area, and in Idaho alone, there are an estimated 1.13 million adult and subadult bull trout (High et al. 2008). Therefore, steelhead fisheries under Alternative 3 would impact a very low percentage of the total number of bull trout in the project area and have a low adverse effect on bull trout. This would be a similar, but slightly lower, level of impact as under Alternatives 1 and 2 and would not affect the overall status of bull trout.

Coho Salmon

Incidental mortality of coho salmon in steelhead fisheries is low. In 2017, less than 200 coho salmon were caught by Idaho anglers in both the steelhead and coho fisheries (Don Whitney, IDFG, personal communication, December 2018). Under Alternative 3, steelhead fisheries would be reduced by approximately 40 percent with a closure of the spring fishery. However, the spring portion of the steelhead fishery would not incidentally capture coho salmon because coho would not be present in the fishing areas in the spring season. Therefore, Alternative 3 would have the same effect on coho salmon as Alternative 2.

Other Fish Species

As described in Section 3.2, Fish, approximately 60 other species of fish live in the Snake River and its tributaries. About one-half are native species, primarily of the families Salmonidae (e.g., rainbow trout, brook trout, whitefish), Catastomidae (e.g., suckers), Cyprinidae (e.g., northern pikeminnow), and Cottidae (e.g., sculpins). Fish from these families may be encountered and a few may be incidentally taken in steelhead fisheries under Alternative 3 but the impact on the species would be negligible because only a very small percentage of the total abundance of these species would be impacted. Therefore, similar to Alternatives 1 and 2, the effects would be negligible.

The other native fish are not likely to be encountered in steelhead fisheries, but may interact with salmon and steelhead ecologically through predator or prey relationships. Similar to Alternative 1 and 2, the effects on these species from Alternative 3 would be negligible because steelhead are not actively feeding when they return to spawn.

4.2.4. Alternative 4 (Close Steelhead Fisheries)

Under Alternative 4, all Snake River steelhead fisheries would be closed. The following sections summarize the anticipated effect of Alternative 4 on fish species. For all fish species, the contribution of steelhead carcasses to the total amount of marine-derived nutrients in the Snake River Basin would be greater under Alternative 4 than other all other alternatives because steelhead would not be targeted in the Snake River Basin fisheries.

Snake River Spring/Summer Chinook Salmon ESU

Snake River spring/summer Chinook salmon enter the Snake River earlier than steelhead and are not often intercepted in Snake River steelhead fisheries. Under Alternative 1, up to 40 Snake River spring/summer Chinook salmon would be encountered across 31 populations with four estimated deaths (IDFG 2018a). These impacts would be not occur under Alternative 4. However, because the effect of the steelhead fishery on Snake River spring/summer Chinook is so low under baseline conditions, the closure of steelhead fisheries under Alternative 4 would be expected to have a negligible impact on the long term abundance, productivity, spatial structure and diversity of the Snake River spring/summer Chinook salmon ESU.

Snake River Fall Chinook Salmon ESU

Under Alternative 4, the impacts of the steelhead fisheries on Snake River fall Chinook would be eliminated. Therefore, compared to Alternatives 1, 2, and 3, Alternative 4 would have a low beneficial effect on the abundance of Snake River Fall Chinook Salmon ESU. It would not be expected to impact the productivity, diversity, or spatial structure of the Snake River fall

Chinook salmon ESU because current abundance exceeds the ESU's minimum abundance threshold for recovery by 50 percent (NWFSC 2015). The minimum abundance threshold is the abundance level adequate for compensatory processes to operate and for maintenance of within-population spatial structure (ICTRT 2007). In addition, populations that, on average, meet or exceed their minimum abundance thresholds are resilient to environmental and anthropogenic disturbances, maintain genetic diversity, and support/provide ecosystem functions.

Snake River Steelhead DPS

Under Alternative 4, all steelhead fisheries in the Snake River Basin would be closed. Although there would still be impacts to natural-origin and hatchery-origin Snake River steelhead via other fisheries such as fall Chinook and coho fisheries, it is difficult to estimate the precise level of effect of these non-steelhead fisheries on steelhead, so for the purposes of this analysis, we assume that the impacts to Snake River steelhead from fisheries in the project area would be *de minimis* under Alternative 4 because existing data suggests that most of the impacts to natural-origin steelhead occur during the steelhead fishery instead of during fisheries that are targeting other species (Section 3.4). Because there would be more natural-origin steelhead spawners under Alternative 4 compared to Alternatives 1, 2, and 3, this alternative would have a low beneficial effect on the abundance of the Snake River Steelhead DPS (Table 24).

Under baseline conditions, productivity for Snake Basin steelhead populations for which it can be measured is well above replacement (i.e., they have productivities of 2-3) (NWFSC 2015). Productivity may increase under Alternative 4 relative to Alternatives 1, 2, and 3 because additional adult steelhead would escape to spawn.

Under Alternative 4, risk to spatial structure for populations in the Snake River DPS would be expected to continue to be low to very low as described in Section 3.2 because steelhead would continue to be well dispersed among the populations.

Table 24. Estimated average rates of natural-origin steelhead mortalities in all Snake River fisheries under Alternative 4 assuming recent abundance levels and using the current Snake Basin Steelhead Run Reconstruction Model.

MPG	Average Natural-origin Adult Abundance at Ice Harbor Dam (2011-2016)	Ave Mortality by MPG
Lower Snake	8,018	*de minimis*
Clearwater	8,402	*de minimis*
Grande Ronde	8,230	*de minimis*

MPG	Average Natural-origin Adult Abundance at Ice Harbor Dam (2011-2016)	Ave Mortality by MPG
Imnaha	2,584	*de minimis*
Salmon	12,203	*de minimis*
Total for DPS	39,437	*de minimis*

Table 25 provides an estimate of harvest impacts on hatchery-origin steelhead under Alternative 4. Fewer hatchery-origin steelhead would be harvested under Alternative 4 relative to Alternative 1, 2, and 3. Therefore, the proportion of hatchery-origin fish on the spawning grounds would increase compared to Alternatives 1, 2, and 3, which would increase genetic/diversity risk to the DPS.

Table 25. Estimated harvest of adipose-clipped, hatchery-origin steelhead from all Snake River fisheries under Alternative 3 assuming recent abundance levels

MPG	Average Annual Harvest	Average Ice Harbor Dam Return	Average Percent Harvested of Fish that Cross Ice Harbor Dam
Lower Snake	*de minimis*	3,916	*de minimis*
Clearwater	*de minimis*	23,291	*de minimis*
Grande Ronde	*de minimis*	18,938	*de minimis*
Salmon	*de minimis*	54,454	*de minimis*
Imnaha	*de minimis*	3,367	*de minimis*
Hells Canyon[3]	*de minimis*	10,747	*de minimis*
Total for DPS	*de minimis*	114,713	*de minimis*

[3] There are no extant natural-origin steelhead populations within this MPG.

Middle-Columbia River Steelhead DPS

In 3 of the 6 years from 2011-2016, a single natural-origin fish from the Middle Columbia Steelhead DPS was killed in Snake River Basin steelhead fisheries, based on the steelhead run reconstruction (Stark 2018). Under Alternative 4, the steelhead fishery would be closed, and there would be no impact on Middle Columbia River steelhead. However, because the effect of the steelhead fishery is so low under baseline conditions, the effects of closing steelhead fisheries under Alternative 4 are expected to be negligible on the long term abundance, productivity, spatial structure and diversity of the Middle Columbia River steelhead DPS. Therefore, the effects of Alternatives 1 through 4 on steelhead are similar.

Snake River Sockeye Salmon ESU

Idaho steelhead fisheries have not reported incidental take of any Snake River sockeye salmon since the 1970s (IDFG 2018b). The other steelhead fisheries in the Snake River are expected to have a similar near-zero impact. Therefore, closing all steelhead fisheries under Alternative 4 would have a negligible impact on the long term abundance, productivity, spatial structure and diversity of the Snake River sockeye salmon ESU. This is the same level of effect of Alternatives 1 through 3.

Bull Trout

Under the proposed fisheries, the USFWS estimates that approximately 4,000 bull trout annually would be incidentally captured during recreational and Tribal fisheries and be disturbed through handling and release (USFWS 2019). Under Alternative 4, steelhead fisheries would be closed. This closure would be expected to reduce the number of bull trout encountered annually by 4,000 fish and reduce mortalities by and estimated 200 bull trout annually. However, because there are an estimated 34,327 adult bull trout in project area and an estimated 1.13 million adult and subadult bull trout in Idaho alone (High et al. 2008), this reduction in mortality would only have a low beneficial effect on bull trout and would not affect their overall status. Effects on bull trout would be less under Alternative 4 than under all the other alternatives.

Coho Salmon

Incidental mortality of coho salmon in steelhead fisheries is low. In 2017, less than 200 coho salmon were caught by Idaho anglers in both the steelhead and coho fisheries (Don Whitney, IDFG, personal communication, December 2018). Under Alternative 4, steelhead fisheries would be closed, and fewer coho would likely be intercepted than under baseline conditions. Therefore, Alternative 4 would have a low beneficial effect on coho salmon in the project area, and more coho salmon would spawn naturally than under Alternatives 1 through 3.

Other Fish Species

As described in Section 3.2, Fish, approximately 60 other species of fish live in the Snake River and its tributaries. About one-half are native species, primarily of the families Salmonidae (e.g., rainbow trout, brook trout, whitefish), Catastomidae (e.g., suckers), Cyprinidae (e.g., northern pikeminnow), and Cottidae (e.g., sculpins). Fish from these families may be encountered and a few may be incidentally taken in steelhead fisheries under Alternative 1 but the impact on the species would be negligible. Under Alternative 4, there would be no incidental capture of these other fish species because there would be no steelhead fishery. However, because the effects of the steelhead fishery on these species would be so low under baseline conditions, the effects of Alternative 4 would be negligible, which is the same level of impact as Alternatives 1 through 3.

The other native fish are not likely to be encountered in steelhead fisheries, but may interact with salmon and steelhead ecologically through predator or prey relationships. Similar to Alternative 1 through 3, the effects on these species from Alternative 4 would be negligible because steelhead are not actively feeding when they return to spawn.

4.2.5. Alternative 5 (Increased Allowable Impact Rates)

Under Alternative 5, the fisheries would operate under a higher allowable harvest rate when steelhead abundance is high. However, if under future conditions, steelhead abundance declines, harvest would not be increased under this alternative. For all fish species, the contribution of steelhead carcasses to the total amount of marine-derived nutrients in the Snake River Basin would be similar to Alternative 1 and 2 when steelhead abundances are under MAT. When steelhead abundance is over MAT, Alternative 5 would result in fewer steelhead carcasses than all other alternatives and thus contribute fewer marine-derived nutrients to the Snake River Basin than the other alternatives.

Snake River Spring/Summer Chinook Salmon ESU

Snake River spring/summer Chinook salmon enter the Snake River earlier than steelhead and are not often intercepted in Snake River steelhead fisheries. Under Alternative 1, up to 40 Snake River spring/summer Chinook salmon would be encountered across 31 populations with four estimated deaths (IDFG 2018a). These impacts would not be expected to increase under Alternative 5 because harvest impacts on Snake River spring/summer Chinook resulting from increased steelhead fisheries would continue to be limited to authorized levels. Therefore, like Alternatives 1 through 4, Alternative 5 would be expected to have a negligible impact on the long term abundance, productivity, spatial structure and diversity of the Snake River spring/summer Chinook salmon ESU.

Snake River Fall Chinook Salmon ESU

Under Alternative 5, the impacts of the steelhead fisheries on Snake River fall Chinook may increase when natural-origin steelhead abundance is above MAT. Therefore, Alternative 5 may have a low adverse impact on fall Chinook salmon abundance, but because the Snake River fall Chinook salmon ESU abundance exceeds the ESU’s minimum abundance threshold for recovery by 50 percent (NWFSC 2015), the increase in impacts to fall Chinook salmon would not be expected to affect the productivity, diversity, or spatial structure of the Snake River fall Chinook salmon ESU.

Snake River Steelhead DPS

Under Alternative 5, the steelhead fisheries would operate under a higher allowable harvest rate when steelhead abundance is high (i.e., above MAT). Therefore, at higher abundance levels, Alternative 5 would reduce steelhead abundance relative to the other alternatives. However, because increased harvest rates would only apply when MPG abundance is above MAT, Alternative 5 is not expected to increase risk to the Snake River Steelhead DPS relative to the other alternatives. Table 26 shows harvest under Alternative 5 under recent abundance levels.

Under baseline conditions, productivity for Snake Basin steelhead populations for which it can be measured is well above replacement (i.e., they have productivities of 2-3) (NWFSC 2015). Productivity may be reduced under Alternative 5 relative to the other alternatives when the populations are at abundance levels that exceed MAT because fewer adult fish would escape to the spawning grounds compared to the other alternatives.

Under Alternative 5, risk to spatial structure for populations in the Snake River DPS would be expected to continue to be low to very low as described in Section 3.2 because steelhead would continue to be well dispersed among the populations.

Table 26. Estimated average rates of natural-origin steelhead mortalities in all Snake River fisheries under Alternative 5 assuming recent abundance levels and using the current Snake Basin Steelhead Run Reconstruction Model.

MPG	Average Natural-origin Adult Abundance at Ice Harbor Dam (2011-2016)	Ave Mortality by MPG (percent of MPG run size that cross Ice Harbor Dam)
Lower Snake	8,018	2352 (29)
Clearwater	8,402	1680 (20)
Grande Ronde	8,230	1893 (23)
Imnaha	2,584	594 (23)
Salmon	12,203	1952 (16)
Total for DPS	39,437	8471 (21)

Table 27 provides an estimate of harvest impacts on hatchery-origin steelhead under Alternative 5. Fewer hatchery-origin steelhead would be harvested under Alternative 4 relative to Alternative 1, 2, 3, and 4. Therefore, the proportion of hatchery-origin fish on the spawning grounds would be reduced compared to Alternatives 1, 2, 3, and 4, which would reduce genetic/diversity risk to the DPS.

Table 27. Estimated harvest of adipose-clipped, hatchery-origin steelhead from all Snake River fisheries under Alternative 5 assuming recent abundance levels

MPG	Average Annual Harvest	Average Ice Harbor Dam Return	Average Percent Harvested of Fish that Cross Ice Harbor Dam
Lower Snake	1216	3,916	31
Clearwater	18,798	23,291	80
Grande Ronde	10,156	18,938	54
Salmon	36,727	54,454	67
Imnaha	1108	3,367	33
Hells Canyon[3]	4674	10,747	43
Total for DPS	72,679	114,713	63

[3] There are no extant natural-origin steelhead populations within this MPG.

Middle-Columbia River Steelhead DPS

In 3 of the 6 years from 2011-2016, a single natural-origin fish from the Middle Columbia Steelhead DPS was killed in Snake River Basin steelhead fisheries, based on the steelhead run reconstruction (Stark 2018). Under Alternative 5, the steelhead fishery would operate with an increased allowable harvest rate when natural-origin steelhead abundance levels are high. However, since the lethal take of this DPS under Alternative 1 is only one fish, the potential increased steelhead fishery during years of high abundance under Alternative 5 would be negligible on the long term abundance, productivity, spatial structure and diversity of the Middle Columbia River steelhead DPS. Therefore, the effects of Alternatives 1 through 4 on steelhead are similar.

Snake River Sockeye Salmon ESU

Idaho steelhead fisheries have not reported incidental take of any Snake River sockeye salmon since the 1970s (IDFG 2018a). The other steelhead fisheries in the Snake River are expected to have a similar near-zero impact on this ESU. Therefore, no sockeye would be expected to be intercepted in the steelhead fisheries under Alternative 5, and similar to Alternatives 1 through 4, Alternative 5 would have a negligible impact on the long term abundance, productivity, spatial structure and diversity of the Snake River sockeye salmon ESU because the lethal take of this ESU would be near zero.

