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

NMFS Consultation Number: WCR-2017-7319

Action Agencies: National Marine Fisheries Service (NMFS)
U.S. Fish and Wildlife Service (USFWS) through the Lower Snake River Compensation Plan (LSRCP)
Bonneville Power Administration (BPA)

Program Operators: Idaho Department of Fish and Game (IDFG)
Nez Perce Tribe (NPT)
Shoshone-Bannock Tribes (SBT)

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?
Snake River spring/summer Chinook salmon (*Oncorhynchus tshawytscha*)	Threatened	Yes	No	No
Snake River steelhead (*O. mykiss*)	Threatened	Yes	No	No
Snake River fall Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	No
Snake River sockeye salmon (*O. nerka*)	Endangered	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: ______________________

FOR Barry A. Thom
Regional Administrator

Date: 11/27/2017

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1. INTRODUCTION

Pursuant to section 4(d) of the Endangered Species Act and associated regulations at 50 CFR 223.203(b)(6), the National Marine Fisheries Service (NMFS) is reviewing a series of salmonid hatchery programs to determine whether the programs meet the regulatory requirements, including a finding that they will not appreciably reduce the likelihood of survival and recovery of threatened salmon or steelhead. If NMFS finds that the requirements are met, the prohibitions of ESA §9 will not apply to the take by the hatchery programs of threatened salmonids.

NMFS describes a hatchery program as a group of fish that have a separate purpose and that may have independent spawning, rearing, marking, and release strategies (NMFS 2008a). The operation and management of every hatchery program is unique in time, and specific to an identifiable stock and its native habitat (Flagg et al. 2004)). NMFS defines integrated hatchery programs as those that are reproductively connected or "integrated" with a natural population, promote natural selection over artificial selection in the hatchery, and contain genetic resources that represent the ecological and genetic diversity of a species.

The underlying activities that drive the Proposed Actions are the operation and maintenance of five hatchery programs rearing and releasing Snake River spring/summer Chinook salmon in the Snake River basin. The hatchery programs are operated by Federal, state, and/or tribal agencies as described in Table 1 and Table 2. Programs are described in detail in Hatchery and Genetic Management Plans (HGMPs) (some have been updated in supplementary material in the form of addendums), which were submitted to NMFS for review.

Table 1. Programs included in the Proposed Action and ESA coverage pathway requested.

Program	HGMP Receipt[1]	Program Operator[2]	Funding Agency	Program Type and Purpose	ESA Pathway
Little Salmon River Basin, Spring Chinook Salmon (Rapid River Fish Hatchery)	October 2016	IDFG	IPC	Segregated Harvest	4(d) Limit 6
Hells Canyon, Snake River Spring Chinook Salmon	October 2016	IDFG	IPC	Segregated Harvest	4(d) Limit 6
South Fork Salmon River Summer Chinook	March 2017	IDFG	LSRCP[3]	Integrated Recovery and Segregated Harvest	4(d) Limit 6
Johnson Creek Artificial Propagation Enhancement Project	February 2017	NPT	BPA	Integrated Recovery	4(d) Tribal Rule
South Fork Chinook Eggbox Project	June 2010	SBT	TBD[4]	Segregated Harvest with potential for being Integrated Recovery	4(d) Tribal Rule

[1]Most recent HGMP receipt (IDFG 2016b; IDFG 2016c; IDFG 2017d; NPT 2017; SBT 2017; SBT and IDFG 2010). Many HGMPs have been previously submitted and updated.
[2]Primary operators are listed, but all programs are coordinated between Idaho, Tribes, and Federal agencies collectively. Operators are: Idaho Fish and Game (IDFG), Nez Perce Tribe (NPT), Shoshone-Bannock Tribes (SBT), United States Fish and Wildlife Service (USFWS), Bonneville Power Administration (BPA), and Idaho Power Company (IPC)
[3]The United States Fish and Wildlife Service (USFWS) is the funding agency through the Lower Snake River Compensation Plan (LSRCP)
[4]BPA and LSRCP have funded this program (previously the Dollar Creek Eggbox Program) in past years. Future funding for the South Fork Chinook Eggbox Program is TBD (to be determined).

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 actions proposed by NMFS, the United States Fish and Wildlife Service (USFWS), and Bonneville Power Administration (BPA).

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). The document will be available through NMFS' Public Consultation Tracking System. A complete record of this consultation is on file at the Sustainable Fisheries Division (SFD) of NMFS in Portland, Oregon.

1.2. Consultation History

The first hatchery consultations in the Columbia Basin followed the first listings of Columbia Basin salmon under the Endangered Species Act (ESA). Snake River sockeye salmon were listed as an endangered species on November 20, 1991, Snake River spring/summer Chinook salmon and Snake River fall Chinook salmon were listed as threatened species on April 22, 1992, and the first hatchery consultation and opinion was completed on April 7, 1994 (NMFS 1994). The 1994 opinion was superseded by "Endangered Species Act Section 7 Biological Opinion on 1995-1998 Hatchery Operations in the Columbia River Basin, Consultation Number 383" completed on April 5, 1995 (NMFS 1995). This opinion determined that hatchery actions jeopardize listed Snake River salmon and required implementation of reasonable and prudent alternatives (RPAs) to avoid jeopardy.

A new opinion was completed on March 29, 1999, after Upper Columbia River (UCR) steelhead were listed under the ESA (62 FR 43937, August 18, 1997) and following the expiration of the previous opinion on December 31, 1998 (NMFS 1999). That opinion concluded that Federal and non-Federal hatchery programs jeopardize Lower Columbia River (LCR) steelhead and Snake River steelhead protected under the ESA and described RPAs necessary to avoid jeopardy. Those measures and conditions included restricting the use of non-endemic steelhead for hatchery broodstock and limiting stray rates of non-endemic salmon and steelhead to less than 5% of the annual natural population in the receiving stream. Soon after, NMFS reinitiated consultation when LCR Chinook salmon, UCR spring Chinook salmon, Upper Willamette Chinook salmon, Upper Willamette steelhead, Columbia River chum salmon, and Middle Columbia steelhead were added to the list of endangered and threatened species (Smith 1999).

Between 1991 and the summer of 1999, the number of distinct groups of Columbia Basin salmon and steelhead listed under the ESA increased from 3 to 12, and this prompted NMFS to reassess its approach to hatchery consultations. In July 1999, NMFS announced that it intended to conduct five consultations and issue five opinions "instead of writing one biological opinion on all hatchery programs in the Columbia River Basin" (Smith 1999). Opinions would be issued for hatchery programs in the (1) Upper Willamette, (2) Middle Columbia River (MCR), (3) LCR, (4) Snake River, and (5) UCR, with the UCR NMFS' first priority (Smith 1999). Between August 2002 and October 2003, NMFS completed consultations under the ESA for approximately twenty hatchery programs in the UCR. For the MCR, NMFS completed a draft opinion, and distributed it to hatchery operators and to funding agencies for review on January 4, 2001, but completion of consultation was put on hold pending several important basin-wide review and planning processes.

The increase in ESA listings during the mid to late 1990s triggered a period of investigation, planning, and reporting across multiple jurisdictions and this served to complicate, at least from a resources and scheduling standpoint, hatchery consultations. A review of Federal funded hatchery programs ordered by Congress was underway at about the same time that the 2000

Federal Columbia River Power System (FCRPS) opinion was issued by NMFS (NMFS 2000). The Northwest Power and Conservation Council (Council) was asked to develop a set of coordinated policies to guide the future use of artificial propagation, and RPA 169 of the FCRPS opinion called for the completion of NMFS-approved hatchery operating plans (i.e., HGMPs) by the end of 2003. The RPA required the Action Agencies to facilitate this process, first by assisting in the development of HGMPs, and then by helping to implement identified hatchery reforms. Also at this time, a new *U.S. v. Oregon* Columbia River Fisheries Management Plan (CRFMP), which included goals for hatchery management, was under negotiation and new information and science on the status and recovery goals for salmon and steelhead was emerging from Technical Recovery Teams (TRTs). Work on HGMPs under the FCRPS opinion was undertaken in cooperation with the Council's Artificial Production Review and Evaluation process, with CRFMP negotiations, and with ESA recovery planning (Foster 2004; Jones Jr. 2002). HGMPs were submitted to NMFS under RPA 169; however, many were incomplete and, therefore, were not found to be sufficient for ESA consultation.

ESA consultations and an opinion were completed in 2007 for nine hatchery programs that produce a substantial proportion of the total number of salmon and steelhead released into the Columbia River annually. These programs are located in the LCR and MCR and are operated by the USFWS and by the Washington Department of Fish and Wildlife (WDFW). NMFS' opinion (NMFS 2007a) determined that operation of the programs would not jeopardize salmon and steelhead protected under the ESA.

On May 5, 2008, NMFS published a Supplemental Comprehensive Analysis (SCA) (NMFS 2008e) and an opinion and RPAs for the FCRPS to avoid jeopardizing ESA-listed salmon and steelhead in the Columbia Basin (NMFS 2008c). The SCA environmental baseline included "the past effects of hatchery operations in the Columbia River Basin. Where hatchery consultations have expired or where hatchery operations have yet to undergo ESA section 7 consultation, the effects of future operations cannot be included in the baseline. In some instances, effects are ongoing (e.g., returning adults from past hatchery practices) and included in this analysis despite the fact that future operations cannot be included in the baseline. The Proposed Action does not encompass hatchery operations per se, and therefore no incidental take coverage is offered through this biological opinion to hatcheries operating in the region. Instead, we expect the operators of each hatchery to address its obligations under the ESA in separate consultations, as required" (see NMFS 2008e, p. 5-40).

Because it was aware of the scope and complexity of ESA consultations facing the co-managers and hatchery operators, NMFS offered substantial advice and guidance to help with the consultations. In September 2008, NMFS announced its intent to conduct a series of ESA consultations and that "from a scientific perspective, it is advisable to review all hatchery programs (i.e., Federal and non-Federal) in the UCR affecting ESA-listed salmon and steelhead concurrently" (Walton 2008). In November 2008, NMFS expressed again, the need for re-evaluation of UCR hatchery programs and provided a "framework for ensuring that these hatchery programs are in compliance with the Federal Endangered Species Act" (Jones Jr. 2008). NMFS also "promised to share key considerations in analyzing HGMPs" and provided those materials to interested parties in February 2009 (Jones Jr. 2009).

On April 28, 2010 (Walton 2010), NMFS issued a letter to "co-managers, hatchery operators, and hatchery funding agencies" that described how NMFS "has been working with co-managers throughout the Northwest on the development and submittal of fishery and hatchery plans in compliance with the Federal ESA." NMFS stated, "In order to facilitate the evaluation of hatchery and fishery plans, we want to clarify the process, including consistency with *U.S. v. Oregon*, habitat conservation plans and other agreements…." With respect to "Development of Hatchery and Harvest Plans for Submittal under the ESA," NMFS clarified: "The development of fishery and hatchery plans for review under the ESA should consider existing agreements and be based on best available science; any applicable multiparty agreements should be considered, and the submittal package should explicitly reference how such agreements were considered. In the Columbia River, for example, the *U.S. v. Oregon* agreement is the starting place for developing hatchery and harvest plans for ESA review…."

Between 2010 and 2016, the hatchery operators and funders have submitted several drafts of HGMPS for the Little Salmon River Basin Spring Chinook Salmon (Rapid River Fish Hatchery), Hells Canyon Snake River Spring Chinook Salmon, South Fork Salmon River Summer Chinook, Johnson Creek Artificial Propagation Enhancement Project, and the South Fork Chinook Eggbox Project hatchery programs. Final HGMPs were submitted for formal review as described in Table 1. Once submitted, NMFS reviewed the HGMPs for sufficiency, and issued letters indicating that the HGMPs were sufficient for consultation (Jones 2017a; Jones 2017b; Purcell 2017). This consultation evaluates the effects of the hatchery programs on four ESU and DPSs of salmon and steelhead in the Snake River Basin under the ESA, and their designated critical habitat. It also evaluates the effects of the programs on Essential Fish Habitat (EFH) under the MSA.

1.3.Proposed Federal Action

"Action," as applied under the ESA, means all activities, of any kind, authorized, funded, or carried out, in whole or in part, by Federal agencies. For EFH consultation, "Federal action" means any on-going or proposed action authorized, funded, or undertaken by a Federal Agency (50 CFR 600.910). Because the actions of the Federal agencies are subsumed within the effects of the hatchery program, and any associated research, monitoring and evaluation, the details of each hatchery program are summarized in this section. 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.

NMFS describes a hatchery program as a group of fish that have a separate purpose and that may have independent spawning, rearing, marking and release strategies (NMFS 2008a). The operation and management of every hatchery program is unique in time, and specific to an identifiable stock and its native habitat (Flagg et al. 2004).

The objective of this opinion is to determine the likely effects on ESA-listed salmon and steelhead and their designated critical habitat resulting from operation of the five spring and summer Chinook salmon hatchery programs. The applicants and co-managers propose to wholly carry out all activities described in the five HGMPs (IDFG 2016c), (IDFG 2016b; IDFG 2017d) (NPT 2017; SBT and IDFG 2010). These five HGMPs include the Little Salmon River Basin

Spring Chinook Salmon (Rapid River), Hells Canyon Snake River Spring Chinook Salmon, the South Fork Salmon River Summer Chinook, Johnson Creek Artificial Propagation Enhancement (JCAPE), and the South Fork Chinook Eggbox Project (SFCEP) programs.

There are three federal Proposed Actions we are considering in this opinion:

- The Proposed Action for the Bonneville Power Administration (BPA) is the funding of the operation, maintenance, and monitoring and evaluation (M&E) of the JCAPE hatchery program[1].
- The Proposed Action for the U.S. Fish and Wildlife Service (USFWS) is the funding of the operation, maintenance, and monitoring and evaluation of the South Fork Salmon River Summer Chinook program and parts of the SFCEP hatchery program through the Lower Snake River Compensation Plan (LSRCP)
- The Proposed Action for NMFS is the approval of the Rapid River, Hells Canyon, South Fork Salmon River (SFSR), South Fork Chinook Eggbox Program (SFCEP), and Johnson Creek Artificial Propagation Enhancement (JCAPE) HGMPs under 4(d) of the ESA. NMFS' 4(d) determinations would allow operation of hatchery related activities for these programs.

This opinion will determine if the Proposed Actions comply with the provisions of Section 7(a)(2) of the ESA. The duration of the Proposed Action is unlimited from the date of Opinion completion.

Under the Pacific Northwest Electric Power Planning and Conservation Act of 1980, 16 U.S.C. §§ 839 *et seq.* (Northwest Power Act), BPA provides funding to protect, mitigate, and enhance fish and wildlife and their habitat affected by the development, operation, and management of federal hydroelectric facilities on the Columbia River and its tributaries. Under this authority, BPA funds operation and maintenance and M&E of the NPT's production of up to 100,000 spring/summer Chinook smolts under the JCAPE program.

The LSRCP Program was authorized by the Water Resources Development Act of 1976, (Public Law 94-587, Section 102, 94th Congress) to mitigate losses caused by the construction and operation of the four lower Snake River dams and navigation lock projects. The LSRCP Office funds and administers all or part of the McCall Fish Hatchery programs. This includes the operation, maintenance, and monitoring and evaluation of the South Fork Salmon River Summer Chinook program and the SFCEP (broodstock collection at McCall Fish Hatchery) hatchery programs.

Moreover, Idaho Power Company (IPC) agrees to funding activities to be undertaken by IDFG for the Little Salmon River Basin Spring Chinook Salmon (Rapid River Fish Hatchery) and the Hells Canyon Snake River Spring Chinook Salmon hatchery programs.

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[1] BPA funds the current production level of spring/summer chinook (up to 100,000 smolts) and M&E for the JCAPE program. BPA is analyzing NPT's proposed increase in production of 50,000 smolts (up to 150,000 smolts).

1.3.1. **Program Purpose and Type**

The purpose of the **Hells Canyon (HC)** and **Rapid River (RR)** hatchery programs are to mitigate for anadromous fish loss caused by the construction and operation of the Hells Canyon Complex (HCC) and provide harvest opportunity. The Hells Canyon Settlement Agreement calls for the program to trap sufficient numbers of adult Chinook salmon to permit the production of three million smolts annually. These hatchery operations and monitoring activities are funded by the Idaho Power Company.

The **South Fork Salmon River (SFSR)** program is designed to meet mitigation, harvest, and conservation objectives, and is part of the LSRCP, a congressionally mandated program pursuant to PL 99-662. The purpose of the LSRCP is to replace salmon and steelhead lost by construction and operation of four hydroelectric dams on the Lower Snake River. These hatchery operations and monitoring activities are funded through the LSRCP.

The **Johnson Creek Artificial Propagation Enhancement (JCAPE)** project is an integrated recovery program with the primary purpose of using indigenous stock to provide for the restoration of summer Chinook salmon in Johnson Creek. In years of abundant returns (i.e., when returns are in excess of broodstock needs for conservation/restoration purposes), the program also provides harvest opportunities. JCAPE is funded by BPA under the Northwest Power Act.

The **South Fork Chinook Eggbox Project (SFCEP)** was developed to increase adult returns of Chinook salmon to the South Fork Salmon River, by investigating low-cost artificial propagation techniques dealing with in-stream egg incubation.

1.3.2. **Proposed Hatchery Broodstock Collection Details**

Spring Chinook salmon broodstock for the **Rapid River** and **Hells Canyon** programs are primarily collected at an adult trap located on Rapid River, about 1.5 miles downstream from the Rapid River Fish Hatchery (RRFH). In most years, hatchery spring Chinook salmon are also trapped at Hells Canyon Dam to supplement these spring Chinook salmon programs. In the event that brood needs for Rapid River and Hells Canyon facilities cannot be met, Rapid River and Hells Canyon programs can be made up of excess Clearwater basin fish. In the event that Clearwater fish will be used in Rapid River and Hells Canyon brood, project operators will contact NMFS in advance for coordination as soon as operators anticipate there might be a shortage. We expect the need to use Clearwater broodstock to be a rare occurrence. The Oxbow Hatchery fish trap is 23 miles downstream of the Oxbow Fish Hatchery (OFH) on the Oregon shore of the Snake River immediately below Hells Canyon Dam. A weir that spans the South Fork Salmon River (SFSR) at River Mile (RM) 71 is used to collect broodstock for the **SFSR** and **SFCEP** programs. Adults are spawned at the SFSR facility and green eggs transported to McCall Fish Hatchery (MCFH) for incubation and rearing. The **JCAPE** program utilizes a temporary in-stream weir and trap to collect broodstock from Johnson Creek. Adults are transferred to holding facilities on the South Fork Salmon River and green eggs are transported to the MCFH for incubation and rearing. Please refer to Table 2 for additional information regarding broodstock collection.

Table 2. Broodstock collection and spawning details. SFSR = South Fork Salmon River; JCAPE = Johnson Creek Artificial Propagation and Enhancement Project; SFCEP = South Fork Chinook Eggbox Project; EFSFSR = East Fork of the South Fork Salmon River. NOR stands for Natural-Origin Return and HOR stands for Hatchery-Origin Return

Program	Broodstock collection for Snake River spring/summer Chinook salmon ESU						
	Component and Purpose	Population	Number and origin	Location(s) and method	Approximate timing	NMFS PNI or pHOS targets and pNOB[1]	Spawning
Rapid River	*Segregated harvest*	Little Salmon River	2,096 (1,048 pairs) HORs	Rapid and Snake Rivers; traps	Late-April through August	pHOS = 0 pNOB = 0	1:1 (F:M); spawning at RRFH
Hells Canyon	*Segregated harvest*	Little Salmon River	400 (200 pairs) HORs	Rapid and Snake Rivers; traps	Late-April through August	pHOS = 0 pNOB = 0	1:1 (F:M); spawning at RRFH
SFSR	*Segregated harvest*	SFSR	678 (339 pairs) HORs for SFSR program; 172 (86 pairs) HORs for the SFCEP 100% HORs (genetically linked with integrated); produce 300,000 eyed eggs; Up to 508 (254 pairs) for the Clearwater Summer Chinook program[2]	SFSR; weir	Late-June through early-September	SFSR population: PNI > 0.5 to PNI > 0.67 depending on NORs (sliding scale) Segregated component pHOS=0; pNOB=0	1:1 (F:M); spawning at MCFH (SFSR adult trap facility)
	Integrated conservation	SFSR	104 (52 pairs) NORs on a sliding scale[3]; produce 150,000 (up to 1 million) smolts	SFSR; weir	Late-June through early-September	SFSR population: PNI > 0.5 to PNI > 0.67 depending on NORs (sliding scale) pNOB = up to 90% (refer to Table 3 and Table 4)	
JCAPE	*Integrated recovery*	East Fork of the SFSR	104 (52 pairs)[4] NORs on a sliding scale[5]	Johnson Creek; picket weir	June through September	EFSFSR population: PNI > 0.67 pNOB = 100%	1:1 (F:M); spawning at MCFH (SFSR adult trap facility)

SFCEP	*Segregated recovery*	SFSR	see SFSR	N/A	N/A	SFSR population: PNI > 0.5 to PNI > 0.67 depending on NORs (sliding scale)	1:1 (F:M); spawning at MCFH

[1] PNI = Proportionate Natural Influence [pNOB/(pNOB+pHOS)]; pHOS = % hatchery-origin fish on the spawning grounds; pNOB = % natural-origin fish in broodstock
[2]Broodstock collection for the Clearwater is planned to be phased out in the next few years.
[3]Refer to Table 3 and Table 4 regarding sliding scale broodstock collection
[4] This proposed increase for the JCAPE program production by up to 50,000 smolts, for a total production of up to 150,000 smolts annually would use up to 52 pairs
[5] If NORs are over 208 natural-origin returns then applicants will collect up to 52 pairs. When NORs are between 100 and 208, applicants are proposing to collect up to 50% of female and male NORs. If there are less than 100 NORs, applicants will consult with NOAA fisheries to determine broodstock numbers
Source: Applicant HGMPs

For the two spring Chinook programs (**Rapid River, Hells Canyon**) that only utilize hatchery-origin broodstock, hatchery origin returns are not intended to spawn naturally. However, some hatchery-origin returns are able to spawn naturally, particularly in the Rapid River program in Little Salmon River.

The **SFSR** program has two program components (segregated and integrated) with a *genetic relationship* between them. In other words, a percentage of returning fish from the integrated component will be used as broodstock in the segregated component. This type of genetic linkage diagrammatically is identical to what the HSRG calls a “stepping stone” system (HSRG 2014). Initial analysis by NMFS of programs connected this way shows that programs so linked pose considerably less risk of hatchery-influenced selection than solely segregated programs (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 over returning integrated hatchery-origin adults.

Beginning with brood year 2014, full implementation of the sliding scale was initiated. As these “integrated” smolts return, they will be: 1) used as broodstock for the next generation of integrated smolts, 2) released upstream of the weir to supplement natural spawning, and 3) used as broodstock in the segregated component of the program. The number of hatchery and natural-origin adults that are either retained for broodstock (for integrated components) or released to spawn naturally is based on a sliding scale (Table 3). These numbers can be highly variable depending on NOR escapement. The abundance of NOR Chinook will determine the proportion of natural-origin fish retained for broodstock (pNOB) and the numbers of hatchery-origin adults released to spawn naturally (pHOS) in the **SFSR** program. This program proposes pHOS levels above the weir to be 10 to 100%, depending on NORs. Managers will keep NMFS updated on run forecasts when it is projected that fewer than 700 adults are expected to return to the SFSR weir. If the natural-origin returns in a given year are forecasted to be fewer than 50 adults to the weir, managers will contact NMFS prior to initiating broodstock collection. Please refer to Table 3 for the broodstock collection and adult release objectives for the SFSR program. In order to reduce risk associated with segregated fish spawning downstream of the SFSR weir, we have prioritized the inclusion of integrated hatchery adults into the segregated component of the hatchery program if the return of integrated hatchery fish exceeds numbers needed to meet broodstock needs for the integrated program and spawning escapement objectives upstream of the weir (Table 4).

Table 3. Sliding scale broodstock and weir management for the integrated broodstock program in the SFSR (McCall Fish Hatchery). The sliding scale was collaboratively developed by IDFG and NPT to include projections of outplants (up to 500 Hatchery origin returns) below the SFSR weir. NORs= Natural origin returns, pHOS = proportion of spawners upstream of SFSR weir that are hatchery origin.

NOR to weir (presented as a range)		NORs released above weir (presented as a range)		Max. number of NORs held for brood (presented as a range)		Max. % of NORs retained for brood	Max pHOS
50	124	30	74	20	50	40	No threshold identified
125	424	75	331	50	93	40	No threshold identified
425	699	332	606	93	93	25	0.45
700	999	544	843	156	156	25	0.45
1,000	1,299	689	988	311	311	35	0.35
1,300	1,999	678	1,377	622	622	50	0.35
2,000	3,000	1,378	2,378	622	622	35	0.35

Source: (IDFG 2017d)

Table 4. Sliding scale of natural origin abundance at the SFSR weir used to determine the size of the integrated smolt program. The sliding scale was collaboratively developed by IDFG and NPT to include projections of outplants (up to 500 Hatchery-origin returns) below the SFSR weir.

Projected NOR to weir (jacks excluded)	Size of integrated smolt program
<700	150,000
700-999	250,000
1,000-1,299	500,000
>1,300	1,000,000

Source: (IDFG 2017d)

JCAPE program uses only natural-origin broodstock. For the **JCAPE** program, if NORs exceed 208 returns then applicants will collect up to 52 pairs. When NORs are between 100 and 208, applicants are proposing to collect up to 50% of female and male NORs. If there are less than 100 NORs, applicants will consult with NMFS to determine broodstock numbers.

Broodstock collection for the **SFCEP** is covered under the **SFSR** HGMP. **SFCEP** uses eggs from fish that are collected from the segregated component of the SFSR program; however, there is a preference to use eggs from the integrated component of the SFSR program.

1.3.3. Proposed Hatchery Egg Incubation and Juvenile Rearing, Acclimation, and Release

The **Hells Canyon** and **Rapid River** programs use the Rapid River Fish Hatchery and the Oxbow Fish Hatchery to incubate eggs. At Rapid River Fish Hatchery, the total rearing capacity is 3.0 million smolts. Up to 1.8 million green eggs are transferred to Oxbow Fish Hatchery each year for incubation to eye-up. Following eye-up, eggs are returned to Rapid River Fish Hatchery for incubation to hatching. The **Hells Canyon** and **Rapid River** programs rear fish in ponds supplied with water diverted from Rapid River. The majority of these smolts produced at Rapid River Fish Hatchery are volitionally released into Rapid River. The Hells Canyon program releases (350,000 yearling smolts) are transported and released directly into the Snake River. Smolts released into the Little Salmon River or the Snake River are not acclimated. For the **Hells Canyon** and **Rapid River** programs, smolts are typically stocked in the Little Salmon River or the Snake River below Hells Canyon Dam pursuant to priorities established in the 2008-2017 *US v. Oregon* Management Agreement. In emergency situations, fish from these programs may also be released at the Pittsburg Landing location downstream of the Hells Canyon Dam on the Snake River.

Egg incubation and juvenile rearing for the **JCAPE** program and **SFSR** program occurs at the McCall Fish Hatchery. The maximum capacity at the McCall Fish Hatchery is 1.15 million fish. For the **SFSR** program, 1 million smolts are transported and released into the South Fork Salmon River at Knox Bridge. River water is pumped into transport vehicles where fish adjust to temperature for a few hours before a direct release. Smolt releases take place over a period of four to five days. All smolts from the **JCAPE** project are transported and released directly into Johnson Creek at Moose Creek. Rearing capacity at McCall Fish Hatchery for the **SFSR** program does not allow for the release of yearling smolts that are in excess of programmed levels. However, surplus eggs may be generated (~ 10% above need) to provide a buffer against culling associated with the presence of bacterial kidney disease. There have been situations where fish in excess of rearing capacity have been released at Knox Bridge as sub-yearlings in the fall; however this activity is not being proposed into the future. All fish released at this life stage were adipose clipped to allow identification as hatchery-origin fish. The target of the **JCAPE** program is to produce and release up to 150,000 smolts; however, the Nez Perce Tribe do not consider any progeny produced by the **JCAPE** program to be "surplus". Regardless, because the maximum rearing capacity at the McCall Hatchery is 1.15 million fish (SFSR rears 1 million), it is unlikely that **JCAPE** releases will be in excess of 150,000 smolt.

The **SFCEP** uses eyed-eggs from the **SFSR** program that are transferred from the McCall Fish Hatchery to in-stream eggboxes. Historically, boxes were installed in Dollar Creek, but as of brood year 2017 will be relocated in Cabin and Curtis creeks, which are tributaries located above the South Fork weir. The new location will allow for PBT-based evaluation of the project; i.e. in terms of contributing to adult recruitment to the river. Eggs are incubated to the eyed-up stage at the McCall Fish Hatchery and are then transferred to the in-stream eggboxes. Juveniles then rear within the eggboxes and are able to swim-up/migrate volitionally. Release sites are accessed the following spring to remove the boxes and estimate hatch success.

