

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

Fall Chinook, Coho Salmon, and Resident Trout Fisheries in the Snake River Basin

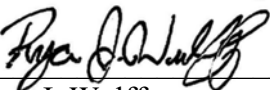
NMFS Consultation Number: WCR-2019-00400

Action Agency: National Marine Fisheries Service (NMFS)

Affected Species and Determinations: ESA-Listed Species	Status	Is the Action Likely to Adversely Affect Species or Critical Habitat?	Is the Action Likely To Jeopardize the Species?	Is the Action Likely To Destroy or Adversely Modify Critical Habitat?
Chinook salmon (<i>Oncorhynchus tshawytscha</i>)				
Snake River spring/summer	Threatened	Yes	No	No
Snake River fall	Threatened	Yes	No	No
Sockeye salmon (<i>O. nerka</i>)				
Snake River	Endangered	Yes	No	No
Steelhead (<i>O. mykiss</i>)				
Snake River	Threatened	Yes	No	No

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

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

Issued By: 
Ryan J. Wulff
Assistant Regional Administrator

Date: August 28, 2019

This page intentionally left blank

TABLE OF CONTENTS

1.	Introduction.....	6
	1.1. Background.....	6
	1.2. Consultation History.....	6
	1.3. Proposed Action.....	7
	1.3.1. Fishery Descriptions.....	7
	1.3.2. Proposed Impact Rates.....	11
	1.3.3. Fishery Monitoring and Reporting.....	13
	1.4. Interrelated and Interdependent Actions.....	14
2.	Endangered Species Act: Biological Opinion and Incidental Take Statement.....	14
	2.1. Analytical Approach.....	14
	2.2.1. Status of Listed Species.....	17
	2.2.2. Critical Habitat.....	39
	2.2.3. Climate Change.....	40
	2.3. Action Area.....	46
	2.4. Environmental Baseline.....	46
	2.4.1. Habitat and Hydropower.....	46
	2.4.2. Climate Change.....	48
	2.4.3. Hatcheries.....	48
	2.4.4. Harvest.....	53
	2.5. Effects of the Action.....	55
	2.5.1. Effects on the Snake River Fall Chinook Salmon ESU.....	55
	2.5.2. Effects on other ESA-listed salmon and steelhead.....	63
	2.5.3. Demographic Effects to All Affected ESUs.....	64
	2.5.4. Illegal Harvest.....	65
	2.5.5. Interrelated and interdependent effects.....	65
	2.5.6. Effects on Critical Habitat.....	66
	2.6. Cumulative Effects.....	67
	2.7. Integration and Synthesis.....	71
	2.7.1. Snake River Fall Chinook Salmon.....	72
	2.7.2. Snake River Steelhead DPS.....	73
	2.7.3. Snake River Spring/Summer Chinook Salmon ESU.....	73
	2.7.4. Snake River Sockeye Salmon ESU.....	74
	2.7.5. Critical Habitat.....	75
	2.8. Conclusion.....	75
	2.9. Incidental Take Statement.....	75
	2.9.1. Amount or Extent of Take Anticipated.....	75
	2.9.2. Effect of the Take.....	76
	2.9.3. Reasonable and Prudent Measures.....	76
	2.9.4. Terms and Conditions.....	77
	2.10. Conservation Recommendations.....	78
	2.11. Reinitiation of Consultation.....	78
3.	Magnuson-Stevens Act Essential Fish Habitat Consultation.....	84
	3.1. Essential Fish Habitat Affected By The Project.....	84
	3.2. Adverse Effects on Essential Fish Habitat.....	84
	3.3. Essential Fish Habitat Conservation Recommendation.....	85

3.4.	Statutory Response Requirement.....	85
3.5.	Supplemental Consultation	85
4.	Data Quality Act Documentation and Pre-Dissemination Review.....	85
4.1.	Utility	85
4.2.	Integrity.....	86
4.3.	Objectivity.....	86
5.	Literature Cited.....	86

TABLE OF TABLES

Table 1. Fishery Details; LGD = Lower Granite Dam; HCD = Hells Canyon Dam.	8
Table 2. Harvest rate schedule for natural-origin fall Chinook at Lower Granite Dam; MAT = Minimum abundance threshold.	12
Table 3. Federal Register notices for the final rules that list species, designate critical habitat, or apply protective regulations to ESA listed species considered in this consultation.	17
Table 4. Snake River Basin Steelhead DPS description.	20
Table 5. Risk levels and viability ratings for Snake River steelhead Major Population Groups (MPGs) (NWFSC 2015). Data are from 2004-2015. ICTRT = Interior Columbia Technical Recovery Team. Current abundance and productivity estimates expressed as geometric means (standard error).	24
Table 6. Snake River Fall Chinook Salmon ESU description.	25
Table 7. Snake River spring/summer Chinook Salmon ESU description.	29
Table 8. Risk levels and viability ratings for Snake River spring/summer Chinook salmon populations (NWFSC 2015); ICTRT = Interior Columbia Technical Recovery Team; MPG = Major Population Group. Data are from 2005-2014. Abundance and productivity estimates expressed as geometric means (standard error).	33
Table 9. Snake River Sockeye Salmon ESU description.	35
Table 10. Hatchery- and natural-origin sockeye salmon returns to Sawtooth Valley, 1999-2018 (Christine Kozfkay, IDFG, personal communication, March 4, 2018; NMFS 2015).	37
Table 11. Hatchery programs above Lower Granite Dam.	49
Table 12. Harvest of hatchery-origin fall Chinook salmon in state and tribal fisheries from 2010-2017.	54
Table 13. Mortality of natural-origin fall Chinook salmon in state and tribal fisheries from 2010-2017.	54
Table 14. Proposed impact rates on natural-origin fall Chinook salmon in Snake River Basin fisheries applied to recent returns.	58
Table 15. Proposed harvest rates of hatchery fall Chinook salmon in Snake River Basin fisheries applied to recent returns.	58
Table 16. Range of natural spawners observed for the 25 th and 100 th year projected values over 100 simulation runs (Sharma 2019).	60

1. INTRODUCTION

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

1.1. Background

NMFS prepared the Biological Opinion (opinion) and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the ESA of 1973, as amended (16 U.S.C. 1531, et seq.), and implementing regulations at 50 CFR 402. The opinion documents consultation on the action proposed by NMFS.

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

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). A complete record of this consultation is on file at the Sustainable Fisheries Division (SFD) of NMFS in Portland, Oregon.

1.2. Consultation History

NMFS has issued four previous section 10(a)(1)(B) permits to the Idaho Department of Fish and Game (IDFG) for their recreational fisheries since first listing Snake River sockeye salmon as endangered (November 20, 1991, 56 FR 58619). In 1993, the IDFG applied for a permit, and NMFS subsequently issued permit 844 that same year after completion of a biological opinion (NMFS 1993). Permit 844 expired December 31, 1998, and IDFG was issued permit 1150 on May 28, 1999, which expired at the end of 1999. The IDFG's next application was accompanied by a conservation plan that detailed how fisheries were conducted, and permit 1233 was issued on May 26, 2000. The IDFG submitted a request on February 25, 2004 (with amendments on March 4, 2004), to renew the ESA coverage. In response, NMFS issued permit 1481.

IDFG submitted a new Fishery Management and Evaluation Plan (FMEP) for all fisheries in 2009 prior to the expiration of permit 1481, and requested a one year permit extension. NMFS granted the extension request, and approved fisheries for resident fish and spring/summer Chinook salmon, but NMFS did not act on the FMEP for steelhead/fall Chinook/coho salmon. IDFG and NMFS resumed discussion of the fall Chinook and coho salmon fisheries in March of 2018 along with the Oregon Department of Fish and Wildlife (ODFW), and the Washington Department of Fish and Wildlife (WDFW). The three states together, with agreement from the tribes, submitted a new fall Chinook salmon FMEP on April 11, 2019 (IDFG 2019b). IDFG also submitted an FMEP for the coho fishery on June 3, 2019 (IDFG 2019a). The ODFW also submitted an FMEP for recreational fisheries targeting coho salmon and resident trout on July 18, 2019 (ODFW 2019).

The Nez Perce Tribe (NPT) conducts Treaty fisheries for fall Chinook salmon and coho salmon with their reserved fishing rights under the Treaty of 1855 (12 Stat. 957). The NPT's treaty fisheries in the Clearwater River subbasin were set forth in previous *United States v. Oregon* biological assessments and associated biological opinions. The NPT treaty fisheries in the Snake Basin were also described in plans provided to NMFS in 2006, 2007, and 2014. The Tribe provided an updated and revised plan to NMFS on November 21, 2018, for evaluation under the 4(d) Tribal rule (Nez Perce Tribe 2018).

At this time, the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) and the Shoshone-Bannock Tribes (SBT) have decided not to submit TRMPs for fall Chinook salmon or coho salmon fisheries. However, both the CTUIR and the SBT may choose to submit one in the future in coordination with the other fishery managers.

1.3. Proposed Action

“Action” means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR 402.02). For purposes of consultation under the MSA, Federal action means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a Federal Agency (50 CFR 600.910).

NMFS proposes to issue a determination that the Snake River fall Chinook salmon, coho salmon, and resident trout FMEPs submitted by IDFG, WDFW, and ODFW meet the criteria required by limit 4 of the 4(d) Rule. NMFS also proposes to issue a determination that the Snake River fall Chinook salmon and coho salmon TRMP submitted by the NPT meets the requirements of the Tribal 4(d) Rule. This Proposed Action encompasses fair sharing of harvestable fish between tribal and non-tribal fisheries in accordance with Treaty fishing rights standards, which is the intent of *U.S. v. Oregon*. In addition, the Proposed Action supports the Federal government's tribal trust and fiduciary responsibilities¹.

1.3.1. Fishery Descriptions

Fall Chinook fisheries target ESA-listed hatchery- and natural-origin Chinook salmon. Coho salmon fisheries target unlisted hatchery- and-natural coho salmon, and thus have only incidental impacts on listed salmon and steelhead species.

¹ The Tribal fishery harvest has been limited (or minimal), but the Tribes intend that the levels of harvest of these fish will increase over time to allow for meaningful exercise of their treaty fishing rights. This increase depends on having sufficient access to fish at all “usual and accustomed” fishing places to catch the treaty harvest share.

Table 1. Fishery Details; LGD = Lower Granite Dam; HCD = Hells Canyon Dam.

Fishery	Manager	Location	Timing	Gear
Recreational fall Chinook salmon	WDFW	Mainstem Snake River below LGD and Tucannon River	Mid-August- November 30	Barbless hook and line
	IDFG, WDFW, ODFW	Mainstem Snake River above LGD to HCD, Salmon River, Grande Ronde River		
	IDFG	Mainstem, north, middle, and south fork Clearwater River		
Treaty fall Chinook salmon	NPT	Tucannon River, Mainstem Snake River from LGD to HCD, Clearwater River mouth to Lochsa/Selway Rivers' confluence, Lower Salmon, Grande Ronde and Imnaha Rivers	Late August- December 31	Dip net, gaff, spear, hook and line, gillnet, weir, seine, or other traditional gear
Recreational mark-selective coho salmon	IDFG	Mainstem Snake River, and mainstem, north, middle, and south fork Clearwater River	September 1- December 31	Barbless hook and line
	ODFW	Grande Ronde and Tributaries, and Oregon portion of the Snake River mainstem	September 1- December 31	Hook and line
Treaty coho salmon	NPT	Tucannon River, Mainstem Snake River from LGD to HCD, Clearwater River mouth to Lochsa/Selway Rivers' confluence, Lower Salmon, Grande Ronde and Imnaha Rivers	Late August - December 31	Dip net, gaff, spear, hook and line, gillnet, weir, seine, or other traditional gear
Recreational Resident Trout	ODFW	Grande Ronde and Imnaha Rivers and Tributaries, and Oregon portion of the Snake River mainstem	See Figure 2	Hook and line

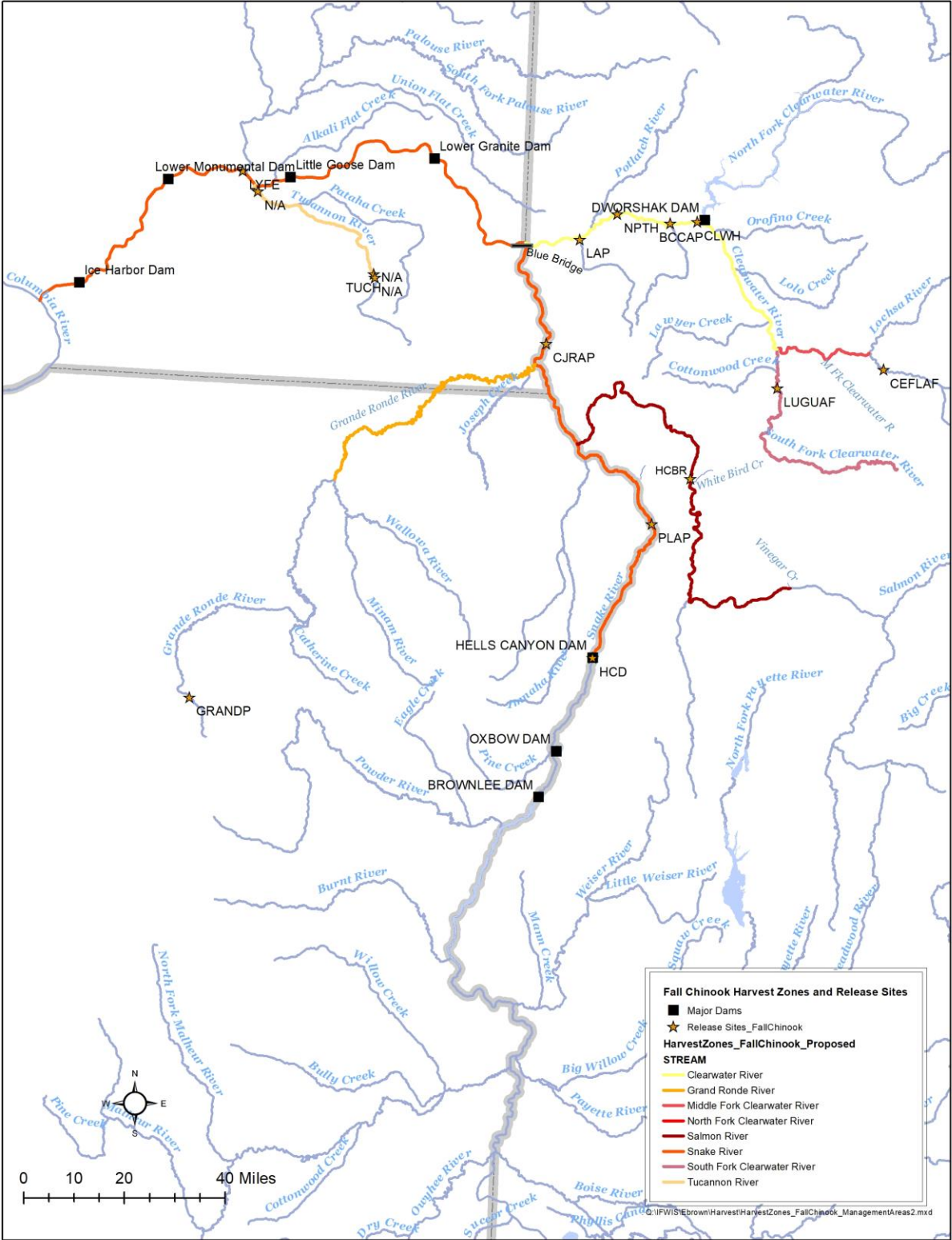


Figure 1. State areas open to fall Chinook and coho salmon (in Idaho only) fishing.

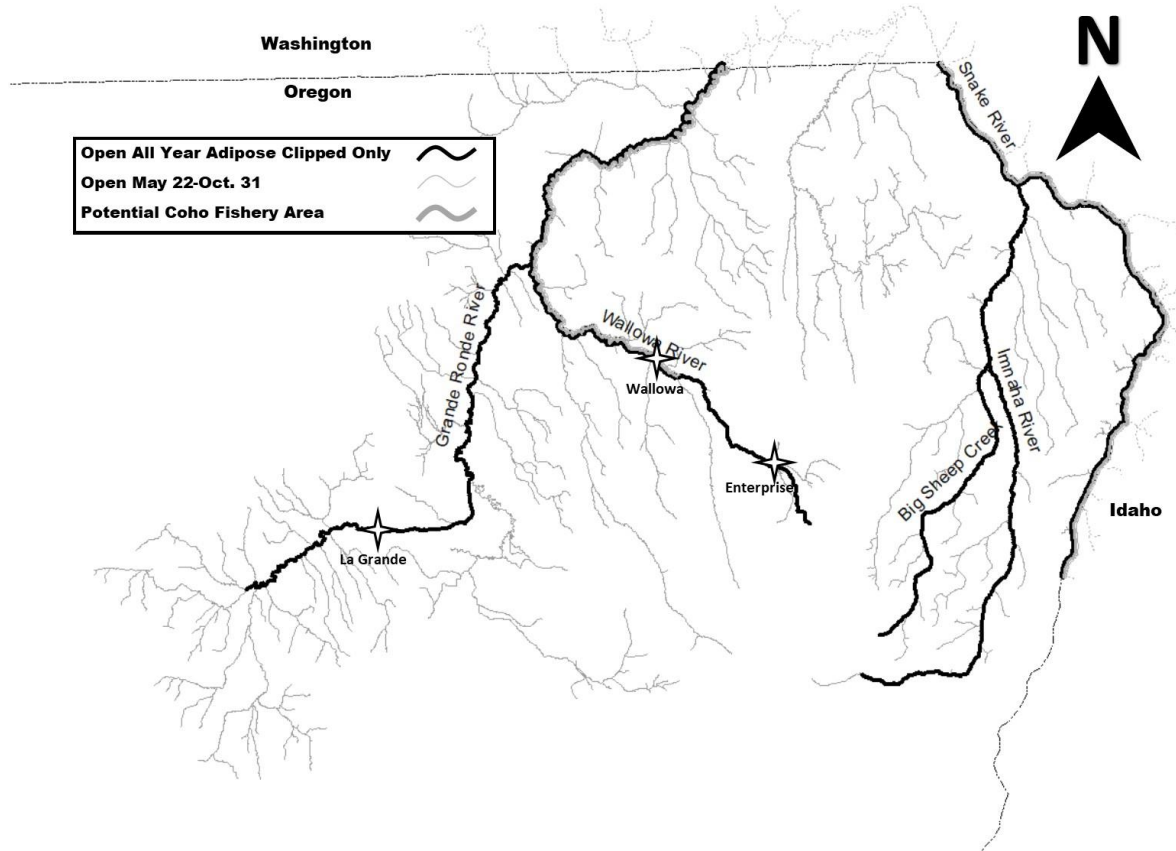


Figure 2. Fishery management area, including reaches that (1) are open all year for harvest of adipose-clipped trout (black lines), (2) open from May 22 to October 31 (thin gray lines) and (3) are potential areas for Coho Salmon fisheries (thick gray lines).

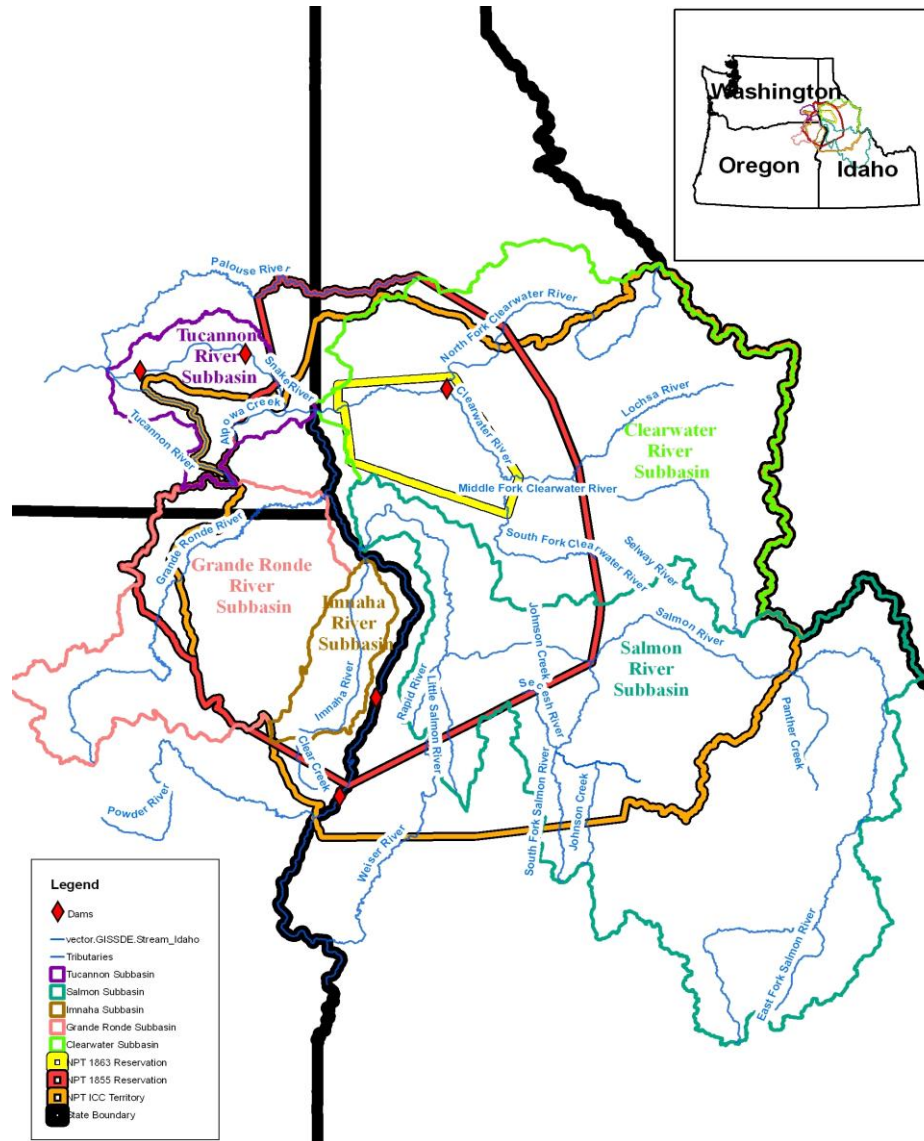


Figure 3. The Snake River Basin and its harvest areas as they relate to the Nez Perce Tribe’s 1855 Reservation and usual and accustomed fishing areas.

1.3.2. Proposed Impact Rates

1.3.2.1. Fall Chinook Salmon

Natural-origin impacts/harvest limits on fall Chinook salmon are based on the abundance of fall Chinook salmon at Lower Granite Dam (LGD; after hatchery and natural broodstock has been collected). As natural-origin run size increases, allowable harvest/impacts also increase. The States propose that no directed harvest of adipose-intact fall Chinook salmon would be allowed when natural-origin fall Chinook salmon abundance is predicted to be below 1,260 adults, and all

fishery impacts would be limited to incidental impacts during the steelhead, coho, and the mark-selective fall Chinook salmon fisheries.

In two consecutive years of natural-origin abundance below 1,260 natural-origin returns, the NPT could consider three approaches to further reduce impacts: 1) approving fisheries to target natural-origin fall Chinook salmon at a number less than what the harvest scale would otherwise allow; or 2) approving fisheries to target natural origin fall Chinook salmon using a harvest rate that is less than 4.5%; or 3) using other measures such as timing and area management to reduce the level of take. These additional harvest conservation measures would occur along with the other non-harvest conservation measures, such as the fall Chinook salmon supplementation program that the Tribe implements on an annual basis (Oatman 2019).

Table 2. Harvest rate schedule for natural-origin fall Chinook at Lower Granite Dam; MAT = Minimum abundance threshold.

Natural-Origin Adult Run Size	Natural-Origin Adult Run Size Relationship to MAT	Non-tribal Harvest Rate (%) ²	Nez Perce Treaty Harvest Rate (%)	Total Allowable Harvest Rate (%)	% Impact for Treaty Fisheries
0 – 1,260 ¹	0.0 - 0.3 MAT	1.5	4.5	6.0	75
1,261 – 2,100	0.3 - 0.5 MAT	2.0	6.0	8.0	75
2,101 – 3,150	0.5 - 0.75 MAT	2.0	7.0	9.0	78
3,151 – 5,040	0.75 – 1.2 MAT	6.0	8.0	14.0	57
> 5,041	> 1.2 MAT	10 + 22 on margin	10 + 22 on margin	20 + 44 on margin ³	50

¹ At this tier, there is no directed take on ad-intact fall Chinook salmon within the recreational fisheries, the impacts are incidental only to steelhead, coho, and mark selective fall Chinook fisheries.

² If mark-selective fisheries are implemented, the non-treaty fisheries may not harvest more than 50% of the harvestable share.

³ An example of this calculation is: $(5200 \times 0.2) + (5200 - 5040 \times 0.44) = 1,110$ natural-origin fish harvested.

Managers intend to conduct the fishery to ensure that the distribution of impacts will be in proportion to the number and distribution of natural spawner redd count data so that one segment of the population is not harvested in greater proportion than another segment of the population. The states propose to partition non-tribal impacts to three geographic areas regardless of where those impacts occur: 5 percent below LGD and 95% above LGD (based on current redd distribution this would allow 47 percent impacts to fish destined for the Snake River/Salmon River/Grande Ronde Rivers, and 48 percent impacts to fish destined for the Clearwater River. There is no spawning aggregate in the Snake River LGD to Blue Bridge geographic area (Figure 1). Thus, harvested fish from this reach could be destined for either of the upstream reaches, and any impacts in this area would be added to the upstream reaches based on the total redd count proportions in those upstream reaches.

Managers intend to limit the season temporally and spatially where fall Chinook salmon spawn in the Clearwater River to minimize the effects to spawning fish and redds. The fishery managers have

elected to include a plan in the proposed action to close fishing for fall Chinook salmon when the proportion of total redds constructed in the Clearwater River is $\geq 20\%$ (typically mid-October). The 20% initiation date will be based on the most recent five-year average across four high density spawning areas totaling 5.1 river kilometers; specifically the Myrtle, Cherry Lane, Big Canyon, and Ahsahka Islands spawning areas.