Bull Trout

Under the proposed fisheries, the USFWS estimates that approximately 4,000 bull trout annually would be incidentally captured during recreational and Tribal fisheries and be disturbed through handling and release (USFWS 2019). Additional bull trout may be incidentally captured under Alternative 5 when higher steelhead abundance allows an increased harvest rate on steelhead. Therefore, the effects of Alternative 5 would be low and adverse because fewer bull trout would spawn naturally than under baseline conditions. Adverse impacts to bull trout would be greater under Alternative 5 than under all of the other alternatives. However, because bull trout abundance is very high, this alternative would only impact a fraction of the bull trout in the project area and would not be expected to affect the overall status of bull trout. .

Coho Salmon

Incidental mortality of coho salmon in steelhead fisheries is low. In 2017, less than 200 coho salmon were caught by Idaho anglers in both the steelhead and coho fisheries (Don Whitney, IDFG, personal communication, December 2018). Under Alternative 4, additional coho may be caught relative to the other alternatives when higher steelhead abundance allows an increased harvest rate on steelhead. Therefore, the effects of Alternative 4 would be low and adverse because fewer coho salmon would spawn naturally than under baseline conditions.

Other Fish Species

As described in Section 3.2, Fish, approximately 60 other species of fish live in the Snake River and its tributaries. About one-half are native species, primarily of the families Salmonidae (e.g., rainbow trout, brook trout, whitefish), Catastomidae (e.g., suckers), Cyprinidae (e.g., northern pikeminnow), and Cottidae (e.g., sculpins). Fish from these families may be encountered and a few may be incidentally taken in steelhead fisheries under baseline conditions but the impact on the species would be negligible because only a very small percentage of the total abundance of these species would be impacted. Under Alternative 5, there may be additional incidental capture of these other fish species relative to Alternatives 1 through 4. However, the effects of Alternative 5 would be negligible because, like Alternatives 1 through 4, only a very small percentage of the total abundance of these species would be impacted.

The other native fish are not likely to be encountered in steelhead fisheries, but may interact with salmon and steelhead ecologically through predator or prey relationships. Similar to Alternatives 1 through 4, the effects on these species from Alternative 5 would be negligible because steelhead area not actively feeding when they return to spawn.

4.3. Vegetation

The overall effects of the alternatives on vegetation are summarized in Table 28 and described in greater detail in Section 4.3.1 through Section 4.3.5.

Table 28. Summary of effects on general vegetation

Resource	Alternative 1	Alternative 2 – Proposed Action	Alternative 3 – Additional Conservation Measures	Alternative 4 – Close Steelhead Fisheries	Alternative 5 – Increased Allowable Impact Rates
Vegetation	Continuation of baseline effect/Negligible	Same as Alternative 1	Negligible	Negligible	Negligible

4.3.1. Alternative 1 (No Action)

Under Alternative 1, harvest would continue at existing levels. Therefore, there would be a continuation of baseline effects on vegetation as described in Section 3.3, Vegetation. In summary, the fisheries could affect vegetation if new access points are created and anglers trample vegetation, but these effects would be expected to be negligible because anglers typically access the riverbanks though well-established access points. While there are two ESA listed plants in the area, they do not occur along the riverbanks in the project area so there would be little to no likelihood that ESA-listed plants would be trampled under Alternative 1.

4.3.2. Alternative 2 (Proposed Action)

Under Alternative 2, harvest of steelhead could gradually increase over time as tribes grow their steelhead fisheries. As a result, in the near term, there would likely be no difference between Alternative 2 and Alternative 1. However, over the long term, there would likely be more tribal steelhead fishing under Alternative 2 than under Alternative 1, which could adversely affect vegetation if new access points are created and anglers trample vegetation. However, even as the tribal fisheries increase, most anglers would be expected to continue to access the riverbank though well-established access points, so there would likely be no difference in impacts to vegetation under Alternative 2 and Alternative 1. While there are two ESA listed plants in the area, they do not occur along the riverbanks in the project area so there would be little to no likelihood that ESA-listed plants would be trampled under Alternative 2.

4.3.3. Alternative 3 (Additional Conservation Measures)

Under Alternative 3, additional conservation measures would be implemented, and fishing pressure would be reduced 40 percent. Therefore, compared to Alternatives 1 and 2, there would be fewer anglers, which may result in less trampling of riparian vegetation as anglers access the riverbank. However, because most anglers access the riverbank through well-established access points, the effects would likely be negligible. In addition, other fisheries would continue to take place under Alternative 3, so anglers would continue to affect vegetation as they accessed the riverbank. Therefore, the effects of Alternative 3 would be negligible on vegetation. While there are two ESA listed plants in the area, they do not occur along the riverbanks in the project area so there would be little to no likelihood that ESA-listed plants would be trampled under Alternative 3.

4.3.4. Alternative 4 (Close Steelhead Fisheries)

Under Alternative 4, steelhead fisheries would close. Therefore, compared to Alternatives 1, 2, and 3, there would be fewer anglers in the project area, which may result in less trampling of riparian vegetation as anglers access the riverbank. However, because most anglers access the riverbank through well-established access points, the effects would likely be negligible. In addition, other fisheries would continue to take place under Alternative 4, so anglers would continue to affect vegetation as they accessed the riverbank. Therefore, the effects of Alternative 4 would be negligible on vegetation. While there are two ESA listed plants in the area, they do not occur along the riverbanks in the project area so there would be little to no likelihood that ESA-listed plants would be trampled under Alternative 4.

4.3.5. Alternative 5 (Increased Allowable Impact Rates)

Under Alternative 5, the allowable harvest impact rate on natural-origin steelhead would increase when natural-origin abundances are high (i.e., exceed MAT). When natural-origin steelhead abundance is under MAT, harvest would occur as under Alternative 2. Compared to Alternatives 1, 2, 3, and 4 the effects of Alternative 5 would be negligible. Although there may be more anglers accessing the riverbank when steelhead abundance is over MAT, most anglers access the riverbank through well-established access points. Therefore, the effects of Alternative 5 relative to the baseline conditions would likely be negligible. While there are two ESA listed plants in the area, they do not occur along the riverbanks in the project area so there would be little to no likelihood that ESA-listed plants would be trampled under Alternative 5.

4.4. Socioeconomics

The overall effects of the alternatives on socioeconomics are summarized in Table 29 and described in greater detail in Section 4.4.1 through Section 4.4.5.

Table 29. Summary of effects of the alternatives on socioeconomics

Resource	Alternative 1	Alternative 2 – Proposed Action	Alternative 3 – Additional Conservation Measures	Alternative 4 – Close Steelhead Fisheries	Alternative 5 – Increased Allowable Impact Rates
Non-Tribal Socioeconomics	Continuation of baseline effect/Moderate beneficial	Same as Alternative 1	Low adverse	Moderate adverse	Low beneficial

Resource	Alternative 1	Alternative 2 – Proposed Action	Alternative 3 – Additional Conservation Measures	Alternative 4 – Close Steelhead Fisheries	Alternative 5 – Increased Allowable Impact Rates
Tribal Socioeconomics	Continuation of baseline effect/low beneficial	Moderate Beneficial	Same as Alternative 1	Moderate adverse	Low beneficial

4.4.1. Alternative 1 (No Action)

The effects of Alternative 1 on non-tribal socioeconomics would be moderate beneficial because recreational steelhead fishing in the Snake River Basin would continue as under baseline conditions and continue to generate revenue though the purchase of fishing-related goods and supplies, retention of local guiding services, and purchase of food and lodging (Section 3.6, Socioeconomics).

The effects of Alternative 1 on tribal socioeconomics would be low beneficial because tribal steelhead fishing in the Snake River Basin would continue as under baseline conditions, which would allow the tribes to engage in practices that are culturally, spiritually, economically, and symbolically important to the tribes (Section 3.6, Socioeconomics). However, the few steelhead that would be harvested under Alternative 1 would not be expected to provide a large source of sustenance for the tribes or support tribal identity, health, individual identity, culture, spirituality, religion, emotional well-being, and economy.

4.4.2. Alternative 2 (Proposed Action)

Under Alternative 2, state-managed recreational steelhead fisheries would occur as under Alternative 1. However, tribal harvest of steelhead could gradually increase over time under Alternative 2 compared to Alternative 1. As a result, in the near term, there would likely be no difference between Alternative 2 and Alternative 1 in terms of socioeconomic impacts. The same amount of revenue would be generated though the purchase of fishing-related goods and supplies, retention of local guiding services, and purchase of food and lodging (Section 3.6, Socioeconomics). However, over the long term, there would be increased tribal steelhead harvest under Alternative 2 when compared to Alternative 1, which would provide a moderate benefit to the tribes as steelhead become more prevalent component of their diet and support tribal identity, health, individual identity, culture, spirituality, religion, emotional well-being, and economy.

4.4.3. Alternative 3 (Additional Conservation Measures)

Under Alternative 3, additional conservation measures would be implemented, and fishing pressure for state-managed recreational steelhead fisheries would be reduced 40 percent. Therefore, relative to Alternative 1, there would be fewer anglers, which may result in a low adverse impact compared to Alternative 1 and 2 as less revenue is generated through the purchase of fishing-related goods and supplies, retention of local guiding services, and purchase of food and lodging (Section 3.6, Socioeconomics).

Tribal fisheries under Alternative 3 would occur as under Alternative 1, so there would be no anticipated socioeconomic benefit to the tribes relative to current conditions. This alternative would not provide for sustenance and does not support tribal identity, health, individual identity, culture, spirituality, religion, emotional well-being, and economy. The socioeconomic benefits of Alternative 3 would be less than under Alternative 2 because tribal steelhead fisheries would be expanded over time under Alternative 2.

4.4.4. Alternative 4 (Close Steelhead Fisheries)

Under Alternative 4, recreational steelhead fisheries would close. Therefore, relative to Alternative 1, 2 and 3, there would be fewer anglers in the project area and less revenue would be generated through the purchase of fishing-related goods and supplies, retention of local guiding services, and purchase of food and lodging (Section 3.6, Socioeconomics). This would be expected to have a moderate adverse socioeconomic impact on non-tribal communities in the project area. As described in Section 3.6, Socioeconomics, the steelhead fishery is estimated to contribute over $31 million in the Clearwater communities alone.

Under Alternative 4, tribal steelhead fisheries would also close. Therefore, compared to Alternatives 1, 2, and 3, Alternative 4 would have a moderate adverse impact to tribal socioeconomics because the tribes would not have the ability to engage in treaty-reserved steelhead fishing and related activities that are culturally, spiritually, economically, and symbolically important to the tribes (Section 3.6, Socioeconomics).

4.4.5. Alternative 5 (Increased Allowable Impact Rates)

Under Alternative 5, the overall allowable harvest impact rate on natural-origin steelhead would increase when natural-origin abundances are high (i.e., abundance exceeds MAT). When natural-origin steelhead abundance is below MAT, harvest would be the same as under Alternative 2 but greater than under Alternatives 1, 3, and 4. However, when abundance exceeds MAT, harvest would be increased over the levels in Alternative 2 and likely provide socioeconomic benefits to both tribal and non-tribal communities though increased revenue generated through the purchase of fishing related goods and supplies, retention of local guiding services, and purchase of food and lodging. The magnitude of benefit would likely be proportional to the abundance of steelhead. That is, when the abundance of steelhead greatly exceeds MAT, the socioeconomic benefits would likely be greater than when the abundance of steelhead is only a little above MAT. In addition, under Alternative 5 and when natural-origin steelhead abundance is above MAT, tribes would be able to engage in more steelhead fishing and related activities that are culturally, spiritually, economically, and symbolically important to the tribes (Section 3.6, Socioeconomics). This alternative would allow the tribes to improve access and increase harvest of fish and support fair sharing of that harvest at higher abundances.

4.5. Environmental Justice

The overall effects of the alternatives on environmental justice are summarized in Table 30 and described in greater detail in Section 4.5.1 through 4.5.5.

Table 30. Summary of effects of the alternatives on environmental justice

Resource	Alternative 1	Alternative 2 – Proposed Action	Alternative 3 – Additional Conservation Measures	Alternative 4 – Close Steelhead Fisheries	Alternative 5 – Increased Allowable Impact Rates
Environmental justice	Continuation of baseline effect/Moderate beneficial	Moderate beneficial	Low adverse	Moderate adverse	Low beneficial

4.5.1. Alternative 1 (No Action)

Under Alternative 1, harvest would continue at existing levels. Therefore, there would be a continuation of baseline effects on environmental justice communities of concern as described in Section 3.5, Environmental Justice. In summary, under Alternative 1, harvest of steelhead, as limited as it may be, would continue to provide income for these communities of concern and provide fish for ceremonial and subsistence purposes, particularly for Native Americans. Therefore, Alternative 1 would provide a moderate beneficial effect to environmental justice communities of concern.

4.5.2. Alternative 2 (Proposed Action)

Under Alternative 2, harvest of steelhead could gradually increase over time as tribes grow their steelhead fisheries. This would be expected to result from improved access to "usual and accustomed" fishing places and increased tribal fishing effort and catch. As a result, in the near term, there would likely be no difference between Alternative 2 and Alternative 1. However, over the long term, there would likely be more likely be more tribal fishing on steelhead under Alternative 2 when compared to Alternative 1. Therefore, this alternative would likely have a moderate beneficial effect on tribes in the project area.

4.5.3. Alternative 3 (Additional Conservation Measures)

Under Alternative 3, additional conservation measures would be implemented, and fishing pressure would be reduced 40 percent. Therefore, compared to Alternatives 1 and 2, there would be fewer anglers and less economic activity derived from steelhead fishing in the spring season, which may result in low adverse effects to environmental justice communities of concern that rely on steelhead fishing to generate jobs and income during that time.

4.5.4. Alternative 4 (Close Steelhead Fisheries)

Under Alternative 4, steelhead fisheries would close. Therefore, compared to alternatives 1, 2, and 3, there would be a moderate negative effect to environmental justice communities of concern that rely on steelhead fishing to generate jobs and income. It is not clear what effect this reduced expenditure would have on the median income in the communities of concern, but a reduction in activities that use locally owned or operated businesses would be expected to have an adverse impact on many of the members of these environmental justice communities of concern. Under Alternative 4, there would not be any steelhead for ceremonial and subsistence purposes.

4.5.5. Alternative 5 (Increased Allowable Impact Rates)

Under Alternative 5, the allowable harvest impact rate on natural-origin steelhead would increase when natural-origin abundances are high (i.e., abundance exceeds MAT). When natural-origin steelhead abundance is under MAT, harvest would occur as under Alternative 2. Relative to Alternative 1, 2, 3, and 4, the effects of Alternative 5 would be beneficial to environmental justice communities of concern as they would likely be able to increase income from steelhead fisheries when abundance levels are high and increase ceremonial and subsistence harvest. However, because these additional benefits would only occur in years with high steelhead abundance, this alternative would only provide low beneficial effects on environmental justice communities of concern relative to the baseline conditions.

5. CUMULATIVE EFFECTS

5.1. Introduction

NEPA defines cumulative effects as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) or person undertakes such other actions" (40 CFR 1508.7). Section 3, Affected Environment, describes the baseline conditions for each resource and reflects the effects of past and existing actions (including hydropower, habitat loss, harvest, and hatchery production). Section 4, Environmental Consequences, evaluates the direct and indirect effects of the alternatives on each resource's baseline condition. Section 5, Cumulative Effects, now considers the cumulative effects of impact of Section 4, Environmental Consequences, presents the incremental impacts of Snake River steelhead harvest alternatives on a range of resources. The direct and indirect effects of each alternative on each resource's status quo conditions are presented in Section 3, Affected Environment. Section 5, Cumulative Effects, now further considers the cumulative effects of each alternative in the context of past actions, present action, and reasonably foreseeable future actions and conditions.