Please refer to Table 5 for additional information regarding annual release groups, marking, egg incubation and rearing, rearing location, acclimation, and release time for the five programs.

Table 5. Summary of annual release groups (number and life stage), marking, egg incubation and rearing locations, acclimation, and release times

Program	Annual release groups (number and life stage)	Marking and Tagging[1]	Egg incubation Location	Rearing Location	Acclimation	Release Time
Rapid River	Up to 2.5 million volitionally released into Rapid River and 150,000 into Little Salmon River (all yearling smolt)	100% ad-clipped and PBT, 120,000 smolts from the Rapid River releases receive CWT, and 52,000 from the Rapid River releases receive PIT tags	Up to 3 million eggs at RRFH (Up to 1.8 million green eggs are transferred to Oxbow Fish Hatchery each year for incubation to eye-up then returned to RRFH)	RRFH	Yes for Rapid River releases; none for LSR releases	mid-March
Hells Canyon	Up to 350,00 directly released into Snake River (yearling smolt)	100% ad-clipped and PBT	Up to 3 million eggs at RRFH (Up to 1.8 million green eggs are transferred to Oxbow Fish Hatchery each year for incubation to eye-up then returned to RRFH)	RRFH	None	mid-March
SFSR	Up to 1 million yearling smolts directly released in SFSR (150,000 of which from integrated program)	Minimum of 750,000 100% ad-clipped and PBT; some CWT/PIT; 150,000 to 250,000 100% CWT, some PIT	MCFH	MCFH	None	March-April
JCAPE	Up to 150,000 yearling smolts directly released in Johnson Creek mid-March to April (all yearling smolt)	100% CWT and PBT and some PIT	MCFH	MCFH	None	late March-early April
SFCEP	Up to 300,000 eyed-eggs reared in eggboxes in Cabin and Curtis creeks, SFSR tributaries; eggs collected as part of SFSR program	100% PBT	Cabin/Curtis creeks or SFSR eggboxes	Cabin/Curtis creeks or SFSR eggboxes	Yes	October

[1]CWT and PIT tagging levels may change based on budgets and evaluations into the future. If tagging rates are likely to change into the future, applicants will contact NMFS to discuss these details.
Source: Applicant HGMPs

Fish health staff monitor the fish throughout their rearing cycle for signs of disease for all programs. Fish are checked and any mortalities are removed daily. A subset of live fish are taken monthly. Fish are also tested prior to transfer to acclimation sites. Recommendations for treating specific disease agents, inspection, and diagnostic services comes from the IDFG Eagle Fish Health Laboratory in Eagle, ID. Approximately 30-45 days prior to release, IDFG Eagle Fish

Health Laboratory takes a 60-fish pre-liberation sample from each rearing pond to assess the prevalence of viral replicating agents at to detect the pathogens responsible for bacterial kidney disease and whirling disease.

1.3.4. **Proposed Disposition of Excess Juvenile and Adult Hatchery Fish**

Hatchery-origin fish in excess of broodstock needs for the **Rapid River** and **Hells Canyon** programs are intended for harvest purposes. Moreover, all hatchery-origin spring Chinook are adipose-clipped, meaning fish may be easily distinguished in harvests and escapement. Disposition of surplus hatchery spring Chinook salmon collected at Rapid River Fish Hatchery varies based on adult return numbers and management objectives. Surplus fish have been transported back to the mainstem Salmon or Little Salmon rivers to be recycled back through the local fishery, i.e., transported to create fisheries. Carcasses may be distributed to tribal entities for subsistence or ceremonial use, to charitable organizations, and/or provided for research or educational purposes, and carcasses frozen for rendering at a later date. In similar fashion, surplus hatchery-origin spring Chinook salmon collected at Hells Canyon adult trap may be transported to other locations, where listed Chinook salmon are not present for fisheries. These fish may also be distributed to tribal entities for subsistence or ceremonial use or to charitable organizations for human consumption.

Generally, Chinook salmon are not collected in surplus of need at the **SFSR** program. However, if the number of hatchery origin fish trapped exceeds broodstock requirements disposition will occur as follows; recycling through active fisheries in the SFSR below the weir, distribution to tribes, food banks or the public for human consumption or outplanted as live fish to natural spawning areas (East Fork of the South Fork Salmon River above the “Glory Hole” or mainstem SFSR). A maximum of 1000 segregated SFSR hatchery-origin fish may be outplanted in the EFSFSR and 500 in the SFSR for natural spawning.

For the **JCAPE** program, when the natural origin adult return exceeds the minimum viability goal of 1,000 Chinook (ICTRT 2005), various release scenarios may be instituted, including the transfer of fish into portions of Johnson Creek or East Fork of the South Fork Salmon River that remain underseeded.

Please refer to Table 6 regarding additional disposition protocols.

Table 6. Summary of disposition by life stage

Program(s)	Life stage	Disposition
Rapid River	Adults	• transported back to mainstem Salmon or Little Salmon Rivers to be recycled back through the local fishery • given to tribes for subsistence and ceremonial use • charitable organizations • research/educational purposes • nutrient enhancement in local watersheds • taken to rendering plants or landfills for disposal

	Juveniles	• yearlings or unfed fry stocked in the Little Salmon River, Snake River below Hells Canyon Dam, or the Clearwater River
	Eggs	• eggs stocked in the Clearwater River
Hells Canyon	Adults	• transported to areas where Chinook salmon are not present to create fisheries • recycling hatchery fish through the fishery in the Snake River downstream of Hells Canyon Dam • given to tribes for subsistence and ceremonial use • given to food banks or the public for human consumption • nutrient enhancement in local watersheds
	Juveniles	• yearlings stocked in the Little Salmon River and/or Snake River below Hells Canyon Dam
SFSR	Adults	• recycling through active fisheries in SFSR • given to tribes for subsistence and ceremonial use • given to food banks or the public for human consumption • transported to areas where Chinook salmon are not present to create fisheries • outplanted as live fish to natural spawning areas in EFSFSR and SFSR (no more than 1000 in the EFSFSR and 500 in SFSR) • nutrient enhancement in local watersheds
	Juveniles	• unfed fry or yearlings may be stocked in the mainstem East Fork of the South Fork Salmon River above the “Glory Hole” passage barrier
	Eggs	• provided to SBT Egg Box program • eggs stocked in the mainstem East Fork of the South Fork Salmon River above the “Glory Hole” passage barrier
JCAPE	Adults	• transfer to portions of Johnson Creek or East Fork of the South Fork Salmon River that remain underseeded (including but not limited to the mainstem East Fork of the South Fork Salmon River above the “Glory Hole” passage barrier)
	Juveniles	• Not applicable
SFCEP	Eggs	• Not applicable

Source: Applicant HGMPs

1.3.5. **Proposed Research, Monitoring, and Evaluation (RM&E)**

- Analyze marked fish recovery data collected by others from the Columbia and Snake River mainstem and tributary fisheries to determine harvest numbers and rate
- Monitor harvest numbers and rates in the SFSR, East Fork of the SFSR, Little Salmon River, and Snake River downstream of Hells Canyon Dam. Monitor adult collection, numbers, origin, length, age, marks/tags, return timing at weirs/traps/hatchery facilities
- Monitor proportion of hatchery- and natural-origin fish in natural production areas and collect basic life history information for management planning
- Index redd counts are conducted on all natural spawning areas affected by supplementation programs and representative portions of carcasses on spawning grounds are sampled for marks, or tags and for age, sex, and size information. Most surveys include extensive redd counts that encompass the entire potential spawning area. Annual estimates of spawners by age are used to monitor inter-annual spawner-recruit trends.
- Adult enumeration, fork length, maturity, migration status, marks/tags, sex, aging (via scale samples and/or otoliths), and condition will occur with use of facility weirs
- Continue maintenance and regular updating of genetic profiles for hatchery- and natural-origin spring/summer Chinook populations in the SFSR, East Fork of the SFSR, and Little Salmon River subbasins
- The JCAPE program is completing a parentage pedigree analysis from tissue collected from all adults returning to the adult weir and unsampled carcasses on the spawning grounds
- The SFCEP is developing a parentage pedigree analysis from tissue collected from all natural adults returning to the adult weir and unsampled carcasses on the spawning grounds. They also intend to develop RM&E to sample survival of all life stages for their program. This may include future electrofishing of the SFSR above the weir and into adjacent streams.
- Monitor discharge water quality/withdrawals and report annually on compliance with related permits and criteria (i.e., screening and fish passage criteria)
- Monitor health and condition of adult and juvenile Chinook associated with hatchery production during hatchery residence
- Estimate smolt-to-adult survival and in season run forecasts at Lower Granite and some tributaries
- Rotary screw traps (JCAPE M&E and SFSR programs) will be used to estimate the abundance, emigration timing, and age composition of naturally produced Chinook salmon migrants and may be used to collect tissue samples for pedigree analysis to determine parentage of migrants.

1.3.5.1. RM&E Activities for Each Program

The Idaho Natural Production Monitoring Program and the Idaho Steelhead Monitoring and Evaluation Study monitors adult and juvenile segments of the natural Chinook salmon and steelhead consistent with the Anadromous Salmonid Monitoring Strategy. The Idaho Natural Production Monitoring program also oversees the systematic redd count survey program for natural populations of Chinook salmon throughout Idaho. Please refer to Table 7 for information regarding specific adult and juvenile RM&E activities for each of the five programs. Past and proposed ESA coverage is specified in Table 7.

Table 7. Specific adult and juvenile RM&E activities for each of the five programs

Program	Spring/summer Chinook salmon ESU				
	Adult		Juvenile		ESA coverage
	Monitoring	Program name	Monitoring	Program name	
All Programs	Systematic tissue sample collection at Lower Granite Dam to provide escapement estimates				NMFS Letter of Determination under 2014 FCRPS Supplemental BiOp and Permit # TE-82106B-0 under Section 10(a)(1)(A) for Bull trout
			Monitoring of survival metrics for all life stages in the hatchery from spawning to release. CWT and/or PBT tagging of representative groups of juveniles to estimate harvest in mixed stock fisheries downstream of Idaho. Stock composition of harvest in Idaho fisheries is estimated using PBT. PIT tagging representative groups of hatchery juveniles to estimate migration timing, outmigration survival rate, and adult returns. Adult PIT detections in the mainstem Columbia River and Lower Snake River dams are used to inform in season fisheries management.		This opinion
Rapid River and Hells Canyon	Rapid River weir, Hells Canyon adult trap, genetic monitoring. Adult trapping and tissue collection. Data collection to include date, gender, length, marks, and tags		Smolt trap downstream of Rapid River weir		This Opinion for Chinook; Currently under State of Idaho Section 6 Authorization for Bull Trout pending concurrent Section 7 Consultation efforts; Smolt trap covered under 4(d) 20863
SFSR	Carcass surveys, redd counts, genetic monitoring	Idaho Salmon Basin VSP Monitoring	Estimate juvenile production, estimate survival to Lower Granite Dam, and monitor migration timing; smolt trap located downstream of SFSR weir near Krassel Ranger Station; operated March-October; most fish counted/released or anesthetized, measured, weighed, and released; smaller groups receive	Idaho Salmon Basin VSP Monitoring	4(d) Authorization 20863

			PIT before release		
	Adult trapping and tissue collection. Data collection to include date, gender, length, marks, and tags				This Opinion for Chinook; Currently under State of Idaho Section 6 Authorization for Bull Trout pending concurrent Section 7 Consultation efforts for hatchery operational activities
JCAPE	A temporary picket weir (RM 5.1 on Johnson Creek) is used to monitor adult return timing, escapement, origin, age and sex of most returns; it is also used to collect tissue for genetic monitoring; Multiple-pass spawning ground, and carcass surveys are conducted to inform population-based M&E performance measures	JCAPE M&E	A rotary screw trap (RM 3.9 on Johnson Creek) is operated March-November to monitor juvenile Chinook production/productivity, as well as migratory survival, and timing to Lower Granite Dam; most fish are anesthetized, measured, weighed, marked (via clips for trap efficiency estimates) and released; smaller groups receive PIT before release; small scale studies include mark observability, juvenile pedigree analysis, and ageing.	JCAPE M&E	The 4(d) limit authorized with this opinion replaces Section 10 permit 1134
SFCEP	Adult trapping and tissue collection. Data collection to include date, gender, length, marks, and tags		Monitor adult recruitment back to the South Fork weir from the eggbox program using PBT	SFCEP M&E	This Opinion for Chinook; Currently under State of Idaho Section 6 Authorization for Bull Trout pending Section 7

Source: Applicant HGMPs

1.3.6. **Proposed Operation, Maintenance, and/or Construction of Hatchery Facilities**

All hatchery programs return water to the diverted creek or river (minus any leakage and evaporation) along with any groundwater discharge. Water at all facilities is withdrawn in accordance with state-issued water rights. LSRCP facilities are being evaluated against the NMFS 2011 screening and passage criteria. The strategy is to work with NMFS and cooperators to discuss compliance outcomes and to prioritize those facilities with compliance issues that need to be addressed based individual risk, program risk, and compliance concern. Modifications and upgrades will be based on the prioritized list and acted upon as funding becomes available.

Additional facilities will be adopting a similar approach to determine compliance with NMFS screening criteria. Programs that rear over 20,000 pounds of fish operate under applicable National Pollutant Discharge Elimination System (NPDES) general permits. Minor armoring would be maintained at the intake diversions, fish ladders, and effluent outfall. For additional information regarding facility water sources for each program, please refer to Table 8.

Several routine (and semi-routine) maintenance activities occur in or near water that could impact fish in the area including: sediment/gravel removal/relocation from intake and/or outfall structures, pond cleaning, pump maintenance, debris removal from intake and outfall structures, and maintenance and stabilization of existing bank protection. All in-water maintenance activities considered "routine" (occurring on an annual basis) or "semi-routine" (occurring with regularity, but not necessarily on an annual basis) for the purposes of this action will occur within existing structures or the footprint of areas that have already been impacted. When maintenance activities occur within water, they will comply with the following guidance:

- In-water work will:
    - Be done during the allowable freshwater work times established for each location, or comply with an approved variance of the allowable freshwater work times with the appropriate state agencies
    - Follow a pollution and erosion control plan that addresses equipment and materials storage sites, fueling operations, staging areas, cement mortars and bonding agents, hazardous materials, spill containment and notification, and debris management
    - Cease if fish are observed in distress at any time as a result of the activities
    - Include notification of NMFS staff
- Equipment will:
    - Be inspected daily, and be free of leaks before leaving the vehicle staging area
    - Work above ordinary high water or in the dry whenever possible
    - Be sized correctly for the work to be performed and have approved oils / lubricants when working below the ordinary high water mark
    - Be staged and fueled in appropriate areas 150 feet from any water body
    - Be cleaned and free of vegetation before they are brought to the site and prior to removal from the project area

Specific details regarding operation, maintenance, and/or construction for each hatchery facility are described below in Sections 1.3.6.1.1 and 1.3.6.1.2.

1.3.6.1.1. Rapid River and Hells Canyon Facilities

Rapid River Fish Hatchery and Trap

These facilities are both supplied with surface water diverted from the Rapid River. The surface water intake at the Rapid River Hatchery was replaced in the spring of 2017. Renovations were made to make the facility compliant with current NMFS screening criteria (NMFS 2011b). The hatchery has specific water rights between intakes and return of 28 cfs under Idaho Department of Water Resources (IDWR) water right number A78-02074 and 18.6 cfs of water rights under IDWR water right number A78-07013. Actual withdrawals range from a low of about 16 cfs in

May to a high of about 35 cfs in February and December. In 2017, use of the gravitational flow filter bed in the incubation building was discontinued, and the gas pump will be replaced with a stand-by generator to operate the electric pumps. Water discharges from the facility either to Rapid River or to Shingle Creek, a tributary to Rapid River, under NPDES permit IDG131009.

Routine maintenance activities include in-river maintenance of the hatchery diversion dam and intake diversion, adult fish trap, and fish ladder; the removal of fine sediment (sand and silts) from the Rapid River Fish Trap; and visual inspection and minor repairs of various wooden, steel, and concrete structures that constitute the adult trap, fish ladder, and water supply intake.

Although instream machinery is not typically placed in the active river channel during debris removal operations, at times the volume of instream debris may necessitate the use of instream equipment. Under such circumstances, the operation of instream equipment would occur during the established in-water work window in coordination with the state resource agencies, USFWS, and NMFS. If a variance to this window is required, no activities would occur until agency approvals are obtained. Impact minimization measures associated with the operation of equipment in the active channel include the use of vegetable-based synthetic fuel oil for instream equipment. An additional routine maintenance action includes the removal of sediment from the Rapid River Trap. Once or twice each spring Chinook salmon trapping season, hatchery personnel flush this material back to the river channel using high pressure water hoses. The process is completed in less than 1 day and the trap/ladder is returned to normal operation after completion. Hatchery personnel periodically complete visual inspections of the structures by entering the river channel with hip boots or waders. Minor repairs may be completed in place by workers using hand tools, whereas more extensive repairs may require portions of these structures to be temporarily removed for repair or replacement. Although heavy equipment would not typically be operated in the wetted stream channel, if semi-routine maintenance or infrastructure repairs are extensive, equipment may be required to enter the wetted channel or to set an isolation cofferdam to conduct the work “in the dry”. As described above, if the operation of instream equipment is required, such activities would occur during the established in-water work window in coordination with the state resource agencies, USFWS, and NMFS.

In addition, when trapping operations are not in progress, the trap is lowered and allows unimpeded migration of anadromous and resident fish around the velocity barrier.

Oxbow Fish Hatchery

Oxbow Fish Hatchery is supplied with both surface water pumped from the Snake River and groundwater pumped from two wells. The hatchery withdraws groundwater per IPC’s water rights granted in permit #G 15440 by the Oregon Water Resources Department (OWRD). Groundwater is used exclusively for egg incubation purposes. Water for adult holding is pumped from the Snake River by two 100-horsepower production pumps that each deliver 8,000 gallons per minute (gpm) and have separate power sources. Only one pump operates at a time, so the second pump acts as an emergency backup. Approximately 15.5 cfs is pumped year round, except in August and September when no surface water is withdrawn. River water from the adult holding ponds and groundwater from the incubation room both discharge to the Snake River. The in-river distance between the hatchery intake and discharge is about 180 feet. Because the hatchery produces less than 20,000 pounds of fish per year and distributes less than 5,000 pounds of feed at any one time, no National Pollutant Discharge Elimination System (NPDES) wastewater permit is required.

Normal and preventative maintenance of hatchery facility structures and equipment is necessary for proper functionality. Normal activities include pond cleaning, pump maintenance, building maintenance, and ground maintenance. Debris removal from intake and outfall structures may be required annually. Work would likely be conducted in May or from August through mid-November. This is conducted using machinery positioned along the bank. Operation of equipment in the active channel is not required for routine maintenance at this facility. Semi-routine maintenance may include repairs to various wooden, steel, and concrete structures that are part of water source intakes, discharges, or other systems that may become compromised simply from age and exposure to changing weather conditions or from unique storm events. Installation of gravel/cobble (up to 12 inch diameter angular rock) may be necessary for structure stabilization due to high flow erosion. If such work cannot be accomplished from the riverbank, semi-routine maintenance activities may require the use of instream equipment, as well as dewatering of small areas surrounding maintenance sites (e.g., intake, outfall). If the operation of instream equipment or in-water work isolation is required, such activities would occur during the established in-water work window in coordination with the state resource agencies, USFWS, and NMFS. If a variance to this window is required, no activities would occur until agency approvals are obtained.

Hells Canyon Fish Trap

Surface water for these facilities is supplied from the Snake River. The trap consists of an attraction channel with approximately 150 feet of ladder, a trap (holding area), and a loading hopper. Vertical turbine pumps provide 18 cubic feet per second (cfs) of river water to operate the fish ladder. In addition, 112 cfs of pumped river water is provided in the form of attraction flow to encourage spring Chinook salmon and steelhead to enter the fish ladder.

Discharge from Hells Canyon Dam greater than 50,000 cfs has the potential to inundate the trap. High flow events of this nature and the associated need to remove debris from the trap occur on average, once every 5 years. Any woody debris present in the water during such high flow events has the potential to be deposited in the trap. Extreme high flows of this nature can also deposit cobble and rubble within the fish ladder, hampering trap operation. Immediate removal of all such debris is necessary to restore normal trapping operation. Rock and woody debris removal is accomplished with a crane and clamshell bucket operated from the embankment above the Hells Canyon Trap. Work is usually completed by mid-May so the trap may operate to collect spring Chinook salmon. No machinery is placed in or near the river channel, thus eliminating any risk of fuel or oil contamination. Due to the large size of the substrate removed from the trap and the high water velocity in the area, the likelihood of transporting fine sediments downstream is minimal. Semi-routine maintenance activities at the Hells Canyon Trap are not part of the proposed action. Separate ESA consultations will be initiated to address potential impacts from semi-routine maintenance activities.

1.3.6.1.2. South Fork Salmon River, Johnson Creek Artificial Propagation Enhancement, and South Fork Chinook Eggbox Project Facilities

McCall Fish Hatchery

McCall Fish Hatchery receives water through an underground, 36-inch gravity line from Payette Lake. Water may be withdrawn from the surface or up to a depth of 50 feet. The IDFG has an agreement with the Payette Lake Reservoir Company to withdraw up to 20 cfs. Incubation plumbing allows for the placement of 26 eight-tray, vertical incubation stacks (Heath type) along the south wall of the hatchery building and removable pipes between three sets of early rearing vats may be lowered into place to provide additional incubation capacity. Rearing facilities include 14 concrete vats (4 feet wide x 40 feet long x 2 feet deep) used for early rearing, two concrete ponds (40.5 feet wide x 196 feet long x 4 feet deep) used for final rearing, and one concrete collection basin (101 feet wide x 15 feet long x 4 feet deep).

Normal and preventative maintenance of hatchery facility structures and equipment is necessary for proper functionality. Normal activities include pond cleaning, pump maintenance, debris removal from intake and outfall structures, building maintenance, and ground maintenance. Semi-routine maintenance may include repairs to various wooden, steel and concrete structures that are part of water source intakes, discharges, or other systems that may become compromised simply from age and exposure to changing weather conditions or from unique storm events. Annual maintenance includes visual inspection of the intake surface, pressure washing of the intake screen, inspection of water control valves, and applying grease as needed to ensure smooth operation. Woody debris and other materials may need to be removed prior to opening the surface intake valve. Periodic inspection of the deep intake by professional divers, and video inspection of water pipelines should be performed on a 25-30 year cycle. The last such inspection took place in August 2004.

South Fork Salmon River Satellite Facility and Weir

The weir located at the South Fork Salmon River Satellite Facility receives surface water directly from the South Fork Salmon River. About 8 cfs to 11 cfs are supplied through a 33-inch underground pipeline that extends approximately 200 yards from a concrete intake structure upstream of the compound. The intake screens are undergoing review, and if compliance issues exist, will either be upgraded in the future to meet NMFS (2011) criteria, or will receive compliance via waivers after coordination with NMFS. Intake upgrades are considered future federal actions that would be consulted on separately under Section 7 of the ESA. The in-river distance between intake and discharge back to the river is about 2,750 feet.

About three to five times each winter, personnel snowmobile into the trap compound to shovel off snow from the crew quarters and from the outhouse/power room. At the end of each trapping/spawning season, domestic water is turned off, all lines are drained/ blown out, and the gas to the crew quarters is turned off. In April or May each year, prior to opening the control valve of the intake structure, boards in the structure are removed and any woody debris is cleared from grating in the river. A pressure nozzle is used to remove sand in the pipeline as well as sand that has deposited in the intake structure. This sediment is discharged back to the river from the intake structure, or returned through the facility and into the river through the facility discharge pipe. Water is typically allowed to flow in this manner for 12 to 24 hours before being channeled through the ponds. Upon facility opening in April or May of each year, the ponds are dry and sand accumulations are shoveled out of the ponds and deposited in uplands away from the river channel. Following manual removal, remaining sand deposits are flushed out of the ponds/trap using a pressure nozzle. Once cleaned, dam boards are added to the holding ponds/trap and wedged into place. Prior to passing water through the holding ponds, ladder boards must be inspected and wedged into place as needed. At the end of the season, boards in the holding ponds/trap are removed and walls are inspected for any damage/concrete erosion.

Water lines are blown out to prevent damage due to freezing, including those leading to the sorting areas in the spawn area. Occasionally juvenile Chinook Salmon are collected when the adult holding ponds are dewatered at the end of the season. Hatchery staff net any stranded fish and release them back to the river. From about May through September, up to 4 to 5 times per season, hatchery operators use excavators, chainsaws, and winches to remove or pass debris from the weir structure that have been deposited during periods of flooding or high water. In addition, as required (varies from up to two times per season to once every 5 years), operators typically use a long-reach excavator from the existing access road on the bank to remove silt, sand, and/or debris from above and in-front of the intake structure. This debris removal ensures adequate flow can enter the facility unobstructed. Although machinery is not typically placed in the active river channel during debris removal operations, at times the volume of instream debris may necessitate the use of instream equipment. Under such circumstances, the operation of instream equipment would occur during the established in-water work window in coordination with the state resource agencies, USFWS, and NMFS. If a variance to this window is required, no activities would occur until agency approvals are obtained.

The permanent bridge holding individual weir panels is inspected for damage each spring. Prior to pivoting weir panels into place, silt and rocks that settled behind the concrete lip of the sill extending across the river must be removed. Most of this material can be removed by pivoting the weir panel close to the lip, causing water turbulence to lift the sand away. Rocks and woody debris must be removed by hand by personnel in the river. Once clear, individual panels can be pivoted then locked into place, beginning from the compound side of the bridge. This maneuver requires the use of a come-along winch that is under high load and extreme care must be exercised. Replacement signage and covers along the downstream side of the weir panels must be inspected to ensure they are in place. At the end of the season, weir panels are unlocked and pivoted to under the bridge, for storage, and locked into place. In the spring, the access road leading down to the trap must be inspected and rocks and trees removed to provide access. An inspection of the immediate grounds is undertaken to identify any winter damage and to identify potential hazard trees that need to be removed prior to summer activities. At the end of the season, water bars on the access road must be cleared or deepened to help prevent erosion in the spring. In addition, the weir is monitored while in use.

In most cases, any machinery used for rock placement would be operated from outside the wetted perimeter of the stream to avoid the possibility of fuel or oil entering the water. However, if the operation of instream equipment is required, such activities would occur during the established in-water work window in coordination with the state resource agencies, USFWS, and NMFS.

All LSCRP facilities, including the South Fork Salmon Satellite Facility, are currently being reviewed to determine compliance needs related to NMFS screening and passage criteria (NMFS 2011b). If upgrades are determined necessary to achieve compliance, instream activities would likely necessitate the installation of a cofferdam to isolate the in-water work area. Instream equipment may be used to place the cofferdam. Such activities would be covered under a separate, project-specific ESA Section 7 consultation.

Johnson Creek Weir and Screw Trap

The adult weir and trap are located in Johnson Creek approximately 8.2 river km (5.1 RM) upstream from the confluence with the East Fork of the South Fork of the Salmon River. The weir is V-shaped and operates from approximately mid-June through mid-September for collection of spring/summer Chinook salmon broodstock. The picket weir spans the entire river channel when in operation, and funnels upstream migrating fish into a trap box at the point of the V. A floating rotary screw trap is used to capture emigrating juvenile salmonids in Johnson Creek. The trap is placed downstream of the weir, approximately 6.2 km upstream from the confluence with the East Fork of the South Fork of the Salmon River. Trap operation is planned to be continuous; however, there are times when traps cannot be operated (typically between September and March) due to low flow or freezing conditions, excessive debris, or mechanical breakdowns.

To minimize fish holding time, the weir is checked daily, and during times of peak migration the weir may be checked several times a day. Adults are processed as the weirs are checked. Non-target species are immediately released with minimal handling. Aside from damages or loss of functionality related to high water events, the integrity of the adult weir may be compromised simply by age and exposure to changing weather conditions. Routine maintenance may also include the removal of sediment and debris from the weir trap. Personnel must periodically complete a visual inspection of the structures by entering the river channel with hip boots or waders. Minor repairs may be completed in place by workers using hand tools, whereas more extensive repairs may require individual weir panels to be temporarily removed for repair or replacement.