1.3.3. Fishery Monitoring and Reporting

The Applicants propose to continue monitoring programs to estimate the harvest, effort and incidental mortality of ESA-listed salmon and steelhead, which are routinely conducted pursuant to existing authorizations. The abundance of Snake River fall Chinook salmon is forecasted prior to the start of the run and fishing season using traditional sibling relationships. The forecast for Snake River fall Chinook returning to LGD is estimated annually using sibling regressions. The forecast at LGD is backed down to the Columbia River mouth by dividing the LGD forecast by average PIT tag conversion rates between Bonneville Dam and LGD and adding harvest from the fisheries in Zones 1-5 below Bonneville Dam. Fall Chinook start entering the Columbia River in late-July. The preseason forecast may be updated by the Technical Advisory Committee once 50% of the run has passed Bonneville Dam or there is compelling evidence to change (upgrade or downgrade) the forecast prior to that date. The run is monitored in-season using detections of PIT tagged fish at all of the mainstem dams to get in-season estimates of abundance, migration timing, and survival through the reaches. The fishery managers in the Snake River meet weekly during fall Chinook and coho salmon fisheries to discuss in-season fishery management.

Post-season, a fall Chinook salmon run reconstruction is conducted by the fishery managers to produce an estimation of natural- and hatchery-origin run size, including the number of adipose-intact hatchery adults, and impacts on natural-origin fall Chinook salmon. This reconstruction uses coded wire tag expansions, verified by Parentage Based Tagging (PBT) analyses, using samples from fish collected in the LGD trap. PBT from harvested, unclipped fall Chinook salmon adults obtained during roving creel surveys is used to determine the proportion and number of natural-origin fall Chinook salmon harvested. The total number of harvested fish (hatchery and natural) can be gleaned from Idaho's creel survey and from Oregon and Washington's Catch Record Cards and will also be provided by the Tribes' through an in-season interview census survey and regular catch reports to the fishery managers (NPT). Fall Chinook salmon redd counts conducted by the NPT, the US Fish and Wildlife Service, and the Idaho Power Company provide an estimate of spawning distribution in the natural environment, and may be used in the future to partition impacts by area.

Each year, fishery managers will coordinate the exchange of harvest and impact data for spawning escapement estimation, and a post-season annual report to NMFS by April 15th a year and a half following the fishery. For example, a fishery conducted in 2017 would have final reporting submitted by April 15th, 2019. The actual impacts on natural-origin fall Chinook salmon will then be compared to those authorized by NMFS to determine if the authorized rates were exceeded to implement any necessary changes to the fisheries to ensure that ESA limits are not exceeded in the future.

1.4. Interrelated and Interdependent Actions

Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration (50 CFR 402.02). NMFS has identified angler access and wading, and boat operation as interdependent or interrelated activities associated with the Proposed Action.

Hatcheries are not part of this Proposed Action. Although fisheries target hatchery-origin returns, harvest frameworks are managed separately from specific hatchery programs, and are not solely tied to production numbers. However, this Opinion accounts for the effects of hatcheries and other fisheries not included in the Proposed Action, including *U.S. v Oregon* fisheries, as part of the species status, baseline, and cumulative effects discussions.

2. ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, each Federal agency must ensure that its actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, Federal action agencies consult with NMFS and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provides an opinion stating how the agency's actions would affect listed species and their critical habitats. If incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an ITS that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

2.1. Analytical Approach

This biological opinion includes both a jeopardy analysis and/or an adverse modification analysis. Section 7(a)(2) of the ESA requires Federal agencies, in consultation with NMFS, to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. The jeopardy analysis considers both survival and recovery of the species. "To jeopardize the continued existence of a listed species" means to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of the species in the wild by reducing the reproduction, numbers, or distribution of that species or reduce the value of designated or proposed critical habitat (50 CFR 402.02).

This biological opinion relies on the definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features" (81 FR 7214, February 11, 2016).

The designations of critical habitat for the species considered in this opinion use the terms primary constituent element (PCE) or essential features. The new critical habitat regulations (81 FR 7414, February 11, 2016) replace this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a “destruction or adverse modification” analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. We use the term PCE as equivalent to PBF or essential feature, due to the description of such features in applicable recovery planning documents.

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

Identify the range-wide status of the species and critical habitat

This section describes the status of species and critical habitat that are the subject of this opinion. The status review starts with a description of the general life history characteristics and the population structure of the ESU/DPS, including the strata or major population groups (MPG) where they occur. NMFS has developed specific guidance for analyzing the status of salmon and steelhead populations in a “viable salmonid populations” (VSP) paper ((McElhany et al. 2000). The VSP approach considers four attributes, the abundance, productivity, spatial structure, and diversity of each population (natural-origin fish only), as part of the overall review of a species’ status. For salmon and steelhead protected under the ESA, the VSP criteria therefore encompass the species’ “reproduction, numbers, or distribution” (50 CFR 402.02). In describing the range-wide status of listed species, NMFS reviews available information on the VSP parameters including abundance, productivity trends (information on trends, supplements the assessment of abundance and productivity parameters), spatial structure and diversity. We also summarize available estimates of extinction risk that are used to characterize the viability of the populations and ESU/DPS, and the limiting factors and threats. To source this information, NMFS relies on viability assessments and criteria in technical recovery team documents, ESA Status Review updates, and recovery plans. We determine the status of critical habitat by examining its PBFs. Status of the species and critical habitat are discussed in Section 2.2.

Describe the environmental baseline in the action area

The environmental baseline includes the past and present impacts of Federal, state, or private actions and other human activities *in the action area* on ESA-listed species. It includes the anticipated impacts of proposed Federal projects that have already undergone formal or early section 7 consultation and the impacts of state or private actions that are contemporaneous with the consultation in process. The environmental baseline is discussed in Section 2.3 of this opinion.

Analyze the effects of the proposed action on both the species and their habitat

Section **Error! Reference source not found.** first describes the various pathways by which hatchery operations can affect ESA-listed salmon and steelhead, then applies that concept to the specific programs considered here.

Cumulative effects

Cumulative effects, as defined in NMFS' implementing regulations (50 CFR 402.02), are the effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area. Future Federal actions that are unrelated to the proposed action are not considered because they require separate section 7 consultation. Cumulative effects are considered in Section **Error! Reference source not found.** of this opinion.

Integration and synthesis

Integration and synthesis occurs in Section 2.7 of this opinion. In this step, NMFS (1) Reviews the status of the species and critical habitat; and (2) adds the effects of the action, the environmental baseline, and cumulative effects to assess the risk that the proposed action poses to species and critical habitat (Section 2.7).

Conclude whether species are jeopardized or critical habitat is adversely modified

Based on the Integration and Synthesis analysis in Section **Error! Reference source not found.**, the opinion determines whether the proposed action is likely to jeopardize ESA protected species or destroy or adversely modify designated critical habitat in Section **Error! Reference source not found.**.

If necessary, suggest a RPA to the proposed action.

If, in completing the last step in the analysis, we determine that the action under consultation is likely to jeopardize the continued existence of listed species or destroy or adversely modify designated critical habitat, we must identify a reasonable and prudent alternative (RPA) to the action. The RPA must not be likely to jeopardize the continued existence of listed species nor adversely modify their designated critical habitat and it must meet other regulatory requirements.

2.2. Range-wide Status of the Species and Critical Habitat

This opinion examines the status of each species and designated critical habitat that would be affected by the Proposed Action (Table 3). The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and ESA listing determinations. This informs the description of the species' likelihood of both survival and recovery. The species status section helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02. The opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the current function of the essential PBFs that help to form that conservation value.

Table 3. Federal Register notices for the final rules that list species, designate critical habitat, or apply protective regulations to ESA listed species considered in this consultation.

Species	Listing Status	Critical Habitat	Protective Regulations
Chinook salmon (<i>Oncorhynchus tshawytscha</i>)			
Snake River spring/summer	Threatened, 79 FR 20802, April 14, 2014	64 FR 57399, October 25, 1999	70 FR 37160, June 28, 2005
Snake River fall	Threatened, 79 FR 20802, April 14, 2014	58 FR 68543, December 28, 1993	70 FR 37160, June 28, 2005
Steelhead (<i>O. mykiss</i>)			
Snake River	Threatened, 79 FR 20802, April 14, 2014	70 FR 52769, September 2, 2005	70 FR 37160, June 28, 2005
Sockeye salmon (<i>O. nerka</i>)			
Snake River	Endangered, 79 FR 20802, April 14, 2014	70 FR 52769, September 2, 2005	Pursuant to ESA Section 9

“Species” Definition: The ESA of 1973, as amended, 16 U.S.C. 1531 *et seq.* defines “species” to include any “distinct population segment (DPS) of any species of vertebrate fish or wildlife which interbreeds when mature.” To identify DPSs of salmon species, NMFS follows the “Policy on Applying the Definition of Species under the ESA to Pacific Salmon” (56 FR 58612, November 20, 1991). Under this policy, a group of Pacific salmon is considered a DPS and hence a “species” under the ESA if it represents an evolutionarily significant unit (ESU) of the biological species. The group must satisfy two criteria to be considered an ESU: (1) It must be substantially reproductively isolated from other con-specific population units; and (2) It must represent an important component in the evolutionary legacy of the species. To identify DPSs of steelhead, NMFS applies the joint FWS-NMFS DPS policy (61 FR 4722, February 7, 1996). Under this policy, a DPS of steelhead must be discrete from other populations, and it must be significant to its taxon.

2.2.1. Status of Listed Species

For Pacific salmon and steelhead, NMFS commonly uses four parameters to assess the viability of the populations that, together, constitute the species: abundance, productivity, spatial structure, and diversity (McElhany et al. 2000). These viable salmonid population (VSP) criteria therefore encompass the species’ reproduction, numbers, or distribution as described in 50 CFR 402.02. When these parameters are collectively at appropriate levels, they maintain a population’s capacity to adapt to various environmental conditions and allow it to sustain itself in the natural environment. These parameters or attributes are substantially influenced by habitat and other environmental conditions.

“Abundance” generally refers to the number of naturally-produced adults (i.e., the progeny of naturally-spawning parents) in the natural environment.

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

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

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

As described above, the ESA allows a DPS (or in the case of salmon, an ESU) of a species to be listed as threatened or endangered. In terms of determining the status of a species, NMFS uses a hierarchical approach for determining ESU-level viability criteria. To do this, an ESU or DPS is divided into natural populations (McElhany et al. 2000). The risk of extinction of each population is evaluated, taking into account population-specific measures of abundance, productivity, spatial structure, and diversity. Natural populations are then grouped into ecologically and geographically similar *strata* referred to as major population groups (MPG), which are evaluated on the basis of population status. In order to be considered viable, an MPG generally must have at least half of its historically present natural populations meeting their population-level viability criteria (McElhany et al. 2006). A viable salmonid ESU or DPS, requires all extant MPGs to be viable, and is naturally self-sustaining, with a high probability of persistence over a 100-year period.

In assessing status, we consider the hierarchical approach described above in combination with the information used in its most recent ESA status review for the salmon and steelhead species considered in this opinion, and if applicable, consider more recent data, that are relevant to the species’ rangewide status. Many times, this information exists in ESA recovery plans. Recent information from recovery plans, where they are developed for a species, is often relevant and is used to supplement the overall review of the species’ status. This step of the analysis tells us how well the species is doing over its entire range in terms of trends in abundance and productivity, spatial distribution, and diversity. It also identifies the causes for the species’ decline.

The status review starts with a description of the general life history characteristics and the population structure of the ESU or DPS including the MPGs where they occur. We review VSP information that is available including abundance, productivity and trends (information on trends supplements the assessment of abundance and productivity parameters), and spatial structure and diversity. We also summarize available estimates of extinction risk that are used to characterize

the viability of each natural population leading-up to a risk assessment for the ESU or DPS, and the limiting factors and threats. This Section concludes by examining the status of critical habitat.

Recovery plans are an important source of information that describe, among other things, the status of the species and its component populations, limiting factors, recovery goals and actions that the plan recommends to address limiting factors. Recovery plans are not regulatory documents and the recommended actions are not assured of happening. Consistency of a proposed action with a recovery plan, therefore, does not by itself provide the basis for determining that an action does not jeopardize the species. However, recovery plans do provide a perspective encompassing all human impacts that is important when assessing the effects of an action. Information from existing recovery plans for each respective ESA-listed salmon and steelhead is discussed where it applies in various sections of this opinion.

2.2.1.1. Snake River Steelhead

On August 18, 1997, NMFS listed the Snake River Basin 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 Basin 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 4) (NWFSC 2015). This DPS consists of A-Index steelhead, which begin their upstream migration earlier, and the B-Index steelhead, which generally exhibit a larger body size as a result of rearing an additional year in the ocean (Copeland et al. 2017; NMFS 2011a). Twenty-six 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 4) (Jones Jr. 2015). 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 (2005c).

Table 4. Snake River Basin Steelhead DPS description.

DPS Description	
Threatened	Listed under ESA as threatened in 1997; updated in 2014
<i>Major Population Groups (6)</i>	<i>Populations (26)</i>
Grande Ronde	Joseph Creek, Upper Mainstem, Lower Mainstem, Wallowa River
Imnaha River	Imnaha River
Clearwater	Lower Mainstem River, North Fork Clearwater (extirpated), 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 Fork, Lemhi River, Pahsimeroi River, East Fork Salmon, Upper Mainstem
Lower Snake	Tucannon River, Asotin Creek
Hells Canyon Tributaries	Wild Horse/Powder River (extirpated)
<i>Artificial production</i>	
Hatchery programs included in DPS	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	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

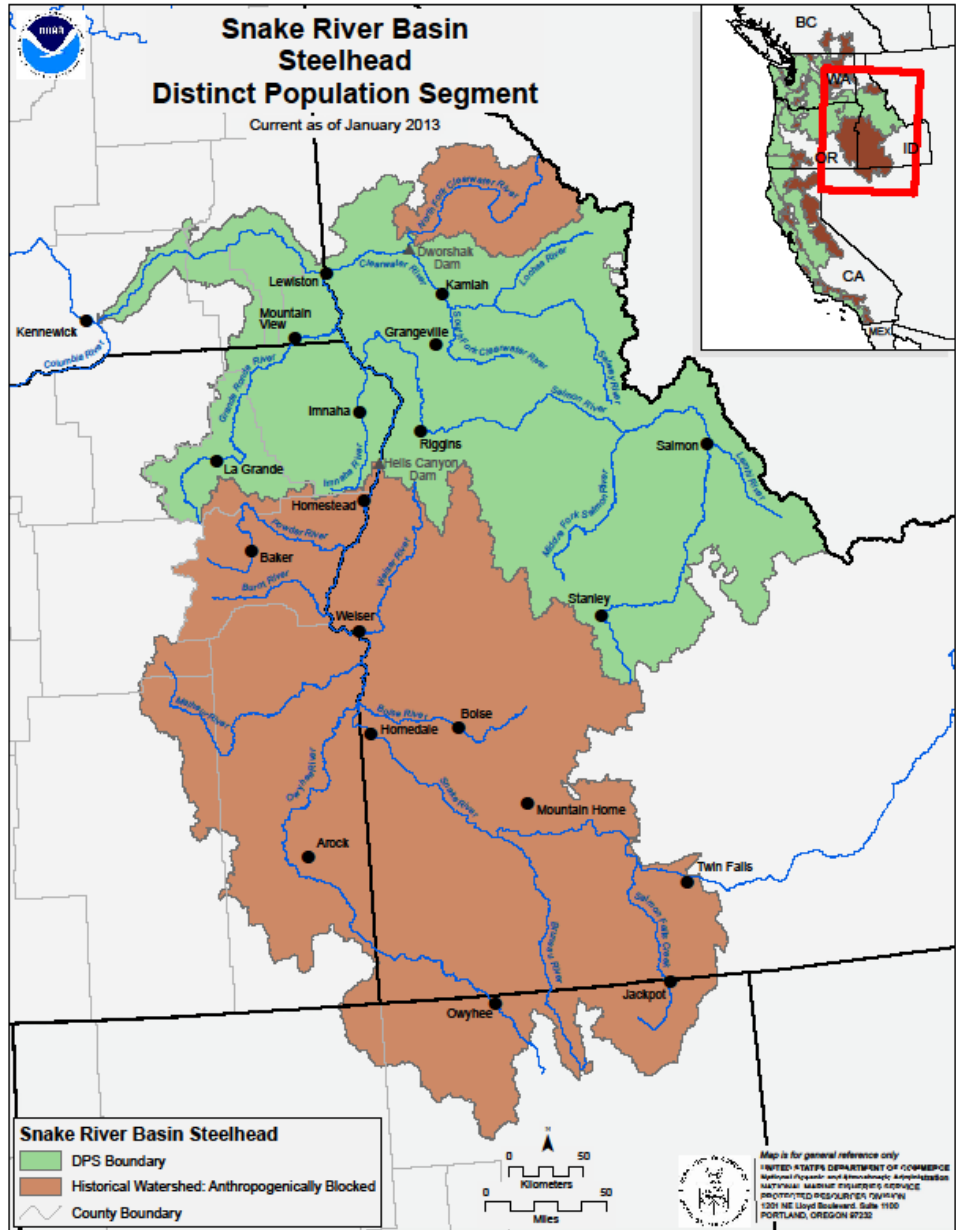


Figure 4. Map of the Snake River Basin Steelhead DPS’s spawning and rearing areas.

Snake River Basin 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 2017e). Because 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 forms 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 2012).

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 Basin 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 2012; NMFS 2013b). A small component returns in the following spring, just prior to spawning.

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 2012; 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 species, in this case the Snake River Basin Steelhead DPS ranges from moderate to high risk and remains at threatened status. 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). 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 versus B (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 (Table 5). These values were derived by assuming a replacement rate of 1, and considering available spawning habitat (ICTRT 2007). Recently, steelhead abundance for this DPS has been low. One possible explanation is the warm-water “Blob” that formed in the Pacific Ocean off the coast of the Pacific Northwest in 2014. Over the last several years, these ocean conditions have led to poor survival of young salmon and

steelhead while they were in the ocean. The Blob has dissipated, but it is still impacting the number of adult salmon and steelhead that are returning the Columbia River Basin. However, recent samples taken by scientists at NMFS' Northwest Fisheries Science Center have indicated that marine conditions are improving.

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 (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 LGR 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 5. Risk levels and viability ratings for Snake River steelhead Major Population Groups (MPGs) (NWFSC 2015). Data are from 2004-2015. ICTRT = Interior Columbia Technical Recovery Team. Current abundance and productivity estimates expressed as geometric means (standard error).

MPG	Population	ICTRT minimum threshold	Natural spawning abundance	Productivity	Abundance and productivity risk ¹	Spatial structure and diversity risk ¹	Overall risk viability rating ¹
Clearwater River	Lower Main	1500	2099 (0.15)	2.36 (0.16)	Moderate	Low	Maintained
	South Fork	1000	Insufficient data		High	Moderate	Maintained/High
	Lolo Creek	500	Insufficient data		High	Moderate	Maintained
	Selway River	1000			Moderate	Low	Maintained
	Lochsa River	1000	1650 (0.17)	2.33 (0.18)	Moderate	Low	Maintained
Salmon River	Little Salmon River	500	Insufficient data		Moderate	Moderate	Maintained
	South Fork	1000			Moderate	Low	Maintained
	Secesh River	500	1028 (0.17)	1.8 (0.15)	Moderate	Low	Maintained
	Chamberlain Creek	500			Moderate	Low	Maintained
	Lower Middle Fork	1000	2213 (0.16)	2.38 (0.10)	Moderate	Low	Maintained
	Upper Middle Fork	1000			Moderate	Low	Maintained
	Panther Creek	500	Insufficient data		Moderate	High	High
	North Fork	500	Insufficient data		Moderate	Moderate	Maintained
	Pahsimeroi River	1000	Insufficient data		Moderate	Moderate	Maintained
	East Fork	1000	Insufficient data		Moderate	Moderate	Maintained
	Upper Main	1000	Insufficient data		Moderate	Moderate	Maintained
	Lemhi	1000	Insufficient data		Moderate	Moderate	Maintained
Imnaha	Imnaha River	1000	Insufficient data		Moderate	Moderate	Maintained
Grande Ronde River	Lower Grande Ronde	1000	Insufficient data		Moderate	Moderate	Maintained
	Joseph Creek	500	1839	1.86	Very Low	Low	Low
	Upper Grande Ronde	1500	1649	3.15	Moderate	Moderate	Low
Lower Snake River	Wallowa River	1000	Insufficient data		High	Moderate	Maintained
	Tucannon River	1000	Insufficient data		High	Moderate	High
	Asotin Creek	500	Insufficient data		Moderate	Moderate	High

¹Uncertain due to lack of data, only a few years of data, or large gaps in data series.

Limiting Factors

One of the necessary steps in recovery and consideration for delisting the species is to ensure that the underlying limiting factors and threats have been addressed. Factors that limit the DPS have been, and continue to be, survival through the Federal Columbia River Power System (FCRPS), impaired tributary fish passage, degraded spawning and rearing habitat, increased water temperature, predation, effects on genetic diversity from hatchery releases, and harvest-related effects (NMFS 2017e). The majority of harvest impacts on steelhead occur in tribal gillnet and dip net fishing targeting Chinook salmon. Because of their larger size, the B-Index fish are more vulnerable to gillnet gear. In recent years, total harvest on the A-Index have been stable around 5%, while harvest rates on the B-Index have generally been in the range of 15-20% (NWFSC 2015).

Overall, the recovery strategy aims to support naturally self-sustaining steelhead populations in the Snake River by minimizing and/or eliminating the limiting factors and threats. This will be achieved by modifying activities associated with harvest, hatcheries, habitat, and the hydrosystem.

2.2.1.2. Snake River Fall Chinook salmon

On June 3, 1992, NMFS listed the Snake River fall 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 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, 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 (2005c), 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 2005c). Table 6 lists the natural and hatchery populations included in the ESU.

Table 6. Snake River Fall Chinook Salmon ESU description.

ESU Description	
Threatened	Listed under ESA in 1992; updated in 2014
<i>Major Population Group (1)</i>	<i>Populations (2)</i>
Snake River	Lower Snake River, Middle Snake River (extirpated)
<i>Artificial Propagation</i>	<i>Programs</i>
Programs in ESU	Lyons Ferry NFH fall, Acclimation Ponds Program fall, Nez Perce Tribal Hatchery fall, Idaho Power fall

ESU Description	
Programs not in ESU	Not applicable

Two historical populations (1 extirpated) within one MPG comprise the Snake River fall Chinook Salmon ESU (Figure 5). The extant natural population spawns and rears in the mainstem Snake River and its tributaries below Hells Canyon Dam. The decline of this ESU was due to heavy fishing pressure beginning in the 1890s and loss of habitat with the construction of the various mainstem Columbia and Snake River dams, 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 Chinook salmon since the 1980s (NMFS 2012). 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).

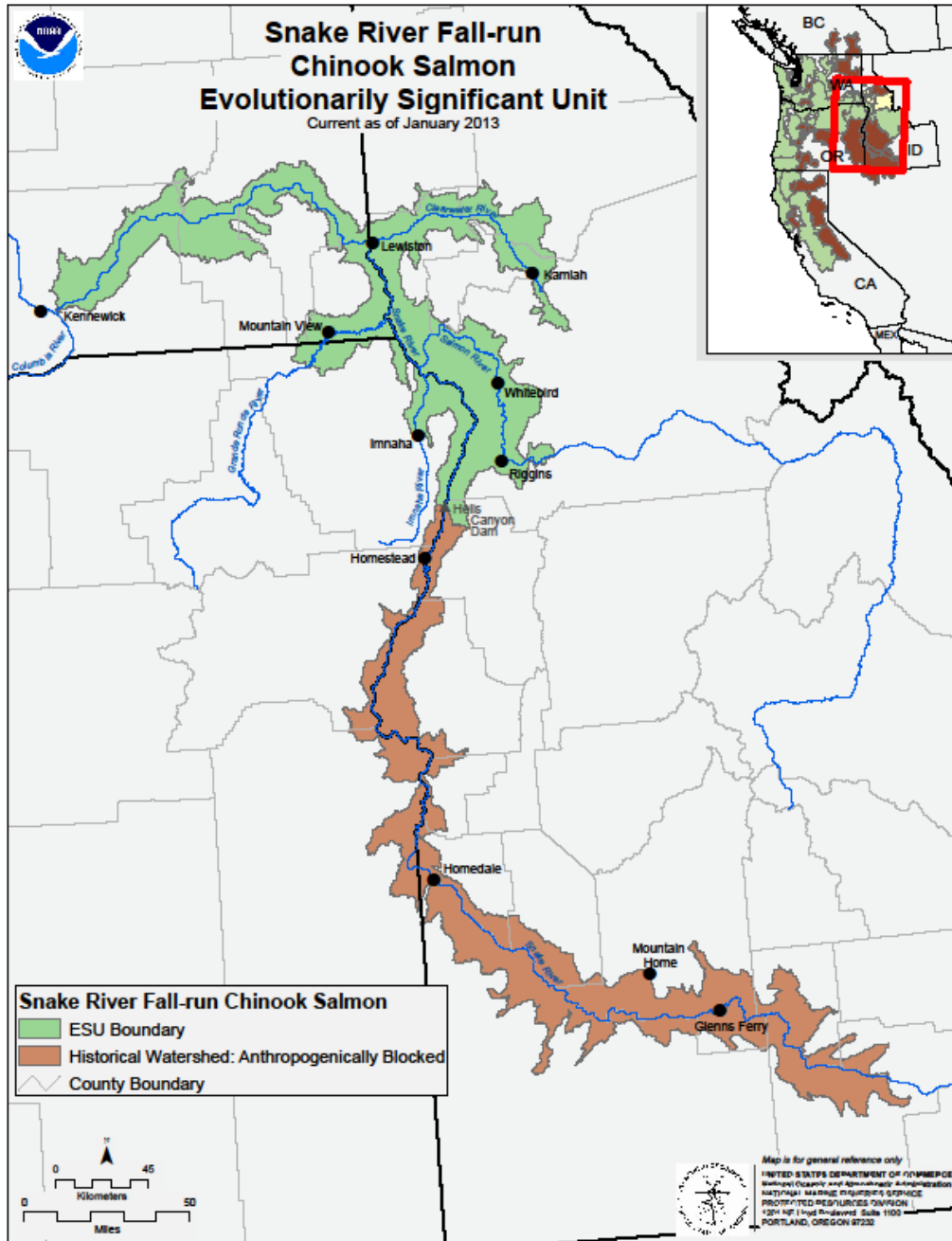


Figure 5. Map of the Snake River Fall Chinook Salmon ESU’s spawning and rearing areas.

Snake River fall Chinook salmon spawning and rearing occurs primarily in larger mainstem rivers, such as the Salmon, Snake, and Clearwater Rivers. Historically, the primary fall 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. Natural spawning is currently limited to the Snake River from the upper end of LGR 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 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 LGR, 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 2012).