Section 5.2, Future Foreseeable Actions, summarizes the anticipated effects from foreseeable future actions and conditions that may influence the resources in our project area. Expected future actions include proposed developments and planned habitat restoration activities. Climate change is an effect of past, present, and future actions that may have a cumulative effect on resources in the project area.

The baseline conditions, as described in the resource subsections in Section 3, include influences from historical and current conditions. Human uses and development have had substantial influences on the area. Human presence in the project area dates back more than 10,000 years when the Columbia River was the dominant contributor of food, water, and transportation for humans. Presently, the primary influencing factors on the Columbia and Snake Rivers are the dams that provide electrical power, flood control, and navigational opportunities, as well as supporting agricultural needs, while simultaneously resulting in long-term environmental impacts on aquatic life.

Our understanding of the operation of the hydrosystem and its related cumulative effects as they pertain to resources in the basin are informed by documents evaluating these effects that have been previously completed for the Columbia Basin. These documents include:

- NMFS' Supplemental Comprehensive Analysis (SCA) (NMFS 2008c);
- NMFS's 2008 Biological Opinion on the Federal Columbia River Hydropower System (NMFS 2008b);
- NMFS' 2010 supplemental Biological Opinion and Adaptive Management Implementation Plan (AMIP) (NMFS 2009);
- NMFS' 2014 Biological Opinion on the Federal Columbia River Hydropower System (NMFS 2014a).

Negative effects of hydropower infrastructure and operations are inevitable. The nature and magnitude of the effects vary, depending on the hydropower system operation, management, and specific location of the hydropower infrastructure. In the project area, some of these effects from hydropower systems on salmon and steelhead that have been factored into this cumulative effects analysis include, but are not limited to:

- Juvenile and adult passage mortality at the eight run-of-river mainstem dams on the mainstem Snake and Columbia Rivers (safe passage in the migration corridor);
- Water quantity (i.e., flow) and seasonal timing (water quantity and velocity and safe passage in the migration corridor; cover/shelter, food/prey, riparian vegetation, and space associated with the connectivity of the estuarine floodplain);
- Temperature in the reaches below the large mainstem storage projects (water quality and safe passage in the migration corridor) and in the mainstem migration corridors;
- Sediment transport and turbidity (water quality and safe passage in the migration corridor);
- Total dissolved gas (water quality and safe passage in the migration corridor);

- Food webs, including both predators and prey (food/prey and safe passage in the migration corridor).

Associated development and human uses have also impacted the Columbia River ecosystem. These factors include port improvements, dredging, fishing[17], urban pollution, and channelization. We are informed by these types of impacts through recovery planning documents such as:

- Columbia River Estuary ESA Recovery Plan Module for Salmon and Steelhead (NMFS 2011);
- Recovery Plan for Lower Columbia Chinook Salmon, Lower Columbia Coho, Columbia River Chum and Lower Columbia Steelhead (NMFS 2013b);
- Upper Columbia Spring-run Chinook and Upper Columbia Steelhead Recovery Plan (UCSRB 2007);
- Snake River Sockeye Salmon Recovery Plan (NMFS 2015a);
- Snake River fall Chinook Salmon Recovery Plan (NMFS 2017a);
- Snake River Spring/Summer Chinook Salmon and Steelhead Recovery Plan (NMFS 2017b).

With the exception of Snake River fall-run Chinook salmon, which generally spawn and rear in the mainstem, salmon and steelhead spawning and rearing habitat is found in tributaries to the Snake River. The quality and quantity of habitat in many Snake River Basin watersheds has declined dramatically in the last 150 years. Forestry, farming, grazing, road construction, hydro system development, mining, and urbanization have changed the historical habitat conditions.

In Appendix B of the *U.S. v OR* FEIS, we reviewed all impacts associated with hatchery effects, and those include: impacts to population viability, impacts on abundance and productivity, impacts on genetic diversity when hatchery fish spawn with wild fish or wild fish are included in hatchery broodstocks, impacts on spatial structure, ecological impacts, and hatchery facility impacts. These impacts are integrated into the analysis of baseline conditions presented in Section 3, effects of the alternatives presented in Section 4, and the cumulative effects presented in Section 5.3. In addition, they can be found in Appendix A of this EA.

The *U.S. v OR* FEIS considered the broader effects of fisheries across the Columbia River Basin, and how in total those fisheries affect the human environment within and beyond the smaller project area for this action. Those effects are described in detail in the *U.S. v OR* FEIS and incorporated into the affected environment sections of this EA (see Section 3).

Total avian predation on steelhead, including Snake River steelhead, is very high. Figure 9

[17] With respect to salmon and steelhead harvest, the broad effects are analyzed more comprehensively in the *U.S. v. Oregon* FEIS, which has been incorporated in its entirety here to focus the analysis of the proposed action.

shows the percentage of PIT tagged Snake River steelhead smolts last detected at Bonneville Dam consumed by Caspian terns in the Columbia River estuary at East Sand Island (TAC 2016). Additionally large numbers of steelhead are consumed by double breasted cormorants in the estuary as well. The average predation rate on PIT-tagged Snake River steelhead last detected at Bonneville Dam from 2007-2017 by cormorants in the estuary was 9.8% (Blaine Parker, CRITFC, personal communication).

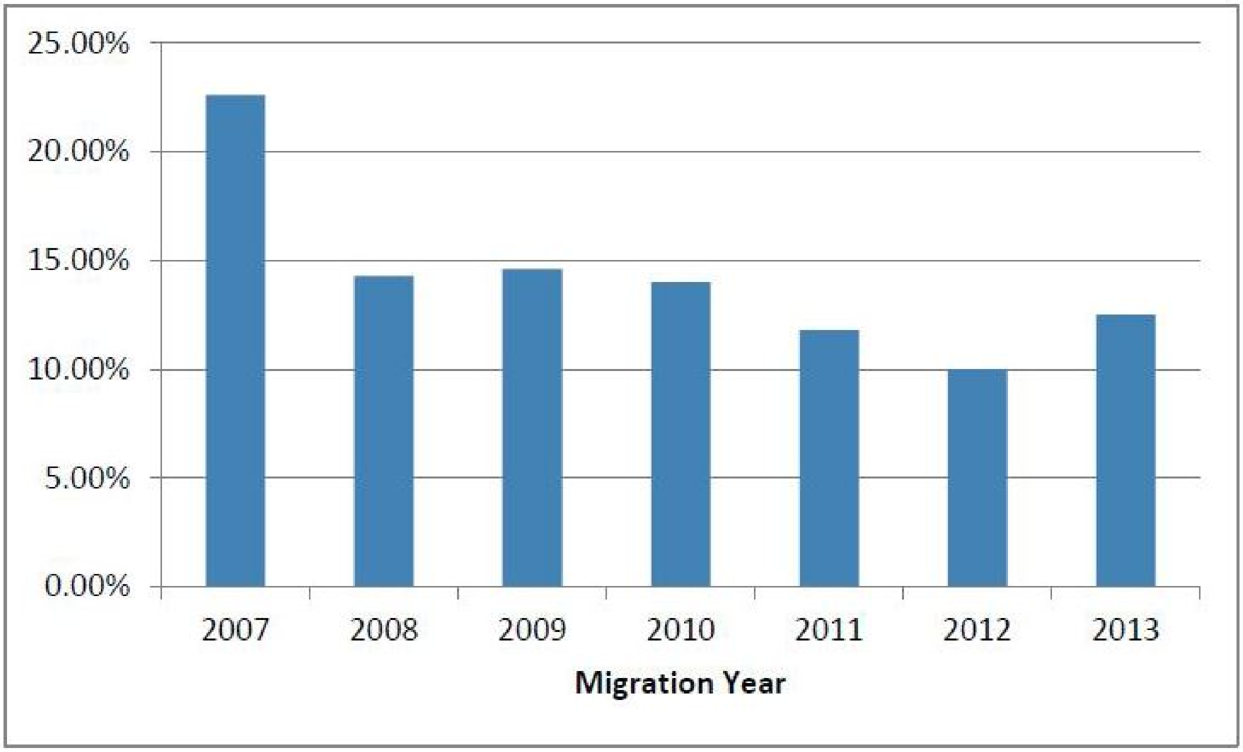

Figure 9. Percentage of PIT tagged Snake River Steelhead (all stocks) detected at Bonneville Dam consumed by Caspian Terns at East Sand Island. Source (TAC 2016).

5.2. Future Foreseeable Actions

Future effects of climate change are discussed, as are the effects of development and proposed or ongoing projects, and habitat restoration and protection of salmon and steelhead efforts. Each of the above topics is described in terms of effects on resources in the project area.

5.2.1. Climate Change

One factor affecting all species managed under a new *U.S. v. Oregon* agreement, and aquatic habitat at large is climate change. The U.S. Global Change Research Program (USGCRP)[18], mandated by Congress in the Global Change Research Act of 1990, reports average warming of about 1.3ºF from 1895 to 2011 and projects an increase in average annual temperature of 3.3ºF to

[18] U.S Global Change Research Program

9.7ºF by 2070 to 2099 (CCSP 2014). Climate change has negative implications for habitats in the Pacific Northwest (Climate Impacts Group 2004; ISAB 2007a; Scheuerell and Williams 2005; Zabel et al. 2006). According to the Independent Scientific Advisory Board (ISAB)[19], these effects pose the following impacts into the future:

- Warmer air temperatures will result in diminished snowpack and a shift to more winter/spring rain and runoff, rather than snow that is stored until the spring/summer melt season.
- With a smaller snowpack, these watersheds will see their runoff diminished earlier in the season, resulting in lower stream-flows in the June through September period. River flows in general and peak river flows are likely to increase during the winter due to more precipitation falling as rain rather than snow.
- Water temperatures are expected to rise, especially during the summer months when lower stream-flows co-occur with warmer air temperatures.

These changes will not be spatially homogeneous across the entire Pacific Northwest. Low-lying areas are likely to be more affected. Climate change may have long-term effects that include, but are not limited to, depletion of important cold water habitat, variation in quality and quantity of tributary rearing habitat, alterations to migration patterns, accelerated embryo development, premature emergence of fry, and increased competition among species (ISAB 2007a).

Climate Change and Pacific Northwest Salmon

Climate change is predicted to cause a variety of impacts to Pacific salmon and their ecosystems (Crozier et al. 2008a; Martins et al. 2012; Mote et al. 2003; Wainwright and Weitkamp 2013). The complex life cycles of anadromous fishes including salmon rely on productive freshwater, estuarine, and marine habitats for growth and survival, making them particularly vulnerable to environmental variation (Morrison et al. 2016). Ultimately, the effect of climate change on salmon and steelhead across the Pacific Northwest will be determined by the specific nature, level, and rate of change and the synergy between interconnected terrestrial/freshwater, estuarine, nearshore and ocean environments.

The primary effects of climate change on Pacific Northwest salmon and steelhead are:

- direct effects of increased water temperatures of fish physiology
- temperature-induced changes to stream flow patterns
- alterations to freshwater, estuarine, and marine food webs

[19] The Independent Scientific Advisory Board (ISAB) serves the National Marine Fisheries Service (NOAA Fisheries), Columbia River Indian Tribes, and Northwest Power and Conservation Council by providing independent scientific advice and recommendations regarding scientific issues that relate to the respective agencies' fish and wildlife programs. https://www.nwcouncil.org/fw/isab/

- changes in estuarine and ocean productivity

While all habitats used by Pacific salmon will be affected, the impacts and certainty of the change vary by habitat type. Some effects (e.g., increasing temperature) affect salmon at all life stages in all habitats, while others are habitat specific, such as stream flow variation in freshwater, sea level rise in estuaries, and upwelling in the ocean. How climate change will affect each stock or population of salmon also varies widely depending on the level or extent of change and the rate of change and the unique life history characteristics of different natural populations (Crozier et al. 2008b). For example, a few weeks difference in migration timing can have large differences in the thermal regime experienced by migrating fish (Martins et al. 2011). This is illustrated by events in 2015 when over 475,000 Upriver Sockeye entered the Columbia River, but only two percent of sockeye counted at Bonneville Dam survived to their spawning grounds. Most died in river beginning in June when the water warmed to above 68 degrees, the temperature at which salmon begin to die. In July, temperatures reached 73 degrees due to elevated temperatures associated with lower snow pack from the previous winter and drought conditions exacerbate due to increased occurrences of warm weather patterns.

Temperature Effects

Like most fishes, salmon are poikilotherms (cold-blooded animals), therefore increasing temperatures in all habitats can have pronounced effects on their physiology, growth, and development rates (see review by (Whitney et al. 2016)). Increases in water temperatures beyond their thermal optima will likely be detrimental through a variety of processes including: increased metabolic rates (and therefore food demand), decreased disease resistance, increased physiological stress, and reduced reproductive success. All of these processes are likely to reduce survival (Beechie et al. 2013; Wainwright and Weitkamp 2013; Whitney et al. 2016). As examples of this, high mortality rates for adult sockeye salmon in the Columbia River have recently been attributed to higher water temperatures and likewise in the Fraser River, as increasing temperatures during adult upstream migration are expected to result in increased mortality of sockeye salmon adults by 9 to 16 percent by century's end (Martins et al. 2011). Juvenile parr-to-smolt survival of Snake River Chinook salmon are predicted to decrease by 31 to 47 percent due to increased summer temperatures (Crozier et al. 2008b).

By contrast, increased temperatures at ranges well below thermal optima (i.e., when the water is cold) can increase growth and development rates. Examples of this include accelerated emergence timing during egg incubation stages, or increased growth rates during fry stages (Crozier et al. 2008a; Martins et al. 2012). Temperature is also an important behavioral cue for migration (Sykes et al. 2009), and elevated temperatures may result in earlier-than-normal migration timing. While there are situations or stocks where this acceleration in processes or behaviors is beneficial, there are also others where it is detrimental (Martins et al. 2012; Whitney et al. 2016).

Freshwater Effects

As described previously, climate change is predicted to increase the intensity of storms, reduce winter snow pack at low and middle elevations, and increase snowpack at high elevations in northern areas. Middle and lower elevation streams will have larger fall/winter flood events and lower late summer flows, while higher elevations may have higher minimum flows. How these changes will affect freshwater ecosystems largely depends on their specific characteristics and location, which vary at fine spatial scales (Crozier et al. 2008b; Martins et al. 2012). For example, within a relatively small geographic area (Salmon River Basin, Idaho), survival of some Chinook salmon populations was shown to be determined largely by temperature, while others were determined by flow (Crozier and Zabel 2006). Certain salmon populations inhabiting regions that are already near or exceeding thermal maxima will be most affected by further increases in temperature and perhaps the rate of the increases while the effects of altered flow are less clear and likely to be basin-specific (Beechie et al. 2013; Crozier et al. 2008b). However, river flow is already becoming more variable in many rivers, and is believed to negatively affect anadromous fish survival more than other environmental parameters (Ward et al. 2015). It is likely this increasingly variable flow is detrimental to multiple salmon and steelhead populations, and likely multiple other freshwater fish species in the Columbia River Basin as well.

Stream ecosystems will likely change in response to climate change in ways that are difficult to predict (Lynch et al. 2016). Changes in stream temperature and flow regimes will likely lead to shifts in the distributions of native species and provide "invasion opportunities" for exotic species. This will result in novel species interactions including predator-prey dynamics, where juvenile native species may be either predators or prey (Lynch et al. 2016; Rehage and Blanchard 2016). How juvenile native species will fare as part of "hybrid food webs," which are constructed from natives, native invaders, and exotic species, is difficult to predict (Naiman et al. 2012).