The screw trap is attached to a cable suspension system anchored by gabion baskets, which allow side to side and upstream/downstream movement of the trap. This permits the trap to be fished in the optimum position during most flow conditions. The trap consists of a trapping cone (1.5 m diameter) supported by a metal A-frame, live box, two six-meter by one-meter pontoons for flotation, and a clean-out drum. The live box of the screw trap is checked every morning (several times throughout each night and day during high water, storms, or ice-up events). Piscivorous fish and large numbers of incidentally captured fish are removed from the live box and scanned for PIT tags. Mortality due to trapping is noted and recorded. Processing procedures are similar to those used by Ashe et al. (1995) and Prentice et al. (1990). Routine maintenance includes minor repairs, anchor relocation or modification, and sediment and debris removal. Maintenance is typically accomplished by personnel in the river channel, and does not require the use of heavy equipment.

South Fork Chinook Eggboxes

Summer Chinook Salmon eggs are placed in six egg boxes located in lower Cabin Creek and in six egg boxes located in lower Curtis Creek. Both creeks are tributaries to the South Fork Salmon River. Boxes are placed in mid October and removed in mid May.

Eggs are loaded into Rubbermaid in-stream boxes standardized with 1/8 inch mesh sides for flow and 1/4 inch mesh tops for volitional emigration. Egg boxes are placed at sites that were selected and standardized with adequate flow to maintain rearing throughout the season. Each box contains approximately 25,000 eggs; therefore approximately 12 boxes are placed each year. Because of the relatively large volumetric size of the boxes, most are placed in pool habitat. Boxes are anchored to the stream bed using a combination of rebar and tie wire.

Release sites are accessed the following spring to remove the boxes and estimate hatch success.

Because this eggbox program produces less than 20,000 pounds of fish per year and distributes less than 5,000 pounds of feed at any one time, no NPDES wastewater permit is required.

Table 8. Facility water source and use for hatchery program operations (N/A = not applicable)

Program	Facility	Surface Water (cfs)					Groundwater (cfs)			Number and type of instream structures	Meet NMFS screening criteria (specify year)?	NPDES Permit (provide number)?
		Source and water right	Average and maximum use	Diversion Distance (Meters)	Discharge Location	Months utilized	Water right	Average and maximum use	Months utilized			
Rapid River and Hells Canyon	Rapid River Fish Hatchery	Rapid River / 7802073 and 7802074	Combined, 34 avg and 46.6 max	208	Rapid River	1/1 to 12/31 and 1/1 to 12/31	n/a	n/a	n/a	1 intake, 1 diversion, 1 fish ladder	Yes (2017)	IDG131009
	Rapid River Fish Trap	Rapid River / water right pending	18 avg and 18 max	18	Rapid River	1/1 to 12/31	n/a	n/a	n/a	1 intake, 1 velocity barrier, 1 fish ladder/trap	n/a see below[1]	n/a
	Oxbow Fish Hatchery	Snake River / See below[2]	11.33 avg and 17 cfs max	55	Snake River	1/1 to 12/31	G-15440 (Oregon)	0.44 avg and 1.8 max	1/1 to 12/31	1 intake, pumped	Yes (2013)	n/a no fish fed on station
	Hells Canyon Fish Trap	Snake River / S-46410 (Oregon)	42 avg and 130 max	9	Snake River	1/1 to 12/31	n/a	n/a	n/a	fish ladder, 2 operation pumps (75 hp), 4 attraction pumps (25 hp), 1 shaft pump (3 hp)	Undetermined see below[3]	n/a
SFSR, JCAPE, and SFCEP[4]	McCall Fish Hatchery	Payette Lake / 65-02466 and 65-12126	16 avg, 23 max	1,128	Payette River	1/1 to 12/31	n/a	n/a	n/a	n/a	n/a	IDG131005
SFSR and SFCEP[4]	South Fork Salmon River Satellite	South Fork Salmon River / 77-07078	9.2 avg, 20 max	823	South Fork Salmon River	6/1 to 9/30	n/a	n/a	n/a	1 intake, 1 weir, 1 fish ladder	see below[5]	n/a
JCAPE	Johnson Creek Weir and Screw Trap	n/a	n/a	n/a	n/a	Weir: 6/1 to 9/30 Screw trap: 2/28 to 11/30	n/a	n/a	n/a	1 weir and 1 screw trap	n/a	n/a
SFCEP	Curtis and Cabin Creek Eggboxes	n/a	n/a	n/a	n/a	10/1 to5/31	n/a	n/a	n/a	12 eggboxes	n/a	n/a

[1]The fish ladder associated with the Rapid River trap is unscreened so as to allow both upstream and downstream fish migration. During a portion of the year IDFG manages upstream movement of adult salmonids via its operation of the trap. During the remainder of the year the trap is reconfigured to allow unimpeded fish movement in both directions.
[2] The Oxbow Fish Hatchery surface water right and use from the Snake River is included in the water rights for State of Oregon Project 161. Amended in December 1961 from the original in December 1955, Article 3b says the licensee shall construct, maintain, and operate facilities for fish migration, propagation, or conservation under the license from Federal Power Commission Project No. 1971. HE 161 was issued on December 19, 1961, with priority dates of June 23, 1947 for 16,000 cfs; December 20, 1955, for 8,500 cfs; and December 4, 1961, for 2,000 cfs. Thus, total water right for the Oxbow Project is 26,500 cfs from the Snake River.
[3]The intake to the Hells Canyon Trap pump chamber is fitted with a trash rack comprised of horizontal bars with 1-inch openings between the bars. The location of trap is in the immediate tailrace of Hells Canyon Dam and presents a low risk of entrainment or impingement of juvenile or adult salmonids. Significant modification of the Hells Canyon Trap is anticipated in association with issuance of a new FERC operating license for the Hells Canyon Complex. Informal consultation with NOAA and the USFWS on the new Hells Canyon license, including review of trap modifications, is ongoing.
[4] SFCEP only utilizes the MCFH for broodstock operations and egg incubation until the eyed-up stage, which is covered under the SFSR HGMP
[5]The existing facility and any subsequent structures (as applicable) were built to design specifications at the time of construction. Structures are currently being evaluated by operators relative to compliance with NMFS's 2011 Screening/Passage criteria. When final assessments are completed, facility managers/cooperators will coordinate with NMFS to determine compliance levels (e.g., in compliance, in compliance with minor variances, or out of compliance) and develop a strategy to prioritize appropriate/necessary modifications contingent on funding availability, program need, and biological impacts to listed and native fish.

Source: (IDFG 2016b; IDFG 2016c; IDFG 2017d; NPT 2017; SBT 2017)

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. NMFS has not identified any interdependent or interrelated activities associated with the proposed action.

Fisheries are not part of this Proposed Action. Although tributary fisheries target hatchery-origin returns from these programs, harvest frameworks are managed separately from hatchery production, and are not solely tied to production numbers. Additionally, production and fishery implementation are subject to different legal mandates and agreements. Because of the complexities in annual management of the production and fishery plans, fisheries in these areas are considered a separate action.

There are also existing mainstem Columbia River and ocean fisheries that may catch fish from these programs. However, these mixed fisheries would exist with or without these programs, and have previously been evaluated in a separate biological opinion (NMFS 2008b). The impacts of fisheries in the Action Area on these programs and, in particular, on ESA-listed salmonids returning to the Action Area for this opinion are included in the environmental baseline.

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. Section 7(a)(2) of the ESA requires Federal agencies to consult with the U.S. Fish and Wildlife Service (USFWS), NMFS, or both, 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. Section 7(b)(3) requires that at the conclusion of consultation, NMFS provide an opinion stating how the agencies' actions will affect listed species or their critical habitat. If incidental take is expected, Section 7(b)(4) requires the provision of an incidental take statement specifying the impact of any incidental taking, and including reasonable and prudent measures to minimize such impacts.

2.1. Introduction to the Biological Opinion

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 Fed. Reg. 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 Fed. Reg. 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. In this biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

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

The 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 (Mitchell Act Biological Opinion) (NMFS 2017b)) that was completed by NMFS in 2017 has largely contributed to the status descriptions (Section 2.3), the description of the environmental baseline (Section 2.5), the description of the factors that are considered when analyzing hatchery effects (Section 2.6), as well as background information used to analyze the hatchery effects (Section 2.6.2) in this Biological Opinion. Information from the Mitchell Act Biological Opinion has either been incorporated by reference or descriptions have been taken directly or modified to suit this Biological Opinion.

2.2. Analytical Approach

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 Population" (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 physical and biological features (also called "primary constituent elements" or PCEs). Status of the species and critical habitat are discussed in Section 2.3.

Description of the environmental baseline

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 2.5 of this opinion.

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 2.7 of this opinion.

Integration and synthesis

Integration and synthesis occurs in Section 2.8 of this opinion. In this step, NMFS adds the effects of the Proposed Action (Section 2.6.2) to the status of ESA protected populations in the Action Area under the environmental baseline (Section 2.5) and to cumulative effects (Section 2.7). Impacts on individuals within the affected populations are analyzed to determine their effects on the VSP parameters for the affected populations, and these are combined with the overall status of the strata/MGP to determine the effects on the ESA-listed species (ESU/DPS) which will be used to formulate the agency's opinion as to whether the hatchery action is likely to: (1) result in appreciable reductions in the likelihood of both survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution; or (2) reduce the value of designated or proposed critical habitat.

Jeopardy and adverse modification

Based on the Integration and Synthesis analysis in Section 2.8, the opinion determines whether the proposed action is likely to jeopardize the survival and recovery of ESA-listed species or destroy or adversely modify designated critical habitat in Section 2.7.

Reasonable and prudent alternative(s) to the Proposed Action

If NMFS determines that the action under consultation is likely to jeopardize the continued existence of listed species or destroy or adversely modify designated critical habitat, NMFS must identify an RPA or RPAs to the Proposed Action.

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

This Opinion examines the status of each ESA listed species that would be affected by the Proposed Action as described in Table 9[2]. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status Section also helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02. The Opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the current function of the essential physical and biological features that help to form that conservation value.

Table 9. Federal Register notices for the final rules that list species, designate critical habitat, or apply protective regulations to a listed species considered in this consultation.

Species	Listing Status	Critical Habitat	Protective Regulations
Chinook salmon *(Oncorhynchus tshawytscha)*			
Snake River spring/summer-run	Threatened, 79 FR[3] 20802, April 14, 2014	64 FR 57399, October 25, 1999	70 FR 37160, June 28, 2005
Snake River fall-run	Threatened, 79 FR 20802, April 14, 2014	58 FR 68543, December 28, 1993	70 FR 37160, June 28, 2005
Sockeye salmon *(O. nerka)*			
Snake River	Endangered, 79 FR 20802, April 14, 2014	70 FR 52630, September 2, 2005	Issued under ESA Section 9
Steelhead *(O. mykiss)*			
Snake River Basin	Threatened, 79 FR 20802, April 14, 2014	70 FR 52769, September 2, 2005	70 FR 37160, June 28, 2005

"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 distinct population, and hence a "species" under the ESA if it represents an 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 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 USFWS-NMFS DPS policy (61 FR 4722, February 7, 1996). Under this

[2] ESA-listed bull trout (*Salvelinus confluentus*) are administered by the FWS. ESA compliance for bull trout is currently being addressed through a separate consultation with FWS.

[3] Citations to "FR" and "Fed. Reg." are citations to the Federal Register.

policy, a DPS of steelhead must be discrete from other populations, and it must be significant to its taxon. The two Chinook salmon species listed in Table 9 each constitute an ESU (a salmon DPS) of the taxonomic species *Oncorhynchus tshawytscha*; Snake River Sockeye salmon constitute an ESU of the taxonomic species *Oncorhynchus nerka;* and the steelhead constitutes a DPS of the taxonomic species *Oncorhynchus mykiss*.

2.3.1. **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 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).

In describing the range-wide status of listed species, we rely on viability assessments and criteria in TRT documents and recovery plans, when available, that describe VSP parameters at the population, major population group (MPG), and species scales (i.e., salmon ESUs and steelhead DPSs). For species with multiple populations, once the biological status of a species' populations and MPGs have been determined, NMFS assesses the status of the entire species. Considerations for species viability include having multiple populations that are viable, ensuring that populations with unique life histories and phenotypes are viable, and that some viable populations are both widespread to avoid concurrent extinctions from mass catastrophes and spatially close to allow functioning as meta-populations (McElhany et al. 2000).

2.3.1.1. Life History and Status of Snake River Spring/Summer Chinook Salmon

On June 3, 1992, NMFS listed the Snake River spring/summer-run Chinook Salmon ESU as a threatened species (57 FR 23458). More recently, the threatened status was reaffirmed on June 28, 2005 (70 FR 37160) and on April 14, 2014 (79 FR 20802) (Table 9). Critical habitat was originally designated on December 28, 1993 (58 FR 68543) but updated most recently on October 25, 1999 (65 FR 57399) (Table 9).

The Snake River spring/summer-run Chinook Salmon ESU includes all naturally spawned populations of spring/summer-run Chinook salmon in the mainstem Snake River and the Tucannon River, Grande Ronde River, Imnaha River, and Salmon River subbasins, as well as 11 artificial propagation programs (Jones Jr. 2015; NWFSC 2015). However, inside the geographic range of the ESU, there are a total of 19 hatchery spring/summer-run Chinook salmon programs currently operational (Jones Jr. 2015). Table 10 lists the natural and hatchery populations included (or excluded) in the ESU.

Table 10. Snake River Spring/Summer-Run Chinook Salmon ESU description and MPGs (Jones Jr. 2015; NWFSC 2015).

ESU Description	
Threatened	Listed under ESA in 1992; updated in 2014 (see Table 9)
5 major population groups	28 historical populations (4 extant)
Major Population Group	***Populations***
Lower Snake River	Tucannon River
Grande Ronde/Imnaha River	Wenaha, Lostine/Wallowa, Minam, Catherine Creek, Upper Grande Ronde, Imnaha
South Fork Salmon River	Secesh, East Fork/Johnson Creek, South Fork Salmon River Mainstem, Little Salmon River
Middle Fork	Bear Valley, Marsh Creek, Sulphur Creek, Loon Creek, Camas Creek, Big Creek, Chamberlain Creek, Lower Middle Fork (MF) Salmon, Upper MF Salmon
Upper Salmon	Lower Salmon Mainstem, Lemhi River, Pahsimeroi River, Upper Salmon Mainstem, East Fork Salmon, Valley Creek, Yankee Fork, North Fork Salmon
Artificial production	
Hatchery programs included in ESU (11)	Tucannon River Spr/Sum, Lostine River Spr/Sum, Catherine Creek Spr/Sum, Looking glass Hatchery Reintroduction Spr/Sum, Upper Grande Ronde Spr/Sum, Imnaha River Spr/Sum, Big Sheep Creek-Adult Spr/Sum out planting from Imnaha program, McCall Hatchery summer, Johnson Creek Artificial Propagation Enhancement summer, Pahsimeroi Hatchery summer, Sawtooth Hatchery spring.

Twenty eight historical populations (4 extirpated) within five MPGs comprise the Snake River spring/summer-run Chinook Salmon ESU. The natural populations are aggregated into the five extant MPGs based on genetic, environmental, and life history characteristics. Figure 1 shows a map of the current ESU and the MPGs within the ESU.

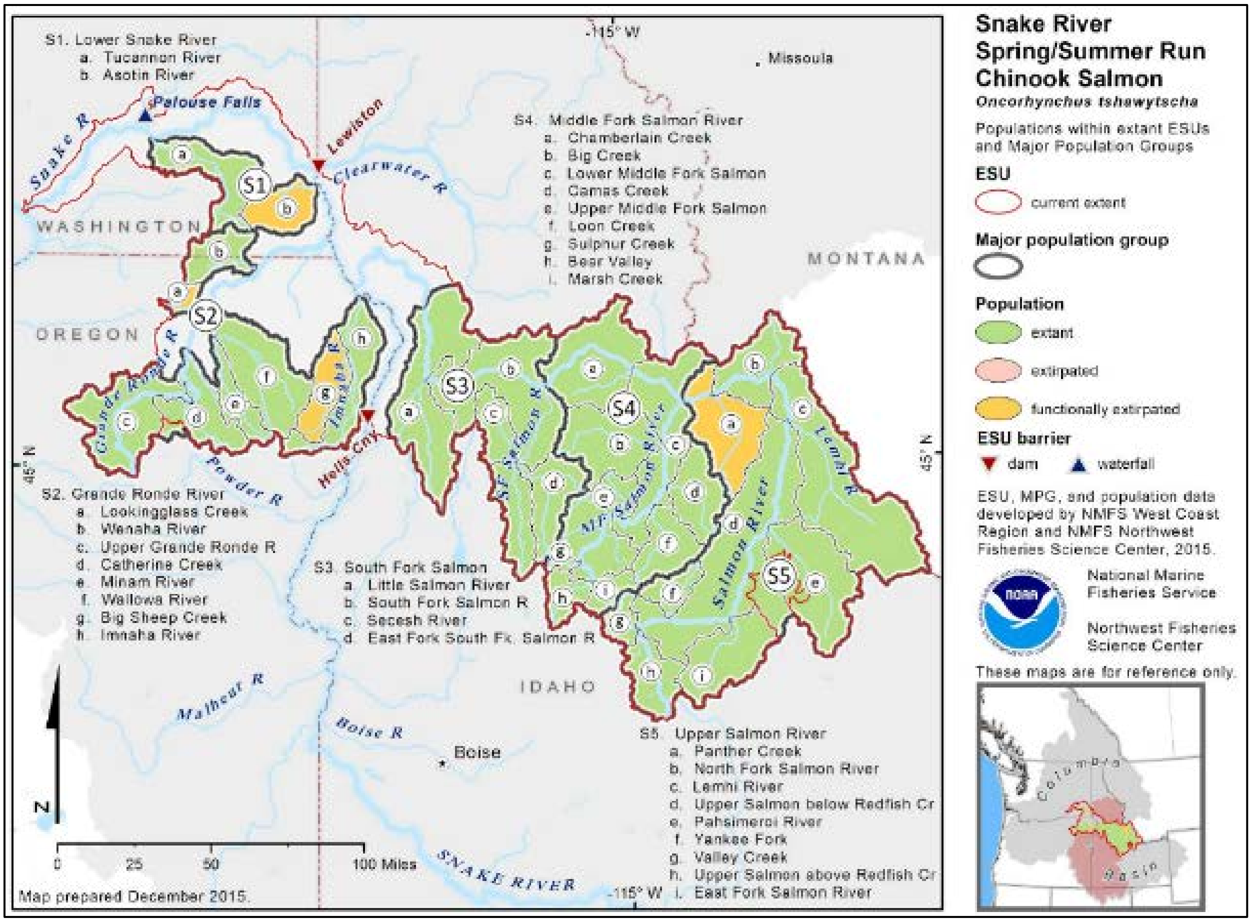

Figure 1. Snake River Spring/Summer-Run Chinook Salmon ESU spawning and rearing areas, illustrating natural populations and MPGs (NWFSC 2015).

The Snake River Spring/Summer Chinook Salmon ESU consists of “stream-type” Chinook salmon, which spend 2 to 3 years in ocean waters and exhibit extensive offshore ocean migrations (Myers et al. 1998). Chinook salmon return to the Columbia River from the ocean in early spring through August. Returning fish hold in deep mainstem and tributary pools until late summer, when they migrate up into tributary areas and spawn from mid- through late August. The eggs incubate over the following winter, and hatch in late winter and early spring of the following year. Juveniles rear through the summer, overwinter, and typically migrate to sea in the spring of their second year of life, although some juveniles may spend an additional year in fresh water. Snake River spring/summer-run Chinook salmon spend two or three years in the ocean before returning to tributary spawning grounds primarily as 4- and 5-year-old fish. A small fraction of the fish return as 3-year-old “jacks,” heavily predominated by males.

Historically, the Snake River drainage is thought to have produced more than 1.5 million adult spring/summer-run Chinook salmon in some years during the late 1800s (Matthews and Waples 1991). By the 1950s, the abundance of spring/summer-run Chinook salmon had declined to an annual average of 125,000 adults, and continued to decline through the 1970s. In 1995, only 1,797 spring/summer-run Chinook salmon adults returned (hatchery and wild fish combined).

Returns at Lower Granite Dam (LGD) (hatchery and wild fish combined) dramatically increased after 2000, with 185,693 adults returning in 2001. The large increase in 2001 was due primarily to hatchery returns, with only 10% of the returns from fish of natural-origin (NMFS 2012).

The causes of oscillations in abundance are uncertain, but likely due to a combination of factors. Over the long-term, population size is affected by a variety of factors, including: ocean conditions, harvest, increased predation in riverine and estuarine environments, construction and continued operation of Snake and Columbia River Dams; increased smolt mortality from poor downstream passage conditions; competition with hatchery fish; and widespread alteration of spawning and rearing habits. Spawning and rearing habits are commonly impaired in places from factors such as agricultural tilling, water withdrawals, sediment from unpaved roads, timber harvest, grazing, mining, and alteration of floodplains and riparian vegetation. Climate change is also recognized as a possible factor in Snake River salmon declines (NMFS 2012; Scheuerell and Williams 2005; Tolimieri and Levin 2004).

Abundance, Productivity, Spatial Structure, and Diversity

Status of the species is determined based on VSP criteria including abundance, productivity, spatial structure, and diversity of its constituent natural populations (McElhany et al. 2000). NMFS has initiated recovery planning for the Snake River drainage, organized around a subset of management unit plans corresponding to state boundaries. The recovery plans will incorporate VSP criteria recommended by the Interior Columbia Technical Recovery Team (ICTRT). The ICTRT recovery criteria are hierarchical in nature, with ESU/DPS level criteria being based on the status of natural-origin Chinook salmon assessed at the population level. The population level assessments are based on a set of metrics designed to evaluate risk across the four VSP elements. The ICTRT approach calls for comparing estimates of current natural-origin abundance and productivity against predefined viability curves (NWFSC 2015). Achieving recovery (i.e., delisting the species) of each ESU is the longer-term goal of the recovery plan. Table 11 shows the most recent metrics for the Snake River spring/summer-run Chinook Salmon ESU. A more detailed description of the populations that are the focus of this consultation follows.

Table 11. Measures of viability and overall viability rating for Snake River spring/summer-run Chinook salmon populations[1] (NWFSC 2015).

Population	Abundance/Productivity Metrics				Spatial Structure and Diversity Metrics			Overall Viability Rating
	ICTRT Minimum Threshold	Natural Spawning Abundance	ICTRT Productivity	Integrated A/P Risk	Natural Processes Risk	Diversity Risk	Integrated SS/D Risk	
Lower Snake River MPG								
Tucannon River	750	↑ 267 (.19	↓ .69 (.23)	High	Low	Moderate	Moderate	HIGH RISK
Asotin Creek	500	extirpated						extirpated
Grande Ronde/Imnaha MPG								
Wenaha River	750	↓ 399 (.12)	↑ .93 (.21)	High	Low	Moderate	Moderate	HIGH RISK
Lostine/Wallowa R.	1,000	↑ 332 (.24)	↑ .98 (.12)	High	Low	Moderate	Moderate	HIGH RISK
Lookingglass R. (ext)	500	extirpated						extirpated
Minam R.	750	↑ 475 (.12)	↑ .94 (18)	High(M)	Low	Moderate	Moderate	HIGH RISK
Catherine Creek	1,000	↑ 110 (.31)	↑ .95 (.15)	High	Moderate	Moderate	Moderate	HIGH RISK
Upper Gr. Ronde R.	1,000	↑ 43 (.26)	↑ .59 (.28)	High	High	Moderate	High	HIGH RISK
Imnaha River	750	↑ 328 (.21)	↑ 1.20 (.09)	High (M)	Low	Moderate	Moderate	HIGH RISK
South Fork MPG								
South Fork Mainstem	1,000	↑ 791 (.18)	↓ 1.21 (.20)	High (M)	Low	Moderate	Moderate	HIGH RISK
Secesh River	750	↑ 472 (.18)	○ 1.25 (.20	High(M)	Low	Low	Low	HIGH RISK
East F./Johnson Cr.	1,000	↑ 208 (.24)	↓ 1.15 (.20)	High	Low	Low	Low	HIGH RISK
Little Salmon River	750	Insf. data			Low	Low	Low	HIGH RISK
Middle Fork MPG								
Chamberlain Creek	750	↑ 641 (.17)	↓ 2.26 (.45)	Moderate	Low	Low	Low	Maintained
Big Creek	1,000	↑ 164 (.23)	↓ 1.10 (.21)	High	Very Low	Moderate	Moderate	HIGH RISK
Loon Creek	500	↓ 54 (.10)	↓ .98 (.40)	High	Low	Moderate	Moderate	HIGH RISK
Camas Creek	500	↑ 38 (.20)	↓ .80 (.29)	High	Low	Moderate	Moderate	HIGH RISK
Lower Mainstem MF	500	Insf. data	Insf.data	-	Moderate	Moderate	Moderate	HIGH RISK
Upper Mainstem MF	750	↑ 71 (.18)	↓ 0.50 (.72)	High	Low	Moderate	Moderate	HIGH RISK
Sulphur Creek	500	↑ 67 (.99)	↑ .92 (.26)	High	Low	Moderate	Moderate	HIGH RISK
Marsh Creek	500	↑ 253 (.27)	↓ 1.21 (.24)	High	Low	Low	Low	HIGH RISK
Bear Valley Creek	750	↑ 474 (.27	↓ 1.37 (.17)	High(M)	Very Low	Low	Low	HIGH RISK
Upper Salmon River MPG								
Salmon Lower Main	2,000	↓ 108 (.18)	↑ 1.18 (.17)	High	Low	Low	Low	HIGH RISK
Salmon Upper Main	1,000	↑ 411 (.14)	↑ 1.22 (.19)	High (M)	Low	Low	Low	HIGH RISK
Pahsimeroi River	1,000	↑ 267 (.16)	↑ 1.37 (.20)	High (M)	Moderate	High	High	HIGH RISK
Lemhi River	2,000	↑ 143 (.23)	↑ 1.30 (.23)	High	High	High	High	HIGH RISK
Valley Creek	500	↑ 121 (.20)	↑ 1.45 (.15)	High	Low	Moderate	Moderate	HIGH RISK
Salmon East Fork	1,000	↑ 347 (.22)	↑ 1.08 (.28)	High	Low	High	high	HIGH RISK
Yankee Fork	500	↑ 44 (.45)	↓ .72 (.39)	High	Moderate	High	High	HIGH RISK
North Fork	500	Insf. data	Insf. data		Low	Low	Low	HIGH RISK
Panther Creek (ext)	750	Insf. data	Insf. data					extirpated

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

There are four independent populations within the South Fork Salmon river Major Population Group (MPG). These include the South Fork Salmon River, Secesh River, East Fork of the South Fork Salmon River (Johnson Creek), and the Little Salmon River. The hatchery programs in this consultation directly affect the South Fork Salmon River, East Fork of the South Fork Salmon River (Johnson Creek), and the Little Salmon River populations. The South Fork Salmon River population is required to meet viable status, while both the East Fork of the South Fork Salmon River (Johnson Creek) and Little Salmon River populations are considered "maintained" populations. In addition, the potential scenario identified by ICTRT calls for the Secesh population to be highly viable. The most recent status review by NMFS (NWFSC 2015) maintains that these populations are all at high risk (Table 12).

Table 12. Risk levels and viability ratings for Snake River spring/summer-run Chinook salmon South Fork Salmon River MPG, populations, and key elements (abundance/productivity "A/P", diversity, and spatial structure/diversity "SS/D") used to determine current overall viability risk for Snake River spring/summer-run Chinook salmon (NWFSC 2015). [1]

MPG	Population	A/P	Diversity	Integrated SS/D	Overall Viability Risk
South Fork Salmon River	South Fork Salmon River	H	M	M	H
	Secesh River	H	L	L	H
	East Fork of the South Fork Salmon River	H	L	L	H
	Little Salmon River	N/A[2]	N/A[2]	N/A[2]	H

[1]Risk ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH), and extirpated (E).
[2]Insufficient data

Limiting Factors

Understanding the limiting factors and threats that affect the Snake River spring/summer-run 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-run Chinook salmon had already began to decline by the 1950s, and it continued declining through the 1970s. In 1995, only 1,797 spring/summer-run Chinook salmon total adults (both hatchery and natural combined) returned to the Snake River (NMFS 2012).

There are many factors that affect the abundance, productivity, spatial structure, and diversity of the Snake River spring/summer-run Chinook Salmon ESU. Factors that limit the ESU's survival and recovery include migration through the Federal Columbia River Power System (FCRPS) dams, the degradation and loss of estuarine areas that help fish transition between fresh and marine waters, spawning and rearing areas that have lost deep pools, loss of cover, reductions in side-channel refuge areas, reductions in high-quality spawning gravels, and interbreeding and competition with hatchery fish that may outnumber natural-origin fish (Ford 2011). The most serious risk factor is low natural productivity and the associated decline in abundance to low levels relative to historical returns. The biological review team (Ford 2011) was concerned about the number of hatchery programs across the ESU, noting that these programs represent ongoing risks to natural populations and can make it difficult to assess trends in natural productivity.