Abundance, Productivity, Spatial Structure, and Diversity

The recently released NMFS Snake River fall Chinook Recovery Plan (NMFS 2017d) proposes that a single population viability scenario could be possible given the unique spatial complexity of the Lower Mainstem Snake River fall 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 Snake River fall Chinook salmon population is viable. This is based on a low risk rating for abundance/productivity and a moderate risk rating for spatial structure/diversity. For abundance/productivity, the rating reflects remaining uncertainty that current increases in abundance can be sustained over the long run. The geometric mean natural-origin fish abundance obtained from the most recent 10 years of annual spawner escapement estimates is 6,418 fish. The most recent status review used the ICTRT simple 20-year recruits per spawner values to estimate the current productivity for this population (1990-2009 brood years) of 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, which is the present potential metric for the population to be rated at very low risk. While natural-origin spawning levels are above the minimum abundance threshold of 4,200, and estimated productivity is also high, neither measure is high enough to achieve the very low risk rating necessary to buffer against significant remaining uncertainty (NWFSC 2015).

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).

Limiting Factors

Understanding the limiting factors and threats that affect the Snake River fall Chinook Salmon ESU provides important information and perspective regarding the status of a species. One of the necessary steps in recovery and consideration for delisting is to ensure that the underlying limiting factors and threats have been addressed. Factors that limit the ESU have been, and continue to be, hydropower projects, predation, harvest, degraded estuary habitat, and degraded mainstem and tributary habitat (Ford et al. 2011; NMFS 2017d). The recovery plan (NMFS 2017d) also describes strategies for addressing each limiting factor. Ocean conditions have also affected the status of this ESU. Ocean conditions affecting the survival of Snake River fall Chinook salmon were generally poor during the early part of the last 20 years (NMFS 2017d).

Overall, the status of Snake River fall Chinook salmon has clearly improved compared to the time of listing and since the time of prior status reviews. The single extant population in the ESU is currently meeting the criteria for a rating of viable developed by the ICTRT, but the ESU as a whole is not meeting the recovery goals described in the recovery plan for the species. These goals require the single population to be “highly viable with high certainty” and/or will require reintroduction of a viable population above the Hells Canyon Dam complex (NMFS 2017d). Overall, the recovery strategy aims to support a naturally self-sustaining fall Chinook salmon population(s) in the Snake River by minimizing and/or eliminating the limiting factors and threats. This will be achieved by modifying activities associated with harvest, hatcheries, habitat, and the hydrosystem.

2.2.1.3. Snake River spring/summer Chinook salmon

On June 3, 1992, NMFS listed the Snake River spring/summer 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 Chinook Salmon ESU includes all naturally spawned populations of spring/summer 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). Thirty-two historical populations (four extirpated) within five MPGs comprise the Snake River spring/summer Chinook Salmon ESU. The natural populations are aggregated into the five extant MPGs based on genetic, environmental, and life-history characteristics. Figure 6 shows a map of the current ESU and the MPGs within the ESU. However, inside the geographic range of the ESU, there are a total of 19 hatchery spring/summer Chinook salmon programs currently operational (Jones Jr. 2015). Table 7 lists the natural and hatchery populations included (or excluded) in the ESU.

Table 7. Snake River spring/summer Chinook Salmon ESU description.

ESU Description	
Threatened	Listed under ESA in 1992; updated in 2014.

ESU Description	
<i>Major Population Group (5)</i>	<i>Populations (32)</i>
Lower Snake River	Tucannon River, Asotin Creek (extirpated)
Grande Ronde/Imnaha River	Wenaha, Lostine/Wallowa, Minam, Catherine Creek, Upper Grande Ronde, Imnaha, Big Sheep Creek (extirpated), Lookingglass Creek (extirpated)
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
Upper Salmon	Lower Salmon Mainstem, Lemhi River, Pahsimeroi River, Upper Salmon Mainstem, East Fork Salmon, Valley Creek, Yankee Fork, North Fork Salmon, Panther Creek (extirpated)
<i>Artificial production</i>	<i>Programs</i>
Programs in ESU	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.
Programs not in ESU	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.

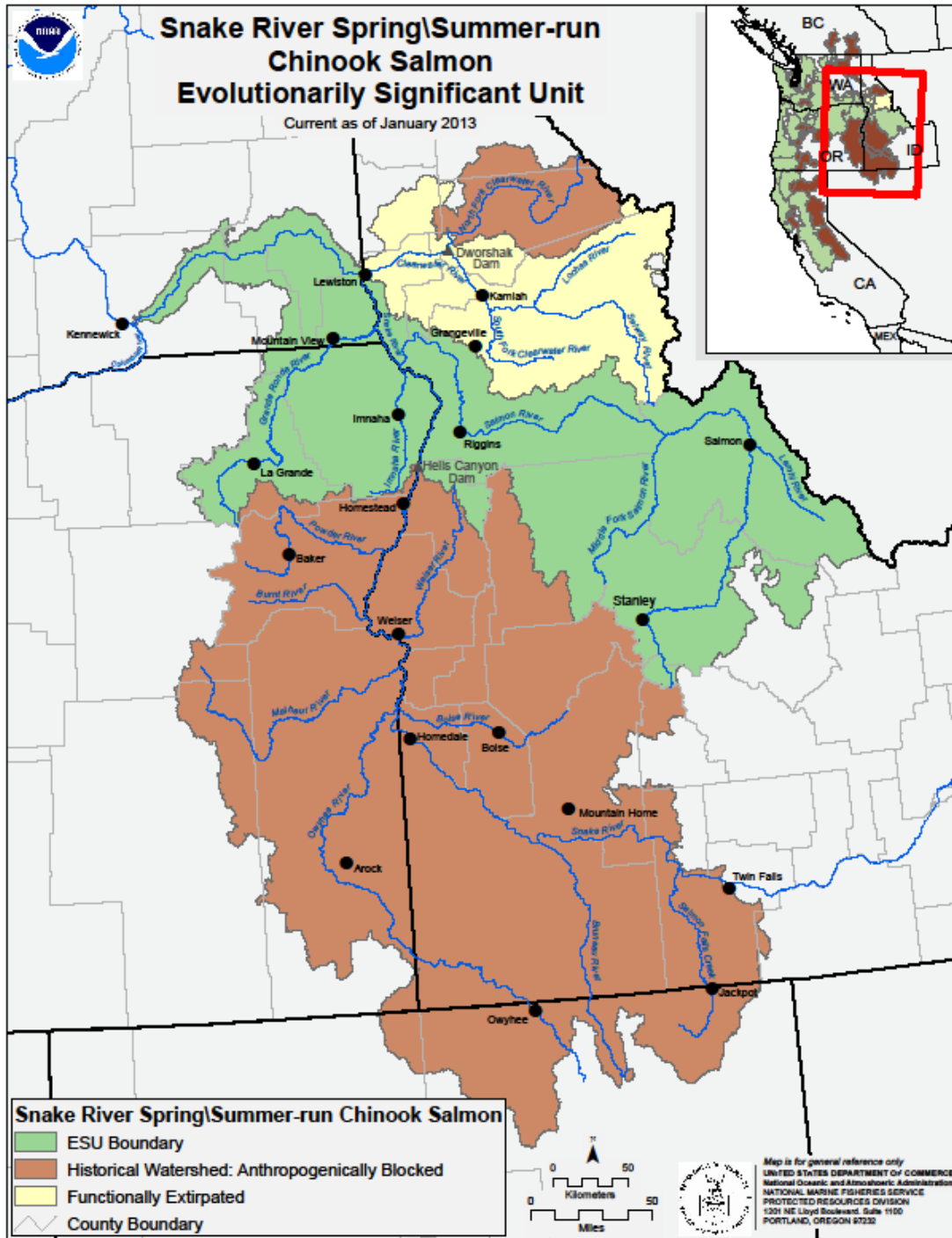


Figure 6. Snake River spring/summer Chinook salmon ESU spawning and rearing areas.

Chinook salmon have a wide variety of life-history patterns that include: variation in age at seaward migration; length of freshwater, estuarine, and oceanic residence; ocean distribution; ocean migratory patterns; and age and season of spawning migration. The Snake River Spring/Summer Chinook Salmon ESU consists of “stream-type” Chinook salmon, which spend two to three years in ocean waters and exhibit extensive offshore ocean migrations (Myers et al.

1998). In general, Chinook salmon tend to occupy streams with lower gradients than steelhead, but there is considerable overlap between the distributions of the two species (NMFS 2012).

Abundance, Productivity, Spatial Structure, and Diversity

Natural-origin abundance has increased over the levels reported in the prior review (Ford et al. 2011) for most populations in this ESU, although the increases were not substantial enough to change viability ratings (Table 8). Relatively high ocean survivals in recent years 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 in the MF MPG, 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 (NWFSC 2015).

Spatial structure ratings remain unchanged or stable with low or moderate risk levels for the majority of the populations in the ESU. 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. Risk levels and viability ratings for Snake River spring/summer Chinook salmon populations (NWFSC 2015); ICTRT = Interior Columbia Technical Recovery Team; MPG = Major Population Group. Data are from 2005-2014. Abundance and productivity estimates expressed as geometric means (standard error).

MPG	Population	ICTRT minimum threshold	Natural spawning abundance	Proportion natural-origin spawners	Productivity	Abundance and productivity risk	Spatial structure and diversity risk	Overall rating	
Lower Snake	Tucannon River	750	267 (0.19)	0.67	0.69 (0.23)	High	Moderate	High risk	
	Asotin Creek	500				Extirpated			
Grande Ronde/ Imnaha	Wenaha River	750	399 (0.12)	0.76	0.93 (0.21)	High	Moderate	High risk	
	Lostine/Wallowa River	1000	332 (0.24)	0.45	0.98 (0.12)	High	Moderate	High risk	
	Lookingglass Creek	500					Extirpated		
	Minam River	750	475 (0.12)	0.89	0.94 (0.18)	High	Moderate	High risk	
	Catherine Creek	1000	110 (0.31)	0.45	0.95 (0.15)	High	Moderate	High risk	
	Upper Grande Ronde	1000	43 (0.26)	0.18	0.59 (0.28)	High	High	High risk	
	Imnaha River	750	328 (0.21)	0.35	1.2 (0.09)	High	Moderate	High risk	
South Fork (SF)	Big Sheep Creek	500					Extirpated		
	SF Mainstem	1000	791 (0.18)	0.77	1.21 (0.2)	High	Moderate	High	
	Secesh River	750	472 (0.18)	0.98	1.25 (0.2)	High	Low	High	
	EF/Johnson Creek	1000	208 (0.24)	0.61	1.15 (0.2)	High	Low	High	
Middle Fork (MF)	Little Salmon River	750				Insufficient data	Low	High	
	Chamberlain Creek	750	641 (0.17)	1.0	2.26 (0.45)	Moderate	Low	Maintained	
	Big Creek	1000	154 (0.23)	1.0	1.1 (0.21)	High	Moderate	High	
	Loon Creek	500	54 (0.1)	1.0	0.98 (0.4)	High	Moderate	High	
	Camas Creek	500	38 (0.2)	1.0	0.8 (0.29)	High	Moderate	High	
	Lower mainstem MF	500					Insufficient data	Moderate	High
	Upper mainstem MF	750	71 (0.18)	1.0	0.5 (0.72)	High	Moderate	High	
	Sulphur Creek	500	67 (0.99)	1.0	0.92 (0.26)	High	Moderate	High	
	Marsh Creek	500	253 (0.27)	1.0	1.21 (0.24)	High	Low	High	
Bear Valley Creek	750	474 (0.27)	1.0	1.37 (0.17)	High	Low	High		
Upper Salmon River	Salmon Lower main	2000	108 (0.18)	1.0	1.18 (0.17)	High	Low	High	
	Salmon upper main	1000	411 (0.18)	0.7	1.22 (0.19)	High	Low	High	
	Pahsimeroi River	1000	267 (0.24)	0.93	1.37 (0.2)	High	High	High	
	Lemhi River	2000	143 (0.18)	1.0	1.3 (0.23)	High	High	High	
	Valley Creek	500	121 (0.18)	1.0	1.45 (0.15)	High	Moderate	High	
	Salmon EF	1000	347 (0.24)	1.0	1.08 (0.28)	High	High	High	
	Yankee Fork	500	44 (0.18)	0.39	0.72 (0.39)	High	High	High	
	North Fork	500					Insufficient data	Low	High
Panther Creek	750						Extirpated		

Limiting Factors

Understanding the limiting factors and threats that affect the Snake River spring/summer Chinook Salmon ESU provides important information and perspective regarding the status of a species. One of the necessary steps in recovery and consideration for delisting is to ensure that the underlying limiting factors and threats have been addressed. The abundance of spring/summer Chinook salmon had already begun to decline by the 1950s, and it continued declining through the 1970s. In 1995, only 1,797 spring/summer Chinook salmon total adults (both hatchery and natural-origins combined) returned to the Snake River (NMFS 2017e).

There are many factors that affect the abundance, productivity, spatial structure, and diversity of the Snake River spring/summer Chinook Salmon ESU. Factors that limit the ESU have been, and continue to be, survival through the Federal Columbia River Power System (FCRPS); the degradation and loss of estuarine areas that help the fish survive the transition between fresh and marine waters, spawning and rearing areas that have lost deep pools, cover, side-channel refuge areas, and high quality spawning gravels; and interbreeding and competition with hatchery fish that far outnumber fish of natural-origin. Overall, the recovery strategy aims to support naturally self-sustaining spring/summer Chinook salmon populations in the Snake River by minimizing and/or eliminating the limiting factors and threats. This will be achieved by modifying activities associated with harvest, hatcheries, habitat, and the hydrosystem.

2.2.1.4. 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) (Table 9). The MPG contains one extant population (Redfish Lake) and four historical populations (Alturas, Pettit, Stanley, and Yellowbelly Lakes) (NMFS 2015) (Figure 7). At the time of listing in 1991, the only confirmed extant population included in this ESU was the beach-spawning population of sockeye salmon from Redfish Lake, with about 10 fish returning per year (NMFS 2015). Historical records indicate that sockeye salmon once occurred in several other lakes in the Stanley Basin, but no adults were observed in these lakes for many decades. Once residual sockeye salmon were observed in Redfish Lake, their relationship to the Redfish Lake anadromous population was uncertain (McClure et al. 2005). Since ESA-listing, progeny of the Redfish Lake sockeye salmon population have been outplanted to Pettit and Alturas Lakes within the Sawtooth Valley for recolonization purposes (NMFS 2011a).

Table 9. Snake River Sockeye Salmon ESU description.

ESU Description	
Threatened	Listed under ESA in 1991; updated in 2014
<i>Major Population Group (1)</i>	<i>Populations (5)</i>
Sawtooth Valley Sockeye	Redfish Lake (extant); Alturas, Pettit, Stanley, Yellowbelly Lakes (extirpated)
<i>Artificial production</i>	<i>Programs</i>
Programs in ESU	Redfish Lake Captive Broodstock
Programs not in ESU	Not applicable

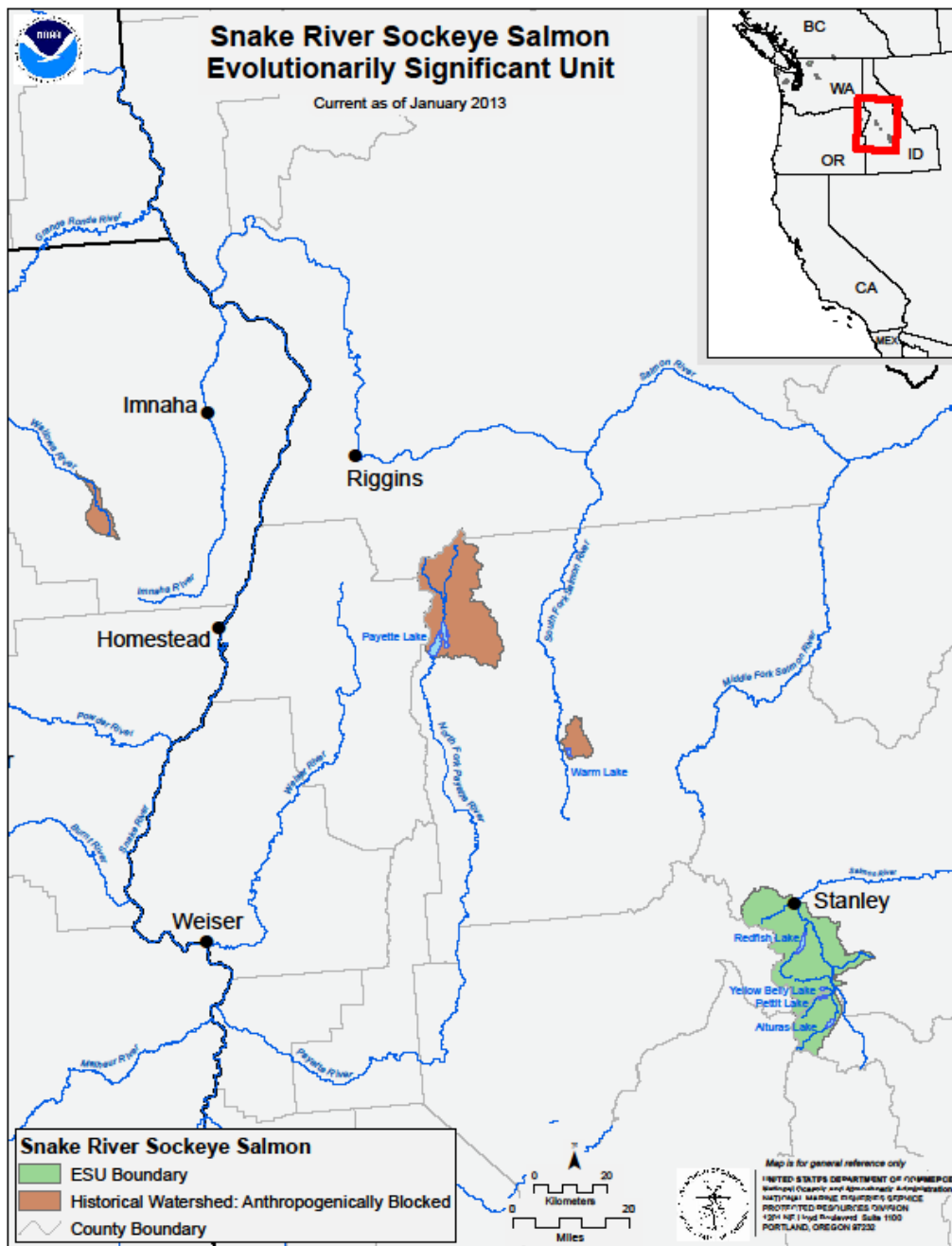


Figure 7. Map of the Snake River Sockeye Salmon ESU’s spawning and rearing areas.

While there are very few sockeye salmon currently following an anadromous life cycle in the Snake River, the small remnant run of the historic population migrates 900 miles downstream from the Sawtooth Valley through the Salmon, Snake, and Columbia Rivers to the ocean (Figure 7). After one to three years in the ocean, they return to the Sawtooth Valley as adults, passing once again through these mainstem rivers and through eight major federal dams, four on the Columbia River and four on the lower Snake River. Anadromous sockeye salmon returning to Redfish Lake in Idaho’s Sawtooth Valley travel a greater distance from the sea, 900 miles, to a

higher elevation (6,500 ft.) than any other sockeye salmon population. They are the southernmost population of sockeye salmon in the world (NMFS 2015).

Abundance, Productivity, Spatial Structure, and Diversity

Best available information indicates that the Snake River Sockeye Salmon ESU is at high risk and remains at endangered status. Annual returns of sockeye salmon through 2018 show that more fish are returning than before initiation of the captive broodstock program, which began soon after the initial ESA listing (Table 10). 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. 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 91 adults in 2015 (including 14 natural-origin fish). Sockeye salmon returns to Alturas Lake ranged from one fish in 2002 to 14 fish in 2010 (NWFSC 2015).

Table 10. Hatchery- and natural-origin sockeye salmon returns to Sawtooth Valley, 1999-2018 (Christine Kozfkay, IDFG, personal communication, March 4, 2018; NMFS 2015).

Return Year	Total Return	Natural Return	Hatchery Return	Alturas Returns¹	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	91	14	77	0	0
2016	596	33	539	0	24
2017	176	11	151	0	14
2018	114	13	100	0	1

¹ These fish are included in the natural return numbers.

The large increases in returning adults in recent years reflect improved downstream and ocean survivals, as well as increases in hatchery 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 historical range (NMFS 2015; 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 2015). 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 Fishhook Creek (NMFS 2015; 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 2012).

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 spawning (NMFS 2015). 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).

Limiting Factors

Factors that limit the ESU have been, and continue to be the result of impaired mainstream and tributary passage, fisheries, chemical treatment of Sawtooth Valley lakes in the 1950s and 1960s, poor ocean conditions, Snake and Columbia River hydropower system, and reduced tributary stream flows and high temperatures. These combined factors reduced the number of sockeye salmon that make it back to spawning areas in the Sawtooth Valley to the single digits, and in some years, zero. The decline in abundance itself has become a major limiting factor, making the remaining population vulnerable to catastrophic loss and posing significant risks to genetic diversity (NMFS 2015; NWFSC 2015).

Some threats that contributed to the original listing of Snake River sockeye salmon now present little harm to the ESU, while others continue to threaten viability. Fisheries are now better regulated through ESA constraints and management agreements, substantially reducing harvest-related mortality. Potential habitat-related threats to the fish, especially in the Sawtooth Valley, pose limited concern since most passage barriers have been removed and much of the natal lake area and headwaters remain protected. Hatchery-related concerns have also been reduced through improved management actions (NMFS 2015).

The recovery plan (NMFS 2015) provides a detailed discussion of limiting factors and threats and describes strategies and actions for addressing each of them. Rather than repeating this extensive

discussion from the recovery plan, it is incorporated here by reference. Overall, the recovery strategy aims to reintroduce and support adaptation of naturally self-sustaining sockeye salmon populations in the Sawtooth Valley lakes. An important first step towards that objective has been the successful establishment of anadromous returns from the remnant Redfish Lake stock gained through a captive broodstock program. The long-term strategy is for the naturally produced population to achieve escapement goals in a manner that is self-sustaining and without the reproductive contribution of hatchery spawners (NMFS 2015).

2.2.2. Critical Habitat

NMFS determines the range-wide status of critical habitat by examining the condition of its 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 (Table 3).

- (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.

The status of critical habitat is based primarily on a watershed-level analysis of conservation value that focused on the presence of ESA-listed species and physical features that are essential to the species' conservation. NMFS organized information at the 5th field hydrologic unit code (HUC) watershed scale because it corresponds to the spatial distribution and site fidelity scales of

salmon and steelhead populations (McElhany et al. 2000). The analysis for the 2005 designations of salmon and steelhead species was completed by Critical Habitat Analytical Review Teams (CHARTs) that focused on large geographical areas corresponding approximately to recovery domains (NMFS 2005b). Each watershed was ranked using a conservation value attributed to the quantity of stream habitat with physical and biological features (PBFs; also known as primary and constituent elements ((PCEs)), the present condition of those PBFs, the likelihood of achieving PBF potential (either naturally or through active restoration), support for rare or important genetic or life history characteristics, support for abundant populations, and support for spawning and rearing populations. In some cases, our understanding of these interim conservation values has been further refined by the work of technical recovery teams and other recovery planning efforts that have better explained the habitat attributes, ecological interactions, and population characteristics important to each species.

The HUCs that have been identified as critical habitat for these species are largely ranked as having high conservation value. Conservation value reflects several factors: (1) how important the area is for various life history stages, (2) how necessary the area is to access other vital areas of habitat, and (3) the relative importance of the populations the area supports relative to the overall viability of the ESU or DPS. No CHART reviews have been conducted for the Snake River fall Chinook salmon ESU, but has been done for the Snake River steelhead DPS. The Snake River Steelhead DPS's range includes 291 watersheds. The CHART assigned low, medium, and high conservation value ratings to 14, 43, and 230 watersheds, respectively (NMFS 2005a). They also identified 4 watersheds that had no conservation value. The following are the major factors limiting the conservation value of critical habitat for Snake River steelhead:

- Agriculture
- Channel modifications/diking
- Dams
- Forestry
- Fire activity and disturbance
- Grazing
- Irrigation impoundments and withdrawals,
- Mineral mining
- Recreational facilities and activities management
- Exotic/ invasive species introductions

2.2.3. Climate Change

One factor affecting the rangewide status of species and aquatic habitat at large is climate change. The U.S. Global Change Research Program (USGCRP)², mandated by Congress in the Global Change Research Act of 1990, reports average warming of about 1.3°F from 1895 to 2011 and projects an increase in average annual temperature of 3.3°F to 9.7°F by 2070 to 2099 (CCSP 2014). Climate change has negative implications for designated critical habitats in the Pacific

² <http://www.globalchange.gov>

Northwest (Climate Impacts Group 2004; ISAB 2007; Scheuerell and Williams 2005; Zabel et al. 2006). According to the Independent Scientific Advisory Board (ISAB)³, 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.

Climate change is predicted to cause a variety of impacts on 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
- 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

³ 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.

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 . For example, a few weeks difference in migration timing can have large differences in the thermal regime experienced by migrating fish . This occurred in 2015 on Upriver Sockeye in the Columbia River when over 475,000 sockeye entered the River but only 2% of sockeye counted at Bonneville Dam survived to their spawning grounds. Most died in the Columbia River beginning in June when the water warmed to above 68°F, the temperature at which salmon begin to die. It got up to 73°F in July, due to elevated temperatures associated with lower snow pack from the previous winter and drought conditions and may be exacerbated 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% by century's end (Martins et al. 2011). Juvenile parr-to-smolt survivals of Snake River Chinook salmon are predicted to decrease 31-47% 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. 2011). 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).

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 (Jones et al. 2014), 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; Percy 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). This is likely to occur to some degree over the next ten years, but at a similar rate as the last ten years.

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; Percy 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 down welling 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 CO₂ 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) and 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 the Pacific Northwest in particular. 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 depend 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 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.

2.3. Action Area

The “action area” means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). The action area resulting from this analysis includes all water accessible to anadromous fish in the entire Snake River Basin above Ice Harbor Dam, including the Tucannon, Clearwater, Salmon, Grande Ronde, and Imnaha River Subbasins.

2.4. Environmental Baseline

Under the Environmental Baseline, NMFS describes what is affecting listed species and designated critical habitat before including any effects resulting from the Proposed Action. The “environmental baseline” includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions that are contemporaneous with the consultation in process (50 CFR 402.02).

2.4.1. Habitat and Hydropower

A discussion of the baseline condition of habitat and hydropower throughout the Columbia River Basin occurs in our Biological Opinion on the Mitchell Act Hatchery programs (NMFS 2017c) and in our Biological Opinion on the 2018 *U.S. v. Oregon* Management Agreement (NMFS 2018b). Here we summarize some of the key impacts on salmon and steelhead habitat, primarily in the Snake River Basin because it encompasses the Action Area for this Opinion.