There are several studies that have applied a model to understand the implications of climate change on Salmon River Basin hydrology and have found that warming results in an earlier shift in the timing of the snowmelt peak (Sridhar et al. 2013; Tang and Lettenmaier 2012).

Estuarine Effects

In estuarine environments, the two big concerns associated with climate change are rates of sea level rise and temperature warming (Limburg et al. 2016; Wainwright and Weitkamp 2013). Estuaries will be affected directly by sea-level rise: as sea level rises, terrestrial habitats will be flooded and tidal wetlands will be submerged (Kirwan et al. 2010; Limburg et al. 2016; Wainwright and Weitkamp 2013). The net effect on wetland habitats depends on whether rates of sea-level rise are sufficiently slow that the rates of marsh plant growth and sedimentation can compensate (Kirwan et al. 2010).

Due to subsidence, sea level rise will affect some areas more than others, with the largest effects expected for the lowlands, like southern Vancouver Island and central Washington coastal areas (Lemmen et al. 2016; Verdonck 2006). The widespread presence of dikes in Pacific Northwest estuaries will restrict upward estuary expansion as sea levels rise, likely resulting in a near-term loss of wetland habitats for salmon (Wainwright and Weitkamp 2013). Sea level rise will also result in greater intrusion of marine water into estuaries, resulting in an overall increase in salinity, which will also contribute to changes in estuarine floral and faunal communities (Kennedy 1990). While not all anadromous fish species are generally highly reliant on estuaries for rearing, extended estuarine use may be important in some populations, especially if stream habitats are degraded and become less productive.

Marine Impacts

In marine waters, increasing temperatures are associated with observed and predicted poleward range expansions of fish and invertebrates in both the Atlantic and Pacific oceans (Asch 2015; Cheung et al. 2015; Lucey and Nye 2010). Rapid poleward species shifts in distribution in response to anomalously warm ocean temperatures have been well documented in recent years, confirming this expectation at short time scales. Range extensions were documented in many species from southern California to Alaska during unusually warm water associated with "The Blob" in 2014 and 2015 (Bond et al. 2015; Di Lorenzo and Mantua 2016), and past strong El Niño events (Fisher et al. 2015; Pearcy 2002).

Exotic species benefit from these extreme conditions to increase their distributions. Green crab (*Carcinus maenas*) recruitment increased in Washington and Oregon waters during winters with warm surface waters, including 2014 (Yamada et al. 2015). Similarly, Humboldt squid (*Dosidicus gigas*) dramatically expanded their range during warm years of 2004-2009 (Litz et al. 2011). The frequency of extreme conditions, such as those associated with El Niño events or "blobs" are predicted to increase in the future (Di Lorenzo and Mantua 2016).

As with changes to stream ecosystems, expected changes to marine ecosystems due to increased temperature, altered productivity, or acidification, will have large ecological implications through mismatches of co-evolved species and unpredictable trophic effects (Cheung et al. 2015; Rehage and Blanchard 2016). These effects will certainly occur, but predicting the composition or outcomes of future trophic interactions is not possible with the tools available at this time.

Pacific Northwest anadromous fish inhabit as many as three marine ecosystems during their ocean residence period: the Salish Sea, the California Current, and the Gulf of Alaska (Brodeur et al. 1992; Morris et al. 2007; Weitkamp and Neely 2002). The response of these ecosystems to climate change is expected to differ, although there is considerable uncertainty in all predictions. It is also unclear whether overall marine survival of anadromous fish in a given year depends on conditions experienced in one versus multiple marine ecosystems. Several are important to Columbia River Basin species, including the California Current and Gulf of Alaska.

Wind-driven upwelling is responsible for the extremely high productivity in the California Current ecosystem (Bograd et al. 2009; Peterson et al. 2014). Minor changes to the timing, intensity, or duration of upwelling, or the depth of water column stratification, can have dramatic effects on the productivity of the ecosystem (Black et al. 2014; Peterson et al. 2014). Current projections for changes to upwelling are mixed: some climate models show upwelling unchanged, but others predict that upwelling will be delayed in spring, and more intense during summer (Rykaczewski et al. 2015). Should the timing and intensity of upwelling change in the future, it may result in a mismatch between the onset of spring ecosystem productivity and the timing of salmon entering the ocean, and a shift towards food webs with a strong sub-tropical component (Bakun et al. 2015).

Columbia River anadromous fish also use coastal areas of British Columbia and Alaska, and mid-ocean marine habitats in the Gulf of Alaska, although their fine-scale distribution and marine ecology during this period are poorly understood (Morris et al. 2007; Pearcy and McKinnell 2007). Increases in temperature in Alaskan marine waters have generally been associated with increases in productivity and salmon survival (Mantua et al. 1997; Martins et al. 2012), thought to result from temperatures that have been below thermal optima (Gargett 1997). Warm ocean temperatures in the Gulf of Alaska are also associated with intensified downwelling and increased coastal stratification, which may result in increased food availability to juvenile salmon along the coast (Hollowed et al. 2009; Martins et al. 2012). Predicted increases in freshwater discharge in British Columbia and Alaska may influence coastal current patterns (Foreman et al. 2014), but the effects on coastal ecosystems are poorly understood.

In addition to becoming warmer, the world's oceans are becoming more acidic as increased atmospheric CO_2 is absorbed by water. The North Pacific is already acidic compared to other oceans, making it particularly susceptible to further increases in acidification (Lemmen et al. 2016). Laboratory and field studies of ocean acidification show it has the greatest effects on invertebrates with calcium-carbonate shells and relatively little direct influence on finfish (see reviews by Haigh et al. (2015); Mathis et al. (2015). Consequently, the largest impact of ocean acidification on salmon will likely be its influence on marine food webs, especially its effects on lower trophic levels, which are largely composed of invertebrates (Haigh et al. 2015; Mathis et al. 2015).

Uncertainty in Climate Predictions

There is considerable uncertainty in the predicted effects of climate change on the globe as a whole, and on Pacific Northwest in particular and there is also the question of indirect effects of climate change and whether human "climate refugees" will move into the range of salmon and steelhead, increasing stresses on their respective habitats (Dalton et al. 2013; Poesch et al. 2016).

Many of the effects of climate change (e.g., increased temperature, altered flow, coastal productivity, etc.) will have direct impacts on the food webs that species examined in this analysis rely on in freshwater, estuarine, and marine habitats to grow and survive. Such ecological effects are extremely difficult to predict even in fairly simple systems, and minor differences in life history characteristics among stocks of salmon may lead to large differences in their response (e.g., Crozier et al. (2008b); Martins et al. (2011); Martins et al. (2012)). This means it is likely that there will be "winners and losers" meaning some salmon populations may enjoy different degrees or levels of benefit from climate change while others will suffer varying levels of harm.

Pacific anadromous fish are adapted to natural cycles of variation in freshwater and marine environments, and their resilience to future environmental conditions depends both on characteristics of each individual population and on the level and rate of change. They should be able to adapt to some changes, but others are beyond their adaptive capacity (Crozier et al. 2008a; Waples et al. 2009). With their complex life cycles, it is also unclear how conditions experienced in one life stage are carried over to subsequent life stages, including changes to the timing of migration between habitats. Systems already stressed due to human disturbance are less resilient to predicted changes than those that are less stressed, leading to additional uncertainty in predictions (Bottom et al. 2011; Naiman et al. 2012; Whitney et al. 2016).

Climate change is expected to impact Pacific Northwest anadromous fish during all stages of their complex life cycle. In addition to the direct effects of rising temperatures, indirect effects include alterations in stream flow patterns in freshwater and changes to food webs in freshwater, estuarine and marine habitats. There is high certainty that predicted physical and chemical changes will occur; however, the ability to predict bio-ecological changes to fish or food webs in response to these physical/chemical changes is extremely limited, leading to considerable uncertainty.

In conclusion, the current literature supports previous concerns that natural climatic variability can amplify and exacerbate long-term climate change impacts. Recent estimates of rates of climate change are similar to those previously published. Anthropogenic climate change will likely to varying degrees affect all west coast fish species, especially when interacting factors are incorporated (e.g., existing threats to populations, water diversion, accelerated mobilization of contaminants, hypoxia, and invasive species). However, through historic selective processes native fish species have adapted their behavior and physiology to inhabit available habitat ranging from southern California up to the Alaskan western coastline. This process by which animals native to the Pacific Northwest are adapted to natural cycles of variation in freshwater and marine environments required a certain degree of plasticity, and may show resilience to future environmental conditions that mimic this natural variation. While climate change effects will certainly result in changes, it is unlikely that specifics are possible to predict. Alternate life history types, such as those associated with extended lake or estuarine rearing, provide an important component of the species diversity with which to guard against an uncertain future. However, the life history types that will be successful in the future is neither static nor predictable, therefore maintaining or promoting existing diversity that is specifically found in the natural populations of Pacific anadromous fish is essential for continued existence of populations into the future (Bottom et al. 2011; Schindler et al. 2010).

5.2.2. Development Projects

Development that has occurred within the Columbia River Basin over the past decade has affected the abundance, distribution, and health of hatchery-origin and natural-origin salmon and steelhead, other fish, economics, wildlife populations, and water quantity and quality. Provided below is a bulleted list of these development trends taken from ISAB (2007b) and (LCREP 2007)

Human populations are increasing primarily in urban metropolitan areas, with smaller increases in rural areas. Increases in demand for water, land, power, agriculture, roads, and housing are associated with this growth. Human Population Growth and Development along the Columbia River Basin Approximately 6 million people live in the Columbia River Basin, concentrated largely in urban parts of the lower Columbia River and the Willamette Valley. The population is presently expanding and is likely to continue to grow in the foreseeable future.

- Human population growth and development can be expressed as potential increases in discharges of pollutants in stormwater runoff from residential, commercial, industrial, agricultural, recreational, and transportation land uses. These are all sources of contaminants that currently degrade water quality and are likely to continue along similar historical trends while recognizing that any improvements through regional planning processes, which promote more open spaces and require stormwater treatment for new construction will likely be offset by the net level of growth.
- Freshwater withdrawals for domestic, industrial, commercial, and public uses are increasing, whereas withdrawals for irrigation purposes are decreasing due to the conversion of agricultural lands to residential areas.
- Forests are being converted for development, which is resulting in forest fragmentation.
- Mining, trade and transportation projects influence the hydrology, water quality, and use of the Columbia River system. As a major river navigation route, the Columbia-Snake Inland Waterway provides shipping access from the Pacific Ocean to Lewiston, Idaho, 465 miles inland.
- Mining in the Columbia River Basin is focused on sand and gravel with the removal occurring along or within rivers.
- Globalization of trade has contributed to the loss of trade in some areas (e.g., the Mexico strawberry market) and to the increase in trade in other areas (e.g., increased Columbia River Basin wine production due to Australian droughts).
- An increase in ship traffic is likely to occur because of Columbia River channel-deepening projects.
- New port infrastructure projects continue to result in loss of aquatic habitat.

- Hazardous materials transport and airborne pollution have been increasing in the Columbia River Basin.

5.2.3. Habitat Restoration and Protection of Salmonids

Throughout the Columbia River Basin, habitat restoration efforts are supported by Federal, state, and local agencies; tribes; environmental organizations; and communities. Projects supported by these entities focus on improving general habitat and ecosystem function or species-specific conservation objectives that, in some cases, are identified through ESA recovery plans. The larger, more region-wide, restoration and conservation efforts, either underway or planned throughout the Columbia River Basin, are presented below. These actions have helped restore habitat, improve fish passage, and reduce pollution. While these efforts are reasonably likely to occur, funding levels may vary on an annual basis. These include:

- National Oceanic and Atmospheric Administration (NOAA) – Community-based Restoration Program (CRP).
- NMFS – Pacific Coastal Salmon Recovery Fund (PCSRF), Columbia and Snake Rivers.
- Northwest Power Planning and Conservation Council – Fish and Wildlife Program, Columbia and Snake Rivers.
- State of Idaho – ESA Section 6 Cooperative Agreement.
- State of Oregon – Oregon Plan for Salmon and Watersheds.
- State of Washington – Governor’s Salmon Recovery Office.
- Miscellaneous Funding Sources – Regional and Local Habitat Restoration and Conservation Support.
- USACE – Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary, Oregon.

5.3. Effects from Future Actions

Here we discuss effects of all expected future actions within the action area focusing on the additional effects of each alternative in the context of future climate change when combined with future actions. Section 3, Affected Environment, describes how past and present conditions have influenced resources in the project area. These conditions represent effects from many years of development, as well as habitat restoration, hydropower operations, existing hatchery production. The expected impacts of the alternatives on resources in the project area are described in Section 4, Environmental Consequences. Future Foreseeable Actions are described in Subsection 5.2. This section considers impacts that may occur as a result of any one of the alternatives being implemented at the same time as other anticipated future actions and presents information in the context of future climate change. This section only discusses future effects that have not already been described and evaluated in Section 4, Environmental Consequences.

5.3.1. Wildlife

Climate change and development in the Columbia River Basin is likely to reduce the abundance and productivity of natural-origin salmon and steelhead populations. Reduction in adult fish abundance would likely have an additional low negative impact on wildlife by reducing available prey. Overall, the total number of salmon and steelhead available as prey to wildlife may be lower than that considered in Section 4.1, Wildlife, for all alternatives if climate change effects are more pronounced than anticipated. Reduced abundance of salmon and steelhead would also decrease the number of salmon and steelhead carcasses available to wildlife for scavenging and for nutrient contribution to the freshwater system. The potential benefits of restoration actions within the basin are difficult to quantify. It is unknown whether these actions would fully, or even partially, mitigate for the impacts of climate change and development on salmon and steelhead abundances. Therefore, it is difficult to estimate future trends in available prey bases for wildlife and available nutrient contributions to the freshwater system. Again, however, localized microclimate fish habitat improvements may be realized from these restoration actions. This potential benefit would be experienced in the future by wildlife that reside in the same localized ecosystems. However, when aggregated with the impacts of past, present, and reasonably foreseeable future actions affecting wildlife in the project area, the proposed action and its alternatives would make a minor additive contribution to cumulative negative impacts of reducing prey availability, via harvest removal, on wildlife.

5.3.2. Fish

According to ISAB (2007a), the effects of future climate change on salmonids would vary among species and with life history stages, but they potentially may affect virtually every species and life history stage of salmonids in the Columbia River Basin. Rising temperatures will increase disease and/or mortality in several iconic salmon species, especially for spring/summer Chinook salmon and sockeye salmon in the interior Columbia and Snake River Basins. This is because increases in water temperature are known to increase stress on these salmonid species thereby reducing their immune response and dually also provide positive conditions for pathogen incubation that is known to be harmful to these salmonid species. As a result, populations that spawn and rear in higher elevation habitat may be increasingly important in the future.

All alternatives, except Alternative 4, remove steelhead from the spawning population. However, Alternatives 2, 3, and 5 would reduce impacts to natural-origin steelhead if abundance fell below a critical abundance threshold. Therefore, Alternatives 2 through 5 would be able to adaptively mitigate to future conditions if they result in a decline in natural-origin steelhead abundance relative to current conditions.

Under Alternative 3 and Alternative 4, steelhead fisheries would be reduced or eliminated. Because most of the steelhead fisheries only harvest hatchery-origin fish, these alternative would result in a higher proportion of hatchery-origin fish spawning naturally. Consequently, these alternatives may lead to a decline in the genetic diversity of steelhead populations over time, which may result in the steelhead populations being less able to adapt to the changing environmental conditions anticipated because of future climate change.