NMFS (2012) determined the range-wide status of critical habitat by examining the condition of its PBF (also called PCEs, in some designations) 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 (e.g., sites with conditions that support spawning, rearing, migration, and foraging). PCEs for Snake River spring/summer-run Chinook salmon are shown in Table 13.

Table 13. PCEs identified for Snake River spring/summer-run Chinook salmon (NMFS 2012).

Habitat Component	Primary Constituent Elements (PCEs)
Spawning and juvenile rearing areas	1) spawning gravel 2) water quality 3) water quantity 4) cover/shelter 5) food 6) riparian vegetation 7) space
Juvenile migration corridors	1) substrate 2) water quality 3) water quantity 4) water temperature 5) water velocity 6) cover/shelter 7) food 8) riparian vegetation 9) space 10) safe passage
Areas for growth and development to adulthood	Ocean areas – not identified
Adult migration corridors	1) substrate 2) water quality 3) water quantity 4) water temperature 5) water velocity 6) cover/shelter 7) riparian vegetation 8) space 9) safe passage

Although the status of the ESU is improved relative to measures available at the time of listing, the ESU has remained at threatened status.

2.3.1.2. Life History and Status of 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) (Table 9). Critical habitat for the DPS was designated on September 2, 2005 (70 FR 52769) (Table 9).

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 (NWFSC 2015). Twenty four historical populations within six MGPs comprise the Snake River Basin Steelhead DPS. Inside the geographic range of the DPS, 19 hatchery steelhead programs are currently operational. Nine of these artificial programs are included in the DPS (Table 14). This DPS consists of A-run steelhead which are primarily returning to spawning areas beginning in the summer and the B-run steelhead, which exhibit a larger body size and begin their migration in the fall (NMFS 2011a). Figure 2 shows a map of the current DPS and the MPGs within the DPS.

Table 14. Snake River Basin Steelhead DPS description and MPGs (Jones Jr. 2015; NMFS 2012; NWFSC 2015).

DPS Description	
Threatened	Listed under ESA as threatened in 1997; updated in 2014 (see Table 9)
6 major population groups	27 historical populations (3 extirpated)
Major Population Group	***Populations***
Grande Ronde	Joseph Creek, Upper Mainstem, Lower Mainstem, Wallowa River
Imnaha River	Imnaha River
Clearwater	Lower Mainstem River, North Fork Clearwater, Lolo Creek, Lochsa River, Selway River, South Fork Clearwater
Salmon River	Little Salmon/Rapid, Chamberlain Creek, Secesh River, South Fork Salmon, Panther Creek, Lower MF, Upper MF, North Fork, Lemhi River, Pahsimeroi River, East Fork Salmon, Upper Mainstem
Lower Snake	Tucannon River, Asotin Creek
Hells Canyon Tributaries	n/a
Artificial production	
Hatchery programs included in DPS (7)	Tucannon River summer, Little Sheep Creek/Imnaha River Hatchery summer, EF Salmon River A, Dworshak NFH B, Lolo Creek B, Clearwater Hatchery B, SF Clearwater (localized) B

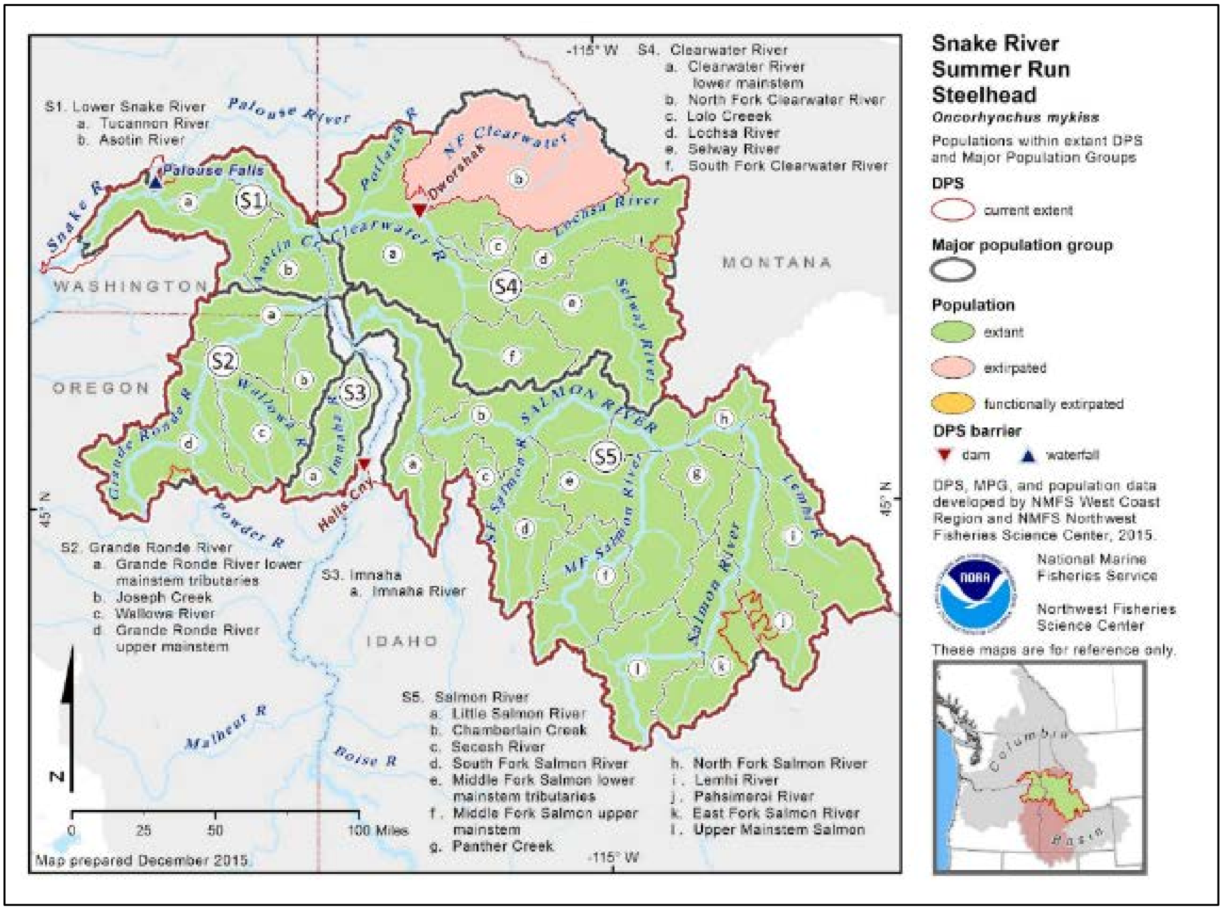

Figure 2. Snake River Basin Steelhead DPS spawning and rearing areas, illustrating natural populations and MPGs (NWFSC 2015).

O. mykiss exhibit perhaps the most complex suite of life-history traits of any species of Pacific salmonid. They can be anadromous or freshwater resident, and under some circumstances, yield offspring of the opposite form. Steelhead are the anadromous form. A non-anadromous form of *O. mykiss* (redband trout) co-occurs with the anadromous form in this DPS, and juvenile life stages of the two forms can be very difficult to differentiate. Steelhead can spend up to 7 years in fresh water prior to smoltification, and then spend up to 3 years in salt water prior to first spawning. This species can also spawn more than once (iteroparous), whereas all other species of *Oncorhynchus*, except cutthroat trout (*O. clarkii)*, spawn once and then die (semelparous). Snake River steelhead are classified as summer-run because they enter the Columbia River from late June to October. After holding over the winter, summer steelhead spawn the following spring (March to May).

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. The most recent status update (NWFSC 2015) used new data (i.e., data from 2009 to 2014) to inform the analysis on this DPS. Additionally, ODFW has continued to refine sampling methods for various survey types, which has also led to more accurate data available for use. However, a great deal of uncertainty remains regarding the relative proportion of hatchery-origin fish in natural spawning areas near major hatchery release sites. Because of this, it is difficult to estimate changes in the DPS viability (NWFSC 2015).

Population-specific adult population abundance is generally not available for the Snake River Basin steelhead due to difficulties conducting surveys in much of their range. Evaluations in the 2015 status review were done using both a set of metrics corresponding to those used in prior BRT reviews, as well as a set corresponding to the specific viability criteria based on ICTRT recommendations for this DPS. The BRT level metrics were consistently done across all ESUs and DPSs to facilitate comparisons across domains. The most recent five year geometric mean abundance estimates for the two long term data series of direct population estimates (Joseph Creek and Upper Grande Ronde Mainstem populations) both increased compared to the prior review estimates; each of the populations increased an average of 2% per year over the past 15 years. Hatchery-origin spawner estimates for both populations continued to be low, and both populations are currently approaching the peak abundance estimates observed since the mid-1980s (NWFSC 2015).

The ICTRT viability criteria adopted in the draft 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. At present, direct estimates of hatchery returns based on PBT analysis are available for the run assessed at LGR (IDFG 2015). Furthermore, information from the Genetic Stock Identification (GSI) assessment sampling provide an opportunity to evaluate the relative contribution of B-run returns within each stock group. No population fell exclusively into the B-run size category, although there were clear differences among population groups in the relative contributions of the larger B-run life history type (NWFSC 2015).

Limiting Factors

Factors that limit the DPS’s survival and recovery include: juvenile and adult migration through the FCRPS; the degradation and loss of estuarine areas that help fish 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 outnumber natural-origin fish.

Steelhead were historically harvested in tribal and non-tribal gillnet fisheries, and in recreational fisheries in the mainstem Columbia River and in tributaries. Steelhead are still harvested in tribal fisheries and there is incidental mortality associated with mark-selective recreational and commercial fisheries. The majority of impacts on the summer run occur in tribal gillnet and dip net fishing targeting Chinook salmon. Because of their larger size, the B run fish are more vulnerable to gillnet gear. In recent years, total exploitation rates (exploitation rates are the sum of all harvest) on the A run have been stable around 5%, while exploitation rates on the B-run have generally been in the range of 15-20% (NWFSC 2015).

Four out of the five MPGs are not meeting the specific objectives in the draft Snake River Recovery Plan, and the status of many individual populations remain uncertain. The additional monitoring programs instituted in the early 2000s to gain better information on natural-origin abundance and related factors have significantly improved the ability to assess status at a more detailed level. The new information has resulted in an updated view of the relative abundance of natural-origin spawners and life history diversity across the populations in the DPS. The more specific 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 geography or elevation rather than the morphological forms (i.e., A-run versus B-run). A great deal of uncertainty still remains regarding the relative proportion of hatchery-origin fish in natural spawning areas near major hatchery release sites within individual populations. Overall, the information analyzed for the 2015 status review does not indicate a change in biological risk status since the status review in 2010 (NWFSC 2015).

2.3.1.3. Life History and Status of Snake River Fall Chinook Salmon

On June 3, 1992, NMFS listed the Snake River fall-run Chinook Salmon ESU as a threatened species (57 FR 23458). More recently, the threatened status was reaffirmed on June 28, 2005 (70 FR 37160) and on April 14, 2014 (79 FR 20802) (Table 9). Critical habitat was designated on December 28, 1993 (58 FR 68543) (Table 9).

The Snake River fall-run Chinook Salmon ESU includes naturally spawned fish in the lower mainstem of the Snake River and the lower reaches of several of the associated major tributaries including the Tucannon, the Grande Ronde, Clearwater, Salmon, and Imnaha Rivers, along with 4 artificial propagation programs (Jones Jr. 2015; NWFSC 2015). All of the hatchery programs are included in the ESU.

Table 15. Snake River Fall-Run Chinook Salmon ESU description and MPGs (Jones Jr. 2015; NWFSC 2015).

ESU Description	
Threatened	Listed under ESA in 1992; updated in 2014 (see Table 9)
1 major population groups	2 historical populations (1 extirpated)
Major Population Group	***Population***
Snake River	Lower Mainstem Fall-Run
Artificial production	
Hatchery programs included in ESU (4)	Lyons Ferry NFH fall, Acclimation Ponds Program fall, Nez Perce Tribal Hatchery fall, Idaho Power fall.

Two historical populations (1 extirpated) within one MPG comprise the Snake River fall-run Chinook Salmon ESU. The extant natural population spawns and rears in the mainstem Snake River and its tributaries below Hells Canyon Dam. Figure 3 shows a map of the ESU area. The decline of this ESU was due to heavy fishing pressure beginning in the 1890s and loss of habitat with the construction of Swan Falls Dam in 1901 and the Hells Canyon Complex from 1958 to 1967, which extirpated one of the historical populations. Hatcheries mitigating for losses caused by the dams have played a major role in the production of Snake River fall-run Chinook salmon since the 1980s (NMFS 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).

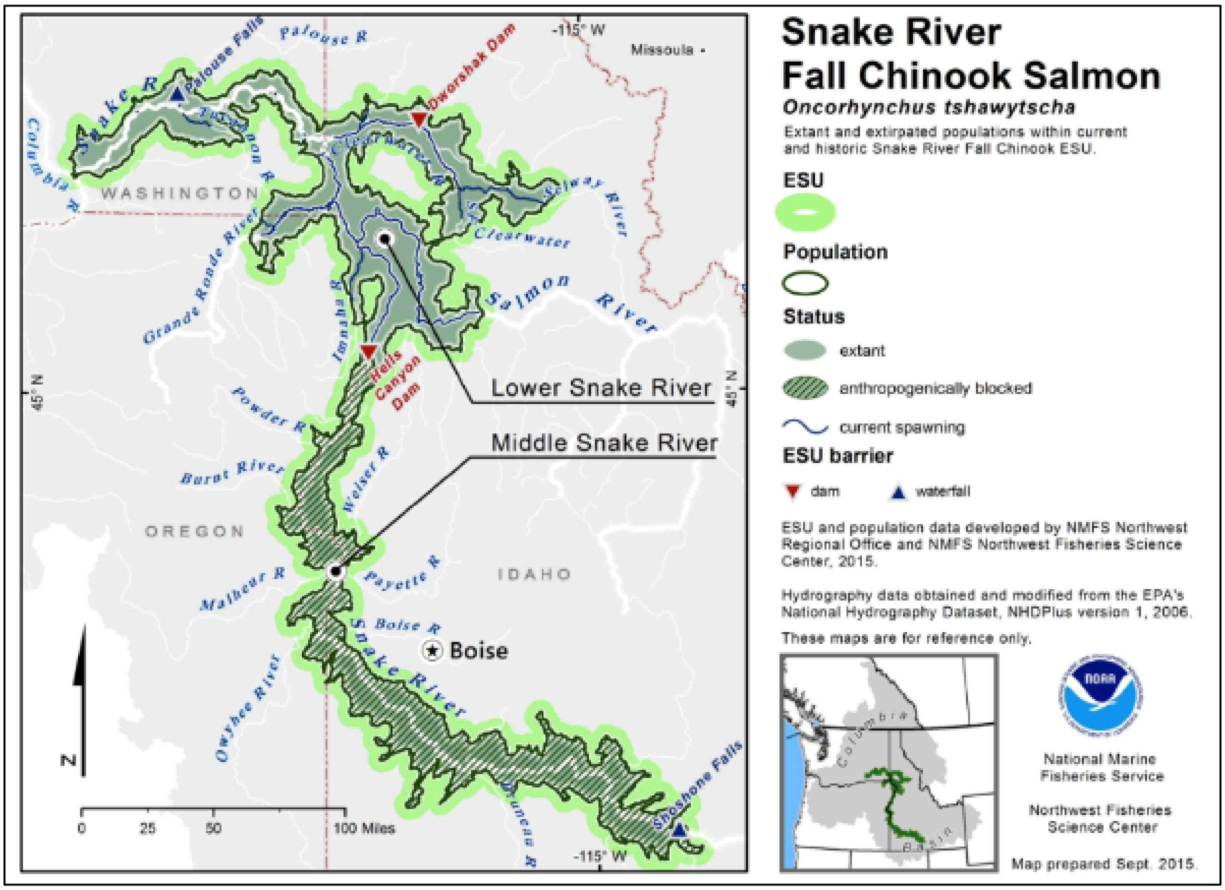

Figure 3. Map of the Snake River Fall-Run Chinook Salmon ESU's spawning and rearing areas, illustrating populations and MPGs (NWFSC 2015).

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

Some fall-run Chinook salmon also spawn in smaller streams such as the Potlatch River, and Asotin and Alpowa Creeks and they may be spawning elsewhere. The vast majority of spawning today occurs upstream of LGD, 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).

As a consequence of losing access to historic spawning and rearing sites heavily influenced by the influx of ground water in the Upper Snake River and effects of dams on downstream water temperatures, Snake River fall-run Chinook salmon now reside in waters that may have thermal regimes that differ from those that historically existed. In addition, alteration of the Lower Snake River by hydroelectric dams has created a series of low-velocity pools that did not exist historically. Both of these habitat alterations have created obstacles to Snake River fall-run Chinook salmon survival. Before alteration of the Snake River Basin by dams, Snake River fall-run Chinook salmon exhibited a largely ocean-type life history, where they migrated downstream during their first-year. Today, fall-run Chinook salmon in the Snake River Basin exhibit one of two life histories that Connor et al. (2005) have called ocean-type and reservoir-type. Juveniles exhibiting the reservoir-type life history overwinter in the pools created by the dams before migrating out of the Snake River. The reservoir-type life history is likely a response to early development in cooler temperatures, which prevents juveniles from reaching a suitable size to migrate out of the Snake River and on to the ocean.

Snake River fall Chinook salmon also spawned historically in the lower mainstems of the Clearwater, Grande Ronde, Salmon, Imnaha, and Tucannon River systems. At least some of these areas probably supported production, but at much lower levels than in the mainstem Snake River. Smaller portions of habitat in the Imnaha and Salmon Rivers have supported Snake River fall-run Chinook salmon. Some limited spawning occurs in all these areas, although returns to the Tucannon River are predominantly releases and strays from the Lyons Ferry Hatchery program (NMFS 2012).

Abundance, Productivity, Spatial Structure, and Diversity

Best available information indicates that the Snake River fall-run Chinook Salmon ESU remains at threatened status, which is based on a low risk rating for abundance/productivity, and a moderate risk rating for spatial structure/diversity (NWFSC 2015).

The recently released Draft NMFS Snake River Fall Chinook Recovery Plan (NMFS 2015b) says that a single population viability scenario could be possible given the unique spatial complexity of the Lower Mainstem Snake River fall-run Chinook salmon population. The recovery plan notes that such 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.

In terms of spatial structure and diversity, the Lower Mainstem Snake River fall-run Chinook salmon population was rated at low risk for Goal A (allowing natural rates and levels of spatially mediated processes) and moderate risk for Goal B (maintaining natural levels of variation) in the status review update (NWFSC 2015), resulting in an overall spatial structure and diversity rating of moderate risk. The moderate risk rating was driven by changes in major life history patterns, shifts in phenotypic traits, and high levels of genetic homogeneity in samples from natural-origin returns. In addition, risk associated with indirect factors (e.g., the high levels of hatchery spawners in natural spawning areas, the potential for selective pressure imposed by current hydropower operations, and cumulative harvest impacts) contribute to the current rating level.

Considering the most recent information available, an increase in estimated productivity (or a decrease in the year-to-year variability associated with the estimate) would be required to achieve delisting status, assuming that natural-origin abundance of the single extant Snake River fall-run Chinook salmon population remains relatively high. An increase in productivity could occur with a further reduction in mortalities across life stages. Such an increase could be generated by actions such as a reduction in harvest impacts (particularly when natural-origin spawner return levels are below the minimum abundance threshold) and/or further improvements in juvenile survivals during downstream migration. It is also possible that survival improvements resulting from various actions (e.g., improved flow-related conditions affecting spawning and rearing, expanded spill programs that increased passage survivals) in recent years have increased productivity, but that increase is effectively masked as a result of the relatively high spawning levels in recent years. A third possibility is that productivity levels may decrease over time as a result of negative impacts of chronically high hatchery proportions across natural spawning areas. Such a decrease would also be largely masked by the high annual spawning levels (NWFSC 2015).

Limiting Factors

Factors that limit the ESU’s survival and recovery include: hydropower projects, predation, harvest, degraded estuary habitat, and degraded mainstem and tributary habitat (Ford 2011). Ocean conditions have also affected the status of this ESU. Ocean conditions affecting the survival of Snake River fall-run Chinook salmon were generally poor during the early part of the last 20 years (NMFS 2012c).

This ESU has been reduced to a single remnant population with a narrow range of available habitat. However, the overall adult abundance has been increasing from the mid-1990s, with substantial growth since the year 2000 (NMFS 2012).

Overall, the status of Snake River fall-run 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 draft recovery plan for the species, which require the single population to be "highly viable with high certainty" and/or will require reintroduction of a viable population above the Hells Canyon Dam complex (NWFSC 2015).

2.3.1.4. Life History and Status of 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) (Table 9). Critical habitat was designated on December 28, 1993 (58 FR 68543) and reaffirmed on September 2, 2005 (Table 9).

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 16).

Table 16. Snake River Sockeye Salmon ESU description and MPG (Jones Jr. 2015; NMFS 2015a).

ESU Description	
Threatened	Listed under ESA in 1991; updated in 2014 (see Table 9)
1 major population group	5 historical populations (4 extirpated)
Major Population Group	***Population***
Sawtooth Valley Sockeye	Redfish Lake
Artificial production	
Hatchery programs included in ESU (1)	Redfish Lake Captive Broodstock

The ICTRT treats Sawtooth Valley Sockeye salmon as the single MPG within the Snake River Sockeye Salmon ESU. The MPG contains one extant population (Redfish Lake) and two to four historical populations (Alturas, Petit, Stanley, and Yellowbelly Lakes) (NMFS 2015a) (Figure 4). 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 2015a). 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, their relationship to the Redfish Lake 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).

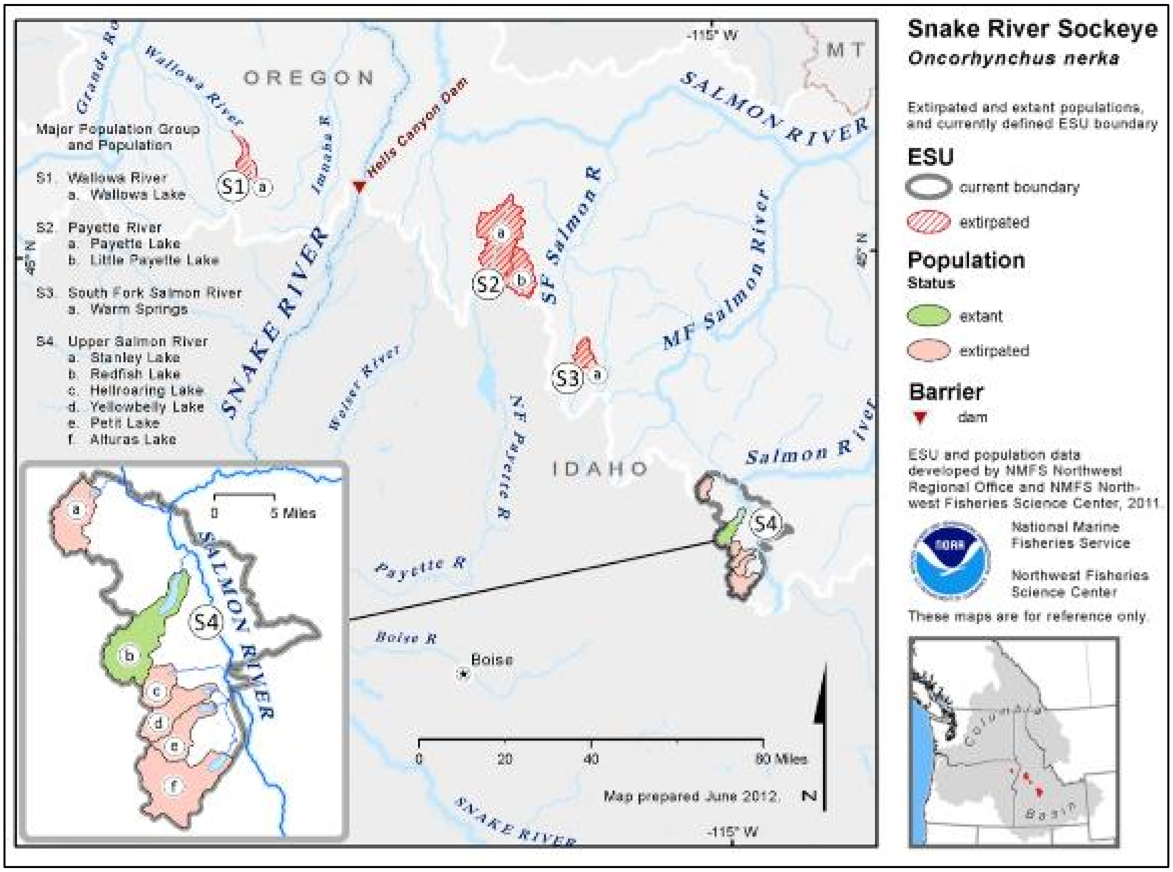

Figure 4. Map of the Snake River Sockeye Salmon ESU's spawning and rearing areas, illustrating populations and MPGs (NWFSC 2015).

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 4). 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 2015a).

Abundance, Productivity, Spatial Structure, and Diversity

Although the endangered Snake River Sockeye Salmon ESU has a long way to go before it will meet the biological viability criteria (i.e., indication that the ESU is self-sustaining and naturally producing and no longer qualifies as a threatened species), annual returns of sockeye salmon through 2013 show that more fish are returning than before initiation of the captive broodstock program which began soon after the initial ESA listing.

Between 1999 and 2007, more than 355 adults returned from the ocean from captive brood releases – almost 20 times the number of natural-origin fish that returned in the 1990s. Though this total is primarily due to large returns in the year 2000. Adult returns in the last six years have ranged from a high of 1,579 fish in 2014 (including 453 natural-origin fish) to a low of 257 adults in 2012 (including 52 natural-origin fish). Sockeye salmon returns to Alturas Lake ranged from one fish in 2002 to 14 fish in 2010. No fish returned to Alturas Lake in 2012, 2013, or 2014 (NMFS 2015b).

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

Furthermore, there is evidence that the historical Snake River Sockeye Salmon ESU included a range of life history patterns, with spawning populations present in several of the small lakes in the Sawtooth Basin (NMFS 2015b). Historical production from Redfish Lake was likely associated with a lake shoal spawning life history pattern although there may have also been some level of spawning in Fish Hook Creek (NMFS 2015b; NWFSC 2015). In NMFS' 2011 status review update for Pacific salmon and steelhead listed under the ESA (Ford 2011), it was not possible to quantify the viability ratings for Snake River Sockeye salmon. Ford (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 2012c).

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

There are many factors that affect the abundance, productivity, spatial structure, and diversity of the Snake River Sockeye Salmon ESU. Factors that limit the ESU have been, and continue to be the result of impaired mainstream and tributary passage, historical commercial 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 2015b; NWFSC 2015). Today, 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, significantly 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 (NMFS 2015b). Climate change is also recognized as a possible factor in Snake River salmon declines (NMFS 2012; Scheuerell and Williams 2005; Tolimieri and Levin 2004).

Limiting Factors

Factors that limit the ESU have been, and continue to be impaired mainstem and tributary passage, historical commercial 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. 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 2015a; NWFSC 2015). However, some limiting factors have improved since the listing. Fisheries are now better regulated through ESA constraints and management agreements, significantly 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 2015a).

2.3.2. **Range Wide Status of 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 9).

(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 three Snake River salmon ESU's, but have been done for both the Snake River and mid-Columbia steelhead DPSs. 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

Also, refer to the Mitchell Act Biological Opinion (NMFS 2017) for a detailed description of how critical habitat has been designated by NMFS.

2.3.2.1. Critical Habitat in Interior Columbia: Snake River Basin, Idaho

Critical habitat has been designated in the Interior Columbia (IC) recovery domain, which includes the Snake River Basin, for the Snake River spring/summer-run Chinook Salmon ESU, Snake River fall-run Chinook Salmon ESU, Snake River Sockeye Salmon ESU, and Snake River Basin Steelhead DPS (Table 9). In the Snake River Basin, some watersheds with PCEs for steelhead (Upper Middle Salmon, Upper Salmon/Pahsimeroi, MF Salmon, Little Salmon, Selway, and Lochsa Rivers) are in good-to-excellent condition with no potential for improvement. Additionally, several Lower Snake River watersheds in the Hells Canyon area, straddling Oregon and Idaho, are in good-to-excellent condition with no potential for improvement (NMFS 2016b).

Habitat quality in tributary streams in the IC recovery domain varies from excellent in wilderness and road-less areas to poor in areas subject to heavy agricultural and urban development. Critical habitat throughout much of the IC recovery domain has been degraded by intense agriculture, alteration of stream morphology (i.e., through channel modifications and diking), riparian vegetation disturbance, wetland draining and conversion, livestock grazing, dredging, road construction and maintenance, logging, mining, and urbanization. Reduced summer stream flows, impaired water quality, and reduction of habitat complexity are common problems for critical habitat in developed areas, including those within the IC recovery domain (NMFS 2016b).