Anywhere hydropower exists, some general effects exist, though those effects vary depending on the hydropower system. In the Action Area, some of these general effects from hydropower systems on biotic and abiotic factors include, but are not limited to:

- Juvenile and adult passage survival at the dams on the mainstem Snake River (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)
- 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)

Currently, salmon and steelhead occupy only a portion of their former range in the Snake River Basin. Starting in the 1800s, dams blocking anadromous fish from their historical habitat were constructed for irrigation, mining, milling, and hydropower. Construction of the Hells Canyon Complex of impassable dams along the Idaho-Oregon border in the 1960s completed the extirpation of anadromous species in the upper Snake River and its tributaries above Hells

Canyon Dam. Major tributaries upstream from Hells Canyon Dam that once supported anadromous fish include the Wildhorse, Powder, Burnt, Weiser, Payette, Malheur, Owyhee, Boise, Bruneau, and Jarbidge Rivers, and Salmon Falls Creek. These tributaries supported sockeye salmon (Payette River), fall Chinook salmon, and an estimated 15 steelhead and 25 spring/summer Chinook salmon populations (McClure et al. 2005).

Other dams besides the Hells Canyon complex have significantly reduced access to salmon and steelhead habitat. Dworshak Dam, completed in 1971, caused the extirpation of Chinook salmon and steelhead runs in the North Fork Clearwater River drainage. Lewiston Dam, built in 1927 and removed in 1973, is believed to have caused the extirpation of native Chinook salmon, but not steelhead, in the Clearwater drainage above the dam site. Harpster Dam, located on the South Fork Clearwater River at approximately river mile (RM) 15, completely blocked both steelhead and Chinook salmon from reaching spawning habitat from 1949 to 1963. The dam was removed in 1963 and fish passage was restored to approximately 500 miles of suitable spawning and rearing habitat.

Spawning, rearing, and migration habitat quality in tributary streams in Idaho occupied by salmon and steelhead varies from excellent in wilderness and roadless areas to poor in areas subject to intensive human land uses. Mining, agricultural practices, alteration of stream morphology, riparian vegetation disturbance, wetland draining and conversion, livestock grazing, dredging, road construction and maintenance, logging, and urbanization have degraded stream habitat throughout much of the Snake River Basin. Reduced summer stream flows, impaired water quality, and loss of habitat complexity are common problems for stream habitat in non-wilderness areas. Human land-use practices throughout the Snake River Basin have modified streams, reducing rearing habitat and increasing water temperature fluctuations.

In many stream reaches occupied by anadromous fish in Idaho, water diversions substantially reduce stream flows during summer months. Withdrawal of water, particularly during low flow periods, increases summer stream temperatures, blocks fish migration, strands fish, and alters sediment transport. Reduced tributary streamflow is considered a major limiting factor for Snake River spring/summer Chinook salmon and Snake River Basin steelhead (NMFS 2011b).

Many streams occupied by salmon and steelhead are listed on the State of Idaho's Clean Water Act section 303(d) list for impaired water quality, such as impairment for elevated water temperature (IDEQ 2014). High summer stream temperatures may currently restrict salmonid use of some historically suitable habitat areas, particularly rearing and migration habitat. Removal of riparian vegetation, alteration of natural stream morphology, and withdrawal of water all contribute to elevated stream temperatures. Water quality in spawning, rearing, and migration habitat has also been impaired by high levels of sedimentation, and by other pollutants such as heavy metal contamination from mine waste (e.g., IDEQ (2001); IDEQ (2003)).

The PACFISH/INFISH Biological Opinion monitoring program on Federal lands (PIBO) that began in 1998 has generally shown improvements in fish habitat in watersheds managed under the Northwest Forest Plan (NFP) Aquatic and Riparian Conservation Strategy (ARCS) and PACFISH. The PIBO summary report (Meredith et al. 2012), found improving trends in managed watershed for five of seven stream habitat characteristics, and declining trends in two

characteristics. Many BLM Management Areas and National Forests in the Interior Columbia River Basin have revised their land management plans in recent years and replaced NFP ARCS and PACFISH measures with a variety of different approaches that differ in the level of protection provided by previous plans. The generally positive trend in fish habitat characteristics that has occurred in recent decades on Federal lands may change under revised plans that follow different rules. A continued trend in habitat improvements is uncertain due to changes in protective measures combined with environmental changes associated with climate change (e.g., Crozier et al. 2016)

2.4.2. Climate Change

In Section 2.2.3, we describe the on-going and anticipated temperature, freshwater, and marine effects of climate change. Because the impacts of climate change are ongoing, these present impacts are reflected in the most recent status of the species, which NMFS recently re-evaluated in 2015 (NWFSC 2015) and was summarized in relevant ESU or DPS specific sections of Section 2.2 of this opinion. Climate change effects are also considered in the Cumulative Effects section (2.6) of this opinion, regarding future potential impacts.

2.4.3. Hatcheries

Included in the Environmental Baseline are the ongoing effects of hatchery programs or facilities which have undergone Federal review under the ESA, as well as past effects of programs that have not undergone review. Table 11 details the list of all hatchery programs in the action area; all have undergone ESA review, and were initiated under the LSRCP, Hells Canyon Settlement Agreement or the Bonneville Power Administration's Fish and Wildlife Program to mitigate for the construction and operation of the four lower Snake River dams, the Hells Canyon Complex, and the Federal Columbia River Power System on salmon and steelhead in the Snake River Basin.

The history and evolution of hatcheries are important factors in analyzing their past and present effects. From their origin more than 100 years ago, hatchery programs have been tasked to compensate for factors that limit anadromous salmonid viability. The first hatcheries, beginning in the late 19th century, provided fish to supplement harvest levels, as human development and harvest impacted naturally produced salmon and steelhead populations. As development of the Columbia River Basin proceeded (e.g., dam construction as part of the FCRPS between 1939 and 1975), hatcheries were used to mitigate for lost salmon and steelhead harvest attributable to reduced salmon and steelhead survival and habitat degradation. Since that time, most hatchery programs have been tasked to maintain fishable returns of adult salmon and steelhead, usually for cultural, social, recreational, or economic purposes, as the capacity of natural habitat to produce salmon and steelhead has been reduced.

A new role for hatcheries emerged during the 1980s and 1990s after naturally produced salmon and steelhead populations declined to unprecedented low levels. Because genetic resources that represent the ecological and genetic diversity of a species can reside in fish spawned in a hatchery, as well as in fish that spawn in the wild, hatcheries began to be used for conservation purposes (e.g., Snake River sockeye salmon). Such hatchery programs are designed to preserve the salmonid genetic resources until the factors limiting salmon and steelhead viability are

addressed. In this role, hatchery programs reduce the risk of extinction (Ford et al. 2011; NMFS 2005c). However, hatchery programs that conserve vital genetic resources are not without risk to the natural salmonid populations because the manner in which these programs are implemented can affect the genetic structure and evolutionary trajectory of the target population (i.e., natural population that the hatchery program aims to conserve) by reducing genetic and phenotypic variability and patterns of local adaptation (HSRG 2014; NMFS 2014). A full description how hatchery programs can affect ESA-listed salmon and steelhead can be found in Appendix A.

Population viability and reductions in threats are key measures for salmon and steelhead recovery (NMFS 2013c). Beside their role in conserving genetic resources, hatchery programs also are a tool that can be used to help improve viability (i.e., supplementation of natural population abundance through hatchery production). In general, these hatchery programs increase the number and spatial distribution of naturally spawning fish by increasing the natural production with returning hatchery adults. These programs are not, however, a proven technology for achieving sustained increases in adult production (ISAB 2003), and the long-term benefits and risks of hatchery supplementation remain untested (Christie et al. 2014).

Because most hatchery programs are ongoing, the effects of these hatchery program are reflected in the most recent status of the species, which NMFS recently re-evaluated in 2015 (NWFSC 2015) and was summarized in relevant ESU or DPS specific sections of Section 2.2 of this opinion. The following sections describe the anticipated effects of hatchery programs that have completed ESA Section 7 consultation. As discussed in detail in the site-specific consultations for each hatchery program, hatcheries generally pose risks to the naturally-spawning salmon and steelhead populations. These risks include genetic risks, competition and predation on natural-origin fish, disease, and broodstock collection and facility effects. However, as described below and in the referenced hatchery program consultations, in many cases steps are being taken to reduce the associated impacts and risks. Thus, while in our assessment of effects we include the continued negative impacts of the hatcheries, we also consider the extent to which implementation of new measures will reduce their effects.

Table 11. Hatchery programs above Lower Granite Dam.

Hatchery Programs in Action Area	Biological Opinion Signature Date	Citation
Lyons Ferry Hatchery Snake River fall Chinook	October 9, 2012	NMFS (2012)
Fall Chinook salmon Acclimation program		
Idaho Power Company fall Chinook		
Nez Perce Tribal Hatchery Snake River fall Chinook	September 28, 2013	NMFS (2013b)
Snake River sockeye Salmon Hatchery Program		
Catherine Creek spring/summer Chinook	June 24, 2016	NMFS (2016a)
Upper Grande Ronde spring/summer Chinook		
Imnaha River spring/summer Chinook		
Lookingglass Creek spring Chinook		
Lostine spring/summer Chinook	January 15, 2017	NMFS (2017c)
Clearwater River coho restoration project		

Hatchery Programs in Action Area	Biological Opinion Signature Date	Citation
Lostine River coho restoration project;		
Grande Ronde Basin summer steelhead	July 11, 2017	NMFS (2017b)
Little Sheep Creek summer steelhead		
Rapid River spring Chinook	November 27, 2017	NMFS (2017f)
Hells Canyon spring Chinook		
South Fork Salmon River summer Chinook		
Johnson Creek Artificial Propagation and Enhancement Project summer Chinook		
South Fork Chinook Eggbox Project summer Chinook	December 12, 2017	NMFS (2017g)
Kooskia spring Chinook		
Clearwater Fish Hatchery spring/summer Chinook		
Nez Perce Tribal Hatchery spring/summer Chinook		
Dworshak spring Chinook	December 12, 2017	NMFS (2017h)
Clearwater River coho (at Dworshak and Kooskia)		
Steelhead Streamside Incubator (SSI) Project		
Dworshak National Fish Hatchery B Steelhead		
East Fork Salmon Natural A Steelhead		
Hells Canyon Snake River A Summer Steelhead		
Little Salmon River A Summer Steelhead		
Pahsimeroi A Summer Steelhead		
South Fork Clearwater (Clearwater Hatchery) B Steelhead		
Upper Salmon River A Steelhead		
Salmon River B	December 26, 2017	NMFS (2017a)
Snake River Kelt Reconditioning		
Yankee Fork spring Chinook		
Panther Creek summer Chinook		
Panther Creek summer Chinook egg box		
Upper Salmon River spring Chinook		
Pahsimeroi summer Chinook		

Snake River Fall Chinook Salmon ESU

The recently completed Snake River fall Chinook salmon recovery plan (NMFS 2017d) includes three recovery scenarios. One scenario deals with genetic risk in an innovative way (because the other two were not considered feasible for a number of reasons) with the creation of natural production emphasis areas (NPEA). An NPEA is theoretically a region of greatly reduced hatchery influence relative to other spawning areas, which would benefit the species by having a portion of the population with low genetic risk from hatchery origin fish. Modeling based on homing fidelity studies available at that time indicated this approach was feasible. Updated homing fidelity information (USFWS 2017) supported the preliminary feasibility of the NPEA. Implementation required the hatchery operators to move the release of 1,000,000 subyearling fall Chinook salmon from Hells Canyon to a site (of equivalent distance to Lower Granite Dam) on

the lower Salmon River. This effects of this action were considered as part of the *U.S. v. Oregon* 2018 Management Agreement Biological Opinion (NMFS 2018b) as well as a site-specific consultation on NMFS issuance of a new section 10 permit for the Snake River fall Chinook hatchery programs (NMFS 2018a). From NMFS' perspective, this management change is expected to reduce genetic risk to the ESU.

Snake River Spring/Summer Chinook ESU

There are 18 spring/summer Chinook salmon hatchery programs in the Snake River Basin. Most of these programs release listed hatchery fish into rivers with ESA-listed natural-origin spring/summer Chinook salmon. Four of these hatchery programs release fish into the Clearwater River, where spring/summer Chinook salmon are not listed under the ESA (NMFS 2017g).

Over the years, hatchery programs in the Salmon River have made improvements to their hatchery programs. In particular, program managers have better integrated natural-origin fish into their broodstock, creating integrated components of their hatchery programs. For example, the South Fork Salmon River, Pahsimeroi, and Sawtooth spring/summer Chinook salmon programs now have two components (segregated and integrated) with a recently implemented genetic relationship between them. This relationship requires that a percentage of returning fish from the integrated component be used as broodstock in the segregated component. This type of genetic linkage is sometimes referred to as a "stepping stone" system (HSRG 2014). Initial analysis by NMFS of programs connected this way shows that these linked programs pose considerably less risk of hatchery-influenced selection than solely segregated programs because they maintain a genetic linkage with the naturally spawning population (Busack 2015).

In this case, the presence of returning segregated hatchery-origin adults on the South Fork Salmon River spawning grounds poses little additional risk compared to integrated hatchery-origin adults. The South Fork Salmon River summer Chinook salmon hatchery program also contributes eyed-eggs to the South Fork Chinook eggbox program, meaning segregated hatchery fish produced with this program are also genetically linked, which is an improvement from when this program operated as the "Dollar Creek Eggbox Program". According to NMFS' site-specific biological opinion (NMFS 2017f), genetic analyses indicate that, depending on natural-origin returns, the proportionate natural influence will range from 50 to 67% on any given year in the South Fork Salmon River population, which favors natural selective forces over hatchery selective forces.

The Rapid River and Hells Canyon programs are segregated and for harvest purposes. In the most recent biological opinion, these programs have found negligible straying associated with these programs into listed natural-origin populations. Program operators have committed to continued monitoring of straying as well as ecological interactions between hatchery and ESA-listed natural-origin fish (NMFS 2017f). The Johnson Creek Artificial Propagation Enhancement program has always used 100% natural-origin fish in their broodstock, minimizing genetic risks associated with this program, and this program will continue to operate with these same conservation considerations and standards. In addition, the proposed Panther Creek Hatchery program may reduce risk to the ESU by re-establishing a natural-origin population. There is also a commitment for this future hatchery program, along with the Yankee Fork Program, to adhere to proportionate natural influence values according to the sliding scale management objectives

described in the biological opinion (NMFS 2017a). Program operators have committed to continued monitoring of straying as well as ecological interactions between hatchery and ESA-listed natural-origin fish for all of these programs.

Most of the hatchery programs located in northeast Oregon and southeast Washington use sliding scales linked to natural-origin population abundance (NMFS 2016a). Under the sliding scales, the programs allow some hatchery-origin fish to spawn in the wild at all abundance levels, but reduce proportions as natural-origin abundance increases. This strategy attempts to balance the risk of extinction (low natural-origin abundance) with the risk of hatchery influence.

Snake River Sockeye ESU

The purpose of the Snake River sockeye hatchery program is to restore sockeye salmon runs to Stanley Basin waters leading, eventually, to sockeye salmon recovery and Indian and non-Indian harvest opportunity. The hatchery program was initiated in 1991, and the Snake River Sockeye Salmon ESU might now be extinct if not for the hatchery program (NMFS 2013b). The hatchery program is expected to accelerate recovery of the Snake River Sockeye Salmon ESU by increasing the number of natural-origin spawners faster than what may occur naturally (NMFS 2013b). In addition, the sockeye salmon hatchery program will continue to provide a genetic reserve for the Snake River Sockeye Salmon ESU to prevent the loss of unique traits due to catastrophes.

The Snake River sockeye hatchery program is using a three-phase approach:

- Phase 1: increase genetic resources and the number of adult sockeye returns (captive brood)
- Phase 2: incorporate more natural-origin returns into hatchery spawning designs and increase natural spawning escapement (population re-colonization phase)
- Phase 3: move towards the development of an integrated program that meets proportionate natural influence (PNI) goals established by the Columbia River Hatchery Scientific Review Group (HSRG; local adaptation phase).

Snake River Steelhead DPS

There are 13 steelhead hatchery programs in the Snake River Basin and one kelt reconditioning program. Most of the steelhead hatchery programs are operated to augment harvest of A and B steelhead, but three programs are for supplementation. Hatchery-origin fish from all of the steelhead programs are identifiable through the use of parental-based tagging. This allows any fish encountered to be identified to the program level. NMFS concluded in its site-specific biological opinions that straying is low for all of the segregated harvest steelhead programs in the Snake River Basin, and is not expected to affect the abundance, productivity, diversity or spatial structure of the DPS because of the low potential for interbreeding and competition for spawning space between hatchery and natural-origin steelhead (NMFS 2017b). Genetic effects of the three integrated programs (East Fork Salmon River Natural, Tucannon, and Little Sheep Creek) are

limited by the use of natural-origin broodstock and proportionate natural influence targets⁴ that meet or exceed current estimates. In addition, all three programs are likely to benefit the DPS through increased abundance and potentially productivity for their respective populations.

Typically, shortly after spawning, a kelt is in fairly poor condition, and its chances of surviving the downstream migration may be low. The objective of kelt reconditioning is to improve the condition of kelts by feeding and treating any disease in a hatchery environment, so that the kelts can be returned to the river in a healthier state (Hatch et al. 2017). The kelt reconditioning program consists of the collection of up to 700 post-spawned steelhead greater than 60 cm, and the administration of disease-preventative medications and feed for the purpose of improving survival over what would be expected in the wild. Upon release, these fish are intended to return to natal populations, thereby increasing spawner escapement and productivity if reconditioned individuals successfully spawn

2.4.4. Harvest

Spring/Summer Chinook Salmon

The spring/summer Chinook fisheries in the Snake River Basin typically occur from late April through mid-August. The non-tribal fisheries selectively target hatchery fish with a clipped adipose fin, while tribal fisheries retain both hatchery and natural-origin fish. These fisheries operate using abundance-based management; as the natural-origin population increases, so does the impact on natural-origin spring/Summer Chinook salmon. The continuation of these fisheries has been evaluated previously by NMFS throughout the Snake River Basin and are included in the baseline (NMFS 2011c; NMFS 2013a).

Fisheries for steelhead and fall Chinook salmon are unlikely to encounter more than a few adult spring/summer Chinook salmon, due to limited spatial and temporal overlap. Resident trout fisheries may encounter juvenile natural-origin spring/summer Chinook salmon, but due to the use of lures, hook size specifications, and timing of these fisheries in rearing areas (May 4-October 31), the number of juveniles encountered is estimated to have resulted in a few adult equivalents annually, probably fewer than ten, though information is incomplete.

Fall Chinook Salmon

While the continuation of fall Chinook fisheries is part of the proposed action, the past execution of these fisheries is in the baseline. The fall Chinook salmon fisheries in the Snake River Basin typically take place from August through November. Similar to spring/summer Chinook salmon, the non-tribal fisheries have selectively targeted hatchery fish with a clipped adipose fin. Tribal fisheries retain both hatchery- and natural-origin fish regardless of external marking. Recent harvest estimates of both hatchery and natural-origin fall Chinook salmon are detailed in Table 12 and Table 13 below ('Tribal mortalities' as represented in these tables are those that result from the Nez Perce treaty fisheries). On average about 4 percent of hatchery fall Chinook salmon and 3

⁴ For East Fork and Little Sheep Creek this is > 0.5. The Tucannon steelhead program's PNI should more than double within the next five years once hatchery program changes are realized, but the low abundance of natural-origin fish means that demographic concerns outweigh genetic risks at the present time.

percent of natural fall Chinook salmon are harvested annually in fisheries targeting fall Chinook salmon. An additional 0-3 percent natural-origin fall Chinook salmon are likely to be incidentally killed in other fisheries, primarily steelhead, occurring throughout the Snake River Basin (NMFS 2019).

There are few incidental encounters or mortality of fall Chinook salmon from spring/summer Chinook salmon fisheries because the fisheries close prior to the arrival of fall Chinook salmon in the Snake River Basin. Resident trout fisheries are unlikely to encounter fall Chinook salmon because the majority of salmon migrate out of rearing areas as subyearlings prior to the opening of resident trout fisheries. The reservoir-type fall Chinook salmon life history smolts are too small (~ 4 inches) to be hooked with legal trout-sized hooks.

Table 12. Harvest of hatchery-origin fall Chinook salmon in state and tribal fisheries from 2010-2017.

Year	Hatchery-origin fall Chinook salmon at LGD	State Mortalities	Tribal Mortalities	Total Mortalities	Mortality (%)	Escapement
2010	32,417	701	549	1,250	4	31,167
2011	15,509	353	183	536	3	14,973
2012	19,058	512	299	811	4	18,247
2013	31,076	1,590	1,024	2,614	8	28,463
2014	38,444	815	309	1,124	3	37,320
2015	37,251	786	264	1,050	3	36,201
2016	23,383	466	491	957	4	22,426
2017	15,144	324	21	345	2	14,424
Average	25,497	693	393	1,086	4	24,411

Sources: (IDFG 2019b; Oatman 2017).

Table 13. Mortality of natural-origin fall Chinook salmon in state and tribal fisheries from 2010-2017.

Year	Natural-origin fall Chinook salmon at LGD	State Mortalities	Tribal	Total Mortalities	Mortality (%)	Escapement
2010	7,347	72	110	182	2	7,171
2011	8,072	34	108	142	2	7,920
2012	11,306	96	139	235	2	11,065
2013	20,132	261	458	719	4	19,400
2014	11,899	89	435	524	4	11,375
2015	15,034	112	522	634	4	14,400
2016	8,762	59	333	392	4	8,370
2017	6,134	33	0	33	0.4	6,101
Average	11,086	95	263	358	3	10,728

Sources: (IDFG 2019b; Oatman 2017).

Steelhead

The effects of continued implementation of the recreational and tribal treaty fisheries on steelhead have previously been evaluated in NMFS (2019) and are included in the baseline. Impacts on natural-origin steelhead from all fisheries are limited to 10 percent of the adults that pass Ice Harbor Dam in the Clearwater, Grande Ronde, and Salmon MPGs, and 5 percent of the adults in the Lower Snake and Imnaha MPGs. NMFS determined that this impact did not appreciably reduce the likelihood of survival and recovery of the Snake River Steelhead DPS.

Sockeye Salmon

There are no fisheries in the Snake River Basin that target hatchery or natural sockeye salmon. However, the spring/summer Chinook salmon fisheries and resident fish fisheries in Idaho, especially those in the Salmon River Basin, may incidentally encounter an estimated 22 sockeye salmon, with a catch-and-release mortality rate of 10 percent (NMFS 2011c). For Idaho steelhead fisheries, no sockeye salmon encounters have been reported since the 1970s (IDFG 2018b).

2.5. Effects of the Action

Under the ESA, “effects of the action” means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur. This section describes the effects of the Proposed Action, independent of the Environmental Baseline and Cumulative Effects. The Proposed Action, the status of ESA-protected species and designated critical habitat, the Environmental Baseline, and the Cumulative Effects are considered together later in this document (see Section 2.7, Integration and Synthesis) to determine whether the Proposed Action is likely to appreciably reduce the likelihood of survival and recovery of ESA protected species or result in the destruction or adverse modification of their designated critical habitat.

2.5.1. Effects on the Snake River Fall Chinook Salmon ESU

2.5.1.1. Catch and release mortality rate in recreational fisheries

For the fisheries we are considering as part of the Proposed Action, only the states’ recreational fall Chinook salmon fishery is managed as a selective fishery by targeting only adipose fin clipped fall Chinook salmon. Furthermore, operating solely the selective fishery would occur in years where natural-origin fall Chinook salmon abundance is below the CAT value of 1,260 adults. However, in years where this is the case, identifying a catch-and-release mortality rate is necessary for more accurately estimating impacts on natural-origin fish.

There are few studies available that provide empirical evidence for a catch and release mortality rate for Chinook salmon in freshwater recreational fisheries. The ODFW estimates a hook-and-release mortality rate for wild spring Chinook in Willamette River fisheries of 8.6 to 12.3% (Schroeder et al. 2000 in Lindsay et al. 2004), which is similar to a mortality of 7.6% over a 5-day

observation period reported by Bendock and Alexandersdottir (1993) for spring and summer Chinook salmon in the Kenai River, Alaska. The WDFW conducted a study with spring Chinook salmon in the Yakima River that found a 2-year average hooking mortality rate of 10% to the spawning area (median of 56 days), and ranged from 6% in 2013 to 12% in 2014. The higher mortality in 2014 compared to 2013 was attributed to a greater percentage of fish hooked in critical locations. These rates increased slightly when the time-point was extended to the onset of spawning (median of 97 days, 11 and 12% respectively; Fritts et al. 2016). In another study, Cowen et al. (2007) caught-and-released 4,634 Chinook salmon (returning from late summer to early fall) in the Nicola River in British Columbia, and reported a hooking mortality rate of 0.9% within a 14-day observation period.

Water temperature is one factor that can heavily influence mortality rates in salmon. Muoneke and Childress (1994) found that mortality increases with warmer water temperatures. Thus, mortality rates in catch-and-release fisheries are likely higher for spring Chinook salmon than for fall Chinook salmon. This appears to be supported by the studies above that show mortality for spring Chinook salmon ranging from 6 to 12% in contrast to the Cowen et al. (2007) study of < 1%. A literature review by Richter and Kolmes (2005), suggests that lethal temperature limits for Chinook salmon are above 25°C. Jonsson and Jonsson (2009) also found the lethal temperature limit for Chinook salmon is 25°C and for Atlantic salmon is 28°C. However this temperature limit does not consider other factors that could stress fish and contribute to mortality, such as catch and release fisheries. For Atlantic salmon, temperatures above 20°C were associated with increased catch and release mortality (Gale et al. 2013). If we assume the same difference in temperature between the maximum lethal level and that associated with catch and release mortality for Atlantic salmon for Chinook salmon, this would come out to about a 17°C threshold before increased mortality may occur. For the fall fisheries, temperatures above 17°C are rare, except for the first part of September (IDFG 2019c).

The state fishery managers are proposing to use a 10% catch and release mortality rate when evaluating the impacts of the proposed recreational fisheries on fall Chinook salmon. The 10% catch and release mortality rate has been used by the *U.S. v. Oregon* Technical Advisory Committee, and within a number of NMFS biological opinions on freshwater fisheries that may encounter Chinook salmon (NMFS 2011c; NMFS 2018b; NMFS 2019). Thus, based on the information above, we also consider 10% to be a reasonable catch and release mortality rate estimate for fall Chinook salmon.