Under Alternative 5, the fisheries would operate under a higher harvest rate when steelhead abundance is high. However, if under future conditions, steelhead abundance declines, harvest would not be increased under this alternative, so there would be no additional cumulative effects on steelhead that were not already discussed in Section 4, Environmental Consequences.

Impacts of the alternatives on other listed and non-listed fish species are low to negligible (Section 4.2, Fish). Under future conditions, these fish species may experience additional stress from higher temperatures and other conditions associated with climate change. The additional stress may lead to reduced abundance if the fish succumb to disease or suffer from a disruption of their food supply. However, the alternatives evaluated in this EA would be expected to make only a minor additive contribution to cumulative effects on these species.

5.3.3. Vegetation

The potential benefits and risk to vegetation as a result of future climate change, development, or restoration activities is difficult to predict. As a result of changing climate, there may be a transition in the prevalence of plant species found along the riverbank. However, the effects of the alternatives on vegetation are expected to be negligible, and these effects are not likely to change when aggregated with the impacts of past, present, and reasonably foreseeable future actions affecting vegetation in the project area.

5.3.4. Socioeconomics

If future conditions result in an overall reduction in abundance of steelhead in the Snake River and populations fall below their critical abundance thresholds, fisheries will be adaptively managed under Alternative 2, Alternative 3, and Alternative 5 to reduce impacts on natural-origin steelhead. These changes may result in adverse impacts to the socioeconomics of communities that rely on steelhead fisheries. There would be no steelhead fisheries under Alternative 4 regardless of the status of the steelhead populations. Therefore, Alternative 4 would not result in additional cumulative effects on socioeconomics that were not already discussed in Section 4.4, Socioeconomics. Alternative 1 would not reduce harvest rates when abundance levels fall below critical abundance thresholds. Therefore, Alternative 1 is not expected to have any additional cumulative effect on socioeconomics that were not already discuss in Section 4.4, Socioeconomics.

5.3.5. Environmental Justice

The environmental justice communities of concern within the Snake River project area include low income, minority populations, and Native Americans (Section 3.5, Environmental Justice). Harvest of steelhead increases income for these communities of concern and provides fish for ceremonial and subsistence purposes, particularly for Native Americans who benefit from an economic, subsistence, and ceremonial perspective. If future conditions result in an overall reduction in abundance of steelhead in the Snake River and populations fall below their critical abundance thresholds, fisheries will be adaptively managed under Alternative 2, Alternative 3, and Alternative 5 to reduce impacts on natural-origin steelhead. These changes would result in adverse impacts to environmental justice communities of concern that rely on steelhead fisheries. These adverse effects are a continued reduction in the number of salmon and steelhead available for the tribe's ceremonial and subsistence harvest and may result in a deterioration in cultural practices and the erosion of salmon and steelhead as a core symbol of tribal identity, health, individual identity, culture, spirituality, religion, emotional well-being, and economy.

There would be no steelhead fisheries under Alternative 4 regardless of the status of the steelhead populations. Therefore, Alternative 4 would not result in additional cumulative effects on environmental justice communities of concern that were not already discussed in Section 4.5, Environmental Justice. Alternative 1 would not reduce harvest rates when abundance levels fall below critical abundance thresholds. Therefore, Alternative 1 is not expected to have any additional cumulative effect on environmental justice communities of concern that were not already discuss in Section 4.5, Environmental Justice.

6. LIST OF AGENCIES AND PERSONS CONSULTED

During development of this EA, NMFS consulted with the following Tribes, agencies, and organizations:

- IDFG
- WDFW
- ODFW
- Nez Perce Tribe
- Shoshone Bannock Tribes
- Confederated Tribes of the Umatilla Indian Reservation
- United States Fish and Wildlife Service

APPENDIX A: FACTORS CONSIDERED WHEN ANALYZING HATCHERY EFFECTS

NMFS' analysis of the Proposed Action is in terms of effects the Proposed Action would be expected to have on ESA-listed species and on designated critical habitat, based on the best scientific information available. The effects, positive and negative, for the two categories of hatchery programs are summarized in Table 3126. Generally speaking, effects range from beneficial to negative when programs use local fish[20] for hatchery broodstock, and from negligible to negative when programs do not use local fish for broodstock[21]. Hatchery programs can benefit population viability, but only if they use genetic resources that represent the ecological and genetic diversity of the target or affected natural population(s). When hatchery programs use genetic resources that do not represent the ecological and genetic diversity of the target or affected natural population(s), NMFS is particularly interested in how effective the program will be at isolating hatchery fish and at avoiding co-occurrence and effects that potentially disadvantage fish from natural populations. NMFS applies available scientific information, identifies the types of circumstances and conditions that are unique to individual hatchery programs, then refines the range in effects for a specific hatchery program. Analysis of a Proposed Action for its effects on ESA-listed species and on designated critical habitat depends on six factors. These factors are:

(1) the hatchery program does or does not remove fish from the natural population and use them for hatchery broodstock,
(2) hatchery fish and the progeny of naturally spawning hatchery fish on spawning grounds and encounters with natural-origin and hatchery fish at adult collection facilities,
(3) hatchery fish and the progeny of naturally spawning hatchery fish in juvenile rearing areas, the migration corridor, estuary, and ocean,
(4) RM&E that exists because of the hatchery program,
(5) operation, maintenance, and construction of hatchery facilities that exist because of the hatchery program, and
(6) fisheries that exist because of the hatchery program, including terminal fisheries intended to reduce the escapement of hatchery-origin fish to spawning grounds.

The analysis assigns an effect for each factor from the following categories:

(1) positive or beneficial effect on population viability,
(2) negligible effect on population viability, and
(3) negative effect on population viability.

[20] The term "local fish" is defined to mean fish with a level of genetic divergence relative to the local natural population(s) that is no more than what occurs within the ESU or steelhead DPS (70 FR 37215, June 28, 2005).
[21] Exceptions include restoring extirpated populations and gene banks.

The effects of hatchery fish on ESU/DPS status will depend on which of the four VSP criteria are currently limiting the ESU/DPS and how the hatchery program affects each of the criteria (NMFS 2005). The category of effect assigned to a factor is based on an analysis of each factor weighed against each affected population's current risk level for abundance, productivity, spatial structure, and diversity, the role or importance of the affected natural population(s) in ESU or steelhead DPS recovery, the target viability for the affected natural population(s), and the environmental baseline including the factors currently limiting population viability.

Table 31. An overview of the range of effects on natural population viability parameters from the two categories of hatchery programs.

Natural population viability parameter	Hatchery broodstock originate from the local population and are included in the ESU or DPS	Hatchery broodstock originate from a non-local population or from fish that are not included in the same ESU or DPS
Productivity	**Positive to negative effect** Hatcheries are unlikely to benefit productivity except in cases where the natural population's small size is, in itself, a predominant factor limiting population growth (i.e., productivity) (NMFS 2004c).	**Negligible to negative effect** Productivity is dependent on differences between hatchery fish and the local natural population (i.e., the more distant the origin of the hatchery fish, the greater the threat), the duration and strength of selection in the hatchery, and the level of isolation achieved by the hatchery program (i.e., the greater the isolation, the closer to a negligible effect).
Diversity	**Positive to negative effect** Hatcheries can temporarily support natural populations that might otherwise be extirpated or suffer severe bottlenecks and have the potential to increase the effective size of small natural populations. On the other hand, broodstock collection that homogenizes population structure is a threat to population diversity.	**Negligible to negative effect** Diversity is dependent on the differences between hatchery fish and the local natural population (i.e., the more distant the origin of the hatchery fish, the greater the threat) and the level of isolation achieved by the hatchery program (i.e., the greater the isolation, the closer to a negligible effect).
Abundance	**Positive to negative effect** Hatchery-origin fish can positively affect the status of an ESU by contributing to the abundance of the natural populations in the ESU (70 FR 37204, June 28, 2005, at 37215). Increased abundance can also increase density dependent effects.	**Negligible to negative effect** Abundance is dependent on the level of isolation achieved by the hatchery program (i.e., the greater the isolation, the closer to a negligible effect), handling, RM&E, and facility operation, maintenance and construction effects.
Spatial Structure	**Positive to negative effect** Hatcheries can accelerate re-colonization and increase population spatial structure, but only in conjunction with remediation of the factor(s) that limited spatial structure in the first place. "Any benefits to spatial structure over the long term depend on the degree to which the hatchery stock(s) add to (rather than replace) natural populations" (70 FR 37204, June 28, 2005 at 37213).	**Negligible to negative effect** Spatial structure is dependent on facility operation, maintenance, and construction effects and the level of isolation achieved by the hatchery program (i.e., the greater the isolation, the closer to a negligible effect).

6.1. Factor 1. The hatchery program does or does not remove fish from the natural population and use them for hatchery broodstock

This factor considers the risk to a natural population from the removal of natural-origin fish for hatchery broodstock. The level of effect for this factor ranges from neutral or negligible to negative.

A primary consideration in analyzing and assigning effects for broodstock collection is the origin and number of fish collected. The analysis considers whether broodstock are of local origin and the biological pros and cons of using ESA-listed fish (natural or hatchery-origin) for hatchery broodstock. It considers the maximum number of fish proposed for collection and the proportion of the donor population tapped to provide hatchery broodstock. “Mining” a natural population to supply hatchery broodstock can reduce population abundance and spatial structure. Also considered here is whether the program “backfills” with fish from outside the local or immediate area. The physical process of collecting hatchery broodstock and the effect of the process on ESA-listed species is considered under Factor 2.

6.2. Factor 2. Hatchery fish and the progeny of naturally spawning hatchery fish on spawning grounds and encounters with natural-origin and hatchery fish at adult collection facilities

NMFS also analyzes the effects of hatchery fish and the progeny of naturally spawning hatchery fish on the spawning grounds. The level of effect for this factor ranges from positive to negative.

There are two aspects to this part of the analysis: genetic effects and ecological effects. NMFS generally views genetic effects as detrimental because we believe that artificial breeding and rearing is likely to result in some degree of genetic change and fitness reduction in hatchery fish and in the progeny of naturally spawning hatchery fish relative to desired levels of diversity and productivity for natural populations based on the weight of available scientific information at this time. Hatchery fish can thus pose a risk to diversity and to natural population rebuilding and recovery when they interbreed with fish from natural populations.

However, NMFS recognizes that beneficial effects exist as well, and that the risks just mentioned may be outweighed under circumstances where demographic or short-term extinction risk to the population is greater than risks to population diversity and productivity. Conservation hatchery programs may accelerate recovery of a target population by increasing abundance faster than may occur naturally (Waples 1999). Hatchery programs can also be used to create genetic reserves for a population to prevent the loss of its unique traits due to catastrophes (Ford et al. 2011).

NMFS also recognizes there is considerable debate regarding genetic risk. The extent and duration of genetic change and fitness loss and the short- and long-term implications and consequences for different species (i.e., for species with multiple life-history types and species subjected to different hatchery practices and protocols) remain unclear and should be the subject of further scientific investigation. As a result, NMFS believes that hatchery intervention is a legitimate and useful tool to alleviate short-term extinction risk, but otherwise managers should seek to limit interactions between hatchery and natural-origin fish and implement hatchery practices that harmonize conservation with the implementation of treaty Indian fishing rights and other applicable laws and policies (NMFS 2011d).

6.2.1. Genetic effects

Hatchery fish can have a variety of genetic effects on natural population productivity and diversity when they interbreed with natural-origin fish. Although there is biological interdependence between them, NMFS considers three major areas of genetic effects of hatchery programs: within-population diversity, outbreeding effects, and hatchery-induced selection. As we have stated above, in most cases, the effects are viewed as risks, but in small populations these effects can sometimes be beneficial, reducing extinction risks.

First, within-population genetic diversity is a general term for the quantity, variety, and combinations of genetic material in a population (Busack and Currens 1995). Within-population diversity is gained through mutations or gene flow from other populations (described below under outbreeding effects) and is lost primarily due to genetic drift, a random loss of diversity due to population size. The rate of loss is determined by the population's effective population size (N_e), which can be considerably smaller than its census size. For a population to maintain genetic diversity reasonably well, the effective size should be in the hundreds (e.g., Lande 1987), and diversity loss can be severe if N_e drops to a few dozen.

Hatchery programs, simply by virtue of creating more fish, can increase N_e. In very small populations, this increase can be a benefit, making selection more effective and reducing other small-population risks (e.g., Lacy 1987; Whitlock 2000; Willi et al. 2006). Conservation hatchery programs can thus serve to protect genetic diversity; several programs, such as the Snake River sockeye salmon program, are important genetic reserves. However, hatchery programs can also directly depress N_e by two principal methods. One is by the simple removal of fish from the population so that they can be used in the hatchery broodstock. If a substantial portion of the population is taken into a hatchery, the hatchery becomes responsible for that portion of the effective size, and if the operation fails, the effective size of the population will be reduced (Waples and Do 1994). Two is when N_e is reduced considerably below the census number of broodstock by using a skewed sex ratio, spawning males multiple times (Busack 2007), and by pooling gametes. Pooling semen is especially problematic because when semen of several males is mixed and applied to eggs, a large portion of the eggs may be fertilized by a single male (Gharrett and Shirley 1985; Withler 1988). An extreme form of N_e reduction is the Ryman-Laikre effect (Ryman et al. 1995; Ryman and Laikre 1991), when N_e is reduced through the return to the spawning grounds of large numbers of hatchery fish from very few parents. On the other hand, factorial mating schemes, in which fish are systematically mated multiple times, can be used to increase N_e (Busack and Knudsen 2007; Fiumera et al. 2004).

Inbreeding depression, another N_e-related phenomenon, is caused by the mating of closely related individuals (e.g., siblings, half-siblings, cousins). The smaller the population, the more likely spawners will be related. Related individuals are likely to contain similar genetic material, and the resulting offspring may then have reduced survival because they are less variable genetically or have double doses of deleterious mutations. The lowered fitness of fish due to inbreeding depression accentuates the genetic risk problem, helping to push a small population toward extinction.

Outbreeding effects, the second major area of genetic effects of hatchery programs, are caused by gene flow from other populations. Gene flow occurs naturally among salmon and steelhead populations, a process referred to as straying (Quinn 1993; Quinn 1997). Natural straying serves a valuable function in preserving diversity that would otherwise be lost through genetic drift and in re-colonizing vacant habitat, and straying is considered a risk only when it occurs at unnatural levels or from unnatural sources. Hatchery programs can result in straying outside natural patterns for two reasons. First, hatchery fish may exhibit reduced homing fidelity relative to natural-origin fish (Goodman 2005; Grant 1997; Jonsson et al. 2003; Quinn 1997), resulting in unnatural levels of gene flow into recipient populations, either in terms of sources or rates. Second, even if hatchery fish home at the same level of fidelity as natural-origin fish, their higher abundance can cause unnatural straying levels into recipient populations. One goal for hatchery programs should be to ensure that hatchery practices do not lead to higher rates of genetic exchange with fish from natural populations than would occur naturally (Ryman 1991). Rearing and release practices and ancestral origin of the hatchery fish can all play a role in straying (Quinn 1997).

Gene flow from other populations can have two effects. It can increase genetic diversity (e.g., Ayllon et al. 2006), which can be a benefit in small populations, but it can also alter established allele frequencies (and co-adapted gene complexes) and reduce the population's level of adaptation, a phenomenon called outbreeding depression (Edmands 2007; McClelland and Naish 2007). In general, the greater the geographic separation between the source or origin of hatchery fish and the recipient natural population, the greater the genetic difference between the two populations (ICTRT 2007), and the greater potential for outbreeding depression. For this reason, NMFS advises hatchery action agencies to develop locally derived hatchery broodstock. Additionally, unusual rates of straying into other populations within or beyond the population's MPG, salmon ESU, or a steelhead DPS can have an homogenizing effect, decreasing intrapopulation genetic variability (e.g.(Vasemagi et al. 2005), and increasing risk to population diversity, one of the four attributes measured to determine population viability. Reduction of within-population and among-population diversity can reduce adaptive potential.