Habitat quality of migratory corridors in this area have been severely affected by the development and operation of the FCRPS dams and reservoirs in the mainstem Columbia River, Bureau of Reclamation tributary projects, and privately owned dams in the Snake River basin. Hydroelectric development has modified natural flow regimes of the rivers, resulting in higher water temperatures, changes in fish community structure that lead to increased rates of piscivorous and avian predation on juvenile salmon and steelhead, and delayed migration for both adult and juvenile salmonids. Physical features of dams, such as turbines, also kill out-migrating fish. In-river survival is inversely related to the number of hydropower projects encountered by emigrating juveniles. Additionally, development and operation of extensive irrigation systems and dams for water withdrawal and storage in tributaries have altered hydrological cycles (NMFS 2016b).

Many stream reaches designated as critical habitat are listed on Idaho's Clean Water Act Section 303(d) list for water temperature. Many areas that were historically suitable rearing and spawning habitat are now unsuitable due to high summer stream temperatures. Removal of riparian vegetation, alteration of natural stream morphology, and withdrawal of water for agricultural or municipal use all contribute to elevated stream temperatures. Furthermore, contaminants, such as insecticides and herbicides from agricultural runoff and heavy metals from mine waste, are common in some areas of critical habitat (NMFS 2016b). They can negatively impact critical habitat and the organisms associated with these areas.

2.4. Action Area

The "Action Area" means all areas to be affected directly or indirectly by the Proposed Action, in which the effects of the action can be meaningfully detected, measured, and evaluated (50 CFR 402.02). The Action Area resulting from this analysis includes the Salmon River upstream through the South Fork Salmon River subbasin as well as the Snake River from Hells Canyon Dam Downstream to Ice Harbor Dam. The extent to which we believe the effects of the Proposed Action can be detected is from the area downstream of the release sites to Ice Harbor Dam. We did not extend the action area beyond Ice Harbor Dam to the estuary/plume because the action area as defined represents the area in which effects of the actin can be meaningfully detected. The Mitchell Act Biological Opinion (2017) considered the effects of hatchery fish in the estuary and ocean, and found that subyearling Chinook salmon and coho salmon are the most likely hatchery fish to have effects in these areas due to their long residence times and relatively high predation rates, respectively. Only yearling Chinook salmon and eyed-eggs are released into the Action Area. This suggests that the likelihood of detecting effects from the releases of hatchery steelhead on natural-origin fish below Ice Harbor Dam have already been examined to the best of our ability.

The effects of the Proposed Action on Southern Resident Killer Whales (SRKW) was considered, but we ultimately determined not to include them in the Action Area because the total number of releases is not large enough to have an effect on Southern Resident Killer Whales. While the primary food source of SRKW is Chinook salmon, the total adult equivalents of all of the proposed hatchery program releases is only 33,368 adult Chinook salmon (based on the average SAR return value of 0.8 to LGD). The Pacific Fisheries Management Council provides ocean abundance estimates for Chinook salmon that originate from the U.S. systems (PFMC 2016a). Between 2008 and 2016, escapement forecasts for Columbia River Chinook salmon stocks ranged from approximately 741,000 to 1,960,800 fish; Puget Sound stocks ranged from 150,600 to 269,800 fish; Washington coast stocks ranged from 65,500 to 115,900 fish, and Oregon and California coast stocks ranged from 142,200 to 1,651,800 fish. The average total Chinook salmon abundance from these sources was approximately 2,035,778 fish. Therefore, 33,368 adult Chinook salmon would be a small portion (or approximately 1.6%) of the total estimated ocean escapement that may be available to SRKW. Therefore, we did not find these proposed releases, which continue to support the escapement totals and do not cause take that would measurably reduce the SRKW prey base, to be a large enough proportion of the run to constitute extending the Action Area to include SRKW geographic ranges.

Within this reach and included in the Action Area are major tributaries where the Proposed Action is likely to have an observable effect. Major tributaries to the Salmon River include Little Salmon River and South Fork Salmon River. We have also included the Rapid River (a tributary to Little Salmon River), East Fork of the South Fork Salmon River (a tributary to the South Fork Salmon River), and Johnson Creek (a tributary to East Fork of the South Fork Salmon River). Besides these tributary reaches, the analyses will focus on the mainstem Salmon and Snake Rivers downstream to Ice Harbor Dam. In addition, Oxbow Fish Hatchery is used to house green eggs before incubation so the area immediately surrounding this facility is included in the Action Area. However, no spawning occurs at Oxbow Fish Hatchery.

2.5. Environmental Baseline

In the Environmental Baseline section, NMFS describes what is affecting ESA-listed species and designated critical habitat in the Action Area 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 and the anticipated impacts of all proposed federal projects in the Action Area that have already undergone formal or early section 7 consultation (50 CFR 402.02). The effects of future actions over which the Federal agency has discretionary involvement or control will be analyzed as 'effects of the action.'

2.5.1. **Idaho Snake River Basin Tributary Habitat**

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

Many tributaries are significantly depleted by water diversions. In 1993, state, Tribal, and conservation group experts estimated that 80% of 153 Columbia tributaries had low flow problems, of which two-thirds were caused, at least in part, by irrigation withdrawals (OWRD 1993). The Northwest Power and Conservation Council showed similar problems in many Idaho tributaries (NPPC 1992). Diminished tributary stream flows have been identified a major limiting factors for most species in the Columbia River Basin upstream of Bonneville Dam (NMFS 2007c).

In many watersheds, access to historical habitat areas is also lost to land development, primarily due to road culverts that are not designed or installed to permit fish passage.

Water quality in many Snake River Basin streams is degraded to varying degrees by human activities, such as construction and operation of dams and diversion structures, water withdrawals, farming and grazing, road construction, timber harvest activities, mining activities, and urbanization. A large number of the streams, river segments, and lakes draining into the Snake River Basin do not meet federally-approved, state or Tribal water quality standards and are now listed as water-quality-impaired under Section 303(d) of the Clean Water Act (CWA). Water quality problems in the upper tributaries contribute to poor water quality in mainstem reaches and the estuary, where sediment and contaminants from the tributaries settle.

Most of the water bodies in Idaho in the Columbia River Basin are on the 303(d) list and do not meet water quality standards for temperature (NMFS 2016c). Temperature alterations affect salmonid metabolism, growth rate, and disease resistance, as well as the timing of adult migrations, fry emergence, and smoltification. Many factors can cause high stream temperatures, but they are primarily related to general land-use practices rather than localized discharges, such as at dams and hatcheries. Some common actions that result in high stream temperatures are the removal of trees or shrubs that directly shade streams, excessive water withdrawals for irrigation or other purposes, and warm irrigation return flows. Loss of wetlands and increases in groundwater withdrawals have contributed to lower base-stream flows, which in turn contribute to water temperature increases because streams with lower flow increase in temperature more rapidly than streams with higher flow. Channel widening and land uses that create shallower streams also increase water temperatures because such streams also increase in temperature more rapidly than deeper streams.

Pollutants also degrade tributary water quality. Salmon require clean gravel for spawning, egg incubation, and emergence of fry. Fine sediments clog the spaces between gravel and restrict the flow of oxygen-rich water to the incubating eggs and they also can entomb fry and prevent them from emerging into the water column. Excess nutrients, low levels of dissolved oxygen, heavy metals, and changes in pH also directly affect water quality for salmon and steelhead.

2.5.1.1. Recent Habitat Restoration Activities

Since the 1990's when salmonid populations began to be listed under the ESA, organizations have coordinated, developed, and implemented various habitat restoration activities in the subbasins within the Snake River Basin. The focus of these projects has been to reduce the effects of ecological concerns (limiting factors) that impact the environment, which may influence VSP metrics of salmonids (Section 2.6). Intensive habitat restoration has been underway since the state of Washington's Salmon Recovery Act of 1998 in the Snake River region.

Since initiation of restoration implementation, significant work has been done to remove fish passage barriers, unscreened irrigation diversions, minimizing fine sediments, and planting riparian buffers. Between 1999 and 2012 in the Snake River Salmon Recovery Region, 52 fish passage barriers were removed or modified, 526 irrigation diversions were properly screened, in-stream flow increased by 81.8 cubic feet per second through efficiency and leases, channel complexity increased by 13.49 miles, 121,730 acres of upland agriculture best management practices were increased to reduce erosion, 262 river miles of riparian habitat was restored, and 7.26 river miles of stream channel confinement was reduced according to the Snake River Salmon Recovery Board. The removal of barriers opened over 229 miles of habitat and the placement of screens has reduced juvenile salmonid injury and mortality. All of these efforts have substantially altered the environmental baseline, and will continue to do so into the future.

2.5.1.2. 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 2017b). The baseline includes all federally-authorized hydropower projects, including projects with licenses issued by the Federal Energy Regulatory Commission, the Federal Columbia River Power System, and other developments which have undergone ESA §7 consultation. Here we summarize some of the key impacts on salmon and steelhead habitat in the Snake River Basin.

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 five run-of-river mainstem dams on the mainstem Snake and Columbia Rivers (safe passage in the migration corridor);
- Water quantity (i.e., flow) and seasonal timing (water quantity and velocity and safe passage in the migration corridor; cover/shelter, food/prey, riparian vegetation, and space associated with the connectivity of the estuarine floodplain);
- Temperature in the reaches below the large mainstem storage projects (water quality and safe passage in the migration corridor)
- 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)

Many floodplains in the Middle and lower Snake River watersheds have been altered by channelization to reduce flooding and by conversion of land to agricultural and residential uses. Flood control structures (i.e. dikes) have been constructed on a number of streams and rivers. These have accelerated surface water runoff and decreased groundwater recharge, contributing to lower summer stream flows. Natural groundwater recharge and discharge patterns have also been modified by groundwater pumpage and surface water diversion for irrigation. Most irrigation water withdrawals occur during the summer dry months when precipitation is lowest and demand for water is the greatest. Road construction, overgrazing, and removal of vegetation in floodplain areas have also caused bank erosion, resulting in wide channels that increase the severity of low summer flows. Primary water quality concerns for salmonids in Snake River tributaries include high water temperatures, which can cause direct mortality or thermal passage barriers, and high sediment loads, which can cause siltation of spawning beds.

While harmful land-use practices continue in some areas, many land management activities, including forestry practices, now have fewer impacts on salmonid habitat due to raised awareness and less invasive techniques. For example, timber harvest on public land has declined drastically since the 1980s and current harvest techniques (e.g., the use of mechanical harvesters and forwarders) and silvicultural prescriptions (i.e., thinning and cleaning) require little, if any, road construction and produce much less sediment. The Federal Conservation Reserve and Enhancement Program began in the 1990's, and since then, nearly 80 percent of all salmonid bearing streams in the area have been re-vegetated with native species and protected from impacts. Under the CREP, highly erodible and other environmentally sensitive lands that have produced crops are converted to a long-term resource-conserving vegetative cover. Participants in the CREP are required to seed native or introduced perennial grasses or a combination of shrubs and trees with native shrubs and grasses.

2.5.1.3. Climate Change

Climate change has negative implications for designated critical habitats in the Pacific Northwest (Climate Impacts Group 2004; ISAB 2007; Scheuerell and Williams 2005; Zabel et al. 2006). Average annual Northwest air temperatures have increased by approximately 1ºC since 1900, or about 50% more than the global average over the same period (ISAB 2007). The latest climate models project a warming of 0.1 ºC to 0.6 ºC per decade over the next century. According to the

Independent Scientific Advisory Board (ISAB), these effects pose the following impacts over the next 40 years:

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

These changes will not be spatially homogeneous across the entire Pacific Northwest. Low-lying areas are likely to be more affected. Climate change may have long-term effects that include, but are not limited to, depletion of important cold water habitat, variation in quality and quantity of tributary rearing habitat, alterations to migration patterns, accelerated embryo development, premature emergence of fry, and increased competition among species (ISAB 2007). For a more detailed description of future climate change effects, refer to the Mitchell Act Biological Opinion (NMFS 2017).

2.5.1.3.1 Effects on salmon

Climate change is predicted to cause a variety of impacts to Pacific salmon and their ecosystems (Crozier et al. (2008a); Martins et al. (2012); Mote et al. (2003); Wainwright and Weitkamp (2013)). The complex life cycles of anadromous fishes including salmon rely on productive freshwater, estuarine, and marine habitats for growth and survival, making them particularly vulnerable to environmental variation (Morrison et al. 2016). Ultimately, the effect of climate change on salmon and steelhead across the region 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 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 population of salmon also varies widely depending on the level or extent of change and the rate of change and the unique life history characteristics of different natural populations (Crozier et al. 2008b). For example, a few weeks difference in migration timing can have large differences in the thermal regime experienced by migrating fish (Martins et al. 2011).

In the Status of Listed Species, Section 2.3.1, local-scale climate effects were listed as a limiting factor for the majority of the species.

2.5.2. **Artificial Propagation**

A more comprehensive discussion of hatchery programs in the Snake River Basin can be found in our opinion on Mitchell Act funded programs (NMFS 2017b). In summary, because most programs are ongoing, the effects of each are reflected in the most recent status of the species, (NWFSC 2015) and was summarized in Section 2.3.1 of this Opinion. In the past, hatcheries have been used to compensate for factors that limit anadromous salmonid viability (e.g., harvest, human development) by maintaining fishable returns of adult salmon and steelhead. A new role for hatcheries emerged during the 1980s and 1990s as a tool to conserve the genetic resources of depressed natural populations and to reduce short-term extinction risk (e.g., Snake River sockeye salmon). Hatchery programs can also be used to help improve viability by supplementing natural population abundance and expanding spatial distribution. However, the long-term benefits and risks of hatchery supplementation remain untested (Christie et al. 2014). Therefore, fixing the factors limiting viability is essential for long-term viability.

Below we have included more detail on the history and purpose of the spring/summer Chinook hatchery programs included in our proposed action: Rapid River, Hells Canyon, South Fork Salmon River, JCAPE, and SFCEP. All programs are currently ongoing; however, there are some differences between how programs are currently being operated and what is being proposed in the Proposed Action, which is covered in Section 2.6.2. Moreover, the effects of the ongoing hatchery programs outline in the Proposed Action (Section 1.3) and included in the Environmental Baseline (Section 2.5) are analyzed in detail in the Effects of the Proposed Action (Section 2.6.2). This effects analysis of the Proposed Action is essential to making our jeopardy determination.

The purpose of the Rapid River and Hells Canyon hatchery programs is to mitigate for anadromous fish losses caused by the construction and operation of the Hells Canyon Complex. Broodstock development for the Rapid River and Hells Canyon programs occurred from 1964 to 1969 when wild spring Chinook salmon adults were trapped at Oxbow and Hells Canyon Dams on the Snake River and were transferred to the Rapid River Fish Hatchery. It is also likely that natural-origin summer Chinook salmon were unintentionally incorporated into the broodstock, as a 1997 study showed that summer and spring Chinook salmon returning to Rapid River are no longer genetically distinct (Moran et al. 1997). Moreover, hatchery records indicate that green or eyed eggs have been used from Pahsimeroi, Clearwater, Dworshak, and ODFW’s Lookingglass hatcheries to supplement these programs. These programs collectively produce a total of 3.0 million spring Chinook salmon smolts every year. Of these releases, the Rapid River program consists of 2.5 million released into Rapid River and 150,000 into the Little Salmon River. The Hells Canyon program consists of 350,000 released into the Snake River below Hells Canyon Dam. In 1964 construction of the Rapid River Fish Hatchery (RRFH) was completed, and early production goals were defined as 600,000 spring Chinook salmon smolts annually. Production goals continued to increase, and following the Hells Canyon Settlement Agreement (HCSA) in 1980, the role of the RRFH was to produce 2.0 million Rapid River spring Chinook salmon and

1.0 million Snake River spring Chinook salmon smolts annually. Production priorities for the 2008-2017 *U.S. v. Oregon* Management Agreement have determined the release locations for these 3.0 million smolts. Approximately 88 to 90 percent of annual broodstock for the production is collected at the Rapid River Fish Hatchery and the balance is collected at the Hells Canyon Trap.

The South Fork Salmon River summer Chinook salmon hatchery program was established to mitigate for fish losses caused by the construction and operation of the four lower Snake River federal dams. The LSRCP program is a federally authorized mandate to annually return a total of 58,700 adult spring/summer Chinook salmon to the affected LSRCP project area and 234,800 adults to commercial and sport fisheries downstream of the project area. Targets associated with the SFSR program reflect local returns of 8,000 adults, with 32,000 available for downstream harvest. The founding broodstock for this program were collected at Little Goose Dam from 1974 to 1978 and from LGD in 1979. Starting in 1980, broodstock was collected from LGD and the South Fork Salmon River. Since 1981, broodstock collection has been exclusively from adults returning to the South Fork Salmon River. Mass marking of hatchery-origin fish was not initiated until brood year 1991; therefore before that time, program operators were unable to distinguish origin of all adult returns. Between 1991 and 2002, part of the production capacity at McCall Fish Hatchery (MCFH) was devoted to developing an integrated broodstock component of the program. This program releases approximately 1.0 million yearling summer Chinook salmon each year into the South Fork Salmon River. Of these current releases, 150,000 are from the integrated conservation component and 850,000 are from the segregated component. The initiation of the integrated program began in 2010, and in 2014 the program reached the second "step" of this process to create a genetic relationship between these programs. Before this, the program operated as a segregated program with broodstock collection beginning in 1974. MCFH was completed in 1979 and since 1981, broodstock collection has occurred at the South Fork Salmon River satellite facility for this program.

The purpose of the JCAPE program is to mitigate for fish losses occurring as a result of the development, operation, and maintenance of the Federal Columbia River Power System (FCRPS). JCAPE program began operation in 1998, and has released on average 100,000 yearling summer Chinook salmon smolts a year in Johnson Creek starting in the year 2000. All broodstock used is from 100 percent natural-origin fish collected in Johnson Creek beginning in year 1998. They have occasionally released more than 100,000 smolts, but have never exceeded 150,000 smolt production in a single year. The 2008-2017 *U.S. v Oregon* Management Agreement allows for a 100,000 yearling smolt annual production level for this program. Moving forward, the Proposed Action for the JCAPE program states a new released level of 150,000 yearling smolt, compared to the environmental baseline of 100,000 yearling smolt.

SFCEP began in 1997 with the original purpose to utilize excess summer Chinook salmon production from MCFH to help maintain, rehabilitate, and enhance Chinook salmon in tributary habitat of the South Fork Salmon River. This program has consistently released 300,000 to 350,000 eyed eggs into Dollar Creek. Moving forward, the Proposed Action for this project states a new release location at the South Fork Salmon River, in Cabin and Curtis Creeks. The broodstock used for this program is exclusively used from the South Fork Salmon River program. Therefore, please see the above description of South Fork Salmon River founding broodstock and hatchery operations for more information.

2.5.3. **Harvest**

The five hatchery programs primarily contribute to spring/summer Chinook salmon fisheries in the mainstem Snake and Columbia Rivers and terminal areas. The current 2008-2017 management agreement defines mainstem Columbia River harvest rates on a sliding scale. This abundance based sliding scale harvest rate[4] (5.5% to 17% for the combined tribal and non-tribal fisheries for natural fish during the spring management period) in the mainstem is based on natural-origin spring/summer Chinook salmon projected to return to the Snake River basin. Harvest share in terminal areas is defined as the number of returning hatchery adults minus the number of adults needed for broodstock. The harvest share is split equally between treaty and non-treaty fisheries. Non-treaty fisheries are mark selective and fisheries target hatchery origin fish while treaty fisheries are not selective. Impacts to natural origin fish are managed based on a sliding scale of abundance of natural origin fish. Few spring/summer Chinook salmon from the South Fork Salmon River are thought to be harvested in ocean fisheries.

The following sections outline the various fisheries that occur in the Action Area that may affect listed species. There are no fisheries that are part of the Proposed Action.

Spring/Summer Chinook Salmon Fisheries

The spring/summer Chinook fisheries in the Snake basin typically occur from late April through July. The non-tribal fisheries selectively target hatchery fish with a clipped adipose fin. Tribal fisheries target both hatchery and natural-origin fish regardless of external marking, meaning there is no incidental take of the target species for their fisheries. Table 17 below shows that an average of ~ 5% of the Snake River spring/summer Chinook salmon ESU is killed by fisheries. This may be an overestimate of the percentage impact because the LGD natural-origin return estimate does not include those fish that return to tributaries of the Snake River below LGD (e.g., Tucannon River).

Table 17. Number of ESA-listed natural-origin spring/summer Chinook salmon encountered and incidentally killed (catch and release mortality is estimated at 10 percent of those caught) in fisheries from 2011-2016. LGD stands for "Lower Granite Dam"

Fishery Manager	Average Incidental Mortality take Authorization	Average Encounter	Average Mortality	Average natural-origin estimated escapement above LGD	% Average natural-origin incidental mortality above LGD

[4]Sliding scale harvest rate increases as projected natural-origin fish increases

IDFG	774	2,260	260	19,788	1.3
SBT[1]	Not Applicable	407	407	19,788	2.1
NPT[1]	Not Applicable	326	326	19,788	1.6

Sources: (Hurst 2017; IDFG 2014; IDFG 2016a; IDFG 2017a; Oatman 2017b; Petrosky 2012; Petrosky 2013; Petrosky 2014)

[1]In this fishery, there is no incidental mortality of natural-origin fish; all fish, regardless of origin are intentionally harvested.

There are no incidental encounters or mortality of Snake River steelhead, fall Chinook salmon or sockeye salmon during spring/summer Chinook salmon fisheries. The reasons are that the fishery does not open until after the steelhead run, and the fishery closes prior to the arrival of fall Chinook salmon in the Snake Basin. Sockeye salmon are not encountered because they typically do not strike at lures used by recreational anglers fishing for Chinook salmon.

Steelhead

Steelhead fisheries above LGD typically occur from September through March of the following year. Although steelhead bound for Idaho enter the Columbia River from about June 1 through October 1 each year, a portion of the run spends the winter in the Columbia and Snake rivers downstream of LGD, and migrates into Idaho in the spring of the following year. Similar to spring/summer Chinook salmon fisheries, the non-tribal fisheries selectively target hatchery fish with a clipped adipose fin. Tribal fisheries target both hatchery and natural-origin fish regardless of external marking, meaning there is no incidental take of the target species for their fisheries. Table 17 below shows that an average of ~ 4.1 % of the Snake River steelhead DPS is killed annually in fisheries above LGD. This may be an overestimate of the percentage impact because the LGD natural-origin return estimate does not include those fish that return to tributaries in the Snake below LGD (i.e., Tucannon River, Asotin Creek).

Table 18. Number of ESA-listed natural-origin steelhead encountered and killed in fisheries from 2011-2016.

Fishery Manager	Average Encounter	Average Mortality	Average natural-origin estimated escapement above LGD	% Average natural-origin mortality above LGD
IDFG	15,888	801[1]	25,690	3.1
SBT[1]	< 100	< 100	25,960	0.4
NPT	167	157	25,960	0.6

Sources: (Hurst 2017; IDFG 2014; IDFG 2016a; IDFG 2017a; Oatman 2017a; Petrosky 2012; Petrosky 2013; Petrosky 2014)
[1]For the state fishery, all mortality of natural-origin fish is incidental (catch and release mortality), and is estimated at 5 percent of those caught.

Table 19. Number of ESA-listed natural-origin fall Chinook salmon encountered and incidentally killed (catch and release mortality is estimated at 10 percent of those caught) in steelhead fisheries from 2011-2016.

Fishery Manager	Average Encounter	Average Mortality	Average natural-origin estimated escapement above LGD	% Average natural-origin mortality above LGD
IDFG	281	28[1]	10,819	0.3
SBT	0	0	10,819	0
NPT	These numbers are included in the table on Fall Chinook fisheries below			

Sources: (Hurst 2017; IDFG 2014; IDFG 2016a; IDFG 2017a; Oatman 2017a; Petrosky 2012; Petrosky 2013; Petrosky 2014)
[1]For the state fishery, all mortality of natural-origin fish is incidental (catch and release mortality), and is estimated at 5 percent (or 14 mortalities) of those caught.

Fall Chinook Salmon Fisheries

The fall Chinook salmon fishery typically takes place from September through October. Similar to spring/summer Chinook salmon and steelhead fisheries, the non-tribal fisheries selectively target hatchery fish with a clipped adipose fin. Tribal fisheries target both hatchery and natural-origin fish regardless of external marking, meaning there is no incidental take of the target species for their fisheries. Table 20 below shows that an average of ~ 4.5 % of the Snake River fall Chinook salmon ESU is killed in fisheries above LGD.

Table 20. Number of ESA-listed natural-origin fall Chinook salmon encountered and incidentally killed (catch and release mortality is estimated at 10 percent of those caught) in fall Chinook salmon fisheries from 2011-2016.

Fishery Manager	Average Encounter	Average Mortality	Average natural-origin estimated escapement above LGD	% Average natural-origin mortality above LGD
IDFG	853	85	10,819	0.8

SBT	Not Applicable			
NPT	400	397	10,819	3.7

Sources: (IDFG 2014; IDFG 2016a; IDFG 2017a; Oatman 2017a; Petrosky 2012; Petrosky 2013; Petrosky 2014)

Other Fisheries

In some years, Idaho opens a kokanee salmon fishery in Redfish Lake to help offset intra-specific competition in Redfish Lake between resident kokanee and sockeye salmon. From 2014 to 2016, an average of 0.5 percent of the sockeye salmon population in Redfish Lake were incidentally harvested in this fishery (Kokanee and sockeye salmon are phenotypically indistinguishable), assuming that sockeye salmon represent 29 percent of the *O. nerka* population **(IDFG 2014; IDFG 2016a; IDFG 2017a)**.

2.5.4. **Other**

Congress established the Pacific Coastal Salmon Recovery Fund (PCSRF) to help protect and recover salmon and steelhead populations and their habitats (NMFS 2007b). The states of Washington, Oregon, California, Idaho, and Alaska, and the Pacific Coastal and Columbia River Tribes receive PCSRF funds from NMFS each year. The fund supplements existing state, tribal, and local programs to foster development of Federal-state-tribal-local partnerships in salmon and steelhead recovery. The PCSRF has made substantial progress in achieving program goals, as indicated in annual Reports to Congress, workshops, and independent reviews.

Information relevant to the Environmental Baseline is also discussed in detail in Chapter 5 of the Supplemental Comprehensive Analysis (SCA), and the related 2008 FCRPS Biological Opinion (NMFS 2008d). Chapter 5 of the SCA (NMFS 2008d), and related portions of the FCRPS Opinion, provide an analysis of the effects of past and ongoing human and natural factors on the current status of the species, their habitats and ecosystems, within the entire Columbia River Basin.

2.6. Effects on ESA Protected Species and on Designated Critical Habitat

2.6.1. **Factors That are Considered When Analyzing Hatchery Effects**

NMFS has substantial experience with hatchery programs and has developed and published a series of guidance documents for designing and evaluating hatchery programs following best available science (Hard et al. 1992; Jones Jr. 2006; McElhany et al. 2000; NMFS 2004b; NMFS 2005c; NMFS 2008a; NMFS 2011b). For Pacific salmon, NMFS evaluates extinction processes and effects of the Proposed Action beginning at the population scale (McElhany et al. 2000). NMFS defines population performance measures in terms of natural-origin fish and four key parameters or attributes -- abundance, productivity, spatial structure, and diversity -- and then relates effects of the Proposed Action at the population scale to the MPG level and ultimately to the survival and recovery of an entire ESU or DPS.

Because of the potential for circumventing the high rates of early mortality typically experienced in the wild, artificial propagation may be useful in the recovery of listed salmon species. However, artificial propagation entails risks as well as opportunities for salmon conservation (Hard et al. 1992). A Proposed Action is analyzed for effects, positive and negative, on the attributes that define population viability: abundance, productivity, spatial structure, and diversity. The effects of a hatchery program on the status of an ESU or steelhead DPS and designated critical habitat "will depend on which of the four key attributes are currently limiting the ESU, and how the hatchery fish within the ESU affect each of the attributes" (70 FR 37215, June 28, 2005). The presence of hatchery fish within the ESU can positively affect the overall status of the ESU by increasing the number of natural spawners, by serving as a source population for repopulating unoccupied habitat and increasing spatial distribution, and by conserving genetic resources. Conversely, a hatchery program managed without adequate consideration can affect a listing determination by reducing adaptive genetic diversity of the ESU, and by reducing the reproductive fitness, productivity, and abundance of the ESU.

NMFS' analysis of the Proposed Action is in terms of effects it would be expected to have on ESA-listed species and on designated critical habitat, based on the best scientific information available. This allows for quantification (wherever possible) of the effects of the seven factors of hatchery operation on each listed species at the population level (in Section 2.6.2), which in turn allows the combination of all such effects with other effects accruing to the species to determine the likelihood of posing jeopardy to the species as a whole (Section 2.7).