2.5.1.2. Sublethal effects of catch and release fisheries

Sublethal effects of catch and release fisheries include decreased spawning success, decreased gamete viability, and increases in compounds that affect muscle physiology. Cowen et al. (2007) found no effect of catch and release fisheries on spawning success. In addition, multiple recapture was not found to reduce spawning success, but frequency of multiple captures was low, with 5.1% of all Chinook salmon recaptured a second time, and 0.3% of all fish recaptured a third time. A second study cited in Cowen et al. (2007) by Fisheries and Oceans Canada, (unpublished data) found that spawning success of Chinook salmon subjected to a more intense hook-and-line fishery in the Chilliwack River (200,000 angler-hours of effort, 5,000 adult Chinook salmon

retained, and 10,000 released in 2005) was lower (average of 91%) than in the Nicola River (average of 96%), where recreational angling for salmon is not permitted.

A study by Booth et al. (1995) examined the effects of catch and release fisheries for wild Atlantic salmon close to spawning on muscle physiology and gamete viability. The authors found that most compounds associated with muscle physiology (lactate, pH, ATP, PCr, and glycogen) returned to normal resting levels within 12 hours of capture. The authors also found that the survival of eggs from captured and non-captured salmon was 98 and 97%, respectively.

The few studies discussed here suggest that spawning success of captured Chinook salmon could be decreased by catch-and-release fisheries, at least in areas that are intensively fished, but the physiological effects on an individual fish may be short-lived, and for those that do make it to spawn, egg survival is very high. More work is needed to better understand the sublethal effects on Chinook salmon specifically, but considering the information above, the sublethal effects are likely to be low.

2.5.1.3. Evaluating impacts/harvest with recent data

Fall Chinook salmon Fisheries

Fall Chinook salmon adults occur in the mainstem of the Snake River and the lower reaches of the major tributaries primarily in September through November. Applying the proposed harvest schedule to natural-origin fall Chinook salmon returns from 2010-2017 indicates that the “buffered” MAT value is likely to be exceeded for all years (Table 14). This value was increased from 3000 to 4200 because of one of the recovery scenarios in the final recovery plan (NMFS 2017d), which targets a single population for recovery. We acknowledge that applying the proposed harvest schedule to previous years would have reduced escapement, and this may alter the subsequent returns for the next brood year. However, many other factors, such as density dependence on the spawning grounds, could also influence recruitment. Thus, the analysis below based on available data provides context on application of the proposed harvest schedule to recent returns, but cannot estimate the effects on the next generation of spawners. The effects of applying the proposed harvest schedule into the future is detailed in section 2.5.1.4

Table 14. Proposed impact rates on natural-origin fall Chinook salmon in Snake River Basin fisheries applied to recent returns.

Year	Natural-origin fall Chinook salmon at LGD ¹	Allowable Harvest Rate	Proposed Fisheries		
			Number of Mortalities	Impact (%)	Escapement Number
2010	7,347	20% + 44% on the margin	2,484	33.8	4,863
2011	8,072		2,948	36.5	5,124
2012	11,306		5,018	44.4	6,288
2013	20,132		10,667	53.0	9,465
2014	11,899		5,398	45.4	6,501
2015	15,034		7,404	49.2	7,630
2016	8,762		3,390	38.7	5,372
2017	6,134		1,708	27.8	4,426

¹After collection of broodstock. Based on data from IDFG (2018a).

Because ESA-listed hatchery-origin fall Chinook salmon are not essential to recovery, no limits on harvest of these fish either with adipose fins intact or clipped are proposed. However, fishing regulations designed to remain within natural-origin harvest impact rates are likely to limit harvest of hatchery fish (Table 15). The adipose-clipped hatchery-origin fall Chinook salmon component are likely to be harvested at a higher rate than either natural-origin or adipose-intact hatchery-origin fish because they are easily identifiable as hatchery-origin fish to anglers, but we do not have data at this time to quantify this likelihood.

Table 15. Proposed harvest rates of hatchery fall Chinook salmon in Snake River Basin fisheries applied to recent returns.

Year	Hatchery-origin fall Chinook salmon at LGD ¹	Proposed Fisheries		
		Mortalities	Mortality (%)	Escapement
2010	32,417	10,962	33.8	21,455
2011	15,509	5,665	36.5	9,844
2012	19,058	8,459	44.4	10,599
2013	31,076	16,466	53.0	14,610
2014	38,444	17,439	45.4	21,005
2015	37,251	18,346	49.2	18,905
2016	23,383	9,047	38.7	14,336
2017	15,114	4,202	27.8	10,912

¹After collection of broodstock. Based on data from IDFG (2018a).

Removal of hatchery-origin fish prior to spawning is likely a benefit to the Snake River fall Chinook salmon ESU. This is because removal reduces the amount of hatchery influence on the spawning grounds as measured by the proportion of the escapement composed of hatchery-origin spawners (pHOS). This metric is one that is currently measured by managers associated with the Snake River fall Chinook salmon hatchery program, and once the adipose-intact fishery begins, NMFS anticipates that the removal rate of hatchery-origin fish will increase.

Density dependent survival and growth has been detected in the Snake River fall Chinook Salmon ESU. Although density dependence-based population response is complex and subject to varying interpretation, Ford et al. (2010) suggested that there may be an indication that density dependent habitat effects are influencing production and Cooney (unpublished results) indicated that there is a strong inference for density dependence effects at higher escapements. A recent analysis by Perry et al. (2017) indicates that density dependent effects may limit natural-origin recruitment when the number of spawners is between 5,000 – 10,000 female spawners, which is equivalent to 10,000 - 20,000 total adult spawners with an equal sex-ratio. In the analysis of Perry et al. (2017), both hatchery- and natural-origin fish are included because hatchery fish escape to spawn naturally with natural-origin fall Chinook salmon. Allowing retention of adipose- intact adult fall Chinook salmon in recreational state fisheries when escapements are above CAT (1,260) would provide a tool to manage spawner abundance to the habitat capacity and biological objectives of the SR fall Chinook population.

Using adult return data from 2010 to 2017, the proposed harvest schedule not only maintains the natural-origin population above the buffered MAT, but total escapement ranges from ~9,358 to 27,506 total spawners. This range falls more within the spawning population range that Perry et al. 2017 indicated the habitat could support before the population would start to encounter density-dependent effects. Thus, with this analysis of recent year data, the proposed harvest schedule would not decrease the population below the buffered MAT value targeted for recovery, and may in fact ensure the population avoids density-dependent impacts that could decrease natural-origin recruitment.

Coho and Resident Trout Fisheries

Because any coho fisheries would overlap with fall Chinook salmon fisheries, it is difficult to attribute effects on natural-origin fall Chinook salmon to only the coho salmon fisheries. In addition, most, if not all anglers are anticipated to target fall Chinook salmon, and would only opportunistically fish for coho salmon. Thus, any effects of fishing for coho salmon would be included in the effects of encounters and subsequent mortalities of fall Chinook salmon described above.

When fall Chinook salmon juveniles are present and overlap open resident trout fisheries, flows are typically high and not conducive to angling for trout, juvenile are too small to recruit to angling equipment, and they migrate quickly to the mainstem Snake River, essentially precluding them from fishery areas (Bratcher 2019).

2.5.1.4. Evaluating impacts/harvest with a simulation model

The recent returns of natural-origin fall Chinook salmon have been relatively high, and thus would have coincided with the top tier of the proposed harvest schedule. To be conservative in our approach and to better understand how the population would perform after implementation of the fishery manager-proposed harvest schedule in years of low abundance, we used a simulation model run 100 times out to 100 years. We began each model run with 300 natural spawners, as this was similar to the lowest abundance observed for Snake River fall Chinook salmon over the

course of the data record (IDFG 2018a). We started the projection with the same number of spawners for four calendar years. We used the Ricker form of the stock-recruit function to inform our simulation model, with a density independent parameter of 2.72 (i.e. productivity $\alpha=2.72$ adults per spawner at low abundances), and maximum recruits set at 25,000 spawners (1/0.00004). The stock-recruit model also identifies the maximum yield⁵ as 10,623 natural spawners. We also incorporated a process error of 0.6 to account for random variation around recruitment due to stochastic environmental effects, which is interpreted as 10-20 orders of magnitude in variation in recruitment. We assumed no management imprecision (i.e., the targeted harvest rates are realized exactly) or auto-correlation (i.e., what happened this year is related to what will happen next year) in recruits (Sharma 2019). NMFS suggests revisiting these assumptions a few years after the fishery is implemented and data becomes available.

Table 16. Range of natural spawners observed for the 25th and 100th year projected values over 100 simulation runs (Sharma 2019).

Metric	Fishery managers Proposal		No Harvest		Status quo	
	Year 25	Year 100	Year 25	Year 100	Year 25	Year 100
Min	424	594	7796	13972	6050	11724
1st Qu	2924	6886	15932	27913	13846	26192
Median	7627	12988	22122	34871	20515	32218
Mean	11373	16068	27259	35815	25563	34095
3rd Qu	12829	22137	31492	42602	30209	41009
Max	109803	68619	145719	80517	144192	79798

The results of the 100 runs of the simulation model in the next 25 years, under the fishery managers' harvest schedule, shows a range of natural spawners from 424 to 109,803 with a mean of 11,373 (Table 16). This value is about half of what the status quo, and no harvest policies, demonstrate.

This is also well above the MAT value of 4,200, and exceeds the maximum yield mentioned above of 10,623, even when model runs begin with the lowest recorded natural-origin abundance on record. When analyzing the runs on the graph below, within the first 10 years for all harvest scenarios, abundance can drop below the MAT and even CAT values frequently as the population recovers from a low starting abundance.

When analyzing the policies over a longer 100-year timeframe, the status quo and no fishing scenarios resulted in higher spawner abundances, but all three means were well above the 4,200 MAT value (> 4 times higher), and exceeded the maximum yield value of 10,623. Although for the fishery managers' proposal, the minimum value at 100 years does fall below CAT, the first

⁵Maximum Yield is a theoretical construct assuming steady state equilibrium dynamics in a stock recruit model. It is the point at which the difference between the production function and replacement is the maximum. In the case of Snake River fall Chinook salmon, this occurs at 10,623 adult spawners and creates a yield of 8,169 adults, assuming a Ricker Stock Recruit relationship.

quartile value is well above (Table 16). When we couple this information with **Error! Reference source not found.**, we see that ~90% of the runs result in values at 100 years that exceed MAT, with < 10% likely falling below CAT. As stated above, these results are also the product of starting each run with the lowest natural-origin abundance on record, with abundances in recent years (Table 14) being much higher (~300 in 1998 to > 6,000 from 2011-2017).

There are a few additional pieces of information to consider when interpreting this analysis. First, the simulations of the fishery managers' policy could not consider management decisions that may take place to reduce harvest rates when abundance falls below the CAT value in consecutive years. This would result in harvest rates that are below the 6% rate associated with the lowest tier of the harvest schedule, and would thus likely be more protective than the status quo scenario in these critical abundance years. Second, hatchery-origin spawners were not included in the simulation modeling exercise. However, it is possible that the natural-origin returns are the progeny of one or even two hatchery-origin parents.

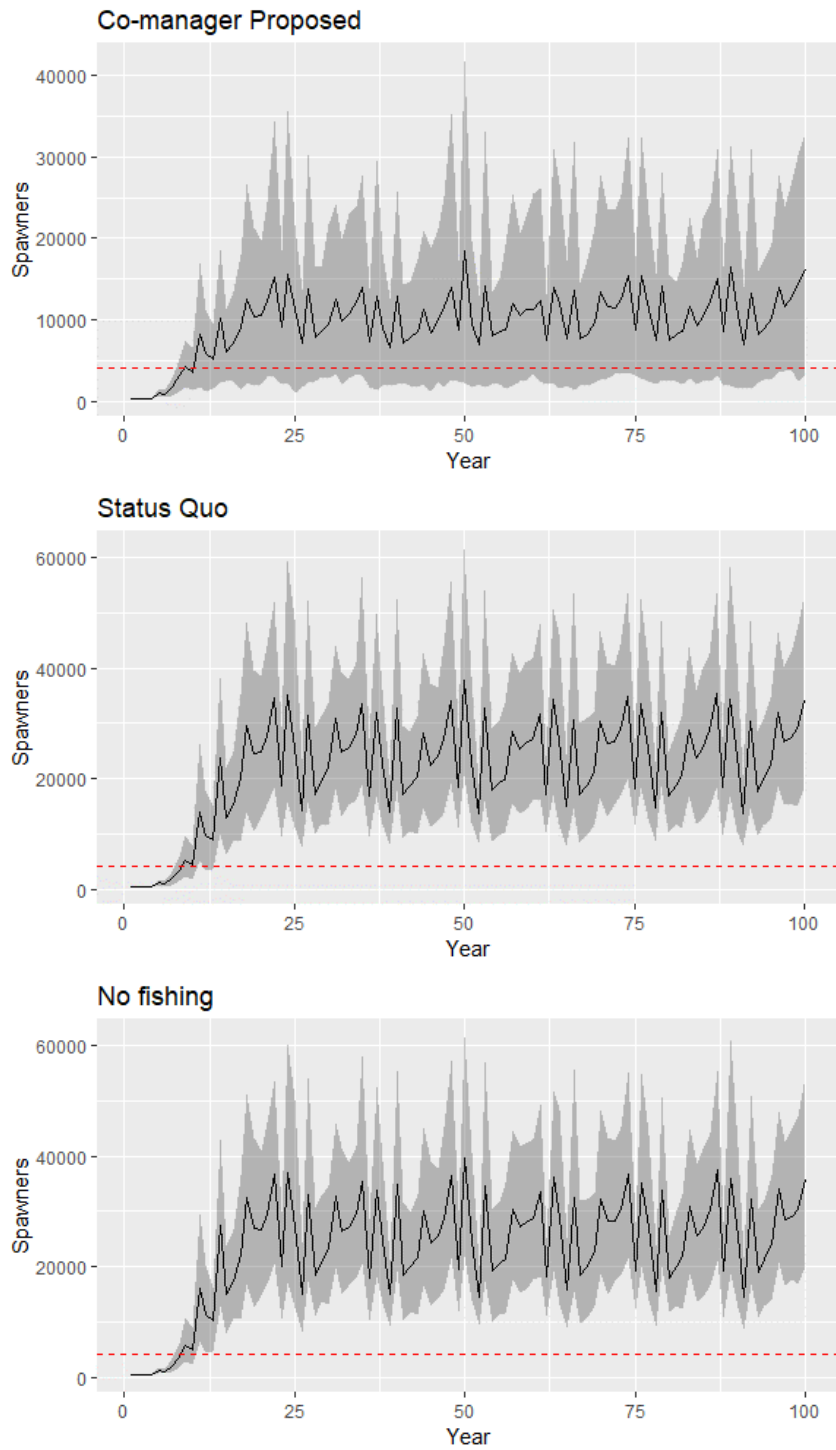


Figure 8. Spawner abundance over the three scenarios for 100 years (shaded areas are 10 and 90th percentiles). Dashed red lines indicate the minimum abundance threshold (MAT) value of 4200 (Sharma 2019).

2.5.2. Effects on other ESA-listed salmon and steelhead

Snake River Steelhead ESU

The impacts on steelhead as a result of the proposed fall Chinook and coho salmon fisheries are difficult to separate from the previously authorized steelhead fisheries in the Snake River Basin (NMFS 2019) because of overlaps in time and space. However, it is likely to be a small proportion of the total impact limits defined for each MPG (< 0.5 percent).

Resident trout impacts on natural-origin steelhead are also minimal, but, because they are impacting the juvenile life stage, conversion to the adult stage was necessary for scale. ODFW conducted an analysis within their FMEP that calculates the amount of angler effort in the resident trout fishery necessary to result in the mortality of one steelhead adult equivalent. In brief, ODFW estimated that 19,020 angler hours resulted in the death of one steelhead adult.

Using their recently developed methodology, they found that the amount of angler hours estimated throughout their entire FMEP area annually is about 530,000 or about 28 steelhead adult equivalents. Of note, is that this is likely to be an overestimate because angler effort estimates were derived from the most popular fishery reaches and then applied to the entire FMEP area. However, many areas within the FMEP are likely fished at much lower rates of effort. When considering the angler hours that would be required to exceed the natural impact rate limits for adult steelhead in ODFW's steelhead FMEP and authorized by NMFS in 2019 after the impacts from all other salmon and steelhead fisheries are considered, it would require over 15 million angler hours in the resident trout fishery on average (see table 4 in ODFW 2019).

Snake River Spring/Summer Chinook Salmon ESU

Fall Chinook and coho salmon fisheries take place in the fall (September to December) after the spring/summer Chinook salmon have reached their tributary spawning habitats (May through August). However, there is likely to be some spatial overlap in the tributaries where all three species overlap. Therefore, we anticipate that encounters with Snake River spring/summer Chinook salmon adults will be minimal due to spatial and temporal overlap, less than 30 annually, with three possible mortalities.

Based on temporal and spatial overlap, juvenile spring/summer Chinook salmon may be encountered in the resident trout fisheries, but they are typically too small to be caught in trout fishery gear. Juvenile spring Chinook typically start emerging as fry in about February, and will grow through spring and summer to around 80mm (~3 inches) in the fall when most trout fisheries close for the year. By the time most trout fisheries open the following spring, most of the juveniles have emigrated at a size of 100mm (~4 inches). Thus, encounters are rare, and the effects at the population and species level are expected to be negligible (Bratcher 2019).

Snake River Sockeye Salmon ESU

There is minimal temporal and spatial overlap with sockeye salmon during the proposed fisheries. Sockeye salmon run during the summer and the majority reach their spawning grounds by August; before the fall salmon fisheries begin. In addition, sockeye salmon only return to spawn in the Stanley Basin of Idaho within the Upper Salmon River, and would only be passing through

Snake Basin fisheries in other areas. Furthermore, since the 1970s (IDFG 2018b), no sockeye salmon have been encountered in Idaho's steelhead fisheries, which are much larger in scale, especially in the Salmon River Basin, where sockeye salmon are migrating.

Juveniles may be encountered in resident trout fisheries within the mainstem Snake River, but juvenile encounters are highly unlikely as none of these fisheries are taking place in the Upper Salmon River. Therefore, we anticipate that encounters with sockeye salmon adults, and/or adult equivalents⁶ will be very small due to minimal spatial and temporal overlap, < 10 annually, with one mortality.

2.5.3. Demographic Effects to All Affected ESUs

Fisheries can affect the demographics of the target fish species over time if they select for certain sizes or run times. Hook-and-line fisheries are size selective, and can be selective for time if regulations are crafted to target certain portions of the run. Gillnets are selective for body shape and migration timing, while purses seines are generally not size selective, but could select for migration timing and for certain behaviors such as schooling (Hard et al. 2008). The authors recommended ensuring some larger/older individuals escape to spawn. Neither the fall Chinook nor the coho salmon fisheries have size limits. With state recreational fisheries that have bag limits and gear that generally targets one fish at a time, it is likely that some larger/older individuals will escape to spawn. The resident trout fisheries do not allow retention of fish below 8 inches to protect juvenile steelhead, and do not allow retention above 20 inches without a steelhead license and during an open steelhead season. Thus, larger/older ESA-listed individuals are likely to escape the fisheries to spawn

Fisheries that are not size selective can still affect the maturation timing of fish if fish spawn earlier to compensate for fishing pressure. Salmon and steelhead fisheries in terminal areas are less likely than non-terminal fisheries to affect maturation timing because fish in terminal areas have already made the decision to spawn. Fishing on mature individuals could affect other life history aspects such as fecundity and/or egg size (Hard et al. 2008). The Snake River Basin is a terminal fishing area where most, if not all, fish have already matured, and thus fishing in this area is not likely to result in a change in maturation timing.

In a review of studies investigating fishery effects, Hard (et al. 2008) found that direct evidence for evolutionary responses of salmon and steelhead populations due to fishing did not exist. Nor did any studies demonstrate a reduction in population viability from these responses. The authors concluded that opportunity for life history alteration due to fishing exists, but it is unknown how quickly the change occurs, if it is genetically based, and if the change is reversible. However, for a fishery to exert selection effects, it needs to substantially affect spawners. This is more likely to occur when harvest rates are high (Hard et al. 2008). The overall natural-origin impact rates proposed for the fall Chinook fisheries are based on natural-origin abundance, and thus the impacts are scaled so that a majority of the spawners escape the fishery to spawn. Only a small

⁶ Adult equivalents are defined as how many juvenile losses would occur to equal one adult loss based on smolt-to-adult recruit estimates.

proportion of the other ESA-listed species are encountered incidentally, and thus life history alteration due to the proposed fisheries is unlikely.

2.5.4. Illegal Harvest

Illegal harvest in recreational fisheries has not been identified as an important cause of the decline of listed species (62 FR 43937, August 18, 1997). State law enforcement officers patrol all open fishing waters and utilize check stations and undercover patrols in areas of high activity. Although illegal harvest does occur, and incidents of intentional or inadvertent illegal take of listed species are cited every year, the number of fish detected as illegal harvest is likely to be very small and is not expected to negatively impact listed species in terms of abundance, productivity, spatial structure, and diversity.

2.5.5. Interrelated and interdependent effects

Angler presence effects

Wading can harm trout eggs that are buried at shallow depths in small gravel, but is not likely to harm salmon eggs that are buried deeply in large gravel and cobble. Briggs (in Healey 1991) reports Chinook eggs buried 20 to 36 cm deep (average 28 cm), while other studies reported eggs buried 10 to 80 cm depending on substrate and intergravel flows. Bell (1990) suggests 18mm to 100mm gravel as preferable for most salmon spawning. However, Groves and Chandler (1999) found that Snake River fall Chinook salmon preferred substrate that was a bit larger, ranging from 25mm to 150mm. Healey (1991) suggests that cleaning the gravel of finer particles and sorting the larger gravel into the egg deposition area provides larger interstices that improve intergravel water flows to irrigate the incubating eggs, and creates more stability than uniformly graded gravel. These factors should make the eggs of naturally spawning salmon less susceptible to disturbance or crushing by wading anglers than trout eggs.

Angler access to spawning areas for listed salmon and steelhead is likely limited. Spring/summer Chinook salmon spawn in late summer and the spawning rivers are frozen during much of the incubation period. Steelhead spawn in the spring at the start of spring runoff and most of the egg incubation takes place in high flows. In addition, most important spawning and rearing areas where natural-origin, ESA-listed spring/summer, and sockeye salmon and steelhead spawn are outside the proposed fishery areas. Thus, it is unlikely that angler access and wading will result in anything beyond discountable effects on these listed species.

For fall Chinook salmon in the mainstem Snake River, fall Chinook salmon redds were constructed in water ranging from 0.2 to 6.5m with the majority of redds (~ 90%) in water deeper than 1m (Groves and Chandler 1999). Few, if any, anglers are likely to wade into water exceeding 1 meter in depth. Thus, effects from angler presence to this spawning aggregate are likely to be discountable. For the Clearwater River spawning aggregate, managers intend to close fall Chinook salmon fishing in high density fall Chinook spawning areas in the Clearwater River prior to peak spawning. These high density areas contain 68% of the redds in 5.1 river kilometers based

on average data from 1998-2018 (NPT 2019). The closures of these areas to fishing, along with the depth of red burial, and the preference for larger gravel sizes found in deeper water, will likely result in discountable effects of angler presence on fall Chinook salmon. Any natural-origin adult mortalities due to angler targeting of spawning fall Chinook salmon would be included in the harvest schedule in Table 2.

Boat operation effects

Boat operation can cause local displacement of juvenile salmon and can cause direct mortality of eggs and alevins when power boats are operated in shallow water. Quantifying the effects of boat operation depends on motor type, traveling speed, bottom structure of the water body, and slope of the shoreline (Lewin et al. 2006), and thus is difficult to do at any scale. Eggs and developing alevins may be killed, displaced, or buried in fine sediment caused by the turbulence of passing power boats (Horton 1994). These impacts were at depths < 0.44m for propeller driven boats and < 0.36m for jet-driven boats for sockeye salmon with small substrate (1-50mm in diameter). Impacts on egg survival decreased rapidly on either side of the center line of the boat.

The sublethal effects of boat traffic on survival, stress, habitat choice, and susceptibility to predation of juvenile salmonids was studied on the Rogue and Chetco Rivers in Oregon (Satterthwaite 1995). Stress indicators increased when power boats were passed through side channels, but not in the main channels where most boat traffic usually occurs. Some juvenile salmonids were displaced by boats passing directly overhead, but few fish showed behavioral response to boats passing at a lateral distance of 5m or more. The juvenile salmon were more likely to show a behavioral response to an oar powered drift boat or kayak than power boats, but the reaction responses were more pronounced among fish displaced by power boats passing directly overhead.

Although powerboat and float boat use can disturb fish or eggs in shallow water, powerboat use for fishing does not occur in areas where steelhead and spring/summer Chinook spawn in shallow water. Thus effects of powerboat use on these species is likely to be discountable. Fall Chinook salmon spawn in areas where powerboats and float boats are used, but fall Chinook typically spawn in deeper water and larger substrate. Although in some areas of the Snake and Clearwater Rivers, redds can be located in pool tailouts or runs (NPT, personal communication, August 6, 2019). However, effects in the Snake River mainstem are likely to be discountable based on the river depth of spawning habitat for fall Chinook salmon described above (i.e. deep water for redd construction and deep redd burial depth) Because managers intend to close high density redd areas prior to peak spawning in the Clearwater River, and fall Chinook salmon redds are buried fairly deep in larger sized gravel, NMFS concludes for fall Chinook salmon that the effects of power- and float boat use are likely to be discountable for the Clearwater River spawning aggregate.

2.5.6. Effects on Critical Habitat

The proposed action is likely to have direct effects on adult migration conditions (through interception of adult fish as they are migrating) and indirect effects on substrate (due to wading), riparian vegetation, and juvenile migration conditions (due to presence of fishers on the banks and in or on the water). By removing adults that would otherwise return to spawning areas, harvest

could affect water quality and forage for juveniles by decreasing the return of marine derived nutrients to spawning and rearing areas. Effects on water quality are likely to be minor; these will be due to garbage or hazardous materials spilled from fishing boats or left on the banks. All of these effects, however, are expected to be small in magnitude and transitory in time frame, and therefore are not likely to reduce the capacity of those features to meet the conservation needs of the affected ESUs.