The proportion of hatchery fish (pHOS)[22] among natural spawners is often used as a surrogate measure of gene flow. Appropriate cautions and qualifications should be considered when using this proportion to analyze outbreeding effects. Adult salmon may wander on their return migration, entering and then leaving tributary streams before spawning (Pastor 2004). These "dip-in" fish may be detected and counted as strays, but may eventually spawn in other areas, resulting in an overestimate of the number of strays that potentially interbreed with the natural population (Keefer et al. 2008). Caution must also be taken in assuming that strays contribute genetically in proportion to their abundance. Several studies demonstrate little genetic impact from straying despite a considerable presence of strays in the spawning population (Blankenship et al. 2007; Saisa et al. 2003). The causative factors for poorer breeding success of strays are likely similar to those identified as responsible for reduced productivity of hatchery-origin fish in general, e.g., differences in run and spawn timing, spawning in less productive habitats, and reduced survival of their progeny (Leider et al. 1990; Reisenbichler and McIntyre 1977; Williamson et al. 2010).

Hatchery-influenced selection (often called domestication), the third major area of genetic effects of hatchery programs, occurs when selection pressures imposed by hatchery spawning and rearing differ greatly from those imposed by the natural environment and causes genetic change that is passed on to natural populations through interbreeding with hatchery-origin fish. These differing selection pressures can be a result of differences in environments or a consequence of protocols and practices used by a hatchery program. Hatchery-influenced selection can range from relaxation of selection that would normally occur in nature, to selection for different characteristics in the hatchery and natural environments, to intentional selection for desired characteristics (Waples 1999).

Genetic change and fitness reduction resulting from hatchery-influenced selection depends on: (1) the difference in selection pressures; (2) the exposure or amount of time the fish spends in the hatchery environment; and (3) the duration of hatchery program operation (i.e., the number of generations that fish are propagated by the program). For an individual, the amount of time a fish spend in the hatchery mostly equates to fish culture. For a population, exposure is determined by the proportion of natural-origin fish in the hatchery broodstock, the proportion of natural spawners consisting of hatchery-origin fish (Ford 2002; Lynch and O'Hely 2001), and the number of years the exposure takes place. In assessing risk or determining impact, all three

[22] It is important to reiterate that as NMFS analyzes them, outbreeding effects are a risk only when the hatchery fish are from a different population than the naturally produced fish. If they are from the same population, then the risk is from hatchery-influenced selection.

factors must be considered. Strong selective fish culture with low hatchery-wild interbreeding can pose less risk than relatively weaker selective fish culture with high levels of interbreeding.

Most of the empirical evidence of fitness depression due to hatchery-influenced selection comes from studies of species that are reared in the hatchery environment for an extended period – one to two years – prior to release (Berejikian and Ford 2004). Exposure time in the hatchery for fall and summer Chinook salmon and Chum salmon is much shorter, just a few months. One especially well-publicized steelhead study (Araki et al. 2007; Araki et al. 2008), showed dramatic fitness declines in the progeny of naturally spawning Hood River hatchery steelhead. Researchers and managers alike have wondered if these results could be considered a potential outcome applicable to all salmonid species, life-history types, and hatchery rearing strategies, but researchers have not reached a definitive conclusion.

Besides the Hood River steelhead work, a number of studies are available on the relative reproductive success (RRS) of hatchery- and natural-origin fish (e.g., Berntson et al. 2011; Ford et al. 2012; Hess et al. 2012; Theriault et al. 2011). All have shown that, generally, hatchery-origin fish have lower reproductive success; however, the differences have not always been statistically significant and, in some years in some studies, the opposite was true. Lowered reproductive success of hatchery-origin fish in these studies is typically considered evidence of hatchery-influenced selection. Although RRS may be a result of hatchery-influenced selection, studies must be carried out for multiple generations to unambiguously detect a genetic effect. To date, only the Hood River steelhead (Araki et al. 2007; Christie et al. 2011) and Wenatchee spring Chinook salmon (Ford et al. 2012) RRS studies have reported multiple-generation effects.

Critical information for analysis of hatchery-induced selection includes the number, location, and timing of naturally spawning hatchery fish, the estimated level of gene flow between hatchery-origin and natural-origin fish, the origin of the hatchery stock (the more distant the origin compared to the affected natural population, the greater the threat), the level and intensity of hatchery selection and the number of years the operation has been run in this way. Efforts to control and evaluate the risk of hatchery-influenced selection are currently largely focused on gene flow between natural-origin and hatchery-origin fish[23]. The Interior Columbia Technical Recovery Team (ICTRT) developed guidelines based on the proportion of spawners in the wild consisting of hatchery-origin fish (pHOS) (Figure 10).

[23] Gene flow between natural-origin and hatchery-origin fish is often interpreted as meaning actual matings between natural-origin and hatchery-origin fish. In some contexts, it can mean that. However, in this document, unless otherwise specified, gene flow means contributing to the same progeny population. For example, hatchery-origin spawners in the wild will either spawn with other hatchery-origin fish or with natural-origin fish. Natural-origin spawners in the wild will either spawn with other natural-origin fish or with hatchery-origin fish. But all these matings, to the extent they are successful, will generate the next generation of natural-origin fish. In other words, all will contribute to the natural-origin gene pool.

More recently, the Hatchery Scientific Review Group (HSRG) developed gene-flow guidelines based on mathematical models developed by (Ford 2002) and by(Lynch and O'Hely 2001). Guidelines for isolated programs are based on pHOS, but guidelines for integrated programs are based also on a metric called proportionate natural influence (PNI), which is a function of pHOS and the proportion of natural-origin fish in the broodstock (pNOB)[24]. PNI is, in theory, a reflection of the relative strength of selection in the hatchery and natural environments; a PNI value greater than 0.5 indicates dominance of natural selective forces. The HSRG guidelines vary according to type of program and conservation importance of the population. When the underlying natural population is of high conservation importance, the guidelines are a pHOS of no greater than 5 percent for isolated programs. For integrated programs, the guidelines are a pHOS no greater than 30 percent and PNI of at least 67 percent for integrated programs (HSRG 2009). Higher levels of hatchery influence are acceptable, however, when a population is at high risk or very high risk of extinction due to low abundance and the hatchery program is being used to conserve the population and reduce extinction risk in the short-term. (HSRG 2004)offered additional guidance regarding isolated programs, stating that risk increases dramatically as the level of divergence increases, especially if the hatchery stock has been selected directly or indirectly for characteristics that differ from the natural population. The HSRG recently produced an update report (HSRG 2014) that stated that the guidelines for isolated programs may not provide as much protection from fitness loss as the corresponding guidelines for integrated programs.

[24] PNI is computed as pNOB/(pNOB+pHOS). This statistic is really an approximation of the true proportionate natural influence, but operationally the distinction is unimportant.

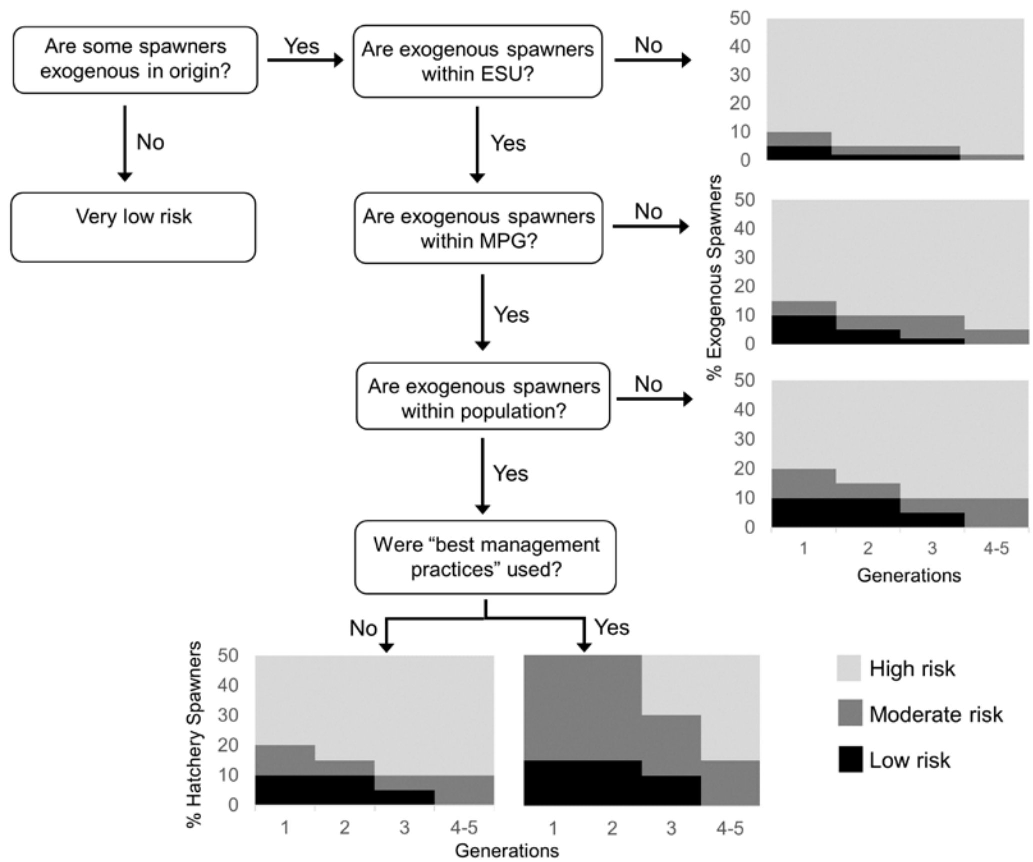

Figure 10. ICTRT (2007b) risk criteria associated with spawner composition for viability assessment of exogenous spawners on maintaining natural patterns of gene flow. Exogenous fish are considered to be all fish hatchery origin, and non-normative strays of natural origin.

Another HSRG team recently reviewed California hatchery programs and developed guidelines that differed considerably from those developed by the earlier group (California HSRG 2012). The California HSRG felt that truly isolated programs in which no hatchery-origin returnees interact genetically with natural populations were impossible in California, and was "generally unsupportive" of the concept. However, if programs were to be managed as isolated, they recommend a pHOS of less than 5 percent. They rejected development of overall pHOS guidelines for integrated programs because the optimal pHOS will depend upon multiple factors, such as "the amount of spawning by natural-origin fish in areas integrated with the hatchery, the value of pNOB, the importance of the integrated population to the larger stock, the fitness differences between hatchery- and natural-origin fish, and societal values, such as angling opportunity." They recommended that program-specific plans be developed with corresponding population-specific targets and thresholds for pHOS, pNOB, and PNI that reflect these factors. However, they did state that PNI should exceed 50 percent in most cases, although in supplementation or reintroduction programs the acceptable pHOS could be much higher than 5 percent, even approaching 100 percent at times. They also recommended for conservation programs that pNOB approach 100 percent, but pNOB levels should not be so high they pose demographic risk to the natural population.

Discussions involving pHOS can be problematic due to variation in its definition. Most commonly, the term pHOS refers to the proportion of the total natural spawning population consisting of hatchery fish, and the term has been used in this way in all NMFS documents. However, the HSRG has defined pHOS inconsistently in its Columbia Basin system report, equating it with "the proportion of the natural spawning population that is made up of hatchery fish" in the Conclusion, Principles and Recommendations section (HSRG 2009), but with "the proportion of *effective* hatchery origin spawners" in their gene-flow criteria. In addition, in their Analytical Methods and Information Sources section (appendix C in HSRG 2009) they introduce a new term, *effective pHOS* ($pHOS_{eff}$) defined as the effective proportion of hatchery fish in the naturally spawning population. This confusion was cleared up in the 2014 update document, where it is clearly stated that the metric of interest is effective pHOS (HSRG 2014).

The HSRG recognized that hatchery fish spawning naturally may on average produce fewer adult progeny than natural-origin spawners, as described above. To account for this difference the HSRG defined *effective* pHOS as:

$$pHOS_{eff} = RRS * pHOS_{census}$$

where $pHOS_{census}$ is the proportion of the naturally spawning population that is composed of hatchery-origin adults (HSRG 2014). In the 2014 report, the HSRG explicitly addressed the differences between *census* pHOS and *effective* pHOS, by defining PNI as:

$$PNI = \frac{pNOB}{(pNOB + pHOS_{eff})}$$

NMFS feels that adjustment of census pHOS by RRS should be done very cautiously, not nearly as freely as the HSRG document would suggest because the Ford (2002) model, which is the foundation of the HSRG gene-flow guidelines, implicitly includes a genetic component of RRS. In that model, hatchery fish are expected to have RRS < 1 (compared to natural fish) due to selection in the hatchery. A component of reduced RRS of hatchery fish is therefore already incorporated in the model and by extension the calculation of PNI. Therefore reducing pHOS values by multiplying by RRS will result in underestimating the relevant pHOS and therefore overestimating PNI. Such adjustments would be particularly inappropriate for hatchery programs with low pNOB, as these programs may well have a substantial reduction in RRS due to genetic factors already incorporated in the model.

In some cases, adjusting pHOS downward may be appropriate, however, particularly if there is strong evidence of a non-genetic component to RRS. Wenatchee spring Chinook salmon (Williamson et al. 2010) is an example case with potentially justified adjustment by RRS, where the spatial distribution of natural-origin and hatchery-origin spawners differs, and the hatchery-origin fish tend to spawn in poorer habitat. However, even in a situation like the Wenatchee spring Chinook salmon, it is unclear how much of an adjustment would be appropriate. By the same logic, it might also be appropriate to adjust pNOB in some circumstances. For example, if hatchery juveniles produced from natural-origin broodstock tend to mature early and residualize (due to non-genetic effects of rearing), as has been documented in some spring Chinook salmon and steelhead programs, the "effective" pNOB might be much lower than the census pNOB.

It is also important to recognize that PNI is only an approximation of relative trait value, based on a model that is itself very simplistic. To the degree that PNI fails to capture important biological information, it would be better to work to include this biological information in the underlying models rather than make ad hoc adjustments to a statistic that was only intended to be rough guideline to managers. We look forward to seeing this issue further clarified in the near future. In the meantime, except for cases in which an adjustment for RRS has strong justification, NMFS feels that census pHOS, rather than effective pHOS, is the appropriate metric to use for genetic risk evaluation.

Additional perspective on pHOS that is independent of HSRG modelling is provided by a simple analysis of the expected proportions of mating types. Figure 11 shows the expected proportion of mating types in a mixed population of natural-origin (N) and hatchery-origin (H) fish as a function of the census pHOS, assuming that N and H adults mate randomly[25]. For example, at a census pHOS level of 10 percent, 81 percent of the matings will be NxN, 18 percent will be NxH, and 1 percent will be HxH. This diagram can also be interpreted as probability of parentage of naturally produced progeny, assuming random mating and equal reproductive success of all mating types. Under this interpretation, progeny produced by a parental group with a pHOS level of 10 percent will have an 81 percent chance of having two natural-origin parents, etc.

Random mating assumes that the natural-origin and hatchery-origin spawners overlap completely spatially and temporally. As overlap decreases, the proportion of NxH matings decreases; with no overlap, the proportion of NxN matings is 1 minus pHOS and the proportion of HxH matings equals pHOS. RRS does not affect the mating type proportions directly but changes their effective proportions. Overlap and RRS can be related. For example, in the Wenatchee River, hatchery spring Chinook salmon tend to spawn lower in the system than natural-origin fish, and

[25] These computations are purely theoretical, based on a simple mathematical binomial expansion ($(a+b)^2=a^2 + 2ab + b^2$).

this accounts for a considerable amount of their lowered reproductive success (Williamson et al. 2010). In that particular situation the hatchery-origin fish were spawning in inferior habitat.