Information that NMFS needs to analyze the effects of a hatchery program on ESA-listed species must be included in an HGMP. Draft HGMPs are reviewed by NMFS for their sufficiency before formal review and analysis of the Proposed Action can begin. Analysis of an HGMP or Proposed Action for its effects on ESA-listed species and on designated critical habitat depends on six factors. These factors are:

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

NMFS analysis assigns an effect category for each factor (negative, negligible, or positive/beneficial) on population viability. The effect category assigned is based on: (1) an analysis of each factor weighed against the affected population(s) current risk level for abundance, productivity, spatial structure, and diversity; (2) the role or importance of the affected natural population(s) in salmon ESU or steelhead DPS recovery; (3) the target viability for the affected natural population(s) and; (4) the Environmental Baseline, including the factors currently limiting population viability. For more information on how NMFS evaluates each factor, please see Appendix A.

2.6.2. Effects of the Proposed Action

This section describes the effects of the Proposed Action, independent of the environmental baseline, and cumulative effects. Under the ESA, "effects of the action" means the direct and indirect effects of an action on critical habitat and on the individuals within a population and how these affect the VSP parameters for the natural population(s) that make up the species, 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.

The methodology and best scientific information NMFS follows for analyzing hatchery effects is summarized in Section 2.6 and then application of the methodology and analysis of the Proposed Action itself follows in Section 2.6.2. Effects of the Proposed Action that are expected to occur later in time (i.e., just after timeframe of the Proposed Action) are included in the analysis in this Opinion to the extent they can be meaningfully evaluated. In Section 2.8, the Proposed Action, the status of ESA-protected species and designated critical habitat, the environmental baseline, and the cumulative effects of future state and private activities within the Action Area that are reasonably certain to occur are analyzed comprehensively 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.

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

Not applicable for fall Chinook salmon, steelhead, or sockeye salmon because none of the proposed hatchery programs propagate these species.

The Rapid River and Hells Canyon hatchery programs do not use natural-origin fish in their broodstock.

The SFSR, SFCEP, and JCAPE programs use natural-origin spring/summer Chinook salmon in their broodstock.

The SFSR program is proposing to use broodstock consisting of up to 90% natural-origin adults in their integrated component of the hatchery program, meaning they may collect a maximum of 678 natural-origin adult spring/summer Chinook salmon from the South Fork Salmon River population (Table 3). These collections also include broodstock collected for the SFCEP, which plans to utilize eggs from the integrated component of the South Fork Salmon River program. However, they will not use more than a 50% share of the natural-origin return to the South Fork Salmon River weir. The number of natural-origin broodstock used is based on a sliding scale (Table 3 from Section 1.3.2); therefore in the event that run sizes decrease, the remaining broodstock will be supplemented with hatchery-origin returns from the segregated program. The most recent five year (2010 to 2014) mean abundance of natural-origin spring/summer Chinook salmon returns to the mainstem SFSR is 1,014 adults (IDFG 2017d); which meets "large" abundance thresholds (Table 22) that were outlined in the Proposed ESA Recovery Plan for Snake River Spring/Summer Chinook Salmon and Steelhead (NMFS 2016c). Collecting a high percentage of NORs is not considered detrimental to the SFSR population, because the collection of a higher percentage of NORs still allows for a PNI of > 0.5 in the population (see Section 2.6.2.2 for the full genetic analysis). In addition, many of the returning natural-origin fish may be descendants from the hatchery program. Furthermore, operators will only collect 50 percent of NORs when the total number of NORs is very high (Table 3). If NORs are very high, then there is little risk to deplete the natural-origin population above the weir.

The only other time they will collect a high percentage of NORs (up to 40 percent) is when NORs are very low. In the case that NORs are very low, the priority will be to increase abundance above all other goals. Removing these individuals from an already low return comes with risk to the natural-origin population by reducing natural spawning and replacing it with hatchery-spawned production. However, including NORs in the broodstock is beneficial on balance in this case, since operators will be releasing hatchery fish above the weir to spawn to boost overall abundance in the absence of a large natural-origin return of adult spawners. Inclusion of NORs in the broodstock improves the genetic makeup of the hatchery fish being released in low-return years, which would decrease the genetic threat to the population while maintaining a spawning population above the weir. In low return years, when abundance concerns are generally prioritized over genetic effects concerns, including NORs in the broodstock will allow abundance goals to be met while also alleviating some of the genetic concerns as well. Since many of the natural-origin returns may be offspring from the hatchery program and since this population currently meets abundance thresholds for a “large” population, it is unlikely that broodstock collection of natural-origin adults will have a negative impact on the abundance of the SFSR population. Thus the genetic (diversity) and abundance impacts to the natural-origin population will be minimal.

JCAPE’s broodstock component uses 100% natural-origin adults from the East fork of the South Fork Salmon River population for their program. This results in a total of 104 natural-origin adults used in the broodstock, with no more than 50% of the natural-origin returns to the Johnson Creek weir. The five year (2011 to 2015) mean abundance of natural-origin spawners to Johnson Creek is 653 adults (NPT 2017). According to the redd spawning surveys for the East Fork of the South Fork Salmon River population, there was a five year (2011 to 2015) mean percentage natural-origin spawners of 19 percent in the East Fork of the South Fork Salmon River and 81 percent in Johnson Creek (Rabe 2017a). Using these percentages, total natural-origin abundance in East Fork of the South Fork Salmon River can be extrapolated. After calculating this value, we estimate the five year mean abundance of natural-origin fish in the East Fork of the South Fork Salmon River to be 153 adults. Adding 653 adults from Johnson Creek to the 153 adults from the East Fork of the South Fork Salmon River totals 806, which is just below the “large” abundance threshold (Table 22) and was outlined in the Proposed ESA Recovery Plan for Snake River Spring/Summer Chinook Salmon and Steelhead (NMFS 2016c). Even though this population is below current abundance thresholds listed in the Proposed Recovery Plan, the total abundance of spring/summer Chinook in the East Fork of the South Fork Salmon Population has increased over the last 15 years. This suggests that the JCAPE hatchery program may have a positive overall effect on abundance, even considering the removal of returning adults. Therefore, the abundance impacts from using natural-origin fish for program broodstock will be minimal.

The removal of broodstock for the SFSR, SFCEP, and JCAPE programs is not thought to be excessive, and the abundance and genetic impacts to the populations are not considered a substantial risk (Section 2.6.2.2).

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

The proposed hatchery programs pose both genetic and ecological risks. Although there is some benefit to the species from the integrated JCAPE program and integrated component of the SFSR program which are designed to supplement the natural populations, the net genetic and ecological effect from all of the programs combined on spring/summer Chinook salmon is negative, as discussed below.

Only ecological and adult collection effects are relevant for fall Chinook, steelhead, and sockeye salmon because these proposed programs do not propagate these species. The overall effect of this factor on these species is negligible, as discussed below.

2.6.2.2.1. Genetic interactions between hatchery- and natural-origin adults

Not applicable for fall Chinook salmon, steelhead, or sockeye salmon.

For each of the five spring/summer Chinook salmon programs, NMFS considers three major areas of genetic effects of hatchery programs: within-population diversity, outbreeding effects, and hatchery-influenced selection. In most cases, the genetic effects are viewed as risks, because interbreeding between hatchery and natural-origin populations tends to promote the detrimental effects of hatchery-influenced selection in the population, which reduces the overall fitness and survival. However, in small populations the diversity effects can sometimes be beneficial in reducing extinction risk compared to the inherent vulnerability of small populations, and the demographic boost afforded by conservation hatchery programs improves survival chances by increasing the population size and reducing the vulnerability (Appendix Section 5.2.1). Conservation hatchery programs included in the Proposed Action include JCAPE and the integrated component of the SFSR program which provide some benefits to the SFSR and EFSFSR populations. Please refer to Appendix Section 5.2.1 for a more thorough description of potential genetic effects of hatchery programs.

As explained below, there are likely to be some negative genetic effects resulting from the programs in the Proposed Action on the genetic diversity and/or fitness of natural-origin Snake River spring/summer Chinook salmon due to hatchery-origin spawner interactions with natural-origin spawners on the spawning grounds.

The Rapid River and Hells Canyon programs release a total of 3 million hatchery-origin spring/summer Chinook from a segregated hatchery program into the Rapid River, Snake River, and Little Salmon River. Hatchery-origin returns will be harvested in fisheries and the majority of the remaining program fish will be collected at the Rapid River adult trap at Hells Canyon Dam and at the Rapid River weir. However, because 150,000 yearlings are released into the

Little Salmon River which does not have a weir, adults may return to this tributary to spawn and, therefore, may pose a risk to the genetic diversity and fitness of natural-origin spawners. Moreover, in years where broodstock needs are not able to be met by hatchery-returns from the Rapid River or Hells Canyon programs, the project operators may use broodstock from the out-of-basin Clearwater hatchery programs, since these programs were founded on Rapid River and Hells Canyon broodstock and display the “spring” life history type. Even though these fish are founded on Rapid River and Hells Canyon broodstock, they are considered “out-of-basin” and therefore we more critically analyze their potential genetic effects on the Little Salmon River population below. This is only used in emergency types of situations, and has not traditionally been utilized much (Table 21). In years where Clearwater eyed-eggs are added to the Rapid River and Hells Canyon programs, no releases will occur at the Little Salmon River. This may help ensure that Clearwater origin fish would have limited spawning interactions with natural-origin fish in the Little Salmon River, where there is no weir for adult management.

Table 21. Brood years and number of eyed-eggs reared at the Rapid River Fish Hatchery that were sourced from Clearwater spring Chinook broodstock. (IDFG 2016b)

Brood Year	Number of eyed eggs reared at Rapid River Fish Hatchery	Clearwater Source Hatchery
2007	0	NA
2008	0	NA
2009	0	NA
2010	0	NA
2011	0	NA
2012	659,269	Dworshak Fish Hatchery
2013	0	NA
2014	0	NA
2015	0	NA
2016	0	NA

The SFSR program releases 1 million hatchery-origin yearlings into the SFSR. At maximum level, these releases will be made up of 850,000 fish from the segregated program component, whereas the 150,000 remaining would be from the integrated component. Ideally, and depending on natural-origin returns, the program releases would be made up entirely of yearlings from the integrated program. Regardless, all of these hatchery-origin returns could negatively affect genetic diversity and fitness of the natural-origin population. The South Fork Chinook Egg Box Program (SFCEP) currently uses 300,000 eyed-eggs from the South Fork Salmon River segregated program, but as returns increase, the SFSR integrated program will be able to provide SFCEP with eggs. Returns from the SFCEP may also have a negative genetic impact on natural-origin fish.

JCAPE uses 100% natural-origin broodstock and releases 150,000 yearlings into Johnson Creek. While the genetic impacts are likely to be minimal from this program because it uses exclusively native natural-origin broodstock, we still expect there to be some fitness effects from the program to the natural-origin population from naturally spawning hatchery program returnees (Section 5, Appendix A).

Diversity and outbreeding effects

All populations that would likely receive hatchery-origin spawners from these hatchery programs are within the South Fork Salmon River MPG. The Rapid River and Hells Canyon programs may contribute HORs to the Little Salmon River population, the South Fork Salmon River program and SFCEP may contribute to the South Fork Salmon River population, and the JCAPE program is intended to contribute to the East Fork of the South Fork Salmon River population. Table 22 indicates the Interior Columbia Technical Recovery Team (ICTRT) viability and size designations for each of the populations within the South Fork Salmon River MPG.

Table 22. ICTRT population viability and size designations (relevant for this consultation) from the South Fork Salmon River Chinook salmon MPG

Population	Viability designation[1]	Population size[2]	
		Designation	Minimum abundance threshold
Little Salmon River spring/summer Chinook salmon	**Maintained**	Intermediate	500
East Fork of the South Fork Salmon River summer Chinook salmon	**Viable or Maintained**	Large	1000
South Fork Salmon River summer Chinook salmon	**Highly Viable or Viable**	Large	1000

[1]Populations were classified as Highly Viable, Viable, or Maintained. These designations are meant to reflect the conservation importance of a population within the MPG from most important (Highly Viable and Viable- bold, red) to moderately important (Maintained-bold, blue). The ICTRT's criteria for viability based on the four VSP parameters (abundance, productivity, spatial structure, and diversity).
[2]Populations were classified as Basic, Intermediate, Large, and Very Large in size.

Straying

This straying analysis includes populations where natural-origin fish may interact with hatchery-origin fish from the proposed hatchery programs. At a minimum, this includes the three spring/summer populations described in Table 24 where hatchery fish from the proposed programs are directly released into these populations. In addition, the analysis may include additional populations where strays from the proposed hatchery programs have been detected. These population level analyses all include river reaches where natural-origin fish may geographically overlap with fish from the proposed hatchery programs.

The Rapid River and Hells Canyon programs use fish that originated from returns to the upper Snake River Basin and likely includes some contribution from the Little Salmon River population. Any non-local stock has the potential to cause some level of decreased diversity and possibly outbreeding depression to natural-origin populations. Because supplementation of the natural population is not an objective for these segregated programs, the number/proportion of hatchery-origin spawners should be limited, and ideally be zero. Because fish stray into areas that are under different management authorities and that may have different approaches to monitoring naturally-spawning fish, it is difficult to assess pHOS for all populations where fish from these two programs may occur. However, we will address this in the following sections. The Rapid River program releases fish into the Little Salmon River, which does not have an adult trap. The Little Salmon River population is considered Maintained, so relatively high pHOS levels may not be as critical as they would be for a Viable population.

Here, and elsewhere in Idaho, strays are detected by PIT tag detections, CWT recoveries, or by use of PBT (parentage-based tagging). PIT tag readers are dispersed throughout the Salmon River Basin, and PIT tagged fish are identified as they pass through these readers. CWT recoveries are typically made during fisheries, on spawning grounds, and at hatchery traps. PBT is an alternative method to PIT tagging and CWT that uses genotyping of hatchery broodstock. Tissue samples are collected, typically from hatchery broodstock and during spawning surveys. With this information, parentage assignments are used to identify the origin and brood year of their progeny. Program strays can be identified with this method after genetic samples have been analyzed. In our straying analyses, CWT and PBT were used to detect fish and calculate population level pHOS values. PBT is used widely among hatchery programs in the Snake River Basin. All returning adult program fish used in hatchery broodstock within the Snake River Basin receive a clip for PBT analysis. Data for our analyses was detected from CWT recoveries and PBT analysis by IDFG, NPT, and SBT in fisheries (e.g. creel census), on spawning grounds, and at hatchery traps from 2011 to 2015, unless otherwise specified. We analyze strays from each of the hatchery programs in the Proposed Action into other populations. We also account for hatchery-origin strays from other programs into the populations within our Action Area. All of these detections are converted into population level pHOS values in Table 29.

Strays from the Rapid River and Hells Canyon hatchery programs that contribute to populations within the Salmon River basin have been identified (Table 23). Furthermore, IDFG has also identified program strays from any hatchery program that utilizes CWT or PBT data that were detected in the Little Salmon River and Rapid Rivers (Table 24). Strays into the Hells Canyon reach were not included in this analysis because that area does not fall within the geographic boundaries of the Snake River spring/summer Chinook salmon ESU. We did not use PIT tag information in this analysis because the CWT data was expanded for the entire population. This information is used to determine what percentage of each population is comprised of strays from hatchery programs.

Table 23. Spring/summer Chinook salmon from the Rapid River and Hells Canyon hatchery programs detected in the Salmon River. (Cassinelli et al. 2012) (Cassinelli et al. 2013) (Sullivan et al. 2015; Sullivan et al. 2016)

Years	Fish detected by CWT[1]	Fish detected by PBT[1, 2]	Recovery location	Release location
2011	3 (84)	0	Lower Salmon River Fishery[3]	Rapid River
2012	0	2 1 1	Sawtooth Fish Trap Pahsimeroi Fish Trap McCall Fish Hatchery	
2013	0	1	McCall Fish Hatchery	

2014	0	1	Sawtooth Fish Trap	
2015	0	1	Pahsimeroi Fish Trap	
Mean[3]	16.8 0 0 0	0 0.6 0.4 0.4	Lower Salmon River Fishery[3] Sawtooth Fish Trap Pahsimeroi Fish Trap McCall Fish Hatchery	

[1]Expanded value (for tagging rate) in parentheses.
[2]PBT stands for parental based tagging and has been sampled and analyzed since 2014 (brood year 2010). All fish used for broodstock and released upstream of the weir are PBT sampled.
[3]No way to determine where these fish would have "ended up" since they were caught in a Lower Salmon River Fishery; therefore, these were not included in the pHOS population calculations.
[4]Means calculated using expanded values, if applicable, per recovery and release location.

Table 24. Spring/summer Chinook salmon from all hatchery programs recovered at the Rapid River Fish Trap. (Cassinelli et al. 2012) (Cassinelli et al. 2013) (Sullivan et al. 2015; Sullivan et al. 2016)

Years	Number CWT recovered[1]	Number PBT detections[1, 2]	Recovery location	Release location
2011	1 1 1 (4)	0 0 0	Rapid River Fish Trap	Lostine River Grande Ronde SFSR
2012	1 (2) 0	0 1		Imnaha River Lostine River
2013	4 (8) 0	0 13		Imnaha River Knox Bridge (SFSR MCFH)
2014	0	0		N/A
2015	0	1 1 2 1 1		Lookingglass Pahsimeroi Lostine Imnaha Catherine Creek
Mean[3]	3.2	4		All releases

[1]Expanded value (for tagging rate) in parentheses.
[2]PBT stands for parental based tagging and has been sampled and analyzed since 2014 (brood year 2010). All fish used for broodstock and released upstream of the weir are PBT sampled.
[3]Averages calculated using expanded values, if applicable.

According to CWT and PBT data from IDFG, a five-year mean of 16.8 fish from the Rapid River hatchery program strayed into the Lower Salmon River area. Because these fish were caught during a fishery, this is likely an over-estimate of strays into that area. Moreover, Rapid River fish strayed a mean of 0.6 adult fish into the Sawtooth Fish Trap, 0.4 adult fish into the Pahsimeroi Fish Trap, and 0.4 adult fish into the McCall Fish Hatchery, demonstrating that few fish likely stray into the upper part of the Salmon River Basin. To determine what percentage of strays end up in the Little Salmon River population, we looked at the means of all hatchery strays to this region. All of these encounters occurred at the Rapid River Fish Trap. An average of 3.2 adult fish from CWT and 4 fish from PBT detections from various hatchery programs ending up at the Rapid River Fish Trap (Table 24). In addition, there were three fish from the Rapid River program that was observed at the Sawtooth Fish trap. This indicates that fish from the Rapid River program could potentially end up in the upper Salmon River.

We will now discuss straying from the SFSR and SFCEP programs, which are based on the South Fork Salmon River population, into other listed populations of concern. Because the SFCEP utilizes eggs instead of juvenile fish, the program is unable to use CWT or PIT tags, making it difficult to monitor strays. We can conservatively use the South Fork Salmon River program as a starting point to estimate program strays from the SFCEP since broodstock is from the same source. However, because juveniles are reared in the natural environment instead of a hatchery setting, we might expect a lower stray rate from this program than from the South Fork Salmon River program.

Tables 25 and 26 present data on strays from the SFSR hatchery program that contribute to populations within the Salmon River basin and program strays from any hatchery program that utilizes CWT or PBT data detected in the South Fork Salmon River. Please see below information regarding the JCAPE program for this information (Table 25and Table 26).

Table 25. Spring/summer Chinook salmon from the SFSR hatchery program detected in the Salmon River. (Cassinelli et al. 2012) (Cassinelli et al. 2013) (Sullivan et al. 2015; Sullivan et al. 2016)

Years	Number CWT recovered[1]	Number PBT detections[1,2]	Recovery location	Release location
2011	1 (4)	0	Rapid River Fish Trap	Knox Bridge (SFSR MCFH)
2012	0	0	N/A	
2013	0	13	Rapid River Fish Trap	
2014	0	0	N/A	
2015	0	1	Red River[3]	
Mean[4]	0.8 0	2.8 0.2	Rapid River Fish Trap Red River[3]	

[1]Expanded value (for tagging rate) in parentheses.
[2] PBT stands for parental based tagging and has been sampled and analyzed since 2014 (brood year 2010). All fish used for broodstock and released upstream of the weir are PBT sampled.

[3]This location is in the Clearwater, which is not included in the Snake River spring/summer Chinook salmon ESU.
[4]Averages calculated using expanded values, if applicable, per recovery and release location.

Table 26. Spring/summer Chinook salmon from all hatchery programs recovered at the SFSR Fish Trap. (Cassinelli et al. 2012) (Cassinelli et al. 2013) (Sullivan et al. 2015; Sullivan et al. 2016)

Years	Number CWT recovered[1]	Number PBT detections[1,2]	Recovery location	Release location
2011	1 1 8	0 0 0	SFSR Fish Trap	Grande Ronde Lookingglass Creek Lostine River

	1 (2) 1	0 0		Powell Selway River
2012	0	1		Lookingglass
2013	0	1 1 1		Sawtooth Rapid River Grande Ronde
2014	1 1	1 1 2		Johnson Creek (JCAPE)[3] Lookingglass Creek Nez Perce Tribal Hatchery
2015	0 1 (2)	2 4 1 2 1 1 2		Grande Ronde Lookingglass Rapid River Nez Perce Tribal Hatchery Catherine Creek Clearwater Powell
Mean[4]	3.4	4.2		All locations

[1]Expanded value (for tagging rate) in parentheses.
[2] PBT stands for parental based tagging and has been sampled and analyzed since 2014 (brood year 2010). All fish used for broodstock and released upstream of the weir are PBT sampled.

[3]This stray was from the JCAPE hatchery program (part of this proposed action) which is operated by the NPT
[4]Averages calculated using expanded values, if applicable

A five-year mean of 0.8 adult fish (CWT) and 2.8 fish (PBT) from the SFSR program were detected at the Rapid River Fish Trap (Table 25). Furthermore, a five-year average of 0.2 fish from the SFSR program were detected at Red River (Table 26). In addition, a mean of 3.4 (CWT) and 4.2 (PBT) fish from various hatchery programs ended up in the South Fork Salmon River population and were detected at the fish trap (Table 26).

We will now discuss strays related to the JCAPE program. NPT has identified strays from the JCAPE hatchery program that contribute to populations within the Salmon River basin (Table 27). Moreover, they have identified strays from any hatchery program that utilizes CWT or PBT data that were detected in Johnson Creek (Table 28). Because the NPT uses 100 percent pNOB in their hatchery broodstock. Straying impacts from this program are expected to be minimal and limited to fitness effects.

Table 27. Spring/summer Chinook salmon from the JCAPE hatchery program detected in the Salmon River. (Cassinelli et al. 2012) (Cassinelli et al. 2013) (Sullivan et al. 2015; Sullivan et al. 2016)

Years	Number CWT recovered[1]	Number PBT detections[1,2]	Recovery location	Release location
2011	0	N/A	N/A	Johnson Creek (JCAPE)
2012	0		N/A	
2013	0		N/A	
2014	1		South Fork Salmon River Fish Trap	
2015	0		N/A	

Mean[3]	0.2		South Fork Salmon River Fish Trap	

[1]Expanded value (for tagging) in parentheses.
[2] PBT stands for parental based tagging and has been sampled and analyzed since 2014 (brood year 2010). All fish used for broodstock and released upstream of the weir are PBT sampled.
[3]Averages calculated using expanded values, if applicable, per recovery and release location.

Table 28. Spring/summer Chinook salmon from all hatchery programs detected at the Johnson Creek Fish Trap (Cassinelli et al. 2012) (Cassinelli et al. 2013) (Sullivan et al. 2015; Sullivan et al. 2016)

Years	Number CWT recovered[1]	Number PBT detections[1,2]	Recovery location	Release location
2011	1 4 (23)	0 0	Johnson Creek Fish Trap	Lookingglass Knox Bridge (SFSR MCFH)
2012	2 4 (23)	0 0		Lookingglass Knox Bridge (SFSR MCFH)
2013	5 3 (17)	0 1		Lookingglass Knox Bridge (SFSR MCFH)
2014	3 3 (17)	0 1		Lookingglass Knox Bridge (SFSR MCFH)
2015	1	0		Lookingglass
Mean[3]	18.3	0.4		All locations

[1]Expanded value (for tagging rate) in parentheses. [2]Averages calculated using expanded values, if applicable.
[2] PBT stands for parental based tagging and has been sampled and analyzed since 2014 (brood year 2010). All fish used for broodstock and released upstream of the weir are PBT sampled.
[3]Averages calculated using expanded values, if applicable, per recovery and release location.

A five-year mean of 0.2 adult fish (CWT) were detected at the South Fork Salmon River Trap from the JCAPE program (Table 27). Furthermore, a five-year average of 18.3 adult fish (CWT) and 0.4 adult fish (PBT) were detected at the JCAPE Trap that originated from the SFSR and Lookingglass hatchery programs (Table 28).

Table 29 summarizes the data from Table 23-Table 28 as pHOS values for populations where fish from any of Proposed Action programs could contribute to, or where other hatchery fish may contribute to populations within the Action Area of this analysis. These hatchery program contributions to the total pHOS are also calculated as a percentage. The viability role of a population (NMFS 2016) was also listed in this table to show how hatchery program strays may be contributing to the likelihood of achieving viability status. Strays and pHOS values are not recorded for fish in the Clearwater, because spring/summer Chinook salmon are not listed in the Clearwater. Regardless, operators have only detected one stray from PBT analysis from the SFSR program in the Clearwater in the most recent five years with data (collected between 2011-2015 during sport fisheries, on spawning grounds, or at hatchery traps). In addition, no hatchery strays from the proposed hatchery programs have been encountered in northeast Oregon or southeast Washington in recent years (2005-2015). However, hatchery strays from Rapid River broodstock, used in the Lookingglass hatchery program, were encountered in Hurricane (2001; one fish), Imnaha (2004; one fish), Lookingglass (2002; 11 fish and 2003; four fish), Lostine (2001; one fish and 2002; one fish), Minam (2001; two fish), and Wenaha (2001; eight fish)

Rivers as late as 2004. Rapid River fish were used as broodstock in the Lookingglass program up until 1999. Juvenile fish using Rapid River fish from 1999 would have returned as late as 2004; therefore, these results make sense.

Table 29. Average pHOS levels (as percentages) for Snake River spring/summer Chinook salmon, by population, in the Action Area or that were affected by the Proposed Action. Escapement estimates used in calculations were from the Salmon Population Summary (SPS) Database reported in the NWFSC Status Review Update for Pacific Salmon and Steelhead listed under the Endangered Species Act (NWFSC 2015)

Population	Role in Viability Scenario (NMFS 2016)	Population level pHOS (2010-2014)	% of out of population hatchery-origin strays from hatchery programs[1]
Little Salmon River (Rapid River included)	Maintained	*Unknown*	Average population level pHOS is unknown, so we cannot calculate contribution from other hatcheries at this time. Strays over the last five years have come from the Lostine River, Grande Ronde, Imnaha, Lookingglass, Pahsimeroi, Catherine Creek, and SFSR Hatchery Programs.
South Fork Salmon River	Viable or Highly Viable	0.23	0.6% (0.006) from the Lostine River, Grande Ronde, Rapid River, Nez Perce Tribal Hatchery, Catherine Creek, Lookingglass Creek, Powell, Clearwater, and JCAPE programs, combined
Secesh River	Viable or Highly Viable	0.02	0%
East Fork of the South Fork Salmon River	Viable or Maintained	0.38	1.78% (0.0178) from the Lookingglass and SFSR Programs
Upper Salmon River Upper Mainstem, above Redfish Lake	Viable or Highly Viable	0.30	0.02% (0.0002) from RR Hatchery Program

[1]Percentages based on five year mean expanded number of strays divided by five year mean total hatchery-origin fish and natural-origin spawning grounds. Hatchery strays into the Action Area are also included in this table, although this was not included in our effects analyses of the hatchery programs.

NMFS has not adopted Hatchery Scientific Review Group (HSRG) gene flow (i.e., pHOS, pNOB, PNI) standards per se. However, at present the HSRG standards and the 5% (or 0.05) stray standard (from segregated programs) from Grant (1997) are the only acknowledged quantitative standards available, so NMFS considers them a useful screening tool. For a particular program, NMFS may, based on specifics of the program, broodstock, and environment, consider a pHOS or PNI level to be a lower risk than the HSRG would but, generally, if a program meets HSRG standards, NMFS will typically consider the risk levels to be acceptable.

These straying effects and population level pHOS values (Table 29) do not constitute a serious threat to the Snake River spring/summer Chinook salmon ESU and are considered negligible since all of the population level pHOS values from the proposed programs are below 0.05. For the most part, strays from the proposed hatchery programs are limited to populations within the SFSR MPG. However, some strays from the Rapid River hatchery program have been recorded into the upper Salmon River. This indicates that while strays are limited to the Snake River spring/summer Chinook salmon ESU, hatchery fish have the capability of straying far into areas in the upper Salmon River. Overall, these gene flow effects from straying do not constitute a major threat to diversity, since they are below 0.05.