2.6. Cumulative Effects

“Cumulative effects” are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02). For the purpose of this analysis, the action area is that part of the Columbia River Basin described in Section 2.2.3. To the extent ongoing activities have occurred in the past and are currently occurring, their effects are included in the baseline (whether they are Federal, state, tribal or private). To the extent those same activities are reasonably certain to occur in the future (and are tribal, state or private), their future effects are included in the cumulative effects analysis. This is the case even if the ongoing tribal, state or private activities may become the subject of a section 10 permit or section 4(d) determination in the future until an opinion for the permit or 4(d) plan has been completed.

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

Future Tribal, state, and local government actions will likely be in the form of legislation, administrative rules, or policy initiatives. Government and private actions may include changes in land and water uses, including ownership and intensity, any of which could impact ESA-listed species or their habitat. Government actions are subject to political, legislative, and fiscal uncertainties. These realities, added to the geographic scope of the action area which encompasses numerous government entities exercising various authorities and the many private landholdings, make any analysis of cumulative effects difficult and frankly speculative. This section identifies representative actions that, based on currently available information, are reasonably certain to occur. It also identifies some goals, objectives, and proposed plans by government entities; however, NMFS is unable to determine at this point in time whether any proposals will in fact result in specific actions.

Habitat

In the Snake River Basin, each state administers the allocation of water resources within its borders, and each tribes administers allocation of tribal water rights within their reservations. Most streams in the Snake River Basin are over appropriated, except in the Salmon and Clearwater subbasins, even though water resource development has slowed in recent years. The state and tribal governments are cooperating with each other and other governments to increase

environmental protections, including better habitat restoration, hatchery, and harvest reforms. NMFS cooperates with the state and tribal water resource management agencies in assessing water resource needs in the Snake River Basin, and in developing flow requirements that will benefit ESA-listed fish. Although water usage is likely to be reduced overall, climate change may influence when and where water is available, thus ensuring a continued need for coordination into the future to protect listed fish.

The state of Washington has various strategies and programs designed to improve the habitat of ESA-listed species and assist in recovery planning, including the Salmon Recovery Planning Act, a framework for developing watershed restoration projects. The state developed a water quality improvement scheme through the development of Total Maximum Daily Loads. As with the Oregon initiatives, these programs could benefit the ESA-listed species if implemented and sustained. The state of Idaho is involved with numerous efforts to enhance the survival and recovery of ESA-listed Snake River salmon and steelhead including an aggressive irrigation diversion screening program, conservation hatchery programs, habitat enhancement activities, and watershed planning efforts.

In the past, each state's economy was heavily dependent on natural resources, with intense resource extraction activity. Changes in the states' economies have occurred in the last decade and are likely to continue with less large scale resource extraction, more targeted extraction methods, and substantial growth in other economic sectors. Growth in new businesses is creating urbanization pressures with increased demands for buildable land, electricity, water supplies, waste disposal sites, and other infrastructure. Economic diversification has contributed to population growth and movement in the states, a trend likely to continue for the next few decades. Such population trends will place greater demands in the action area for electricity, water, and buildable land; will affect water quality directly and indirectly; and will increase the need for transportation, communication, and other infrastructure development. The impacts associated with economic and population demands will affect habitat features, such as water quality and quantity, which are important to the survival and recovery of the ESA-listed species. The overall effect is likely to be negative, unless carefully planned for and mitigated.

Some of the state programs described above are designed to address these impacts. Also, Washington enacted a Growth Management Act to help communities plan for growth and address growth impacts on the natural environment. If the programs continue, they may help lessen some of the potential adverse effects identified above.

Local governments will be faced with similar but more direct pressures from population growth and movement. There will be demands for intensified development in rural areas as well as increased demands for water, municipal infrastructure, and other resources. The reaction of local governments to such pressures is difficult to assess at this time without certainty in policy and funding. Because there is little consistency among local governments in dealing with land use and environmental issues, any positive effects from local government actions on ESA-listed species and their habitat are likely to be scattered throughout the action area.

Tribal governments will continue to participate in cooperative efforts involving watershed and basin planning designed to improve fish habitat. The results from changes in tribal forest and

agriculture practices, in water resource allocations, and in changes to land uses are difficult to assess for the same reasons discussed under state and local actions. The earlier discussions related to growth impacts apply also to tribal government actions. Tribal governments will need to apply comprehensive and beneficial natural resource programs to areas under their jurisdiction to produce measurable positive effects for ESA-listed species and their habitat.

The effects of private actions are the most uncertain. Private landowners may convert current use of their lands, or they may intensify or diminish current uses. Individual landowners may voluntarily initiate actions to improve environmental conditions, or they may abandon or resist any improvement efforts. Their actions may be compelled by new laws, or may result from growth and economic pressures. Changes in ownership patterns will have unknown impacts. Whether any of these private actions will occur is highly unpredictable, and the effects even more so.

The effects of angler access and wading, and powerboat use in the river from all fisheries operating in the action area is unlikely to result in anything beyond discountable effects on critical habitat. This is because angler access points are well established, and are utilized by fishermen for multiple fisheries. Powerboat use is also used for multiple fisheries. The effects of these activities is also anticipated to be transitory in time frame, and therefore are not likely to reduce the capacity of those features to meet the conservation needs of the affected ESUs.

Hatcheries

More detailed discussion of cumulative effects for hatchery programs in the Columbia River Basin can be found in our biological opinion on the funding of Mitchell Act hatchery programs (NMFS 2017). Because all hatcheries in the Columbia River Basin either have already undergone ESA section 7 consultation or will need to undergo consultation, their operation is not included here as cumulative effects. However, it is useful to consider the aggregation of such effects expected to occur into the future, to provide context for the current analysis.

In summary, it is likely that the type and extent of salmon and steelhead hatchery programs and the numbers of fish released in the analysis area and throughout the Columbia Basin generally will change over time. Although adverse effects will continue, these changes are likely to reduce effects such as competition and predation on natural-origin salmon and steelhead compared to current levels, especially for those species that are listed under the ESA. This is because all salmon and steelhead hatchery and harvest programs funded and operated by non-federal agencies and tribes in the Columbia River Basin have to undergo review under the ESA to ensure that listed species are not jeopardized and that “take” under the ESA from salmon and steelhead hatchery programs is minimized or avoided. Where needed, reductions in effects on listed salmon and steelhead are likely to occur through:

- Hatchery monitoring information
- Times and locations of fish releases to reduce risks of competition and predation
- Management of overlap in hatchery- and natural-origin spawners to meet gene flow objectives
- Decreased use of isolated hatchery programs
- Increased use of integrated hatchery programs for conservation purposes

- Incorporation of new research results and improved best management practices for hatchery operations
- Creation of wild fish only areas
- Changes in hatchery production levels
- Increased use of marking of hatchery-origin fish
- Improved estimates of natural-origin salmon and steelhead abundance for abundance-based fishery management

Harvest

The proposed recreational fishery activities in the Snake River Basin are designed with a mandate for sustainable resource use under both Federal and State law and policy. Because the allowable impacts on listed species follow an abundance-based sliding scale, or maximum allowable incidental impact rate, if other conservation measures are unsuccessful in returning fish to the area, fishery impacts would be constrained. Therefore, the additive impacts of the proposed action for all ESA-listed species considered here are expected to be minor, because of reporting and monitoring requirements that would ensure compatibility with other conservation strategies.

Within the action area, there are expected to be beneficial effects on the biological and human environments associated with fishery management (e.g., reduction in naturally spawning hatchery fish and local economies). Conservative management of recreational fishing is only one element of a large suite of regulations and environmental factors that may influence the overall status of listed salmon populations and their habitat. The recreational fishing program is coordinated with monitoring and adaptive management measures so that fishery managers can respond to changes in the status of affected listed salmon and ensure that the affected ESUs are adequately protected.

The NPT's treaty-reserved fishing rights and fisheries in the Snake Basin continue to be critically important to the Tribe in maintaining and practicing its culture and ways of life and fishing-based economy. It is customary practice for the Tribe to shape tributary fishing regimes to be sensitive to the biological and conservation needs of the fish. The NPT uses its Tribal Code to help administer the treaty-reserved rights and natural resources of the Tribe. The Tribe governs its fishing and hunting activities to the fullest extent of tribal jurisdiction in order to properly regulate, manage and protect all of the fish and game resources available to the tribe and its members. Key elements of this include, for example: properly regulating, managing and protecting all of the fish and game resources available to the tribe and its members; taking such action necessary to protect, manage and enhance fish and wildlife; and providing for the conservation, enhancement and management of the tribe's fish and wildlife resources.

Climate Change

The cumulative effect of climate change on ESA-listed salmon and steelhead are difficult to predict, but are assumed in the status of the ESA-listed species affected by the Proposed Action. The Proposed Action addresses climate change effects by aligning future fisheries with recovery, primarily by ensuring that natural populations are capable of improving in productivity, abundance, and diversity, which will allow them to adapt to changing environments. 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

individual populations and on the level and rate of change. However, the life history types that will be successful in the future are neither static nor predictable. Therefore, maintaining or promoting existing diversity that is found in the natural populations of Pacific anadromous fish is the wisest strategy for continued existence of populations.

Summary

Non-federal actions are likely to continue affecting the ESA-listed species. The cumulative effects in the action area are difficult to analyze considering the geographic landscape of this consultation, the political variation in the action area, the uncertainties associated with government and private actions, and the changing economies of the region. Whether these effects will increase or decrease is a matter of speculation; however, based on the trends identified in this section, the adverse cumulative effects are likely to increase. Although state, tribal, and local governments have developed plans and initiatives to benefit ESA-listed fish, they must be applied and sustained in a comprehensive way before NMFS can consider them “reasonably certain to occur” in its analysis of cumulative effects.

2.7. Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the Proposed Action. In this section, NMFS adds the effects of the Proposed Action (section 2.5) to the environmental baseline (**Error! Reference source not found.**) and to cumulative effects (**Error! Reference source not found.**), taking into account the status of the species and critical habitat (section 2.2), to formulate the agency’s opinion as to whether the Proposed Action is likely to: (1) reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated or proposed critical habitat for the conservation of the species.

In assessing the overall risk of the Proposed Action on each species, NMFS considers the risks of each factor discussed in Section **Error! Reference source not found.**, above, in combination, considering their potential additive effects with each other and with other actions in the area (environmental baseline and cumulative effects). This combination serves to translate the positive and negative effects posed by the Proposed Action into a determination as to whether the Proposed Action as a whole would appreciably reduce the likelihood of survival and recovery of the listed species and how their designated critical habitat would be affected.

Our environmental baseline analysis considers the effects of hydropower, changes in habitat (both beneficial and adverse), fisheries, and hatcheries on these ESUs. For example, the last few years of low salmon and steelhead abundance may be affected, at least in part, by a warm-water “blob” that formed in the Pacific Ocean off the coast of the Pacific Northwest in 2014. As a result of the blob, there has been poor survival of young salmon and steelhead while in the ocean over the last several years, which has reduced the number of adults returning to spawn. However, recent data from scientists at NMFS’ Northwest Fisheries Science Center have indicated that marine conditions are improving, and the intrinsic productivity of Snake River steelhead is expected to provide resilience to the effects of short-term perturbations in marine survival. As we continue to

deal with a changing climate, management of these factors may also alleviate some of the potential adverse effects (e.g., hatcheries serving as a genetic reserve for natural populations).

2.7.1. Snake River Fall Chinook Salmon

Best available information indicates that the Snake River Fall Chinook Salmon ESU is at moderate risk and remains threatened (see Table 4-6 in NMFS 2017d). However, this ESU has seen much improvement in its abundance, productivity, spatial structure, and diversity over the last few decades from a low of 306 natural-origin adults in 1998, to over 15,000 natural-origin adults in 2015. While there is only a single extant population within the ESU, the recovery plan identifies a buffered MAT value of 4,200 that takes into account the limited spatial structure of the ESU, and allows for a recovery scenario built around the single population.

The harvest schedule being proposed reduces impacts on the natural-origin fall Chinook salmon population based on the natural-origin run size at Lower Granite Dam to a level appropriate to the population's status. Our analysis showed that, in implementing this approach, the mean number of natural-origin spawners is estimated to exceed not only MAT, but the maximum sustainable yield value of 10,623 at both 25 and 100 years into the future. Furthermore, our simple model was not designed to include the fishery managers' proposal to further reduce natural-origin impacts when consecutive years of returns fall within the lowest tier of the harvest schedule (< 1,260 natural-origin spawners). Applying this additional conservation measure is likely to further limit impacts beyond what our analysis demonstrates, which would likely result in increased spawner abundances in low-abundance years. Furthermore, we considered the effects of angler presence and boat use on fall Chinook salmon, and found the effects to be discountable based on Chinook habitat preferences for red construction, and due to the managers' proposed closures in high density red areas in the Clearwater River.

The recovery plans for each ESU describe the on-going and proposed state, tribal, and local government actions that are targeted to reduce known threats to ESA-listed salmon. Such actions are improving habitat, hatchery, and harvest practices to protect listed salmon ESUs. However, the degree of improvement is likely to be limited to some degree by climate change and development necessary to cope with human population growth. For the Snake River Fall Chinook Salmon ESU, NMFS expects this improvement to continue and it could lead to increases in abundance, productivity, spatial structure, and diversity. The harvest of fall Chinook salmon implemented according to the proposed harvest schedule is not expected to adversely affect this trend because it scales back harvest to incidental effect from state fisheries targeting other species, and to small-scale tribal fisheries during years of low abundance. The fishery managers have committed to further limit impacts when abundances fall below the CAT in consecutive years, and to manage the fishery for relatively low impact rates (between 6 and 20 percent) until the natural-origin population exceeds the buffered MAT value, ensuring that harvest of fall Chinook salmon in the Snake River Basin does not preclude ESU recovery. After considering the current viability status of these species, the Environmental Baseline, and other pertinent cumulative effects, including any anticipated Federal, state, or private projects, NMFS concludes that the small effects of the Proposed Action on abundance, productivity, spatial structure, and diversity, added to other ongoing and anticipated actions, will not appreciably reduce the likelihood of survival and recovery of this ESA-listed ESU.

2.7.2. Snake River Steelhead DPS

Best available information indicates that the Snake River Steelhead DPS is at high risk and remains at threatened status (NWFSC 2015). However, in NMFS' most recent status review (NWFSC 2015), for populations where estimates of the status of abundance, productivity, spatial structure and diversity exist, abundances are close to or exceed MAT, and productivity is well over replacement (i.e., at least 1 progeny is produced on average for each parent).

Snake River steelhead listed under the ESA are primarily affected by the proposed action via mortality of listed, adult and juvenile, natural-origin steelhead incidental to the proposed fisheries. The proposed fisheries are expected to kill no more than 0.5 percent of the portion of the Snake River Steelhead DPS that escape to the Snake River Basin, and a much lower percentage if calculated based on the number of Snake River steelhead that return to the mouth of the Columbia River. Furthermore, this proportion is included in the recently authorized fixed harvest rates by MPG for the Snake River Steelhead DPS within the Snake River Basin. This framework for allowable impact rates on natural-origin steelhead throughout the Snake River Basin was analyzed previously by NMFS (2019), and NMFS found that the action did not reduce the likelihood of survival and recovery of the DPS.

The recovery plan for this DPS describes the on-going and proposed state, tribal, and local government actions that are targeted to reduce known threats to ESA-listed steelhead. Such actions include improving habitat conditions, and hatchery and harvest practices to protect listed steelhead DPSs, and NMFS expects this trend to continue, and could lead to increases in abundance, productivity, spatial structure, and diversity. However, the degree of improvement is likely to be limited to some degree by climate change and development necessary to cope with human population growth. After considering the current viability status of these species, the environmental baseline, and other pertinent cumulative effects, including any anticipated Federal, state, or private projects, NMFS concludes that the effects of the Proposed Action, added to other ongoing and anticipated actions, will not appreciably reduce the likelihood of survival and recovery of this ESA-listed DPS in the wild.

2.7.3. Snake River Spring/Summer Chinook Salmon ESU

Best available information indicates that the Snake River Spring/Summer Chinook Salmon ESU is at high risk and remains threatened (NWFSC 2015). Our environmental baseline analysis considers the effects of hydropower, changes in habitat (both beneficial and adverse), fisheries, and hatcheries on this ESU. Although all may have contributed to the listing of this ESU, all factors have also seen improvements in the way they are managed/operated. In addition, the management of these factors may be further adjusted in the future and alleviate some of the potentially adverse effects of climate change (e.g., hatcheries serving as a genetic reserve for natural populations).

The time and area separation between the proposed fisheries and spring/summer Chinook salmon nearly eliminates impacts on spring/summer Chinook salmon, although we cannot rule out slight decreases in adult abundance and potentially productivity. As stated earlier, we anticipate that 30

adults could be encountered in the proposed fisheries, as well as a small proportion of juveniles within Oregon's resident trout fishery. However, this number of fish distributed across the 31 populations in the ESU is unlikely to have any measureable effect on the abundance or productivity of the ESU.

The recovery plans for the ESU describe the on-going and proposed state, tribal, and local government actions that are targeted to reduce known threats to ESA-listed salmon. Such actions are improving habitat conditions, and hatchery and harvest practices to protect listed salmon ESUs. NMFS expects this trend to continue and could lead to increases in abundance, productivity, spatial structure and diversity. However, the degree of improvement is likely to be limited to some degree by climate change and development necessary to cope with human population growth. After considering the current viability status of these species, the Environmental Baseline, and other pertinent cumulative effects, including any anticipated Federal, state, or private projects, NMFS concludes that the small effects of the Proposed Action on abundance, productivity, spatial structure, and diversity, added to other ongoing and anticipated actions, will not appreciably reduce the likelihood of survival and recovery of this ESA-listed ESU.

2.7.4. Snake River Sockeye Salmon ESU

Best available information indicates that the Snake River Sockeye Salmon ESU is at high risk and remains endangered (NWFSC 2015). The proposed fisheries in the Snake River Basin are not anticipated to result in more than 10 encounters and 1 mortality of sockeye salmon adults annually. Because no sockeye salmon have been encountered in Idaho's steelhead fisheries since the 1970s, which are much larger in scale, especially in the Salmon River Basin, where sockeye salmon are migrating, take is likely to be a rare occurrence. In addition, over the last decade, sockeye salmon average abundance has increased about 18 times compared to the previous decade (36 from 1999 to 2008; 640 from 2009-2018; Table 10). Thus, this level of impact is expected to have a minimal effect on viability of the ESU, and is not expected to appreciably reduce the likelihood of survival and recovery of Snake River sockeye salmon.

The recovery plans for the ESU describe the on-going and proposed state, tribal, and local government actions that are targeted to reduce known threats to ESA-listed salmon. Such actions are improving habitat conditions, and hatchery and harvest practices to protect listed salmon ESUs. NMFS expects this trend to continue and could lead to increases in abundance, productivity, spatial structure and diversity. However, the degree of improvement is likely to be limited to some degree by climate change and development necessary to cope with human population growth. After considering the current viability status of these species, the Environmental Baseline, and other pertinent cumulative effects, including any anticipated Federal, state, or private projects, NMFS concludes that the small effects of the Proposed Action on abundance, productivity, spatial structure, and diversity, added to other ongoing and anticipated actions, will not appreciably reduce the likelihood of survival and recovery of this ESA-listed ESU.

2.7.5. Critical Habitat

The direct effects on 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. By removing adults that would otherwise return to spawning areas, harvest could affect water quality and forage for juveniles by decreasing the return of marine derived nutrients to spawning and rearing areas. Effects on water quality are likely to be minor; these will be due to garbage or hazardous materials spilled from fishing boats or left on the banks. Therefore, these effects are not likely to reduce the capacity of those features to meet the conservation needs of the affected ESUs.

2.8. Conclusion

After reviewing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the Proposed Action, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' biological opinion that the Proposed Action is not likely to jeopardize the continued existence of the Snake River Basin Steelhead DPS, the Snake River Fall Chinook Salmon ESU, the Snake River Spring/Summer Chinook Salmon ESU, or the Snake River Sockeye Salmon ESU, or destroy or adversely modify their designated critical habitat.

2.9. Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibits the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns, including breeding, feeding, or sheltering. Harass is defined as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

2.9.1. Amount or Extent of Take Anticipated

The proposed 4(d) authorization is for activities to be conducted indefinitely. Harvest of clipped and unclipped hatchery-origin fall Chinook salmon is considered direct take and is not listed in this ITS. NMFS has identified one form of incidental take resulting from the proposed action, angler capture of non-target species.

Snake River Fall Chinook Salmon.

The states will be implementing mark-selective fisheries when natural-origin abundance is below CAT (1,260) at Lower Granite Dam. Thus any encounter and/or mortality of a natural-origin fall Chinook salmon would be considered incidental to mark-selective fisheries. **Error! Reference source not found.** shows that when natural-origin abundance is below CAT, impacts would be limited to $\leq 6\%$. However, given the allocation of impacts agreed to by the fishery managers, recreational fisheries are allocated 1.5% of the 6% total impacts at a natural-origin abundance of 1,260. Because tribal fisheries are not-selective, the only incidental take of fall Chinook salmon at this harvest schedule tier would be from state recreational fisheries of up to 19 natural-origin fall Chinook salmon mortalities with 190 encounters.

Snake River Steelhead

Incidental take of steelhead is anticipated to be a small proportion (< 0.5 percent of each MPG) of the steelhead take previously authorized in our Opinion on the Snake Basin Steelhead Fisheries (NMFS 2019).

Snake River Spring/Summer Chinook Salmon

Incidental take of spring/summer Chinook salmon will not exceed 30 encounters with three mortalities annually.

Snake River Sockeye

Incidental take of sockeye salmon will not exceed 10 encounters with one mortality annually.

2.9.2. Effect of the Take

In Section 2.7, NMFS determined that the level of anticipated take, coupled with other effects of the Proposed Action, is not likely to jeopardize the continued existence of the Snake River Fall Chinook Salmon ESU, or Snake River Steelhead DPS, the Snake River Spring/Summer Chinook Salmon ESU, or the Snake River Sockeye Salmon ESU, or result in the destruction or adverse modification of their designated critical habitat. Note that the incidental take assigned here consists of estimates of take resulting from the specific fisheries under review. However, there are several overlapping fisheries in the area, any one of which could be the source of a particular incidental take. Therefore, this determination calculates the incidental take assigned due to the proposed fisheries, which considers the take (both incidental and direct) that occurs as a result of all fisheries in the area. By doing so, we are assured that the action is not likely to jeopardize the affected listed species.

2.9.3. Reasonable and Prudent Measures

“Reasonable and prudent measures” are nondiscretionary measures to minimize the amount or extent of incidental take (50 CFR 402.02). NMFS concludes that the following reasonable and prudent measures are necessary and appropriate to minimize incidental take. In general, NMFS will require:

1. State applicants minimize adverse effects on ESA-listed salmon and steelhead in state-managed salmon fisheries by requiring live release of all non-target fish and application of the FMEPs as described.
2. All fishery managers to coordinate annually on allocation and harvest impacts to ensure take is not exceeded.
3. All fishery managers to estimate number of redds in the Clearwater River for spawning fall Chinook salmon, and conduct further research, monitoring, and evaluation to estimate redd depth, and angler distribution and effort over the fishery season.
4. An annual post-season fishery report be submitted to NMFS, to include the impacts of the incidental take on listed species in the action area.
5. A review of the Proposed Action every five years to verify validity of assumptions, identify new information gaps, discuss any changes to the harvest regime, and review requested information.
6. Fishery managers to report harvest of natural- and hatchery-origin fall Chinook salmon to the entity responsible for updating the stock-recruit model, and calculating the proportionate natural influence.

2.9.4. Terms and Conditions

The terms and conditions described below are non-discretionary, and NMFS or any applicant must comply with them in order to implement the RPMs (50 CFR 402.14). NMFS or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this ITS (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse. Thus, NMFS shall:

1. Require that state fishery managers minimize adverse effects on ESA-listed salmon and steelhead in state-managed salmon fisheries by requiring live release of all non-target fish and application of the FMEPs as described.
2. Require all fishery managers to coordinate annually on allocation and harvest impacts on Snake River fall Chinook salmon to ensure take is not exceeded. This coordination shall include provisions whereby fishery managers:
 - a. Submit a pre-season fishery plan by July 31st for fall Chinook salmon and August 31st for coho salmon that includes the projected natural-origin run size and impact rate, and fishery season structure (e.g., open areas, bag limits).
 - b. Notify NMFS of impacts that exceed those in the ITS in-season and post-season as soon as possible.
3. Require all fishery managers to estimate number of redds in the Clearwater River for spawning fall Chinook salmon, and conduct further research, monitoring, and evaluation to estimate redd depth, and angler distribution and effort over the fishery season.

4. Require an annual post-season fishery report be submitted to NMFS by April 15th a year and a half after the close of the fishery (e.g., fishery in fall of 2019, report due April 15, 2021). The report is expected to include:
 - a. Encounter and mortality of ESA-listed natural-origin fall Chinook salmon
 - b. Encounters and mortality of ESA-listed sockeye salmon
 - c. Any fishery season structure changes from the pre-season plan
5. Conduct a review of the Proposed Action every five years to verify validity of assumptions (particularly those in the stock-recruit, and simulation models), identify new information gaps, discuss any changes to the harvest regime, and review requested information.
6. Require fishery managers to report harvest of natural- and hatchery-origin fall Chinook salmon to the entity responsible for updating the stock-recruit model, calculating spawner composition/distribution, and calculating the proportionate natural influence.

2.10. Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a Proposed Action on listed species or critical habitat (50 CFR 402.02). NMFS has identified two conservation recommendations appropriate to the Proposed Action:

1. Continue to collect and analyze data that will better inform and allow development of fishery management to the spawning aggregate level; Clearwater, Snake River Mainstem, Lower Salmon, Grande Ronde, and Tucannon.
2. Evaluate whether catch and release mortality rate calculation should vary over the timeframe of the fishery to account for changes in river temperature. Evidence suggests that warmer temperatures could lead to higher levels of catch and release mortality.

2.11. Not Likely to Adversely Affect Determination

2.11.1. Southern Resident Killer Whale DPS

The Southern Resident killer whale DPS was listed as endangered on February 16, 2006 (70 FR 69903) and a recovery plan was completed in 2008 (NMFS 2008). A 5-year review under the ESA completed in 2016 concluded that Southern Residents should remain listed as endangered and includes recent information on the population, threats, and new research results and publications (NMFS 2016b). Critical habitat in inland waters of Washington was designated on November 29, 2006 (71 FR 69054). Because NMFS determined the action is not likely to adversely affect SKRWs, this document does not provide detailed discussion of environmental baseline or cumulative effects for the SRKW portion of the action area.