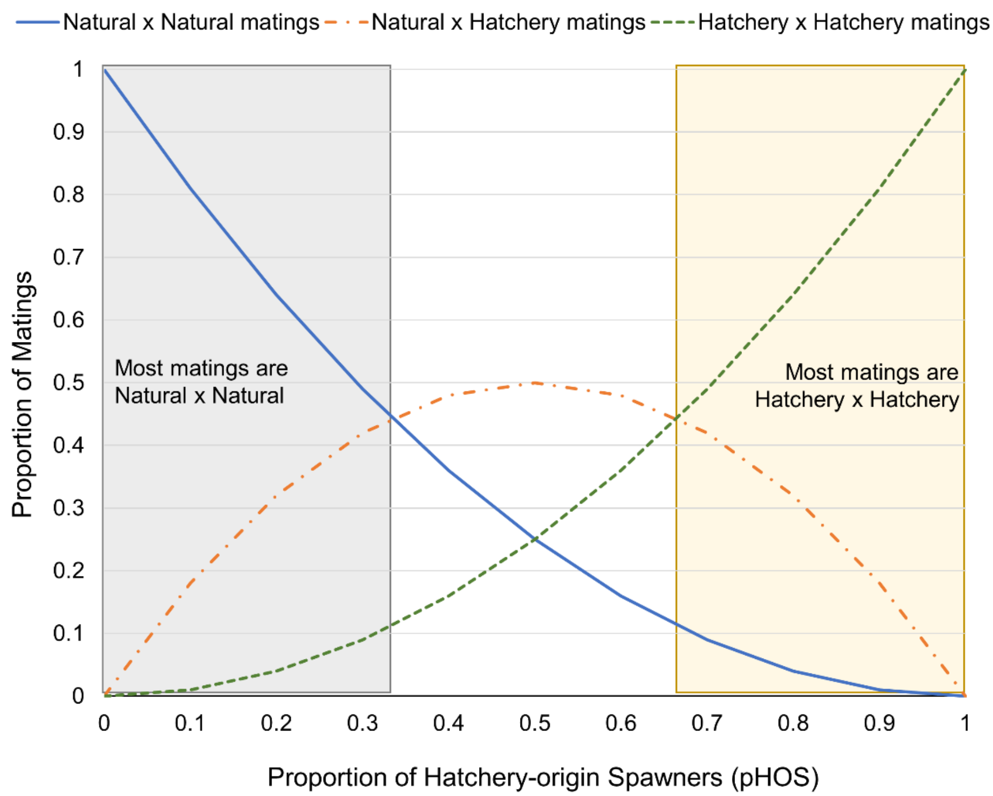

Figure 11. Relative proportions of types of matings as a function of proportion of hatchery-origin fish on the spawning grounds (pHOS).

6.2.2. Ecological effects

Ecological effects for this factor (i.e., hatchery fish and the progeny of naturally spawning hatchery fish on the spawning grounds) refer to effects from competition for spawning sites and redd superimposition, contributions to marine-derived nutrients, and the removal of fine sediments from spawning gravels. Ecological effects on the spawning grounds may be positive or negative. To the extent that hatcheries contribute added fish to the ecosystem, there can be positive effects. For example, when anadromous salmonids return to spawn, hatchery-origin and natural-origin alike, they transport marine-derived nutrients stored in their bodies to freshwater and terrestrial ecosystems. Their carcasses provide a direct food source for juvenile salmonids and other fish, aquatic invertebrates, and terrestrial animals, and their decomposition supplies nutrients that may increase primary and secondary production (Gresh et al. 2000; Kline et al. 1990; Larkin and Slaney 1996; Murota 2003; Piorkowski 1995; Quamme and Slaney 2003; Wipfli et al. 2003). As a result, the growth and survival of juvenile salmonids may increase (Bell

2001; Bilton et al. 1982; Bradford et al. 2000; Brakensiek 2002; Hager and Noble 1976; Hartman and Scrivener 1990; Holtby 1988; Johnston et al. 1990; Larkin and Slaney 1996; Quinn and Peterson 1996; Ward and Slaney 1988).

Additionally, studies have demonstrated that perturbation of spawning gravels by spawning salmonids loosens cemented (compacted) gravel areas used by spawning salmon (e.g., (Montgomery et al. 1996). The act of spawning also coarsens gravel in spawning reaches, removing fine material that blocks interstitial gravel flow and reduces the survival of incubating eggs in egg pockets of redds.

The added spawner density resulting from hatchery-origin fish spawning in the wild can have negative consequences at times. In particular, the potential exists for hatchery-derived fish to superimpose or destroy the eggs and embryos of ESA-listed species when there is spatial overlap between hatchery and natural spawners. Redd superimposition has been shown to be a cause of egg loss in pink salmon and other species (e.g., Fukushima et al. 1998).

6.2.3. Adult Collection Facilities

The analysis also considers the effects from encounters with natural-origin fish that are incidental to broodstock collection. Here, NMFS analyzes effects from sorting, holding, and handling natural-origin fish in the course of broodstock collection. Some programs collect their broodstock from fish voluntarily entering the hatchery, typically into a ladder and holding pond, while others sort through the run at large, usually at a weir, ladder, or sampling facility. Generally speaking, the more a hatchery program accesses the run at large for hatchery broodstock – that is, the more fish that are handled or delayed during migration – the greater the negative effect on natural-origin and hatchery-origin fish that are intended to spawn naturally and on ESA-listed species. The information NMFS uses for this analysis includes a description of the facilities, practices, and protocols for collecting broodstock, the environmental conditions under which broodstock collection is conducted, and the encounter rate for ESA-listed fish.

NMFS also analyzes the effects of structures, either temporary or permanent, that are used to collect hatchery broodstock, and remove hatchery fish from the river or stream and prevent them from spawning naturally, on juvenile and adult fish from encounters with these structures. NMFS determines through the analysis, for example, whether the spatial structure, productivity, or abundance of a natural population is affected when fish encounter a structure used for broodstock collection, usually a weir or ladder.

6.3. Factor 3. Hatchery fish and the progeny of naturally spawning hatchery fish in juvenile rearing areas, the migratory corridor, estuary, and ocean

NMFS also analyzes the potential for competition and predation when the progeny of naturally spawning hatchery fish and hatchery releases share juvenile rearing areas. The level of effect for this factor ranges from neutral or negligible to negative.

6.3.1. Competition

Generally speaking, competition and a corresponding reduction in productivity and survival may result from direct or indirect interactions. Direct interactions occur when hatchery-origin fish interfere with the accessibility to limited resources by natural-origin fish, and indirect interactions occur when the utilization of a limited resource by hatchery fish reduces the amount available for fish from the natural population (Rensel et al. 1984). Natural-origin fish may be competitively displaced by hatchery fish early in life, especially when hatchery fish are more numerous, are of equal or greater size, take up residency before naturally produced fry emerge from redds, and residualize. Hatchery fish might alter natural-origin salmon behavioral patterns and habitat use, making natural-origin fish more susceptible to predators (Hillman and Mullan 1989; Steward and Bjornn 1990). Hatchery-origin fish may also alter natural-origin salmonid migratory responses or movement patterns, leading to a decrease in foraging success by the natural-origin fish (Hillman and Mullan 1989; Steward and Bjornn 1990). Actual impacts on natural-origin fish would thus depend on the degree of dietary overlap, food availability, size-related differences in prey selection, foraging tactics, and differences in microhabitat use (Steward and Bjornn 1990).

Specific hazards associated with competitive impacts of hatchery salmonids on listed natural-origin salmonids may include competition for food and rearing sites (NMFS 2012a). In an assessment of the potential ecological impacts of hatchery fish production on naturally produced salmonids, the Species Interaction Work Group (Rensel et al. 1984) concluded that naturally produced coho and Chinook salmon and steelhead are all potentially at “high risk” due to competition (both interspecific and intraspecific) from hatchery fish of any of these three species. In contrast, the risk to naturally produced pink, chum, and sockeye salmon due to competition from hatchery salmon and steelhead was judged to be low.

Several factors influence the risk of competition posed by hatchery releases: whether competition is intra- or interspecific; the duration of freshwater co-occurrence of hatchery and natural-origin fish; relative body sizes of the two groups; prior residence of shared habitat; environmentally induced developmental differences; and density in shared habitat (Tatara and Berejikian 2012). Intraspecific competition would be expected to be greater than interspecific, and competition would be expected to increase with prolonged freshwater co-occurrence. Hatchery smolts are commonly larger than natural-origin fish, and larger fish usually are superior competitors.

However, natural-origin fish have the competitive advantage of prior residence when defending territories and resources in shared natural freshwater habitat. Tatara and Berejikian (2012) further reported that hatchery-influenced developmental differences from co-occurring natural-origin fish are variable and can favor both hatchery- and natural-origin fish. They concluded that of all factors, fish density of the composite population in relation to habitat carrying capacity likely exerts the greatest influence.

En masse hatchery salmon smolt releases may cause displacement of rearing natural-origin juvenile salmonids from occupied stream areas, leading to abandonment of advantageous feeding stations, or premature out-migration by natural-origin juvenile salmonids. Pearsons et al. (1994) reported small-scale displacement of juvenile naturally produced rainbow trout from stream sections by hatchery steelhead. Small-scale displacements and agonistic interactions observed between hatchery steelhead and natural-origin juvenile trout were most likely a result of size differences and not something inherently different about hatchery fish.

A proportion of the smolts released from a hatchery may not migrate to the ocean but rather reside for a period of time in the vicinity of the release point. These non-migratory smolts (residuals) may directly compete for food and space with natural-origin juvenile salmonids of similar age. Although this behavior has been studied and observed, most frequently in the case of hatchery steelhead, residualism has been reported as a potential issue for hatchery coho and Chinook salmon as well. Adverse impacts of residual hatchery Chinook and coho salmon on natural-origin salmonids can occur, especially given that the number of smolts per release is generally higher; however, the issue of residualism for these species has not been as widely investigated compared to steelhead. Therefore, for all species, monitoring of natural stream areas in the vicinity of hatchery release points may be necessary to determine the potential effects of hatchery smolt residualism on natural-origin juvenile salmonids.

The risk of adverse competitive interactions between hatchery- and natural-origin fish can be minimized by:

- Releasing hatchery smolts that are physiologically ready to migrate. Hatchery fish released as smolts emigrate seaward soon after liberation, minimizing the potential for competition with juvenile naturally produced fish in freshwater (California HSRG 2012; Steward and Bjornn 1990)
- Operating hatcheries such that hatchery fish are reared to a size sufficient to ensure that smoltification occurs in nearly the entire population
- Releasing hatchery smolts in lower river areas, below areas used for stream-rearing by naturally produced juveniles

- Monitoring the incidence of non-migratory smolts (residuals) after release and adjusting rearing strategies, release location, and release timing if substantial competition with naturally rearing juveniles is determined likely

Critical to analyzing competition risk is information on the quality and quantity of spawning and rearing habitat in the action area,[26] including the distribution of spawning and rearing habitat by quality and best estimates for spawning and rearing habitat capacity. Additional important information includes the abundance, distribution, and timing for naturally spawning hatchery fish and natural-origin fish; the timing of emergence; the distribution and estimated abundance for progeny from both hatchery and natural-origin natural spawners; the abundance, size, distribution, and timing for juvenile hatchery fish in the action area; and the size of hatchery fish relative to co-occurring natural-origin fish.

6.3.2. Predation

Another potential ecological effect of hatchery releases is predation. Salmon and steelhead are piscivorous and can prey on other salmon and steelhead. Predation, either direct (consumption by hatchery fish) or indirect (increases in predation by other predator species due to enhanced attraction), can result from hatchery fish released into the wild. Considered here is predation by hatchery-origin fish, the progeny of naturally spawning hatchery fish, and avian and other predators attracted to the area by an abundance of hatchery fish. Hatchery fish originating from egg boxes and fish planted as non-migrant fry or fingerlings can prey upon fish from the local natural population during juvenile rearing. Hatchery fish released at a later stage, so they are more likely to emigrate quickly to the ocean, can prey on fry and fingerlings that are encountered during the downstream migration. Some of these hatchery fish do not emigrate and instead take up residence in the stream (residuals) where they can prey on stream-rearing juveniles over a more prolonged period, as discussed above. The progeny of naturally spawning hatchery fish also can prey on fish from a natural population and pose a threat. In general, the threat from predation is greatest when natural populations of salmon and steelhead are at low abundance, when spatial structure is already reduced, when habitat, particularly refuge habitat, is limited, and when environmental conditions favor high visibility.

Rensel et al. (1984) rated most risks associated with predation as unknown because there was relatively little documentation in the literature of predation interactions in either freshwater or marine areas at the time. More studies are now available, but they are still too sparse to allow many generalizations to be made about risk. Newly released hatchery-origin yearling salmon and steelhead may prey on juvenile fall Chinook and steelhead and other juvenile salmon in the freshwater and marine environments (Hargreaves and LeBrasseur 1986; Hawkins and Tipping

[26] "Action area" means all areas to be affected directly or indirectly by the action in which the effects of the action can be meaningfully detected and evaluated.

1999; Pearsons and Fritts 1999). Low predation rates have been reported for released steelhead juveniles (Hawkins and Tipping 1999; Naman and Sharpe 2012). Hatchery steelhead release timing and protocols used widely in the Pacific Northwest were shown to be associated with negligible predation by migrating hatchery steelhead on fall Chinook fry, which had already emigrated or had grown large enough to reduce or eliminate their susceptibility to predation when hatchery steelhead entered the rivers (Sharpe et al. 2008). Hawkins (1998) documented hatchery spring Chinook salmon yearling predation on naturally produced fall Chinook salmon juveniles in the Lewis River. Predation on smaller Chinook salmon was found to be much higher in naturally produced smolts (coho salmon and cutthroat, predominately) than their hatchery counterparts.

Predation may be greatest when large numbers of hatchery smolts encounter newly emerged fry or fingerlings, or when hatchery fish are large relative to naturally produced fish (Rensel et al. 1984). Due to their location in the stream or river, size, and time of emergence, newly emerged salmonid fry are likely to be the most vulnerable to predation. Their vulnerability is believed to be greatest immediately upon emergence from the gravel and then their vulnerability decreases as they move into shallow, shoreline areas (USFWS 1994). Emigration out of important rearing areas and foraging inefficiency of newly released hatchery smolts may reduce the degree of predation on salmonid fry (USFWS 1994).

Some reports suggest that hatchery fish can prey on fish that are up to 1/2 their length (HSRG 2004; Pearsons and Fritts 1999), but other studies have concluded that salmonid predators prey on fish 1/3 or less their length (Beauchamp 1990; Cannamela 1992; CBFWA 1996; Hillman and Mullan 1989; Horner 1978). Hatchery fish may also be less efficient predators as compared to their natural-origin conspecifics, reducing the potential for predation impacts (Bachman 1984; Olla et al. 1998; Sosiak et al. 1979).

There are several steps that hatchery programs can implement to reduce or avoid the threat of predation:

- Releasing all hatchery fish as actively migrating smolts through volitional release practices so that the fish migrate quickly seaward, limiting the duration of interaction with any co-occurring natural-origin fish downstream of the release site.
- Ensuring that a high proportion of the population have physiologically achieved full smolt status. Juvenile salmon tend to migrate seaward rapidly when fully smolted, limiting the duration of interaction between hatchery fish and naturally produced fish present within, and downstream of, release areas.
- Releasing hatchery smolts in lower river areas near river mouths and below upstream areas used for stream-rearing young-of-the-year naturally produced salmon fry, thereby reducing the likelihood for interaction between the hatchery and naturally produced fish.