Hatchery-influenced selection effects

As explained in Appendix A, there are effects on natural-origin populations, when hatchery fish spawn in the wild, because wild-spawning hatchery adults carry traits related to hatchery-influenced selection. To assess the impacts of hatchery programs on the natural population located in the same basin, NMFS generally evaluates PNI and pHOS values to determine the overall hatchery-influenced selection effects. This PNI and pHOS analysis includes populations where hatchery-origin fish may have a genetic effect on hatchery-origin fish from the proposed hatchery programs. The pHOS analysis includes the three spring/summer populations described in Table 24 where hatchery fish from the proposed programs are directly released into these populations. Our analysis of PNI only includes hatchery programs with integrated program components that are intended to spawn with natural-origin fish in the population. Therefore, for the SFSR hatchery program we analyzed PNI in the SFSR population and for the JCAPE program we analyzed PNI in the East Fork of the SFSR population.

At this time, the pHOS values resulting from the Rapid River and Hells Canyon programs into nearby populations is unknown. Natural and hatchery-origin spawning in the Little Salmon River population is not well documented; therefore it is difficult to estimate pHOS levels. However, because the Little Salmon River only plays a “Maintained” role in (NMFS 2016a) viability scenarios (Table 22), PNI and pHOS calculations are not a pressing concern, at this time.

The SFSR population plays a “Viable” role in (NMFS 2016a) viability scenarios (Table 22), therefore PNI and pHOS should be calculated and considered for understanding the effects of the SFSR hatchery program. In 2014, the SFSR program began incorporating integrated returns back into the segregated component of their program. IDFG has set a minimum of 150,000 smolt from the integrated component of the program and a maximum of 850,000 smolts from the segregated component of the program. Depending on NOR size and according to the sliding scale broodstock collection goals, the integrated component of the program could increase in size (**Table 4**).

According to our multi-population component gene-flow model (Busack 2015) for PNI, switching the South Fork Salmon River program into a program with genetically linked integrated and segregated components has increased the South Fork Salmon River population PNI in recent years, based on modelling the last five years (Table 28) program. In 2014, we estimated PNI for the South Fork Salmon River population to be 0.63, with a pHOS of 0.18. We included natural-origin jacks in the total natural-origin spawner calculations. However, due to low jacking rates from previous years, we do not think this artificially inflated the 2014 PNI value.

Table 30. Modeled PNI for the South Fork Salmon River population including the South Fork Salmon River program contributions based on 2010-2014 data

Year	PNI[1]	Total pHOS[2]
2010	0.25	0.20
2011	0.21	0.24
2012	0.22	0.23
2013	0.19	0.28
2014[3]	0.63	0.18

[1]PNI calculations do not include the SFCEP broodstock/releases or broodstock used for the Clearwater releases. HOR estimates were calculated using SAR estimates from natural-origin juveniles (Bradford 1995)
[2] pHOS due to both integrated and segregated components of pHOS were used in the models; but, total pHOS is reported here. Strays from the segregated component have been accounted for by adding in 0.02 (2%) segregated pHOS level, to be conservative
[3]2014 is the first year that integrated HORs were used in the segregated component of the hatchery program

In order to more accurately describe this PNI value for the entire SFSR population, we included three additional factors: 1) SFCEP broodstock used (since additional segregated fish contribute to the broodstock), 2) the SFCEP releases (because these releases are all in the SFSR population), and 3) the broodstock used for the Clearwater releases (which the operators intend to phase out in the next few years). This yielded a new PNI of 0.40 and a pHOS of 0.33. The Clearwater releases do not return to the South Fork Salmon River, therefore, we did not include them in spawning estimates in our PNI calculation. Because there are limited data regarding SFCEP survival rates, we applied Bradford's 1995 calculated value for percentage Chinook salmon egg to smolt survival in the natural environment (7%) and then applied the average LGD smolt to adult survival (0.8%) to estimate number of adult returns to SFSR. Alternatively, we used a pHOS correction equation to estimate the new pHOS value when SFCEP fish are accounted for in the PNI model. This correction is used to verify that the manually calculated adult SFCEP survival estimates are accurate. We accomplished this by estimating the proportion of unidentifiable (i.e. SFCEP returns) fish as well as the proportion of marked/tagged fish removed at the weir and adjusting the apparent pHOS′ to the true $\boldsymbol{pHOS}$ through the following equation (Busack 2017):

$\boldsymbol{pHOS} = \text{pHOS}' * \frac{(1-rem)*(1-u)+u}{(1-rem)*(1-u)}$, where *rem* is the "removal rate" (i.e. weir efficiency) and u is the proportion of hatchery fish that are unidentifiable.

For the SFSR population, we applied a 98% efficiency rate (*rem*) for the SFSR weir and used a 2% unidentifiable rate (u). The corrected pHOS value was 0.36 (instead of the previously calculated 0.33). Using this equation, we obtained a PNI of 0.38 (previously calculated as 0.40). These pHOS and PNI values were similar between the "survival estimate" and "pHOS correction" methods, so we decided to use the "survival estimate" method since we had some program survival rates to utilize. Because the Clearwater broodstock will eventually be phased out, we additionally modeled a situation in 2014 excluding the Clearwater broodstock, but including SFCEP broodstock. This PNI was calculated to be 0.43 and the pHOS was still 0.33.

Because co-managers intend to phase into having a higher level of integration in their programs in their Proposed Action, we expect these PNI values to continue to increase into the future. The sliding scale future management scenarios have been calculated in Table 3. This sliding scale was collaboratively developed by IDFG and the NPT to include outplanted and recycled fish in future management scenarios. Past amounts of fish recycled and outplanted in the SFSR mainstem are shown in Table 31. The level of hatchery-influenced selection associated with fish originating from eggbox programs is uncertain, but we believe it is less than those reared for long periods of time in the hatchery because early life stages (eyed-egg to smolt) may not be subjected to as much selection in a hatchery environment. Therefore, we have modeled scenarios where estimated numbers of fish returning from the SFCEP are treated both as HORs and as NORs (Table 32). For the scenario where SFCEP fish are treated as HORs, we are assuming that there is as much hatchery-influence selection occurring as traditional hatchery fish. In the alternative scenario where SFCEP fish are treated as NORs, we assume that no hatchery-influenced selection is occurring. Even though the level of hatchery-influenced selection on eggbox program fish is unknown, we expect PNI values to fall somewhere between these two modeled scenarios. The Clearwater releases were not modeled in these scenarios because those releases will be eliminated. In addition, IDFG proposes to remove segregated hatchery-origin adults in the South Fork Salmon River when minimum escapement to major and minor spawning aggregates are met. This will further increase PNI and will limit pHOS in the future.

Table 31. SFSR segregated program fish outplants into the SFSR mainstem over the last five years

Year	Number of recycled fish[1]	Number of outplanted fish
2011	375	0
2012	744	0
2013	611	0
2014	200	0
2015	983	4
Five year mean	**582.6**	**0.8**

[1]Recycled fish are intended to be caught during fisheries
[2]Outplanted fish are intended to spawn in the natural environment

Table 32. PNI for the South Fork Salmon River population above the weir based on sliding scale future scenarios. The sliding scale was collaboratively developed by IDFG and NPT to include projections of outplants (up to 500 Hatchery-origin returns in the SFSR mainstem) below the SFSR weir. Weighted average of the natural population was assigned based on means of the most recent ten years of data (2005 – 2014).

NORs to weir[1]	Size of Integrated component	PNI (SFCEP treated as NORs)[2]	Total pHOS (SFCEP treated as NORs)[2, 3, 4]		PNI (SFCEP treated as HORs)[2]	Total pHOS (SFCEP treated as HORs)[2, 3, 4]	
			Above weir	Below weir		Above weir	Below weir
300[5] – 699	150,000	**0.64 – 0.57**	0.45 – 0	0.37	**0.54 – 0.84**	0.49 – 0	0.41
700[6] – 999	250,000	**0.57 – 0.74**	0.45 – 0.16	0.37	**0.54 – 0.68**	0.51 – 0.21	0.41
1,000 – 1,299	500,000	**0.63 – 0.93**	0.35 – 0.01	0.37	**0.62 – 0.81**	0.35 – 0.07	0.41
1,300 – 3,000+	1,000,000	**0.65 – 0.90+**	0.35 – 0	0.37	**0.63 – 0.82**	0.35 – 0	0.41

[1]Although scale is organized by NORs to the weir, the model accounts for all NORs above and below weir, based on mean of most recent ten years of data (2005-2014)
[2]pHOS estimates on were based on minimum abundance threshold of 300 adults above weir (if there 300- 699 NORs to weir) and 1000 spawners above weir (if > 700 NORs to weir); proportion of integrated fish in segregated component is based on 2014 values; the below-weir NOS/HOS estimates were means of most recent ten years of data (2005-2014). Segregated strays are accounted for by adding in 0.02 (2%) segregated pHOS level to be conservative
[3]Integrated and segregated components of pHOS were used, but total pHOS is reported here. Maximum pHOS values were set from the sliding scale in the Proposed Action (**Table 3**).
[4]pNOB was assumed to be 0.66-0.67 in the Integrated component. When SFCEP fish are treated as NORs, we assumed 0.25 proportion of integration in the Segregated component. When they are treated as HORs, we assumed 0.22 proportion of integration in the Segregated component. These proportions of integration were based on 2104 estimates. A minimum of 6% integration in the segregated component was set for this scale. At the lowest PNI scale tier (700 NORs), resulting PNI is 0.53.
[5]IDFG minimum weir escapement threshold is 300 adults. If NOR returns plus and integrated adults is below this, segregated adults may be released upstream to spawn naturally to meet escapement objectives. PNI targets are set aside in years with less than 300 NORs in favor of demographics.
[6] When the projected return to the weir exceeds 700 adult NORs, IDFG will incrementally increase the integrated smolt release and concurrently reduce size of segregated release to maintain at least 1000 spawners above the weir.

The East Fork of the South Fork Salmon River population has low productivity and a moderate abundance of NORs and has been designated as "Maintain" for viability (Table 22). We have calculated PNI over the last five years (Table 34) and estimated future PNI based on increased production outlined in the Proposed Action. The pHOS values of first generation hatchery-origin fish with 100% natural-origin parents range from 0.27 and 0.45. The future modeled scenario including the increased hatchery production by 50,000 juveniles results in a PNI value of 0.67 or higher. Moreover, IDFG outplants SFSR spring/summer Chinook salmon from the segregated program into the EFSFSR, beyond the "Glory Hole" natural barrier (Table 33). Thus we have also calculated PNI scenarios that include these outplants. We have accomplished this by using EFSFSR population spawning data and have treated the EFSFSR and Johnson Creek as separate "populations" in the PNI model. We have weighted the different reaches (or populations) by total numbers of redds observed in each reach. These values are all reported in Table 34 as well. According to spawning ground data, very few of the outplanted SFSR fish successfully spawn.

Therefore, the PNI is not largely affected by including these outplanted fish in the model which means that these outplated fish are not significantly contributing to the genetic structure of the EFSFSR population.

Table 33. SFSR program segregated program fish outplants into the EFSFSR over the last five years

Year	Number of outplants in the EFSFSR above the Glory Hole[1]
2011	459
2012	294
2013	130
2014	0
2015	190
Five year mean	**214.6**

[1]In **2009-**2010, there have been SFSR outplants into the EFSFSR below the "Glory Hole". From 2011 onward, there have only been outplants above the "Glory Hole" in the EFSFSR

Table 34. PNI for the East Fork of the South Fork Salmon River population, including the JCAPE contributions as well as the JCAPE contributions combined with the EFSFSR outplants over the last five years

Year	JCAPE program		JCAPE program and EFSFSR Outplants[2]		
	PNI	Total pHOS[1] in Johnson Creek	PNI and model weights in parentheses	Total pHOS[3]	
				Johnson Creek	EFSFSR mainstem
2011	0.72	0.39	0.71 (74% JC)	0.39	0.55
2012	0.79	0.27	0.78 (80% JC)	0.27	0.44
2013	0.77	0.30	0.76 (80% JC)	0.30	0.41
2014	0.74	0.36	0.74 (86% JC)	0.36	0
2015	0.69	0.45	0.69 (84% JC)	0.45	0.43
Future[4]	**0.69**	**0.45**	**0.69 (81 % JC)**	**0.45**	**0.44**
Future with outplants[5]	n/a		**0.68 (81 % JC)**	**0.45**	**0.94**

[1] pHOS in Johnson Creek is only made up of integrated hatchery-origin returns from previous years. Segregated strays have also been accounted for in this model, by adding in an additional 0.02 (2%) segregated pHOS level to be conservative

[2]Values were weighted by natural-origin spawner ratios

[3]pHOS in EFSFSR mainstem consists of outplanted returns plus some integrated (JCAPE program) and segregated (other program) strays. These have been accounted for by adding in 0.01 (1%) segregated pHOS level and 0.01 (1%) integrated pHOS level to be conservative

[4]Modeled scenario with increased production (50,000 smolt), as indicated in the Proposed Action, by using smolt-to-adult return estimates from the JCAPE program. This scenario also includes recent five year averages of redds in EFSFSR (above and below the Glory Hole) and Johnson Creek (above and below the weir)
[5]Maximum outplants equal 1000 segregated SFSR program fish outplanted into the EFSFSR, as agreed upon by. IDFG and NPT. PNI and pHOS values were based on the proportion of redds out of total number of potential outplants.

The population level PNI and pHOS values (Table 30 - Table 34) resulting from the hatchery programs in the Proposed Action do not constitute a serious threat to the Snake River spring/summer Chinook salmon ESU. The integrated, genetically linked SFSR and SFCEP hatchery programs have resulting population level PNI values that are projected to approach or exceed 0.67 in the SFSR population according to the sliding scale (Table 32). This value may fall below to a value of 0.54 in years where natural-origin returns are poor (Table 32). Even then, however, this lower PNI value is acceptable, because at this minimal level of natural-origin returns, meeting a minimum level population abundance is more critical than the potential negative hatchery-influenced selection effects. These PNI sliding scale calculations are reliable future estimates, as indicated by recent data. In 2014, the SFSR program was fully integrated, meaning that this was the first year that this program created a genetic relationship between the integrated and segregated program components. The resulting PNI value was 0.64 (Table 32). The JCAPE program results in PNI values >0.67 (Table 34), which is a reflection of how the program was designed by co-managers to be integrated conservation (using 100% natural-origin broodstock) for the purposes of program fish being able to spawn naturally in the environment. These PNI values are acceptable because they indicate that the natural environment is driving selection of the population, which minimizes adverse genetic effects of operating hatchery programs. Five-year PNI averages will be used to measure the genetic influence of hatchery-origin fish on ESA listed natural-origin fish. In relation to VSP criteria (Section 2.6), hatchery-origin selection effects resulting from the operation of hatchery programs in the Proposed Action do not constitute a threat to fitness or productivity of the populations, and result in a small negative effect on the populations.

2.6.2.2.2. Ecological interactions between hatchery- and natural-origin adults

Hatchery-origin fish can have ecological effects on natural-origin fish when they compete for spawning sites, superimpose redds, and/or contribute marine derived nutrients to freshwater areas.

Nutrient contribution

To the extent that hatcheries contribute added fish to the ecosystem, there can be positive effects. For example, when anadromous salmonids return to spawn, hatchery-origin and natural-origin alike, they transport marine-derived nutrients stored in their bodies to freshwater and terrestrial ecosystems. Their carcasses provide a direct food source for juvenile salmonids and other fish, aquatic invertebrates, and terrestrial animals, and their decomposition supplies nutrients that may increase primary and secondary production (Gresh et al. 2000; Kline et al. 1990; Larkin and Slaney 1996; Murota 2003; Piorkowski 1995; Quamme and Slaney 2003; Wipfli et al. 2003). As a result, the growth and survival of juvenile salmonids may increase (Bell 2001; Bilton et al. 1982; Bradford et al. 2000; Brakensiek 2002; Hager and Noble 1976; Hartman and Scrivener 1990; Holtby 1988; Johnston et al. 1990; Larkin and Slaney 1996; Quinn and Peterson 1996;

Ward and Slaney 1988). For a more detailed description of ecological interactions, refer to (Mitchell Act Biological Opinion 2017).

Salmon and steelhead are important transporters of marine-derived nutrients into the freshwater and terrestrial systems through the decomposition of fish carcasses (Cederholm et al. 2000). One typical added nutrient as result of increased hatchery fish production is phosphorus. Increased phosphorus can benefit salmonids because phosphorus is typically a limiting nutrient for prey sources. For example, growth rates in *Daphnia* (a prey source for salmonids) have been shown to increase with increased phosphorus in the algae (Boersma et al. 2009). This means that by increasing phosphorus in the system, this could potentially provide a larger prey mass for salmonids.

The propagation and release of hatchery-origin fish and eggs from the five proposed programs potentially adds 566 kg (Table 35) of phosphorus annually into the environment in addition to what is typically added to the system by natural-origin fish. This is likely an overestimation of nutrients added to the system, because hatchery-origin returns are subjected to removal from harvest, broodstock collection, and gene flow management. Regardless, these added hatchery-origin fish may add additional beneficial nutrients into the system.

Table 35. Total phosphorous imported by adult returns from the proposed hatchery programs per year based on the equation: $I_t = A_t \times m_A \times P_A$, where I represents the annual import of phosphorus by adult salmon into the freshwater, t represents the year, A_t is the total number of adult spawners in year t , m_A represents the mean mass of an individual adult, and P_A is the proportion of phosphorus in the body of adults (Scheuerell 2005).

Program	$\# \text{ smolt release} \times \text{smolt to adult survival} = A_t$[1]	Number of adults, A_t	Adult Mass (kg), m_A[2]	Concentration of phosphorous (kg/adult), P_A[3]	Phosphorus imported (kg/year), I_t
Rapid River	2.65 million *x* 0.006	15,900	5.5	0.0038	332.3
Hells Canyon	350,000 *x* 0.007	2,450	5.5	0.0038	51.2
South Fork Salmon River	850,000 *x* 0.009	7,650	5.5	0.0038	159.9
	150,000 *x* 0.003	450			9.4
JCAPE	150,000 *x* 0.003	450	5.5	0.0038	9.4
SFCEP	300,000 eggs *x* 0.070 *x* 0.008	168	5.5	0.0038	3.8
				Total:	**566**

[1]Average smolt to adult survival to LGD for the most recent years where data is available for each of the different hatchery programs
[2]5.5 kg was used as the mean mass of adult Chinook salmon from the Snake River basin (Peery et al. 2003)
[3]Moore and Schindler (2004) assume 0.38% mass-specific concentrations of phosphorus in adults
[4]To calculate eyed-egg survival to adult, we applied Bradford's 1995 calculated value for percentage Chinook salmon egg to smolt survival in the natural environment (7%) and then applied the average LGD smolt to adult survival (0.8%) to estimate number of adult returns

Spawning site competition and redd superimposition

According to the program HGMPs, run and spawn timing between hatchery-origin and natural-origin Snake River spring/summer Chinook is very similar. Therefore, hatchery-origin fish that make it onto spawning grounds may compete with natural-origin spring/summer Chinook salmon for spawning sites and redd superimposition may also occur. The JCAPE program produces hatchery-origin fish that are intended to spawn with natural-origin fish to supplement the natural-origin population. As calculated in Factor 1, Section 2.6.2.1 the natural East Fork of the South Fork Salmon River population remains just under the minimum abundance threshold for a "Large" population. Because of this, there is likely room for both natural-origin and hatchery-origin returns to spawn without competing for spawning sites or superimposing redds. Regardless, co-operators have made efforts to ensure that hatchery influence is managed in a way which would not lead to these interactions with natural-origin fish. For the other four programs, efforts are made to reduce hatchery-origin spawners on natural-origin spawning grounds, and pHOS calculations and are in line with recommendations made by the HSRG (Hatchery Scientific Review Group 2009).

There is unlikely to be spawning site competition or redd superimposition with hatchery-origin Chinook salmon and the other three listed species (Table 36). This is because their spawn timings largely do not overlap; therefore, there is limited opportunity for these potential ecological interactions to occur. It is possible that hatchery-origin spring/summer Chinook salmon could compete with natural-origin fall Chinook salmon because there is a slight overlap in spawn timings in October. However, the Snake River fall Chinook salmon ESU only geographically overlaps with a portion of the Snake River spring/summer Chinook salmon ESU. This overlap primarily occurs in the South Fork of the Salmon River MPG Little Salmon River population, but there is also a small portion of overlap with the South Fork of the Salmon River population. Therefore, the releases from the five programs may create opportunities for spawning site competition and redd superimposition between hatchery-origin fish and Snake River fall Chinook salmon, but we would expect these effects to be minimal. Hatchery operators are familiar with identifying morphological differences between fall and spring/summer Chinook, therefore it is unlikely that they use incorrect species broodstock. The ongoing PBT genetic analyses will indicate any spawning overlap between fall and spring/summer Chinook salmon, which would determine levels of spawning site competition and redd superimposition between these species.

Table 36. Run and spawn timing of Snake River spring and summer Chinook salmon, steelhead, fall Chinook salmon, and sockeye salmon

Species		Run timing	Spawning
spring/summer Chinook salmon		March to mid-August	late July to October
steelhead		September to November	March to June
fall Chinook salmon		late-August to November	late-September to mid-December
sockeye	resident life form I	NA	late-fall

salmon	resident life form II: kokanee	NA	late-summer to early-fall
	anadromous	mid-summer	late-fall

Source: IDFG website, http://fishandgame.idaho.gov

The overall ecological effects from adult hatchery-origin fish on listed salmon and steelhead are likely to be negligible. The effects of nutrient contribution in the form of marine-derived nutrients will be slightly positive to listed species, which does not constitute a measurable change to VSP criteria. In addition, and the effects of spawning site competition and red superimposition will be negligible and will not affect VSP criteria.

2.6.2.2.3. Encounter of listed species at adult collection facilities

Hatchery operators may incidentally encounter ESA-listed salmonids at adult collection facilities. These encounters may cause handling related stress or mortality to fish from sorting, holding, and handling. Therefore, the operation of these facilities poses potential incidental harm to Snake River spring/summer Chinook salmon not intended for broodstock, steelhead, fall Chinook salmon, and sockeye salmon. This threat can be minimized by collecting, processing, and passing fish within 24 hours of initial trapping.

Snake River spring/summer Chinook salmon

Adult collection facilities may affect spring/summer Chinook in a number of ways. Handling these fish may result in stress and/or physical injury which could lead to short-term or long-term post-release mortality. Long-term mortality is difficult to observe, therefore only immediate mortality events have been recorded as mortalities.

Rapid River and Hells Canyon

The number of natural-origin spring Chinook salmon from the Little Salmon River population that were captured, handled, released, and released or unintentionally killed at the Rapid River velocity barrier are listed Table 37. None of these trapped fish are used in broodstock because Rapid River and Hells Canyon hatchery programs are both segregated. There has only been one observed injury/mortality during these capture/handle/release events associated with broodstock collection at RRFH in the last 12 years of most recent data available.

Table 37. Yearly and 12 year average take of natural-origin spring/summer Chinook salmon associated with trapping for broodstock at the Rapid River velocity barrier (RRVB) on the Little Salmon River (LSR) for years 2001 to 2012 (IDFG 2016c)

Return Year	Natural Adult Run LSR	Number Trapped at RRVB	Trapping/Holding Mortalities (incidental)	Number Spawned (direct)	Total Mortality	% Mortality of Trapped Fish
2001	468	399	0	NA	0	0

2002	331	284	0	NA	0	0
2003	158	122	0	NA	0	0
2004	137	112	0	NA	0	0
2005	67	60	0	NA	0	0
2006	131	120	0	NA	0	0
2007	197	197	0	NA	0	0
2008	231	209	0	NA	0	0
2009	52	30	0	NA	0	0
2010	126	63	0	NA	0	0
2011	154	108	1	NA	1	0.93
2012	78	38	0	NA	0	0
Average	**171**	**145**	**<1**	**NA**	**<1**	**0.08**

The Hells Canyon Dam trap is located outside of the South Fork Salmon River MPG and the entire Snake River spring/summer Chinook salmon ESU. Therefore, natural-origin spring/summer Chinook are not assumed to substantially spawn in the Snake River mainstem below and in the general vicinity of the Hells Canyon Dam. Regardless, some natural-origin spring Chinook salmon are occasionally encountered during broodstock collection at the Hells Canyon Dam trap. Table 38 includes the total number of natural-origin spring Chinook salmon from the one of the Snake River Chinook populations that were captured, handled, released, and released or unintentionally killed at the Hells Canyon Dam trap during broodstock collection activities. The origin of these natural-origin Chinook salmon is unknown; however, they are likely to belong to the South Fork Salmon River, Middle Fork Salmon River, or possibly even from the Upper Salmon River MPGs.

Table 38. Yearly and 12 year average take of natural-origin spring/summer Chinook salmon associated with trapping for broodstock at the Hells Canyon Dam (HCD) trap on the Snake River (SR) for years 2001 to 2012 (IDFG 2016b)

Return Year	Natural Adult Run	Number Trapped at HCD trap	Trapping/Holding Mortalities (incidental)	Number Spawned (direct)	Total Mortality	% Mortality of Trapped Fish
2001	NA	NA	0	NA	0	0
2002	NA	6	0	NA	0	0
2003	NA	5	0	NA	0	0
2004	NA	19	0	NA	0	0
2005	NA	16	0	NA	0	0
2006	NA	4	0	NA	0	0
2007	NA	8	0	NA	0	0
2008	NA	39	0	NA	0	0
2009	NA	4	0	NA	0	0
2010	NA	13	0	NA	0	0
2011	NA	19	0	NA	0	0
2012	NA	23	0	NA	0	0

Average	**NA**	**14**	**0**	**NA**	**0**	**0**

South Fork Salmon River (including SFCEP broodstock)

The average annual number of natural-origin summer Chinook salmon adults handled at the South Fork Salmon River weir was 751 with a range of 254 to 1580 (Table 39). The trap may handle 100% of natural-origin adults moving upstream to spawn in habitat above the weir. Weir efficiency averaged 98% in recent years. Non-lethal take includes capture, handle, mark (opercle punch) and release of all adults released upstream. Tissue samples fin clips are taken from all adults released upstream. Lethal take of listed natural-origin adults includes direct take of adults for broodstock (include pre-spawn mortality that occurs during trapping and holding) and unintentional mortality associated with weir operations. For spawn years 2001-2014 average annual lethal direct take of adults was 39 (range: 1-193) which represents an annual average of 4.9% (range: 0.2-27.0) of the natural-origin adults trapped at the weir. Unintentional mortality associated with the operation of the adult trapping facility is low (average mortality rate of natural fish as a result of trapping and handling was 0.4% range 0.0-1.1%).

Table 39. Yearly and 14 year average take of natural-origin spring/summer Chinook salmon associated with trapping for broodstock at the McCall Fish Hatchery satellite facility on the South Fork Salmon River for years 2001 to 2014 (IDFG 2017d)

Return Year	Natural Adult Run SFSR Mainstem[1]	Number Trapped	Trapping/Holding Mortalities (incidental)[2]	Number Spawned (direct)	Total Mortality	% Mortality of Trapped Fish
2001	984	1580	30	30	60	3.8
2002	885	1281	60	114	174	13.6
2003	1797	1495	12	0	12	0.8
2004	870	595	1	0	1	0.2
2005	551	254	1	0	1	0.4
2006	628	262	3	0	3	1.1
2007	672	274	2	0	2	0.7
2008	691	594	5	0	5	0.8
2009	607	552	4	0	4	0.7
2010[3]	1585	1351	8	77	8	0.6
2011[3]	1314	698	8	75	8	1.1
2012[3]	828	456	2	49	2	0.4
2013	421	406	3	68	71	17.5
2014[4]	920	688	71	122	193	27.0
Average	**911**	**749**	**15**	**38**	**39**	**4.9**

[1]Number is an estimate based on red counts that are expanded by 2.31 fish per red and the proportion of observed carcasses that were natural-origin
[2] In addition, IDFG incidentally encounters less than ten steelhead during the operation of this trap
[3]All natural fish spawned were males (crossed with hatchery females) and were subsequently released upstream to spawn naturally

[4]High holding mortality resulted from intense rain event that led to high debris and sediment laden flow at the adult holding facility. Real time monitoring equipment was installed upstream of the weir to help mitigate this situation in the future.
Source: McCall Fish Hatchery Brood and Run reports and IDFG unpublished data (directly from the SFSR HGMP)

JCAPE

Broodstock collection for the JCAPE program has resulted in the collection and use of an average of 76 natural-origin summer Chinook salmon, with a range of 254 to 1580 (Table 40). The proposed broodstock collection for the operation of the JCAPE program moving forward would result in the direct take of 40 to 104 natural-origin summer Chinook salmon from Johnson Creek. Biological information is collected from live-adults that includes: length, sex, and tissue. Capture, tagging, and handling related mortality (incidental take) of adults is also included in Table 40. Broodstock related incidental take has ranged from 6.67% to 41.3% annually. Percent mortality associated with weir operation has generally been around 1% annually. Assuming that the average number of mortalities does not appreciably change in the future, the projected estimates of a take due to broodstock management should range between seven to 31 adult fish annually ($\alpha = 0.05$). Projected estimates of take due to weir operation range from zero to four adults annually.