Several factors identified in the final recovery plan for Southern Resident killer whales may be limiting recovery including quantity and quality of prey, toxic chemicals that accumulate in top

predators, and disturbance from sound and vessels. Oil spills are also a risk factor. It is likely that multiple threats are acting together to impact the whales. Although it is not clear which threat or threats are most significant to the survival and recovery of Southern Residents, all of the threats identified are potential limiting factors in their population dynamics (NMFS 2008).

Southern Resident killer whales consist of three pods (J, K, and L) and inhabit coastal waters off Washington, Oregon, and Vancouver Island and are known to travel as far south as central California and as far north as Southeast Alaska (Carretta et al. 2018; Hanson et al. 2013; NMFS 2008). During the spring, summer, and fall months, the whales spend a substantial amount of time in the inland waterways of the Strait of Georgia, Strait of Juan de Fuca, and Puget Sound (Bigg 1982; Whale Museum unpublished data; Ford et al. 2000; Hanson and Emmons 2010; Hauser et al. 2007; Krahn et al. 2002). All three pods generally remain in the Georgia Basin through October and make frequent trips to the outer coasts of Washington and southern Vancouver Island and are occasionally sighted as far west as Tofino and Barkley Sound (Ford et al. 2000; Whale Museum unpublished data; Hanson and Emmons 2010).

By late fall, all three pods are seen less frequently in inland waters. In recent years, several sightings and acoustic detections of Southern Residents have been obtained off the Washington and Oregon coasts in the winter and spring (Hanson and Emmons 2010; NWFSC unpublished data; Hanson et al. 2013). Satellite-linked tag deployments have also provided more data on the Southern Resident killer whale movements in the winter indicating that K and L pods use the coastal waters along Washington, Oregon, and California during non-summer months. Detection rates of K and L pods on the passive acoustic recorders indicate Southern Residents occur with greater frequency off the Columbia River and Westport and are most common in March (Hanson et al. 2013). J pod has also only been detected on one of seven passive acoustic recorders positioned along the outer coast (Hanson et al. 2013). The limited range of the sightings/ acoustic detections of J pod in coastal waters, the lack of coincident occurrence during the K and L pod sightings, and the results from satellite tagging in 2012–2016 (NWFSC unpublished data) indicate J pod's limited occurrence along the outer coast and extensive occurrence in inland waters, particularly in the northern Georgia Strait.

Southern Resident killer whales consume a variety of fish species (22 species) and one species of squid (Ford and Ellis 2006; Ford et al. 2000; Ford et al. 1998; Ford et al. 2016; Hanson and Emmons 2010), but salmon are identified as their primary prey. Southern Residents are the subject of ongoing research, including direct observation, scale and tissue sampling of prey remains, and fecal sampling. Scale and tissue sampling from May to September indicate that their diet consists of a high percentage of Chinook salmon (monthly proportions as high as >90%) (Ford et al. 2016; Hanson and Emmons 2010). The diet data also indicates that the whales are consuming mostly larger (i.e., older) Chinook salmon. DNA quantification methods are also used to estimate the proportion of different prey species in the diet from fecal samples (Deagle et al. 2005). Recently, Ford et al. (2016) confirmed the importance of Chinook salmon to the Southern Residents in the summer months using DNA sequencing from whale feces. Salmon and steelhead made up to 98% of the inferred diet, of which almost 80% were Chinook salmon.

Coho salmon and steelhead are also found in the diet in spring and fall months when Chinook salmon are less abundant. Specifically, coho salmon contribute to over 40% of the diet in late

summer, which is evidence of prey shifting at the end of summer towards coho salmon (Ford and Ellis 2006; Ford et al. 1998; Ford et al. 2016; Hanson and Emmons 2010). Less than 3% each of chum salmon, sockeye salmon, and steelhead were observed in fecal DNA samples collected in the summer months (May through September). Prey remains and fecal samples collected in inland waters during October through December indicate Chinook and chum salmon are primarily contributors of the whale's diet (NWFSC unpublished data). Observations of whales overlapping with salmon runs (Krahn et al. 2009; Wiles 2004; Zamon et al. 2007) and collection of prey and fecal samples have also occurred in the winter months. Preliminary analysis of prey remains and fecal samples sampled during the winter and spring in coastal waters indicated the majority of prey samples were Chinook salmon (80% of prey remains and 67% of fecal samples were Chinook salmon), with a smaller number of steelhead, chum salmon, and halibut (NWFSC unpublished data). The occurrence of K and L pods off the Columbia River in March suggests the importance of Columbia River spring runs of Chinook salmon in their diet (Hanson et al. 2013). Chinook genetic stock identification from samples collected in winter and spring in coastal waters included 12 U.S. west coast stocks, and over half the Chinook salmon consumed originated in the Columbia River (NWFSC unpublished data).

NMFS has continued to fund the Center for Whale Research to conduct an annual census of the Southern Resident population. As of August 2019, two new calves have been reported by the Center for Whale Research as well as the likely death of three adults. Although the 2019 census report is still pending, with the births and deaths reported so far this year, the Southern Residents total 73 individuals. The NWFSC continues to evaluate changes in fecundity and mortality rates, and has updated the work on population viability analyses conducted for the 2004 Status Review for Southern Resident Killer Whales and a science panel review of the effects of salmon fisheries (Hilborn et al. 2012; Krahn et al. 2004; Ward et al. 2013). Following from that work, the data now suggests a downward trend in population growth projected over the next 50 years. As the model projects out over a longer time frame (50 years) there is increased uncertainty around the estimates, however, if all of the parameters in the model remain the same the overall trend shows a decline in later years. This downward trend is in part due to the changing age and sex structure of the population, but also related to the relatively low fecundity rate observed over the period from 2011 to 2016 (Figure 2-27 in NMFS 2016b). Recent evidence indicates pregnancy hormones (progesterone and testosterone) can be detected in Southern Resident killer whale feces and have indicated several miscarriages, particularly in late pregnancy (Wasser et al. 2017). The authors suggest this reduced fecundity is largely due to nutritional limitation.

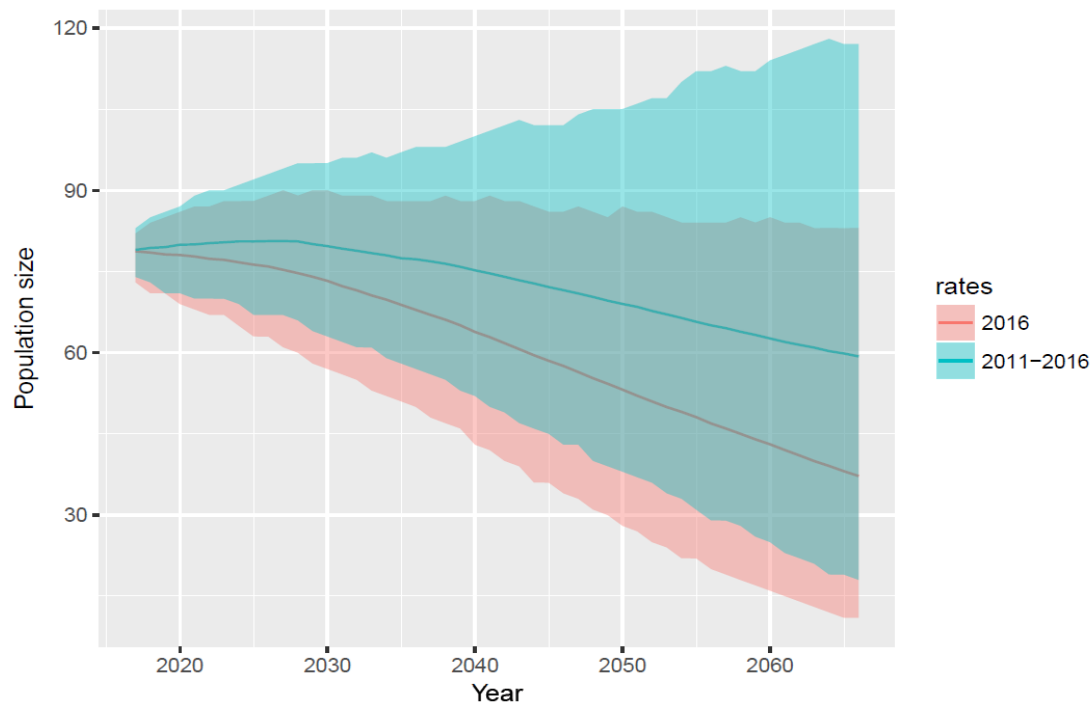


Figure 9. Southern Resident killer whale population size projections from 2016 to 2066 using two scenarios: (1) projections using demographic rates held at 2016 levels (pink line), and (2) projections using demographic rates from 2011 to 2016 (blue line) (NMFS 2016b).

To explore potential demographic projections, Lacy et al. (2017) constructed a population viability assessment that considered sublethal effects and the cumulative impacts of threats (contaminants, acoustic disturbance, and prey abundance). They found that over the range of scenarios tested, the effects of prey abundance on fecundity and survival had the largest impact on the population growth rate. Furthermore, they suggested in order for the population to reach the recovery target of 2.3% growth rate, the acoustic disturbance would need to be reduced in half and the Chinook abundance would need to be increased by 15% (Lacy et al. 2017).

As described above, the proposed action has two components: 1) the new Snake River fall Chinook salmon, coho salmon, and resident trout FMEP submitted by IDFG, WDFW, and ODFW; and 2) the Snake River fall Chinook salmon and coho salmon TRMP submitted by the Nez Perce Tribe. The proposed action occurs in the river and does not overlap with the whales, however, the fisheries may affect Southern Resident killer whales through indirect effects to their primary prey. This analysis focuses on effects to Chinook salmon availability in the ocean because the best available information indicates that salmon are the preferred prey of Southern Resident killer whales year round, including in coastal waters, and that Chinook salmon are the preferred salmon prey species. To assess the indirect effects of the proposed action on the Southern Resident killer whale DPS, we considered the geographic area of overlap in the marine distribution of Snake Rivers spring/summer and fall Chinook salmon affected by the action, and the range of Southern Resident killer whales. For actions, including fisheries that may affect the prey base for the whales, we evaluate the short-term and long-term effects from the proposed action.

Short-Term (Annual) Effects

Here we define short-term effects to mean annual effects. The terminal fisheries managed under the proposed FEMP and TRMP would occur after the fish have returned to the river and are no longer available to the whales in the ocean, so the annual harvest would not affect the prey available to the whales. From 2010 to 2017, 75% of the average harvest in state and tribal fisheries consisted of hatchery-origin Chinook (Table 12 and Table 13). While there is no limit on harvest of hatchery-origin fall Chinook salmon, the fishery regulations designed to remain within natural-origin impact ranges are likely to limit harvest of hatchery fish. The effects of the fisheries on natural-origin fall Chinook salmon and their contributions to population abundance and prey availability for the whales in future years is considered to be low under long-term effects. Encounters with spring/summer Chinook salmon are expected to be minimal (30 adults) and also occur in the river where they would not affect the prey immediately available to the whales. In addition, any fishing vessel activity would not overlap with the whales so there would be no short-term or direct acoustic or other foraging disturbance impacts on the whales from fishing vessels.

Long-Term Effects

Since the fishery occurs in the river and does not reduce prey immediately available to the whales, the pathway for indirect effects to the whales is through long-term effects on prey abundance. Here we define long-term effects as those that occur beyond a year. There is limited overlap of the action with spring/summer Chinook salmon and the minimal number that could be taken are unlikely to have any measurable effect on abundance or productivity.

Based on the analysis for fall Chinook salmon in this Opinion, the proposed harvest schedule is expected to reduce impacts to natural-origin fish from hatchery-origin spawners, and result in meeting or exceeding recovery plan goals and maximum sustainable yield. Based on the analysis and modeling, the proposed harvest schedule is not expected to reduce the number of natural-origin spawners below the 11,086 average (years 2010-2017) identified in Table 13, compared to our long term projections (Table 16), which would equate to no expected reduction in prey when available to the whales as adults in the ocean. As described in Section 2.8, over the long term, NMFS' analysis concluded that the proposed action is not likely to jeopardize the continued existence of the listed Chinook salmon ESUs and or destroy or adversely modify their designated critical habitat. Healthy natural-origin salmon populations are important to the long-term maintenance of prey populations available to Southern Resident killer whales. With harvest practices responsive to low abundance years for natural-origin fish and additional recovery actions being implemented, NMFS expects continued improvement which could lead to increases in abundance. Increased abundance would improve the prey base for the Southern Residents, however, the degree of improvement is likely to be limited by climate change and population development in response to human population growth.

In summary, based on limited overlap with spring/summer Chinook salmon, protections for natural-origin fall Chinook salmon and expected consistent or increasing abundance in future years, NMFS concludes that the long-term effects to prey availability are insignificant.

Critical Habitat

The final designation of critical habitat for the Southern Resident killer whale DPS was published on November 29, 2006 (71 FR 69054). Critical habitat consists of three specific areas: (1) the Summer Core Area in Haro Strait and waters around the San Juan Islands; (2) Puget Sound; and (3) the Strait of Juan de Fuca. These areas comprise approximately 2,560 square miles of marine habitat. Based on the natural history of the Southern Residents and their habitat needs, NMFS identified the following physical or biological features essential to conservation: (1) Water quality to support growth and development; (2) Prey species of sufficient quantity, quality and availability to support individual growth, reproduction and development, as well as overall population growth; and (3) Passage conditions to allow for migration, resting, and foraging.

The proposed action occurs outside designated critical habitat. However, a relatively very small amount of Snake River Chinook salmon are recovered in Puget Sound, especially relative to the proportion of Puget Sound Chinook salmon present (Weitkamp 2010). Because only a very small proportion of Snake River fish are recovered in Puget Sound, the impact of the proposed action on the prey feature is not expected to be measurable and is insignificant.

On January 21, 2014, NMFS received a petition requesting that we revise critical habitat citing recent information on the whales habitat use along the West Coast of the United States. Center for Biological Diversity proposes that the critical habitat designation be revised and expanded to include areas of the Pacific Ocean between Cape Flattery, WA, and Point Reyes, CA, extending approximately 47 miles (76 km) offshore. NMFS published a 90 day finding on April 25, 2014 (79 FR 22933) that the petition contained substantial information to support the proposed measure and that NMFS would further consider the action. We also solicited information from the public. Based upon our review of public comments and the available information, NMFS issued a 12 month finding on February 24, 2015 (80 FR 9682) describing how we intended to proceed with the requested revision, which is still in development.

Conclusion

Short-term effects are not anticipated and long-term effects to the prey base and prey feature of critical habitat are insignificant. Based on this analysis, NMFS concludes that the proposed action is not likely to adversely affect the Southern Resident killer whale DPS or their designated critical habitat.

2.12. Reinitiation of Consultation

This concludes formal consultation on the approval and implementation of fall Chinook salmon, coho salmon, and resident trout fisheries in the Snake River Basin. As 50 CFR 402.16 states, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) The amount or extent of incidental take specified in the ITS is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the agency action is subsequently modified in a manner that causes an effect on the listed species or critical habitat that was not considered in this opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

3. MAGNUSON-STEVENSON ACT ESSENTIAL FISH HABITAT CONSULTATION

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

This analysis is based, in part, on descriptions of EFH for Pacific Coast salmon (PFMC 2014) contained in the fishery management plans developed by the Pacific Fishery Management Council (PFMC) and approved by the Secretary of Commerce.

3.1. Essential Fish Habitat Affected By The Project

The Proposed Action is the implementation of Snake River fisheries, as described in Section **Error! Reference source not found.** The action area (Section **Error! Reference source not found.**) of the Proposed Action includes habitat described as EFH for Chinook and coho salmon (PFMC 2003) within the Snake River Basin. Because EFH has not been described for steelhead, the analysis is restricted to the effects of the Proposed Action on EFH for Chinook and coho salmon. For Chinook salmon, EFH encompasses all available watersheds in Idaho. For coho salmon, EFH in Idaho occurs in the Lower Salmon River, and throughout the Clearwater Subbasin with the exception of the Lochsa and Lower North Fork Clearwater Rivers (PFMC 2014)

As described by PFMC (2003), the freshwater EFH for Chinook and coho salmon has five habitat areas of particular concern (HAPCs): (1) complex channels and floodplain habitat; (2) thermal refugia; (3) spawning habitat; (4) estuaries; and (5) marine and estuarine submerged aquatic vegetation. The aspects of EFH that might be affected by the Proposed Action include effects on natural-origin Chinook and coho salmon in spawning and rearing areas (primarily addressing HAPC 3).

3.2. Adverse Effects on Essential Fish Habitat

EFH may be affected by fisheries through interception of adult fish as they are migrating and through indirect effects on substrate, riparian vegetation, and juvenile migration. The indirect effects are expected to be small in magnitude and transitory in time frame. By removing adults that would otherwise return to spawning areas, harvest could also affect water quality and forage for juveniles by decreasing the return of marine-derived nutrients to spawning and rearing areas. However, this is unlikely to result in more than a negligible effect due to the vast area and the fact

that many adults would escape the fisheries to spawn. The removal of adults may also provide a benefit by removing hatchery-origin spawners, and any potential progeny that could compete with natural-origin spawners for space and food. Effects on water quality are likely to be minor because they are small in scale, and are expected to dissipate quickly; these will be due to garbage or hazardous materials spilled from fishing boats or left on the banks.

Thus, NMFS concludes that the proposed action would not adversely affect designated EFH for Chinook or coho salmon.

3.3. Essential Fish Habitat Conservation Recommendation

NMFS did not identify any potential adverse effects by the Proposed Action on EFH for Chinook and coho salmon. NMFS believes that the Proposed Action, as described in the FMEPs and the ITS (Section **Error! Reference source not found.**), includes the best approaches to avoid or minimize any adverse effects that might result in the near future. Thus, NMFS has no conservation recommendations specifically for salmon EFH.

3.4. Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, the Federal action agencies must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation from NMFS.

Because NMFS has determined that the proposed action is not likely to adversely affect EFH for Pacific salmon, no statutory response is required at this time.

3.5. Supplemental Consultation

NMFS must reinitiate EFH consultation if the Proposed Action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH conservation recommendations (50 CFR 600.920(l)).

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

Section 515 of the Treasury and General Government Appropriations Act of 2001 (Public Law 106-554) ("Data Quality Act") specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the Biological Opinion addresses these DQA components, documents compliance with the Data Quality Act, and certifies that this Biological Opinion has undergone pre-dissemination review.

4.1. Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are the IDFG, ODFW, WDFW, NPT, CTUIR, and SBT. NMFS has determined that the proposed action will not jeopardize the affected ESUs/DPSs or destroy or adversely modify their critical habitat; the MSA consultation determined that the proposed action would not adversely affect designated EFH for

Pacific salmon. Therefore, NMFS can issue an incidental take permit. The scientific community, resource managers, and the stakeholders benefit from the consultation. Individual copies of this opinion were provided to the IDFG, ODFW, WDFW, NPT, CTUIR, and SBT. A complete record of this consultation is on file at the SFD of NMFS in Portland, Oregon. The format and naming adheres to conventional standards for style.

4.2. Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, “Security of Automated Information Resources,” Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

4.3. Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased, and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA Regulations, 50 CFR 402.01 et seq., and the MSA implementing regulations regarding EFH, 50 CFR 600.920(j).

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the literature cited section. The analyses in this biological opinion/EFH consultation contain more background on information sources and quality.

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

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

5. LITERATURE CITED

- Asch, R. G. 2015. Climate change and decadal shifts in the phenology of larval fishes in the California Current ecosystem. PNAS 112(30):E4065–E4074.
- Bakun, A., and coauthors. 2015. Anticipated effects of climate change on coastal upwelling ecosystems. Current Climate Change Reports 1(2):85-93.
- Beechie, T., and coauthors. 2013. Restoring Salmon Habitat for a Changing Climate. River Research and Applications 29(8):939-960.
- Bell, M. C. 1990. Fisheries Handbook of Engineering Requirements and Biological Criteria. Fish Passage Development and Evaluation Program, Corps of Engineers, North Pacific Division, Portland, Oregon. 353p.

- Bendock, T., and M. Alexandersdottir. 1993. Hooking mortality of Chinook salmon released in the Kenai River, Alaska. *North American Journal of Fisheries Management* 13(3):540-549.
- Bigg, M. 1982. An assessment of killer whale (*Orcinus orca*) stocks off Vancouver Island, British Columbia. *Report of the International Whaling Commission* 32(65):655-666.
- Black, B. A., and coauthors. 2014. Six centuries of variability and extremes in a coupled marine-terrestrial ecosystem. *Science* 345(6203):1498-1502.
- Bograd, S. J., and coauthors. 2009. Phenology of coastal upwelling in the California Current. *Geophysical Research Letters* 36(1).
- Bond, N. A., M. F. Cronin, H. Freeland, and N. Mantua. 2015. Causes and impacts of the 2014 warm anomaly in the NE Pacific. *Geophysical Research Letters* 42(9):3414–3420.
- Booth, R. K., J. D. Kieffer, K. Davidson, A. T. Bielak, and B. L. Tufts. 1995. Effects of late-season catch and release angling on anaerobic metabolism, acid-base status, survival, and gamete viability in wild Atlantic salmon (*Salmo salar*). *Canadian Journal of Fisheries and Aquatic Sciences* 52:283-290.
- Bottom, D. L., K. K. Jones, C. A. Simenstad, C. L. Smith, and R. Cooper. 2011. Pathways to resilience. Oregon Sea Grant. Pathways to resilience: sustaining salmon ecosystems in a changing world (Vol. 11, No. 1). Oregon Sea Grant.
- Bratcher, K. W. 2019. Email to Charlene Hurst (NMFS) from Kyle Bratcher (IDFG). Draft clarification of effects on spring/summer Chinook salmon from Oregon's resident trout fisheries in northeast Oregon. June 20, 2019. 1p.
- Brodeur, R. D., R. C. Francis, and W. G. Pearcy. 1992. Food consumption of juvenile coho (*Oncorhynchus kisutch*) and Chinook salmon (*O. tshawytscha*) on the continental shelf off Washington and Oregon. *Canadian Journal of Fisheries and Aquatic Sciences* 49:1670-1685.
- Busack, C. 2015. Extending the Ford model to three or more populations. August 31, 2015. Sustainable Fisheries Division, West Coast Region, National Marine Fisheries Service. 5p.
- Carretta, J. V., and coauthors. 2018. U.S. Pacific Draft Marine Mammal Stock Assessments: 2018. NOAA Technical Memorandum NMFS. NOAA-TM-NMFS-SWFSC-XXX. Published for public review and comment on September 18, 2018. 102p.
- CCSP. 2014. U.S. Global Change Research Program. Northwest Report. <https://nca2014.globalchange.gov/report/regions/northwest>. Accessed 12/14/2017.
- Cheung, W. W. L., R. D. Brodeur, T. A. Okey, and D. Pauly. 2015. Projecting future changes in distributions of pelagic fish species of Northeast Pacific shelf seas. *Progress in Oceanography* 130:19-31.
- Christie, M. R., M. J. Ford, and M. S. Blouin. 2014. On the reproductive success of early-generation hatchery fish in the wild. *Evolutionary Applications* 7:883-896.
- Climate Impacts Group. 2004. Overview of Climate Change Impacts in the U.S. Pacific Northwest. July 29, 2004. Climate Impacts Group, University of Washington, Seattle, Washington. 13p.
- Connor, W. P., J. G. Sneva, K. F. Tiffan, R. K. Steinhorst, and D. Ross. 2005. Two alternative juvenile life history types for fall Chinook salmon in the Snake River basin. *Transactions of the American Fisheries Society* 134(2):291-304.
- Copeland, T., M. W. Ackerman, K. K. Wright, and A. Byrne. 2017. Life history diversity of Snake River steelhead populations between and within management categories. *North American Journal of Fisheries Management* 37(2):395-404.

- Cowen, L., N. Trouton, and R. E. Bailey. 2007. Effects of angling on Chinook salmon for the Nicola River, British Columbia, 1996-2002. *North American Journal of Fisheries Management* 27:256-267.
- Crozier, L., E. Dorfmeier, T. Marsh, B. Sandford, and D. Widener. 2016. Refining our understanding of early and late migration of adult Upper Columbia spring and Snake River spring/summer Chinook salmon: passage timing, travel time, fallback and survival. March 2016. NWFSC, Seattle, Washington. 57p.
- Crozier, L., and R. W. Zabel. 2006. Climate impacts at multiple scales: evidence for differential population responses in juvenile Chinook salmon. *Journal of Animal Ecology* 75(5):1100-1109.
- Crozier, L. G., and coauthors. 2008a. Potential responses to climate change in organisms with complex life histories: Evolution and plasticity in Pacific salmon.
- Crozier, L. G., R. W. Zabel, and A. F. Hamlet. 2008b. Predicting differential effects of climate change at the population level with life-cycle models of spring Chinook salmon. *Global Change Biology* 14(2):236–249.
- Dalton, M., P. W. Mote, and A. K. S. [Eds.]. 2013. *Climate Change in the Northwest, Implications for Our Landscapes, Waters, and Communities*. Washington, DC: Island Press. 271p.
- Deagle, B. E., and coauthors. 2005. Molecular scatology as a tool to study diet: analysis of prey DNA in scats from captive Steller sea lions. *Molecular Ecology* 14(6):1831–1842.
- Di Lorenzo, E., and N. Mantua. 2016. Multi-year persistence of the 2014/15 North Pacific marine heatwave. *Nature Climate Change*.
- Fisher, J. L., W. T. Peterson, and R. R. Rykaczewski. 2015. The impact of El Niño events on the pelagic food chain in the northern California Current. *Global Change Biology* 21(12):4401–4414.
- Ford, J. K. B., and G. M. Ellis. 2006. Selective foraging by fish-eating killer whales *Orcinus orca* in British Columbia. *Marine Ecology Progress Series* 316:185–199.
- Ford, J. K. B., G. M. Ellis, and K. C. Balcomb. 2000. *Killer Whales: The Natural History and Genealogy of *Orcinus orca* in British Columbia and Washington State*. Vancouver, British Columbia, UBC Press, 2nd Edition.
- Ford, J. K. B., and coauthors. 1998. Dietary specialization in two sympatric populations of killer whales (*Orcinus orca*) in coastal British Columbia and adjacent waters. *Canadian Journal of Zoology* 76(8):1456-1471.
- Ford, M. J., and coauthors. 2011. Status Review Update for Pacific Salmon and Steelhead Listed Under the Endangered Species Act: Pacific Northwest. November 2011. U.S. Dept. Commer., NOAA Tech. Memo., NMFS-NWFSC-113. 307p.
- Ford, M. J., and coauthors. 2016. Estimation of a killer whale (*Orcinus orca*) population's diet using sequencing analysis of DNA from feces. *PLoS ONE* 11(1):1-14.
- Foreman, M. G. G., W. Callendar, D. Masson, J. Morrison, and I. Fine. 2014. A model simulation of future oceanic conditions along the British Columbia continental shelf. Part II: results and analyses. *Atmosphere-Ocean* 52(1):20-38.
- Fritts, A. L., G. M. Temple, C. Lillquist, and D. Rawding. 2016. Post-Release Survival of Yakima River Spring Chinook Salmon Associated with a Mark-Selective Fishery. WDFW, Olympia, Washington. 22p.
- Gale, M. K., S. G. Hinch, and M. R. Donaldson. 2013. The role of temperature in the capture and release of fish. *Fish and Fisheries* 14(1):1-33.