- Operating hatchery programs and releases to minimize the potential for residualism.

6.3.3. Disease

The release of hatchery fish and hatchery effluent into juvenile rearing areas can lead to transmission of pathogens, contact with chemicals or altering of environmental parameters (e.g., dissolved oxygen) that can result in disease outbreaks. Fish diseases can be subdivided into two main categories: infectious and non-infectious. Infectious diseases are those caused by pathogens such as viruses, bacteria, and parasites. Noninfectious diseases are those that cannot be transmitted between fish and are typically caused by genetic or environmental factors (e.g., low dissolved oxygen). Pathogens can also be categorized as exotic or endemic. For our purposes, exotic pathogens are those that have no history of occurrence within state boundaries. For example, *Oncorhynchus masou virus* (OMV) would be considered an exotic pathogen if identified anywhere in Washington state. Endemic pathogens are native to a state, but may not be present in all watersheds.

In natural fish populations, the risk of disease associated with hatchery programs may increase through a variety of mechanisms (Naish et al. 2008), including:

- Introduction of exotic pathogens
- Introduction of endemic pathogens to a new watershed
- Intentional release of infected fish or fish carcasses
- Continual pathogen reservoir
- Pathogen amplification

The transmission of pathogens between hatchery and natural fish can occur indirectly through hatchery water influent/effluent or directly via contact with infected fish. Within a hatchery, the likelihood of transmission leading to an epizootic (i.e., disease outbreak) is increased compared to the natural environment because hatchery fish are reared at higher densities and closer proximity than would naturally occur. During an epizootic, hatchery fish can shed relatively large amounts of pathogen into the hatchery effluent and ultimately, the environment, amplifying pathogen numbers. However, few, if any, examples of hatcheries contributing to an increase in disease in natural populations have been reported (Naish et al. 2008; Steward and Bjornn 1990). This lack of reporting is because both hatchery and natural-origin salmon and trout are susceptible to the same pathogens (Noakes et al. 2000), which are often endemic and ubiquitous (e.g., *Renibacterium salmoninarum,* the cause of Bacterial Kidney Disease).

Adherence to a number of state, federal, and tribal fish health policies limits the disease risks associated with hatchery programs (IHOT 1995; NWIFC and WDFW 2006; ODFW 2003; USFWS 2004). Specifically, the policies govern the transfer of fish, eggs, carcasses, and water to prevent the spread of exotic and endemic reportable pathogens. For all pathogens, both reportable and non-reportable, pathogen spread and amplification are minimized through regular monitoring (typically monthly) removing mortalities, and disinfecting all eggs. Vaccines may provide additional protection from certain pathogens when available (e.g., *Vibrio anguillarum*). If a pathogen is determined to be the cause of fish mortality, treatments (e.g., antibiotics) will be used to limit further pathogen transmission and amplification. Some pathogens, such as *infectious hematopoietic necrosis virus* (IHNV), have no known treatment. Thus, if an epizootic occurs for those pathogens, the only way to control pathogen amplification is to cull infected individuals or terminate all susceptible fish. In addition, current hatchery operations often rear hatchery fish on a timeline that mimics their natural life history, which limits the presence of fish susceptible to pathogen infection and prevents hatchery fish from becoming a pathogen reservoir when no natural fish hosts are present.

In addition to the state, federal and tribal fish health policies, disease risks can be further minimized by preventing pathogens from entering the hatchery facility through the treatment of incoming water (e.g., by using ozone) or by leaving the hatchery through hatchery effluent (Naish et al. 2008). Although preventing the exposure of fish to any pathogens prior to their release into the natural environment may make the hatchery fish more susceptible to infection after release into the natural environment, reduced fish densities in the natural environment compared to hatcheries likely reduces the risk of fish encountering pathogens at infectious levels (Naish et al. 2008). Treating the hatchery effluent would also minimize amplification, but would not reduce disease outbreaks within the hatchery itself caused by pathogens present in the incoming water supply. Another challenge with treating hatchery effluent is the lack of reliable, standardized guidelines for testing or a consistent practice of controlling pathogens in effluent (LaPatra 2003). However, hatchery facilities located near marine waters likely limit freshwater pathogen amplification downstream of the hatchery without human intervention because the pathogens are killed before transmission to fish when the effluent mixes with saltwater.

Noninfectious diseases are those that cannot be transmitted between fish and are typically caused by genetic or environmental factors (e.g., low dissolved oxygen). Hatchery facilities routinely use a variety of chemicals for treatment and sanitation purposes. Chlorine levels in the hatchery effluent, specifically, are monitored with a National Pollutant Discharge Elimination System (NPDES) permit administered by the Environmental Protection Agency. Other chemicals are discharged in accordance with manufacturer instructions. The NPDES permit also requires monitoring of settleable and unsettleable solids, temperature, and dissolved oxygen in the hatchery effluent on a regular basis to ensure compliance with environmental standards and to prevent fish mortality. In contrast to infectious diseases, which typically are manifest by a limited number of life stages and over a protracted time period, non-infectious diseases caused by environmental factors typically affect all life stages of fish indiscriminately and over a relatively short period of time. One group of non-infectious diseases that are expected to occur rarely in current hatchery operations are those caused by nutritional deficiencies because of the vast literature available on successful rearing of salmon and trout in aquaculture.

6.3.4. Acclimation

One factor the can affect hatchery fish distribution and the potential to spatially overlap with natural-origin spawners, and thus the potential for genetic and ecological impacts, is the acclimation (the process of allowing fish to adjust to the environment in which they will be released) of hatchery juveniles before release. Acclimation of hatchery juvenile before release increases the probability that hatchery adults will home back to the release location, reducing their potential to stray into natural spawning areas. Acclimating fish for a period of time also allows them to recover from the stress caused by the transportation of the fish to the release location and by handling. (Dittman and Quinn 2008) provide an extensive literature review and introduction to homing of Pacific salmon. They note that, as early as the 19th century, marking studies had shown that salmonids would home to the stream, or even the specific reach, where they originated. The ability to home to their home or "natal" stream is thought to be due to odors to which the juvenile salmonids were exposed while living in the stream (olfactory imprinting) and migrating from it years earlier (Dittman and Quinn 2008; Keefer and Caudill 2014). Fisheries managers use this innate ability of salmon and steelhead to home to specific streams by using acclimation ponds to support the reintroduction of species into newly accessible habitat or into areas where they have been extirpated (Dunnigan 1999; Quinn 1997; YKFP 2008).

(Dittman and Quinn 2008) reference numerous experiments that indicated that a critical period for olfactory imprinting is during the parr-smolt transformation, which is the period when the salmonids go through changes in physiology, morphology, and behavior in preparation for transitioning from fresh water to the ocean (Beckman et al. 2000; Hoar 1976). Salmon species with more complex life histories (e.g., sockeye salmon) may imprint at multiple times from emergence to early migration (Dittman et al. 2010). Imprinting to a particular location, be it the hatchery, or an acclimation pond, through the acclimation and release of hatchery salmon and steelhead is employed by fisheries managers with the goal that the hatchery fish released from these locations will return to that particular site and not stray into other areas (Bentzen et al. 2001; Fulton and Pearson 1981; Hard and Heard 1999; Kostow 2009; Quinn 1997; Westley et al. 2013). However, this strategy may result in varying levels of success in regards to the proportion of the returning fish that stray outside of their natal stream. (e.g., (Clarke et al. 2011; Kenaston et al. 2001).

Having hatchery salmon and steelhead home to a particular location is one measure that can be taken to reduce the proportion of hatchery fish in the naturally spawning population. By having the hatchery fish home to a particular location, those fish can be removed (e.g., through fisheries, use of a weir) or they can be isolated from primary spawning areas. Factors that can affect the success of homing include:

- The timing of the acclimation, such that a majority of the hatchery juveniles are going through the parr-smolt transformation during acclimation
- A water source unique enough to attract returning adults
- Whether or not the hatchery fish can access the stream reach where they were released
- Whether or not the water quantity and quality is such that returning hatchery fish will hold in that area before removal and/or their harvest in fisheries.

6.4. Factor 4. Research, monitoring, and evaluation that exists because of the hatchery program

NMFS also analyzes proposed RM&E for its effects on listed species and on designated critical habitat. The level of effect for this factor ranges from positive to negative.

Generally speaking, negative effects on the fish from RM&E are weighed against the value or benefit of new information, particularly information that tests key assumptions and that reduces uncertainty. RM&E actions can cause harmful changes in behavior and reduced survival; such actions include, but are not limited to:

- Observation during surveying
- Collecting and handling (purposeful or inadvertent)
- Holding the fish in captivity, sampling (e.g., the removal of scales and tissues)
- Tagging and fin-clipping, and observing the fish (in-water or from the bank)

6.4.1. Observing/Harassing

For some parts of the proposed studies, listed fish would be observed in-water (e.g., by snorkel surveys, wading surveys, or observation 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 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/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. These avoidance behaviors are expected to be in the range of normal predator and disturbance behaviors. Redds may be visually inspected, but would not be walked on.

6.4.2. Capturing/handling

Any physical handling or psychological disturbance is known to be stressful to fish (Sharpe et al. 1998). Primary contributing factors to stress and death from handling are excessive doses of anesthetic, differences in water temperatures (between the river and holding vessel), dissolved oxygen conditions, the amount of time fish are held out of the water, and physical trauma. Stress increases rapidly if the water temperature exceeds 18ºC or dissolved oxygen is below saturation. Fish 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. Decreased survival can result from high stress levels because stress can be immediately debilitating, and may also increase the potential for vulnerability to subsequent challenges (Sharpe et al. 1998). Debris buildup at traps can also kill or injure fish if the traps are not monitored and cleared regularly.

6.4.3. Fin clipping and tagging

Many studies have examined the effects of fin clips on fish growth, survival, and behavior. The results of these studies are somewhat varied, but fin clips do not generally alter fish growth (Brynildson and Brynildson 1967; Gjerde and Refstie 1988). Mortality among fin-clipped fish is variable, but can be as high as 80 percent (Nicola and Cordone 1973). In some cases, though, no significant difference in mortality was found between clipped and un-clipped fish (Gjerde and Refstie 1988; Vincent-Lang 1993). The mortality rate typically depends on which fin is clipped. Recovery rates are generally higher for adipose- and pelvic-fin-clipped fish than for those that have clipped pectoral, dorsal, or anal fins (Nicola and Cordone 1973), probably because the adipose and pelvic fins are not as important as other fins for movement or balance (McNeil and Crossman 1979). However, some work has shown that fish without an adipose fin may have a more difficult time swimming through turbulent water (Buckland-Nicks et al. 2011; Reimchen and Temple 2003).

In addition to fin clipping, PIT tags and CWTs are included in the Proposed Action. PIT tags are 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, so it is critical that researchers ensure that the operations take place in the safest possible manner. Tagging needs to take place where there is cold water of high quality, a carefully controlled environment for administering anesthesia, sanitary conditions, quality control checking, and a recovery holding tank.

Most studies have concluded that PIT tags generally have very little effect on growth, mortality, or behavior. Early studies of PIT tags showed no long-term effect on growth or survival (Prentice et al. 1987; Prentice and Park 1984; Rondorf and Miller 1994). 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 orally or surgically implanted sham radio tags or PIT tags. However, (Knudsen et al. 2009) found that, over several brood years, PIT tag induced smolt-adult mortality in Yakima River spring Chinook salmon averaged 10.3 percent and was at times as high as 33.3 percent.

Coded-wire tags are made of magnetized, stainless-steel wire and are injected into the nasal cartilage of a salmon and thus cause little direct tissue damage (Bergman et al. 1968; Bordner et al. 1990). The conditions under which CWTs should be inserted are similar to those required for PIT tags. A major advantage to using CWTs is that they have a negligible effect on the biological condition or response of tagged salmon (Vander Haegen et al. 2005); 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).

Mortality from tagging 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. Tags may cause wounds that do not heal properly, may make swimming more difficult, or may make tagged animals more vulnerable to predation (Howe and Hoyt 1982; Matthews and Reavis 1990; Moring 1990). Tagging may also reduce fish growth by increasing the energetic costs of swimming and maintaining balance.

NMFS has developed general guidelines to reduce impacts when collecting listed adult and juvenile salmonids (NMFS 2000; NMFS 2008a) that have been incorporated as terms and conditions into section 7 opinions and section 10 permits for research and enhancement. Additional monitoring principles for supplementation programs have been developed by the (Galbreath et al. 2008).

The effects of these actions should not be confused with handling effects analyzed under broodstock collection. In addition, NMFS also considers the overall effectiveness of the RM&E program. There are five factors that NMFS takes into account when it assesses the beneficial and negative effects of hatchery RM&E: (1) the status of the affected species and effects of the proposed RM&E on the species and on designated critical habitat, (2) critical uncertainties concerning effects on the species, (3) performance monitoring and determining the effectiveness of the hatchery program at achieving its goals and objectives, (4) identifying and quantifying collateral effects, and (5) tracking compliance of the hatchery program with the terms and conditions for implementing the program. After assessing the proposed hatchery RM&E and before it makes any recommendations to the action agency(s) NMFS considers the benefit or usefulness of new or additional information, whether the desired information is available from another source, the effects on ESA-listed species, and cost.

Hatchery actions also must be assessed for masking effects. For these purposes, masking is when hatchery fish included in the Proposed Action mix with and are not identifiable from other fish.

The effect of masking is that it undermines and confuses RM&E and status and trends monitoring. Both adult and juvenile hatchery fish can have masking effects. When presented with a proposed hatchery action, NMFS analyzes the nature and level of uncertainties caused by masking and whether and to what extent listed salmon and steelhead are at increased risk. The analysis also takes into account the role of the affected salmon and steelhead population(s) in recovery and whether unidentifiable hatchery fish compromise important RM&E.

6.5. Factor 5. Construction, operation, and maintenance, of facilities that exist because of the hatchery program

The construction/installation, operation, and maintenance of hatchery facilities can alter fish behavior and can injure or kill eggs, juveniles, and adults. These actions can also degrade habitat function and reduce or block access to spawning and rearing habitats altogether. Here, NMFS analyzes changes to: riparian habitat, channel morphology, habitat complexity, in-stream substrates, and water quantity and quality attributable to operation, maintenance, and construction activities. NMFS also confirms whether water diversions and fish passage facilities are constructed and operated consistent with NMFS criteria. The level of effect for this factor ranges from neutral or negligible to negative.

6.6. Factor 6. Fisheries that exist because of the hatchery program

There are two aspects of fisheries that are potentially relevant to NMFS' analysis of the Proposed Action in a section 7 consultation. One is where there are fisheries that exist because of the HGMP that describes the Proposed Action (i.e., the fishery is an interrelated and interdependent action), and listed species are inadvertently and incidentally taken in those fisheries. The other is when fisheries are used as a tool to prevent the hatchery fish associated with the HGMP, including hatchery fish included in an ESA-listed salmon ESU or steelhead DPS, from spawning naturally. The level of effect for this factor ranges from neutral or negligible to negative.

"Many hatchery programs are capable of producing more fish than are immediately useful in the conservation and recovery of an ESU and can play an important role in fulfilling trust and treaty obligations with regard to harvest of some Pacific salmon and steelhead populations. For ESUs listed as threatened, NMFS will, where appropriate, exercise its authority under section 4(d) of the ESA to allow the harvest of listed hatchery fish that are surplus to the conservation and recovery needs of the ESU, in accordance with approved harvest plans" (NMFS 2005). In any event, fisheries must be strictly regulated based on the take, including catch and release effects, of ESA-listed species.

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