- Gargett, A. E. 1997. The optimal stability 'window': a mechanism underlying decadal fluctuations in North Pacific salmon stocks? *Fisheries Oceanography* 6(2):109-117.
- Good, T. P., R. S. Waples, and P. Adams. 2005. Updated Status of Federally Listed ESUs of West Coast Salmon and Steelhead. June 2005. U.S. Dept. of Commer., NOAA Tech. Memo., NMFS-NWFSC-66. 637p.
- Groves, P. A., and J. A. Chandler. 1999. Spawning habitat used by fall Chinook salmon in the Snake River. *North American Journal of Fisheries Management* 19(4):912-922.
- Haigh, R., D. Ianson, C. A. Holt, H. E. Neate, and A. M. Edwards. 2015. Effects of ocean acidification on temperate coastal marine ecosystems and fisheries in the Northeast Pacific. *PLoS ONE* 10(2):e0117533.
- Hanson, M. B., and C. K. Emmons. 2010. Annual Residency Patterns of Southern Resident Killer Whales in the Inland Waters of Washington and British Columbia. Revised Draft - 30 October 10. 11p.
- Hanson, M. B., C. K. Emmons, E. J. Ward, J. A. Nystuen, and M. O. Lammers. 2013. Assessing the coastal occurrence of endangered killer whales using autonomous passive acoustic recorders. *The Journal of the Acoustical Society of America* 134(5):3486-3495.
- Hard, J. J., and coauthors. 2008. Evolutionary consequences of fishing and their implications for salmon. *Evolutionary Applications* 1:338-408.
- Hatch, D. R., and coauthors. 2017. Kelt Reconditioning and Reproductive Success Evaluation Research. Project Number 2007-401-00. January, 2016 - December, 2016. January 2017. CRITFC, Portland, Oregon. 113p.
- Hauser, D. D. W., M. G. Logsdon, E. E. Holmes, G. R. VanBlaricom, and R. W. Osborne. 2007. Summer distribution patterns of Southern Resident Killer Whales *Orcinus orca*: core areas and spatial segregation of social groups. *Marine Ecology Progress Series* 351:301-310.
- Healey, M. C. 1991. Life History of Chinook Salmon (*Oncorhynchus tshawytscha*). In C. Groot and L. Margolis (eds.), *Life history of Pacific Salmon*, pages 311-393. University of British Columbia Press. Vancouver, B.C. 89p.
- Hilborn, R., and coauthors. 2012. The Effects of Salmon Fisheries on Southern Resident Killer Whales: Final Report of the Independent Science Panel. November 30, 2012. Prepared with the assistance of D.R. Marmorek and A.W. Hall, ESSA Technologies Ltd., Vancouver, B.C. for NMFS, Seattle, Washington and Fisheries and Oceans Canada (Vancouver. BC). 87p.
- Hollowed, A. B., and coauthors. 2009. A framework for modelling fish and shellfish responses to future climate change. *ICES Journal of Marine Science* 66:1584-1594.
- Horton, G. 1994. Effects of jet boats on salmonid reproduction in Alaskan streams. Master's thesis. University of Alaska, Fairbanks, Alaska.
- HSRG. 2014. On the Science of Hatcheries: An updated perspective on the role of hatcheries in salmon and steelhead management in the Pacific Northwest. June 2014, (updated October 2014). 160p.
- ICTRT. 2007. Viability Criteria for Application to Interior Columbia Basin Salmonid ESUs. Review draft. March 2007. 93p.
- IDEQ. 2001. Middle Salmon River-Panther Creek Subbasin Assessment and TMDL. Idaho Department of Environmental Quality, Boise, Idaho. 114p
- IDEQ. 2003. Idaho Department of Environmental Quality and U.S. Environmental Protection Agency. 2003. South Fork Clearwater River Subbasin Assessment and Total Maximum Daily Loads. IDEQ, Boise, Idaho. 680p.

- IDEQ. 2014. Idaho's 2012 Integrated Report. January 2014. Idaho Department of Environmental Quality, Boise, Idaho.
- IDFG. 2015. Chinook and Steelhead Genotyping for Genetic Stock Identification at Lower Granite Dam. IDFG Report Number 15-02. January 2015. Annual Progress Report - January 1, 2014 - December 31, 2014. IDFG, Boise, Idaho. 69p.
- IDFG. 2018a. Fall Chinook esp to and abv LGR summary excel report. December 7, 2018.
- IDFG. 2018b. Fisheries Management and Evaluation Plan submitted under ESA Section 4(d). Updated 2018. IDFG Recreational Steelhead Fisheries. IDFG, Boise, Idaho. 32p.
- IDFG. 2019a. Fisheries Management and Evaluation Plan for the State of Idaho Coho salmon Sport Fishery. May 2019. IDFG, Boise, Idaho. 20p.
- IDFG. 2019b. Fisheries Management and Evaluation Plan, Submitted Under the 4(d) Rule Limit 4. Fishery Management and Evaluation Plan for the State of Idaho, Washington, and Oregon Anadromous Fish Species Sport Fishing Programs for Directed Adipose-Intact Fall Chinook Salmon Fisheries. April 2019. 27p.
- IDFG. 2019c. Idaho Department of Fish and Game response to comments on Recreational Steelhead Fisheries Monitoring and Evaluation Plan (FMEP). February 8, 2019. 26p.
- ISAB. 2003. ISAB Review of Salmon and Steelhead Supplementation. ISAB 2003-3 Supplementation Report. 120p.
- ISAB. 2007. Climate Change Impacts on Columbia River Basin Fish and Wildlife. May 11, 2007. Report ISAB 2007-2. Northwest Power and Conservation Council, Portland, Oregon. 146p
- Jones Jr., R. P. 2015. Memorandum to Chris Yates from Rob Jones 2015 5-Year Review - Listing Status under the Endangered Species Act for Hatchery Programs Associated with 28 Salmon Evolutionarily Significant Units and Steelhead Distinct Population Segments. September 28, 2015. NMFS West Coast Region, Sustainable Fisheries Division, Portland, Oregon. 54p.
- Jones, K. K., T. J. Cornwell, D. L. Bottom, L. A. Campbell, and S. Stein. 2014. The contribution of estuary-resident life histories to the return of adult *Oncorhynchus kisutch*. *Journal of Fish Biology* 85(1):52-80.
- Jonsson, B., and N. Jonsson. 2009. Review Paper - A review of the likely effects of climate change on anadromous Atlantic salmon *Salmo salar* and brown trout *Salmo trutta*, with particular reference to water temperature and flow. *Journal of Fish Biology* 75(10):2381–2447.
- Kennedy, V. S. 1990. Anticipated effects of climate change on estuarine and coastal fisheries. *Fisheries* 15(6):16-24.
- Kirwan, M. L., and coauthors. 2010. Limits on the adaptability of coastal marshes to rising sea level. *Geophysical Research Letters* 37(23).
- Krahn, M. M., and coauthors. 2004. 2004 Status Review of Southern Resident Killer Whales (*Orcinus orca*) under the Endangered Species Act. December 2004. U.S. Dept. Commer., NOAA Tech. Memo., NMFS-NWFSC-62. NMFS, Seattle, Washington. 95p.
- Krahn, M. M., and coauthors. 2009. Effects of age, sex and reproductive status on persistent organic pollutant concentrations in “Southern Resident” killer whales. *Marine Pollution Bulletin* 58(10):1522–1529.
- Krahn, M. M., and coauthors. 2002. Status Review of Southern Resident Killer Whales (*Orcinus orca*) under the Endangered Species Act. December 2002. U.S. Dept. Commer., NOAA Tech. Memo., NMFS-NWFSC-54. 159p.

- Lacy, R. C., and coauthors. 2017. Evaluating anthropogenic threats to endangered killer whales to inform effective recovery plans. *Scientific Reports* 7(1):1-12.
- Laufle, J. C., G. B. Pauley, and M. F. Shepard. 1986. Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (Pacific Northwest) - coho salmon. TR EL-82-4. U.S. Fish and Wildlife Service. Biol. Rep. 82(11.48).
- Lemmen, D. S., F. J. Warren, T. S. James, and C. S. L. M. Clarke. 2016. Canada's Marine Coasts in a Changing Climate; Government of Canada, Ottawa, Ontario. 280p.
- Lewin, W.-C., R. Arlinghaus, and T. Mehner. 2006. Documented and potential biological impacts of recreational fishing: Insights for management and conservation. *Reviews in Fisheries Science* 14:305–367.
- Limburg, K., and coauthors. 2016. Round-the-Coast: snapshots of estuarine climate change effects. *Fisheries* 41(7):392-394.
- Lindsay, R. B., R. K. Schroeder, K. R. Kenaston, R. N. Toman, and M. A. Buckman. 2004. Hooking mortality by anatomical location and its use in estimating mortality of spring Chinook salmon caught and released in a river sport fishery. *North American Journal of Fisheries Management* 24:367-378.
- Litz, M. N. C., A. J. Phillips, R. D. Brodeur, and R. L. Emmett. 2011. Seasonal occurrences of Humboldt Squid (*Dosidicus Gigas*) in the northern California current system. *CalCOFI Rep* 52: 97-108.
- Lucey, S. M., and J. A. Nye. 2010. Shifting species assemblages in the Northeast US continental shelf large marine ecosystem. *Marine Ecology Progress Series* 415:23-33.
- Lynch, A. J., and coauthors. 2016. Climate Change Effects on North American Inland Fish Populations and Assemblages. *Fisheries* 41(7):346-361.
- Magnuson, J. J., L. B. Crowder, and P. A. Medvick. 1979. Temperature as an ecological resource. *American Zoologist* 19:331-343.
- Mantua, N. J., S. R. Hare, Y. Zhang, J. M. Wallace, and R. C. Francis. 1997. A Pacific interdecadal climate oscillation with impacts on salmon production. *Bulletin of the American Meteorological Society* 78(6):1069-1079.
- Martins, E. G., S. G. Hinch, S. J. Cooke, and D. A. Patterson. 2012. Climate effects on growth, phenology, and survival of sockeye salmon (*Oncorhynchus nerka*): a synthesis of the current state of knowledge and future research directions. *Reviews in Fish Biology and Fisheries* 22(4):887-914.
- Martins, E. G., and coauthors. 2011. Effects of river temperature and climate warming on stock-specific survival of adult migrating Fraser River sockeye salmon (*Oncorhynchus nerka*). *Global Change Biology* 17(1):99-114.
- Mathis, J. T., and coauthors. 2015. Ocean acidification risk assessment for Alaska's fishery sector. *Progress in Oceanography* 136:71-91.
- McClure, M., T. Cooney, and ICTRT. 2005. Memorandum to NMFS NW Regional Office, Co-managers and other interested parties. May 11, 2005. Updated population delineation in the interior Columbia Basin. 14p.
- McElhany, P., and coauthors. 2006. Revised Viability Criteria for Salmon and Steelhead in the Willamette and Lower Columbia Basins. Review Draft. April 1, 2006. 178p.
- McElhany, P., M. H. Ruckelshaus, M. J. Ford, T. C. Wainwright, and E. P. Bjorkstedt. 2000. Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units. U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC-42. 174p.

- Meredith, C., and coauthors. 2012. PIBO Effectiveness Monitoring Program for Streams and Riparian Areas. USDA Forest Service. 2012 Annual Summary Report. 49p.
- Morris, J. F. T., and coauthors. 2007. Stock-specific migrations of juvenile coho salmon derived from coded-wire tag recoveries on the continental shelf of Western North America. *American Fisheries Society Symposium* 57:81.
- Morrison, W. E., M. W. Nelson, R. B. Griffis, and J. A. Hare. 2016. Methodology for assessing the vulnerability of marine and anadromous fish stocks in a changing climate. *Fisheries* 41(7):407-409.
- Mote, P. W., and coauthors. 2003. Preparing for climatic change: the water, salmon, and forests of the Pacific Northwest. *Climatic change* 61(1-2):45-88.
- Muoneke, M. I., and W. M. Childress. 1994. Hooking mortality: A review for recreational fisheries. *Reviews in Fisheries Science* 2(2):123-156.
- Myers, J. M., and coauthors. 1998. Status Review of Chinook Salmon from Washington, Idaho, Oregon, and California. February 1998. U.S. Dept. Commer., NOAA Tech Memo., NMFS-NWFSC-35. 476p.
- Naiman, R. J., and coauthors. 2012. Developing a broader scientific foundation for river restoration: Columbia River food webs *PNAS* 109(52):21201–21207.
- Nez Perce Tribe. 2018. Nez Perce Tribe Tributary Harvest Plan for Snake River Summer Steelhead, Fall Chinook, and Coho Salmon in the Snake River Basin. November 2018. 38p.
- NMFS. 2005a. Appendix A CHART assessment for the Puget Sound salmon evolutionary significant unit from final assessment of NOAA Fisheries' Critical Habitat Analytical Review Teams for 12 ESUs of West Coast salmon and steelhead. August 2005. 55p.
- NMFS. 2005b. Final assessment of NOAA Fisheries' Critical Habitat Analytical Review Teams for 12 Evolutionarily Significant Units of West Coast Salmon and Steelhead. NMFS NWR Protected Resources Division, Portland, Oregon. 587p.
- NMFS. 2005c. Policy on the consideration of hatchery-origin fish in Endangered Species Act listing determinations for Pacific salmon and steelhead. Pages 37204-37216 in D. o. Commerce, editor. *Federal Register*, Volume 70 No. 123.
- NMFS. 2008. Recovery Plan for Southern Resident Killer Whales (*Orcinus orca*). National Marine Fisheries Service, Seattle, Washington. 251p.
- NMFS. 2011a. 5-Year Review: Summary & Evaluation of Snake River Sockeye, Snake River Spring/Summer Chinook, Snake River Fall-run Chinook, Snake River Basin Steelhead. NMFS, Portland, Oregon. 65p.
- NMFS. 2011b. Columbia River Estuary ESA Recovery Plan Module for Salmon and Steelhead. January 2011. NMFS, Northwest Region. 260p.
- NMFS. 2011c. Endangered Species Act Section 7 Consultation Biological Opinion and Magnuson-Stevens Act Essential Fish Habitat Consultation: Approval of two Fishery Management and Evaluation Plans (FMEP) describing Recreational Fisheries proposed by the Idaho Department of Fish and Game. April 19, 2011.
- NMFS. 2012. Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. Snake River Fall Chinook Salmon Hatchery Programs, ESA section 10(a)(1)(A) permits, numbers 16607 and 16615. October 9, 2012. NMFS, Portland, Oregon. NMFS Consultation No.: NWR-2011-03947 and NWR-2011-03948. 175p.

- NMFS. 2013a. Endangered Species Act Section 7 Consultation Biological Opinion and Magnuson-Stevens Act Essential Fish Habitat Consultation-Biological Opinion on the Effects of the three Tribal Resource Management Plans and two Fishery Management and Evaluation Plans on Snake River Chinook Salmon and Steelhead Species Listed Under the Endangered Species Act. June 25, 2013. NMFS, Seattle, Washington. 58p.
- NMFS. 2013b. Endangered Species Act Section 7(a)(2) Biological Opinion, Section 7(a)(2) Not Likely to Adversely Affect Determination, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. September 28, 2013. Snake River Sockeye Salmon Hatchery Program. NMFS Consultation No.: NWR-2013-10541. 90p.
- NMFS. 2013c. ESA Recovery Plan for Lower Columbia River coho salmon, Lower Columbia River Chinook salmon, Columbia River chum salmon, and Lower Columbia River steelhead. June 2013. 503p.
- NMFS. 2014. Final Environmental Impact Statement to inform Columbia River Basin Hatchery Operations and the Funding of Mitchell Act Hatchery Programs. West Coast Region. National Marine Fisheries Service. Portland, Oregon.
- NMFS. 2015. ESA Recovery Plan for Snake River Sockeye Salmon (*Oncorhynchus nerka*). June 8, 2015. NMFS, West Coast Region. 431p.
- NMFS. 2016a. Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation Six Lower Snake River Spring/Summer Chinook Salmon Hatchery Programs. June 24, 2016. NMFS Consultation No.: WCR-2013-21. 142p.
- NMFS. 2016b. Southern Resident Killer Whales (*Orcinus orca*) 5-Year Review: Summary and Evaluation. December 2016. NMFS, West Coast Region, Seattle, Washington. 74p.
- NMFS. 2017a. Endangered Species Act Section 7 Consultation Biological Opinion. Four Salmon River Basin Spring/Summer Chinook Salmon Hatchery Programs in the Upper Salmon River Basin. NMFS Consultation No.: WCR 2017-7432.
- NMFS. 2017b. Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. Four Lower Snake River Steelhead Hatchery Programs. July 11, 2017. NMFS Consultation No.: WCR-2017-6358. 134p.
- NMFS. 2017c. Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. NOAA's National Marine Fisheries Service's implementation of the Mitchell Act Final Environmental Impact Statement preferred alternative and administration of Mitchell Act hatchery funding. January 15, 2017. NMFS Consultation No.: WCR-2014-697. 535p.
- NMFS. 2017d. ESA Recovery Plan for Snake River Fall Chinook Salmon (*Oncorhynchus tshawytscha*). November 2017. NMFS, West Coast Region, Portland, Oregon. 366p.
- NMFS. 2017e. ESA Recovery Plan for Snake River Spring/Summer Chinook Salmon (*Oncorhynchus tshawytscha*) & Snake River Basin Steelhead (*Oncorhynchus mykiss*). November, 2017. NMFS, West Coast Region, Portland, Oregon. 284p.
- NMFS. 2017f. Final Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. Five Snake River Basin Spring/Summer Chinook Salmon Hatchery Programs. November 27, 2017. NMFS Consultation No.: WCR-2017-7319. 152p.

- NMFS. 2017g. Final Endangered Species Act Section 7 Consultation Biological Opinion. December 12, 2017. Five Clearwater River Basin Spring/Summer Chinook Salmon and Coho Salmon Hatchery Programs. NMFS Consultation No.: WCR-2017-7303. 145p.
- NMFS. 2017h. Final Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. December 12, 2017. Nine Snake River Steelhead Hatchery Programs and one Kelt Reconditioning Program in Idaho. NMFS Consultation No.: WCR-2017-7286. 139p.
- NMFS. 2018a. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. Snake River Fall Chinook Salmon Hatchery Programs, ESA section 10(a)(1)(A) permits, numbers 16607–2R and 16615–2R. September 13, 2018. NMFS Consultation Numbers: WCR-2018-9988. 163p.
- NMFS. 2018b. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response. Consultation on effects of the 2018-2027 *U.S. v. Oregon* Management Agreement. February 23, 2018. NMFS Consultation No.: WCR-2017-7164. 597p.
- 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.
- NPT. 2019. Memo to Dave Johnson (NPT) from William Young. Clearwater River fall Chinook redd distribution and timing. Nez Perce Tribe, Lapwai, ID. August 14, 2019. 2p.
- NWFSC. 2015. Status Review Update for Pacific Salmon and Steelhead listed under the Endangered Species Act: Pacific Northwest. December 21, 2015. NWFSC, Seattle, Washington. 356p.
- Oatman, J. 2017. NPT Steelhead-Fall Chinook estimates_NPT_7-25-17 excel report.
- Oatman, J. 2019. Addendum to the tribe's TRMP for steelhead, fall Chinook and coho salmon fisheries in the Snake River Basin: Nez Perce Tribe Points on Conservation Measures and the Harvest Sliding Scale to Use to Benefit Snake River Fall Chinook. May 10, 2019. 3p.
- ODFW. 2019. ODFW Resident Trout and Coho salmon Fisheries in the Grande Ronde, Imnaha, and Snake Rivers FMEP. ODFW, La Grande, Oregon. 22p.
- Pearcy, W. G. 2002. Marine nekton off Oregon and the 1997–98 El Niño. *Progress in Oceanography* 54(1):399-403.
- Pearcy, W. G., and S. M. McKinnell. 2007. The ocean ecology of salmon in the Northeast Pacific Ocean - An abridged history. *American Fisheries Society Symposium* 57:7-30.
- Peterson, W. T., and coauthors. 2014. Applied fisheries oceanography: Ecosystem indicators of ocean conditions inform fisheries management in the California current. *Oceanography* 27(4):80-89.
- PFMC. 2003. Pacific Coast Management Plan. Fishery Management Plan for Commercial and Recreational Salmon Fisheries off the coasts of Washington, Oregon and California as revised through Amendment 14. (Adopted March 1999). September 2003. PFMC, Portland, Oregon. 78p.
- PFMC. 2014. Appendix A to the Pacific Coast Salmon Fishery Management Plan as modified by Amendment 18 to the Pacific Coast Salmon Plan: Identification and description of essential fish habitat, adverse impacts, and recommended conservation measures for

- salmon. Pacific Fishery Management Council, Portland, Oregon. September 2014. 227 pages including appendices. Appendix A is available online at: http://www.pcouncil.org/wp-content/uploads/Salmon_EFH_Appendix_A_FINAL_September-25.pdf.
- Poesch, M. S., L. Chavarie, C. Chu, S. N. Pandit, and W. Tonn. 2016. Climate change impacts on freshwater fishes: a Canadian perspective. *Fisheries* 41(1):385-391.
- Rehage, J. S., and J. R. Blanchard. 2016. What can we expect from climate change for species invasions? *Fisheries* 41(7):405-407.
- Richter, A., and S. A. Kolmes. 2005. Maximum temperature limits for Chinook, coho, and chum salmon, and steelhead trout in the Pacific Northwest. *Reviews in Fisheries Science* 13(1):23-49.
- Rykaczewski, R. R., and coauthors. 2015. Poleward displacement of coastal upwelling-favorable winds in the ocean's eastern boundary currents through the 21st century. *Geophysical Research Letters* 42(15):6424–6431.
- Satterthwaite, T. D. 1995. Effects of Boat Traffic on Juvenile Salmonids in the Rogue River: Completion Report. Oregon Department of Fish and Wildlife.
- Scheuerell, M. D., and J. G. Williams. 2005. Forecasting climate-induced changes in the survival of Snake River spring/summer Chinook salmon (*Oncorhynchus tshawytscha*). *Fisheries Oceanography* 14(6):448-457.
- Shapovalov, L., and A. C. Taft. 1954. The Life Histories of the Steelhead Rainbow Trout (*Salmo gairdneri*) and Silver Salmon (*Oncorhynchus kisutch*) with special reference to Waddell Creek, California, and Recommendations Regarding Their Management. California Department of Fish and Game Fish Bulletin 98.
- Sharma, R. 2019. Evaluation of Alternative Harvest schedules proposed on the Snake River Fall Chinook. June 4, 2019. 8p.
- Sykes, G. E., C. J. Johnson, and J. M. Shrimpton. 2009. Temperature and flow effects on migration timing of Chinook salmon smolts. *Transactions of the American Fisheries Society* 138(6):1252–1265.
- Thurrow, R. 1987. Evaluation of South Fork Salmon River steelhead trout fishery restoration program. Idaho Fish and Game Department and U.S. Fish and Wildlife Service, completion report. Boise, Idaho.
- USFWS. 2017. U.S. Fish and Wildlife Service-Lower Snake River Compensation Plan Office, editor. 2017. Proceedings of the Snake River fall Chinook Symposium May 16th and 17th, 2017, Clarkston, Washington. <https://www.fws.gov/lsnakecomplan/Meetings/2017FallChinookSymposium.html> (Accessed 11/14/2017). 103p.
- Verdonck, D. 2006. Contemporary vertical crustal deformation in Cascadia. *Tectonophysics* 417(3):221-230.
- Wainwright, T. C., and L. A. Weitkamp. 2013. Effects of climate change on Oregon Coast coho salmon: habitat and life-cycle interactions. *Northwest Science* 87(3):219-242.
- Waples, R. S., T. Beechie, and G. R. Pess. 2009. Evolutionary history, habitat disturbance regimes, and anthropogenic changes: What do these mean for resilience of Pacific Salmon populations? *Ecology and Society* 14(1).
- Ward, E. J., J. H. Anderson, T. J. Beechie, G. R. Pess, and M. J. Ford. 2015. Increasing hydrologic variability threatens depleted anadromous fish populations. *Global Change Biology*.

- Ward, E. J., and coauthors. 2013. Estimating the Impacts of Chinook Salmon Abundance and Prey Removal by Ocean Fishing on Southern Resident Killer Whale Population Dynamics. July 2013. U.S. Dept. Commer., NOAA Tech. Memo., NMFS-NWFSC-123. 85p.
- Wasser, S. K., and coauthors. 2017. Population growth is limited by nutritional impacts on pregnancy success in endangered Southern Resident killer whales (*Orcinus orca*). PLoS ONE 12(6):1-22.
- Weitkamp, L., and K. Neely. 2002. Coho salmon (*Oncorhynchus kisutch*) ocean migration patterns: insight from marine coded-wire tag recoveries. Canadian Bulletin of Fisheries and Aquatic Sciences 59(7):1100–1115.
- Weitkamp, L. A. 2010. Marine distributions of Chinook salmon from the west coast of North America determined by coded wire tag recoveries. American Fisheries Society 139(1):147-170.
- Whitney, J. E., and coauthors. 2016. Physiological basis of climate change impacts on North American inland fishes. Fisheries 41(7):332-345.
- Wiles, G. J. 2004. Washington State Status Report for the Killer Whale. March 2004. WDFW, Olympia, Washington. 120p.
- Yamada, S. B., W. T. Peterson, and P. M. Kosro. 2015. Biological and physical ocean indicators predict the success of an invasive crab, *Carcinus maenas*, in the northern California Current. Marine Ecology Progress Series 537:175-189.
- Zabel, R. W., M. D. Scheuerell, M. M. McClure, and J. G. Williams. 2006. The interplay between climate variability and density dependence in the population viability of Chinook salmon. Conservation Biology 20(1):190-200.
- Zamon, J. E., T. J. Guy, K. Balcomb, and D. Ellifrit. 2007. Winter observations of Southern Resident Killer Whales (*Orcinus orca*) near the Columbia River plume during the 2005 spring Chinook salmon (*Oncorhynchus tshawytscha*) spawning migration. Northwestern Naturalist 88(3):193-198.