Table 40. Yearly and 17 year average take of natural-origin spring/summer Chinook salmon associated with trapping for broodstock at the Johnson Creek picket weir located at River Mile 8.2 for years 1998 to 2015 (excluding year 1999) (NPT 2017)

Return Year	Natural Adult Run Johnson Creek	Number Trapped	Trapping/Holding Mortalities (incidental)	Number Spawned (direct)	Total Mortality (incidental and direct)	% Incidental Mortality of Trapped Fish
1998	218	113	5	49	54	4.4
2000	~160	152	32	41	73	21.1
2001	~1250	1243	72	78	150	5.8
2002	~1245	783	19	78	97	2.4
2003	~750	606	26	53	79	4.3
2004	~375	211	5	52	57	2.4
2005	~200	131	10	65	75	7.6
2006	~200	102	8	52	60	7.8
2007	~225	155	4	48	52	2.6
2008	~500	326	16	61	77	4.9
2009	~490	275	14	54	70	5.1
2010	~1125	542	10	60	70	1.8
2011	~650	474	8	58	66	1.7
2012	~850	529	12	60	72	2.3
2013	~600	686	16	61	77	2.3
2014	1652	1067	30	64	94	2.8
2015	~850	528	9	63	72	1.7

Average	**614**	**466**	**17**	**59**	**76**	**4.8**

Overall, the encounter of fish at adult collection facilities are likely to have a minimally negative impact on listed salmonids.

2.6.2.3. Factors 3. Hatchery-origin fish and the progeny of naturally spawning hatchery-origin fish in juvenile rearing areas and migratory corridors

NMFS also analyzes the potential for competition and predation when the progeny of naturally spawning hatchery fish and hatchery releases share juvenile rearing areas and migratory corridors. This factor can have effects on the productivity VSP parameter (Section 2.6) of the natural population. The effect of this factor ranges from negligible to negative.

Because we have drawn our Action Area down until Ice Harbor Dam on the Snake River, we have only considered the effects of program juvenile hatchery-origin fish in juvenile rearing areas and the migratory corridor down to Ice Harbor Dam. The effects of Factor 3 on all listed species analyzed in this Biological Opinion are considered negative.

2.6.2.3.1. Hatchery release competition and predation effects

We used the PCD Risk model of Pearsons and Busack (2012) PCD Risk, to quantify the potential number of natural-origin salmon and steelhead juveniles lost to competition and predation from the release of hatchery-origin juveniles. The original version of the model suffered from operating system conflicts that prevented completion of model runs and was suspected of also having coding errors. As a result, the program was modified by Busack in 2017 into a considerably simpler version to increase supportability and reliability. At present, the program does not include disease effects and probabilistic output. Parameter values used in the model runs are shown in Table 41, Table 42, and Table 43.

For our model runs, we assumed a 100 percent population overlap between hatchery-origin spring/summer Chinook salmon juveniles and all natural-origin species (juveniles) present. Hatchery-origin spring Chinook salmon in the Rapid River, Hells Canyon, SFSR, SFCEP, and JCAPE programs outmigrate from March to September. All of these releases could overlap with natural-origin Chinook and sockeye salmon, and steelhead in the Snake River Basin. However, we acknowledge that a 100 percent population overlap in microhabitats is likely an overestimation. In addition, our model does not assess effects on age-0 steelhead because steelhead spawn from March to June with a peak from April to May in the Action Area (Busby et al. 1996). Thus, it is unlikely that any age-0 steelhead would have emerged in time to interact with the hatchery steelhead smolts as they migrate downstream.

In contrast to how we have used the model in other areas (e.g., Upper Columbia River), we considered the proportion of fish being barged downstream in this model. We used barging proportions from 2008 and 2015 (Table 43) to represent the range of possible barging proportions, which vary annually. This may give us a more accurate representation of the amount of program hatchery fish within the Action Area. To do this, we had to estimate survival and travel times form each release site down to LGD. We then estimated the number of hatchery Chinook salmon that made it down to LGD, summed them, and ran this number through the model as an aggregate with new inputs for survival and travel time from LGD to Ice Harbor Dam (Table 44).

Table 41. Parameters in the PCD Risk model that are the same across all programs. All values from HETT (2014) unless otherwise noted

Parameter	Value
Habitat complexity	0.1
Population overlap	1.0
Habitat segregation	0.3 for Chinook salmon; 0.6 for all other species
Dominance mode	3
Piscivory	0.0023 for Chinook salmon; 0 for all other species
Maximum encounters per day	3
Predator:prey length ratio for predation	0.25[1]
Average temperature across release sites	11.4°C[2]

[1](Daly et al. 2009)
[2]PTAGIS accessed in July 2017.

Table 42. Age and average size of listed natural-origin salmon and steelhead encountered by juvenile hatchery fish after release.

Species	Age Class	Size in mm (SD)
Chinook salmon	0	55 (10)
	1	91 (11)
Steelhead	1	71 (10)
	2	128 (30)
Sockeye Salmon[1]	1	86 (7)
	2	128 (8)

[1]For the sockeye salmon runs, we assumed that a maximum of 61,000 natural-origin outmigrants in the model. We also assumed an age class composition of 13% “age two” fish and 87% “age one” fish (Leth 2017) (Rabe 2017b)

Table 43. Hatchery fish parameter values for the PCD Risk model. For aggregate model runs from Lower Granite Dam (LGD) to Ice Harbor Dam (ICH), survival times, travel times, and SAR values were combined and averaged for all releases. PTAGIS database; Fish Passage Center, accessed on August 1, 2017; (Leth 2017) (Rabe 2017b)

Program	Release site	Proposed Release #	Size in mm (SD)	Survival rate		Travel (Residence) Time in median days		Proportion Barged from LGD to ICH	
				Release to LGD[1]	LGD to ICH[1]	Release to LGD[1]	LGD to ICH[1]	2008	2015
Rapid River	RR	2,500,000	149 (20)	0.78	0.77	39[2]	7	0.37	0.08
	LSR[3]	150,000				41[2]			
Hells Canyon	SR[4]	350,000		0.66		32[2]			
SFSR (and SFCEP)	SFSR	1,021,000[5]		0.66		42		0.27	
JCAPE	JC	150,000		0.35		54		0.32	

[1]LGD stands for Lower Granite Dam; ICH stands for Ice Harbor Dam
[2] Travel times for the Rapid River and Hells Canyon programs were calculated based on the travel rate information from the PIT tagged fish released from the Rapid River Program, and applied to the distance the fish traveled at each of the releases. It is noteworthy to add that these are maximum travel times because this time begins as soon as the fish were volitionally released into the river.
[3]LSR stands for Little Salmon River
[4] SR stands for Snake River
[5]Egg to smolt survival for the SFCEP program was estimated based on (Bradford 1995)

Based on the data above, our model results show that hatchery-origin Chinook salmon are likely to have the largest negative effect on natural-origin Chinook, followed by steelhead, and sockeye salmon. The maximum numbers of fish lost are also shown in Table 44 and would not change if more natural-origin fish were present throughout the Action Area because we ran the model with natural-origin fish numbers at the point where all possible hatchery fish interactions are exhausted at the end of each day. The exception to this is for sockeye salmon because we have data for natural-origin abundance for the one population that comprises the entire ESU that demonstrates that from 2006-2016 the maximum number of natural-origin sockeye salmon produced was ~61,000. Thus we used this value in the model along with the actual proportions of each age-class (87 percent age-1, and 13 percent age-2) available (Kozfkay 2017). These model effects shown as juvenile and adult equivalent fish lost can also be represented as a travel time standard for a year-to-year measurement. This can be accomplished by taking a five-year running medium of travel time of hatchery-origin spring/summer Chinook outmigrants to reach LGD after release (Table 43) beginning in year 2018. Once this is accomplished, you can then compare the five year running medians across a given five year time frame (e.g. 2018 to 2022). If travel times exceed the five-year median by five or more days in at least three of the five years used to establish the median, this indicates that the effects (including take estimates) may be greater than our existing estimates suggest. These travel time values are easily measurable using PIT tags, screw traps, or other juvenile monitoring techniques, and are linked to the current model estimates.

Using the number of each species that pass over LGD, which is 30,607 for natural-origin Chinook salmon (Table 17 and Table 20 both fall and spring/summer runs combined; in Harvest baseline section), 25,991 for steelhead (Table 18 in Harvest baseline section), and 1,115 for both hatchery and natural sockeye salmon (DART, 10-year average from 2007-2016 accessed August 2, 2017). These would equate to a potential loss of ~ 2.1-2.2, 1.5-1.6, and 2 percent (range of values for Chinook salmon, steelhead, and sockeye salmon for the 2008 and 2015 aggregate runs) of the potential adult return from competition and predation during the juvenile life stage. In addition, these negative effects are spread out over the various populations that comprise the Snake River ESUs/DPSs, and also include the unlisted spring/summer Chinook salmon originating from the Clearwater Subbasin.

Table 44. Maximum numbers and percent of natural-origin salmon and steelhead lost to competition and predation with hatchery-origin Chinook salmon released from the Proposed Action.

Program	Chinook		Steelhead[2]	Sockeye
	Predation	Competition[1]	Competition[1]	Competition[1]
To Lower Granite Dam				
Rapid River	1730.5	18283.2	7343.1	1692.1
Hells Canyon	472.9	12328.8	4794.9	677.7
SFSR (and SFCEP)	5408.4	45211.2	25018.5	889.8
JCAPE	233.3	6746.3	2631.3	1141.3
To Ice Harbor Dam				
Aggregate-2008 (large proportion)	380	16490	14260	153.6
Aggregate-2015 (small proportion)	720	23270	18490	153.5
Total Juveniles Lost (2008-2015)	**107284.6-114404.6**		**54047.8-58277.8**	**4554.5-455.4**
SAR[3]	0.6		0.7	0.5
Adult Equivalents	**637.8-680.5**		**382.8-412.4**	**22.8-22.8**

[1] Competition as used here is the number of natural-origin fish lost to competitive interactions assuming that all competitive interactions that result in body weight loss are applied to each fish until death occurs (i.e., when a fish loses 50% of its body weight). This is not reality, but does provide a maximum mortality estimate using these parameter values. Moreover, the model showed that steelhead and sockeye are not expected to be prey items for the program hatchery fish so only competition is reported

[2]For the aggregate runs, we only used “age two” steelhead in the model, because “age one” fish are not likely to occur at that reach (cite).

[3]SAR stands for “smolt-to-adult survival”. Data sources for rates: Chinook Salmon (IDFG 2011; IDFG 2016c; IDFG 2017d; NPT 2017; SBT 2017; SBT and IDFG 2010), Steelhead (NMFS 2017), and sockeye salmon (IDFG 2012). Of note is that SARs for the segregated programs are not adjusted to account for harvest; they are calculated based on what arrives at the weir.

Similar to the use of models for biological systems elsewhere, this model cannot possibly account for all the variables that could influence competition and predation of hatchery juveniles on natural juveniles. For example, the model assumes that if a hatchery fish is piscivorous and stomach capacity allows the fish to consume prey it will be natural-origin prey. The reality is hatchery-origin fish could choose to eat a wide variety of invertebrates, other fish species (e.g., shad, minnows), and other hatchery-origin fish in addition to natural-origin smolts. However, we believe that with this model we are estimating, to the best of our ability, a worst-case estimate for the effects on natural-origin juveniles.

Residual hatchery spring/summer Chinook salmon are not explicitly accounted for in our model at this time. However, the applicants have proposed actions that which are expected to minimize their ecological and genetic impacts. Recent data exists that residualism may occur as result of hatchery rearing and has been measured in some Upper Columbia River hatchery programs (NMFS 2017c). Therefore, we will measure residualism into the future. We will measure this by calculating the total number of hatchery fish encountered until LGD 60 days after release. For program releases into "maintain" populations (Table 22), which include Rapid River, Hells Canyon, and JCAPE programs, a range of travel times will be calculated for fish to LGD, or at the closest PIT tag arrays to release if available. For example, the PIT tag array currently in place in Johnson Creek will be used to detect fish that have delayed outmigration and remain in the EFSFSR population. Running five year averages will then be calculated for this measurement.

For program releases that occur in a "viable" population (Table 22), which includes the SFSR program, visual observation at pre-release sampling will be completed and a percentage of spring/summer Chinook salmon that are precociously mature prior to release will be recorded and calculated. This visual observation will be relied on as part of the proposed action, but to date has not taken place for the SFSR program. Therefore, to estimate the likely extent of residualism, NMFS must consider evidence from other programs. There are recent, relevant studies which have measured precocial maturation as result of hatchery rearing. In particular, a steelhead hatchery program in the Upper Columbia River recorded precocial maturation rates less two percent of observed hatchery fish (measured as a five year average from 2009 to 2013) (USFWS 2016). These rates may not be entirely transferable to Chinook salmon precocial maturation rates for the proposed hatchery programs, but it provides guidelines to these standards. In addition, some studies have indicated that hatchery reared Chinook salmon may occur at much higher rates than the two percent rate observed for steelhead in the Upper Columbia. In particular, one study found Chinook salmon mini jack rates to be very high and range from 19 to 57 percent of observed juveniles from hatchery programs that used Hood River and Carson stock (Spangenberg et al. 2015). While we do not expect precocial maturation rates to be this high in the SFSR program (these results largely reflect environmental conditions that are not observed in the Snake River Basin), we do expect them to be higher than the 2 percent rate for steelhead in the Upper Columbia River. Based on informal communications with co-managers, we estimate that no more than five percent of observed hatchery fish should express precocial maturation for the SFSR program. A five-year running average will be used to determine these effects into the future. This is the first time that the SFSR program has utilized visual observations to estimate the amount of precocious fish (primarily males) in their hatchery release groups; therefore no data exists to understand what has been done in the past. This will be implemented into the future to assess these results. Moreover, the SFCEP releases eyed-eggs in the SFSR, therefore precocious maturation from hatchery rearing is not expected to occur.

2.6.2.3.2. Naturally-produced progeny competition

Naturally spawning hatchery-origin Chinook salmon are likely to be less efficient at reproduction than their natural-origin counterparts (Christie et al. 2014), but the progeny of such hatchery-origin spawners are likely to make up a sizable portion of the juvenile fish population. This is actually a desired result of the integrated recovery programs. There is no reason to expect offspring of naturally spawning hatchery-origin adults to behave differently from the offspring of natural-origin parents. Therefore, the only expected effect of this added production is a density-dependent response of decreasing growth and potential exceedance of habitat capacity.

Because spring/summer Chinook salmon historically coexisted in substantial numbers with steelhead, it follows that there must have been adequate passage and habitat to allow both species to be productive and abundant. It does not follow automatically, however, that the historical situation can be restored under present-day conditions. Habitat and passage conditions have changed considerably over time to the point that both species are so depleted that they are listed under the ESA. However, ecological impacts may increase in the future if the Chinook salmon populations grow. Should the situation arise where spring/summer Chinook salmon natural production is limiting steelhead natural production, recovery planners would have to prioritize one species over another. NMFS expects that the monitoring efforts would detect negative impacts before they reach problematic levels, and we include language in the Incidental Take Statement (ITS; Section 2.10) to ensure that appropriate monitoring takes place.

2.6.2.3.3. Disease

The risk of pathogen transmission to natural-origin salmon and steelhead is negligible for these Chinook salmon programs. Please refer to Table 45 for information on pathogen incidences at hatchery facilities over the last three most recent years of data. Despite these detections/outbreaks with pathogens that could be transmitted to natural-origin salmon and steelhead, all are easily treatable (if determined necessary), controlled by IDFG's Fish Health Laboratory, and are endemic to the Columbia Basin. Therefore there is little risk of native pathogen transmission and no risk of non-native pathogen transmission to ESA listed natural-origin fish.

Table 45. Pathogen information over the most recent three years of data at facilities where fish are reared and/or acclimated (IDFG 2017b; IDFG 2017c)

Program	Years	Rearing or acclimation on location	Pathogen detected	Treatment/control regime	Dates/times of year	Epidemic?	Exotic pathogen detection
Rapid River Fish Hatchery[1]	2014	Rearing	*Renibacterium*	No treatment	Dec-release	No	No
	2015	Rearing	*Renibacterium*	No treatment	Nov-release	No	No
	2016	Rearing	*Renibacterium*	No treatment	Prior to	No	No

					release		
McCall Fish Hatchery2	2014	Rearing	*Phoma herbarum*	No treatment	April-June	No	No
	2015	Rearing	*Phoma herbarum*	No treatment	April-June	No	No
	2016	Rearing	*Phoma herbarum*	No treatment	April-June	No	No
Oxbow Fish Hatchery[3]	2014	Rearing	*Renibacterium*	No treatment	Dec-release	No	No
	2015	Rearing	*Renibacterium*	No treatment	Nov-release	No	No
	2016	Rearing	*Renibacterium*	No treatment	Prior to release	No	No

[1]Includes fish reared for the Hells Canyon program
[2]Includes fish reared for the JCAPE program. SFCEP fish are reared in the natural environment from eggboxes, and no pathogens have been detected for this program.
[3]Pathogen information for the Oxbow Fish Hatchery is identical to pathogen information for the Rapid River Fish Hatchery

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

NMFS analyses the incidental effects of the proposed research, monitoring, and evaluation (RM&E) on listed species. This factor can also affect the productivity VSP parameter (Section 2.6) of the natural population.

The monitoring and evaluation activities directly related to the proposed hatchery programs are part of a larger effort to determine the overall status of the Snake River spring/summer Chinook salmon ESU. Because the intent is to improve our understanding of listed population status, the information gained through these studies outweigh the associated risks to the populations. This is because only a small proportion of the population is likely to be encountered during these efforts, resulting in an overall negligible effect of RM&E on Snake River spring/summer Chinook. The effects on Snake River fall Chinook, sockeye, and steelhead are also negligible.

The proposed RM&E directly related to fish culture uses well-established (e.g., AHSWG 2008) methods and protocols. Listed fish are cultured in the SFSR and SFCEP. The average green egg-to smolt survival rates at McCall Fish Hatchery where both the SFSR and SFCEP rear eggs to the “eye-up” stage have been about 86 percent from 1997-2012 (IDFG 2017d) (SBT and IDFG 2010) (SBT 2017). These rates are anticipated prior to egg takes, and generally pose little to no risk to the population because these survival rates greatly exceed survival expectations of egg-to-smolt survival in the wild (e.g., egg-to-smolt survival was 7 percent for Chinook salmon (Bradford 1995)).

Many RM&E projects exist within the Snake Basin. Among these RM&E efforts include spawning surveys, electrofishing, tissue sampling, hook-and-line angling, marking, tagging, anesthetization, stain or dye immersion, snorkel surveys, and juvenile trapping activities. With the exception of some juvenile trapping activities, many RM&E efforts exist independently from hatchery programs and the effects of these actions have been covered in previous Section 10 Permits and 4(d) Authorizations in the Snake River Basin. These include the 4(d) “IDFG Salmon Basin VSP monitoring for spring/summer Chinook and steelhead” project (APPS #20863), the

4(d) "IDFG Region 2 Fish Management" project (APPS #20868), and Section 10 permit numbers 1341-5R, 19391, 1339-4R, 1334-6R, 1124-4R, 16298-3R, and 1454. The expected take from each of the RM&E activities were previously analyzed under these 4(d) Authorizations and Section 10 Permits. None of these analyses resulted in jeopardy, and the overall effects from RM&E activities were thought to both have beneficial and negative effects, resulting in negligible overall effects.

RM&E activities at the juvenile smolt trap located in the Johnson Creek exist as result of hatchery operations (Table 46). The effects of these activities were previously analyzed under a Section 10 Permit # 1134 which was operated by NPT, the past operation of which is included in the environmental baseline. Under the proposed action these activities will continue, and the related interactions and mortality associated with natural-origin fish are reflected in Table 46.

Table 46. Juvenile salmonid take information at screw trap on Johnson Creek, previously covered under a Section 10 Permit # 1134 (NMFS 2011c)

Species and juvenile life stage	Proposed handling, sampling, or tagging	Indirect Mortality	Adult equivalents handling, sampling, or tagging	Adult equivalents indirect mortality
SR spring/summer Chinook; natural-origin (juvenile)	24,123	98	145	1
SR spring/summer Chinook; natural-origin (spawned adult carcass)	206	0	NA	
SR spring/summer Chinook; natural-origin (smolt)	1,472	6	9	0
SR spring/summer Chinook; listed hatchery-origin (adipose intact) (smolt)	3,394	4	9	0
SR summer steelhead; natural-origin (spawned adult carcass)	2	0	NA	
SR summer steelhead; natural-origin (juvenile/smolt)	4,700	18	33	0
SR spring/summer Chinook; natural-origin (smolt)	604	2	4	0

[1]Refer to Table 44 for SAR calculations used to obtain adult equivalent values

Moreover, adult weir trapping activities that exist as result of hatchery operations are likely to include take of listed species. Please refer to Section 1.3.2 regarding broodstock collection activities and the direct tale of Snake River spring/summer Chinook salmon. During broodstock collection, RM&E activities also take place that are often opportunistic and in addition to meeting broodstock goals. These RM&E activities at adult weirs include capture, marking, tagging, taking tissue samples, and releasing live animals. In addition, other fish not directly intended for "take" may be incidentally caught, at which point RM&E activities may be utilized. Other than the incidental encounters of steelhead mentioned, there is likely to be no effect of the activities on other listed species. This is because sockeye and fall Chinook salmon are separated spatially and/or temporally from this activity, and have not been encountered previously.

2.6.2.5. Factor 5. Construction, operation, and maintenance of facilities that exist because of the hatchery programs

The construction/installation, operation, and maintenance of hatchery facilities can alter fish behavior and can injure or kill eggs, juveniles and adults. It can also degrade habitat function and reduce or block access to spawning and rearing habitats altogether. Here, NMFS analyzes changes to riparian habitat, channel morphology and habitat complexity, in-stream substrates, and water quantity and water quality attributable to operation, maintenance, and construction activities and confirms whether water diversions and fish passage facilities are constructed and operated consistent with NMFS criteria. This factor can potentially affect a population's abundance, productivity, and spatial structure VSP parameters (Section 2.6). The effect of this factor ranges from negligible to negative. We anticipate that any effects from routine hatchery maintenance would not result any deviation beyond normal fish behavioral responses to environmental disturbances.

The operation and maintenance of facilities associated with hatchery programs included in the Proposed Action would have a negligible effect on ESA-listed species and critical habitat. No construction is included as part of the Proposed Action. The best management practices regarding specific water withdrawal, screening criteria, facility upgrades, maintenance activities, and NPDES permit information for each hatchery facility are described in the Proposed Action (Section 1.3.6.1.1 and 1.3.6.1.2). These best management practices will limit effects on listed salmonids and their associated critical habitat. Furthermore, the hatchery facility activities described in the Proposed Action (Table 8) do not include any facility construction actions. Therefore, the Rapid River Fish Hatchery and Trap, Oxbow Fish Hatchery, Hells Canyon Fish Trap, McCall Fish Hatchery, South Fork Salmon River Satellite, and the South Fork Chinook Eggbox Project will have a small negative effect on listed salmon and steelhead.

The Proposed Action does not propose any changes in water withdrawals from current operations; therefore, current effects are assumed into the future. The current surface water withdrawals measured in maximum percent of flow diversions (in cubic feet per second; cfs) from hatchery facility operations are shown in Table 47. The maximum percent of flow divergence is highest in the Rapid River Fish Hatchery and Trap (water use combined) at 22%; however; this value is typically lower. Dewatering of redds or prevention of natural-origin fish movement had not been observed at any facility when water flow could be limited by hatchery operations during "low-flow" months. Moreover, the facility funders and operators are reviewing all facilities for compliance with the most recent NMFS' 2011 screening criteria (NMFS 2011a). These criteria ensure that the mesh or slot-size in the screening material and the approach velocity of water toward the intake screening meet standards that reduce the risk of both entrainment and impingement of listed juvenile salmonids. Upon review of hatchery facilities, funders and operators will prioritize repairs and upgrades into the future. Moreover, facilities are routinely observed for any signs that screens are not effectively excluding fish from intakes. Thus, we do not anticipate effects on listed salmon and steelhead from water intake structures. Note that, because climate change trends indicate that juveniles may outmigrate earlier, the risk of dewatering juvenile rearing habitat when flows are at their lowest under likely changes in climate conditions, is reduced even further (Dittmer 2013).

Table 47. Range of daily minimum average streamflow (in cfs) measured all months of the year between 1970 and 2016 from the United States Geological Survey (USGS) website, maximum daily water use per facility, and calculated range of maximum percent flow divergence from facility operations. USGS website accessed August 3, 2017

Program	Range of daily minimum average streamflow (in cfs)	Maximum daily surface water use (in cfs)	% flow divergence
Rapid River Fish Hatchery and trap	293 – 2,830 (USGS gauge #13316500 on LSR)	64.6	2 - 22
Hells Canyon trap	11,000- 28,800 (USGS gauge #13290450 on Snake River)	130	0.5 - 1
Oxbow Fish Hatchery (some RR incubation)	11,000- 28,800 (USGS gauge #13290450 on Snake River)	17	<0.1 – 0.2
McCall Fish Hatchery (SFSR, JCAPE, and SFCEP)	n/a		
South Fork Salmon River Satellite (SFSR and SFCEP)	188 – 2,180 (USGS gauge #13310700 on SFSR)	20	0.9 - 11

[1]The McCall Fish Hatchery is located on the Payette River (non-anadromous waters) so therefore these actions will not interfere with ESA listed salmonids

The total facility discharges proportionally small volumes of water with waste (predominantly biological waste) into a larger water body, which results in temporary, very low or undetectable levels of contaminants. General effects of various biological waste in hatchery effluent are summarized in (NMFS 2004a), though the biological waste is not likely to have a detectable effect on listed species because of an abatement pond that reduces the biological waste, as well as the small volume of effluent compared to the stream flow.

Therapeutic chemicals used to control or eliminate pathogens (i.e., formaldehyde, sodium chloride, iodine, potassium permanganate, hydrogen peroxide, antibiotics), can also be present in hatchery effluent. However, these chemicals are not likely to be problematic for ESA-listed species because they are quickly diluted beyond manufacturer's instructions when added to the total effluent and again after discharge into the recipient water body. Therapeutants are also used periodically, and not constantly during hatchery rearing. In addition, many of them break down quickly in the water and/or are not likely to bioaccumulate in the environment. For example, formaldehyde readily biodegrades within 30 to 40 hours in stagnant waters. Similarly, potassium permanganate would be reduced to compounds of low toxicity within minutes Aquatic organisms are also capable of transforming formaldehyde through various metabolic pathways into non-toxic substances, preventing bioaccumulation in organisms (EPA 2015).

Hatchery maintenance activities could also displace juvenile fish. Specifically, through noise and instream activity as well as exposing fish to brief pulses in sediment may alter the routine movement of juvenile fish. These activities may result in short term displacement (within the normal range of fish behaviors in response to noise or a periodic habitat disturbance), but it is unlikely that long-term displacement will occur. The Proposed Action includes best management practices that limit the type, timing, and magnitude of allowable instream activities. These practices would likely limit potential short term effects and would not result in a measurable effect.

All of the hatchery facilities listed above are either operated under NPDES permits, or do not need a NPDES permit because rearing levels in the acclimation pond are below permit minimums. To the extent that permits are current and on file, the effects of operations are in the baseline, but for the sake of analysis we consider them here. Facility effluent is monitored to ensure compliance with permit requirements. Though compliance with NPDES permit conditions is not an assurance that effects will not occur to ESA-listed salmonids, the facilities use the water specifically for the purposes of rearing ESA-listed Chinook salmon, and juveniles are directly exposed to effluent levels in the hatchery facilities. Those juveniles have a low mortality during hatchery residence. This suggests that the effects of effluent does not have an effect on the hatchery-reared Chinook juveniles. It stands to reason that the same effluent, which is further diluted once discharged, will not have a measurable impact on natural-origin salmon populations in the area.

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

There are two aspects of fisheries that are potentially relevant to NMFS' analysis of hatchery program effects. One is where that fisheries exist because of the Proposed Action (i.e., the fishery is an interrelated and interdependent action to the hatchery) and listed natural-origin species are inadvertently and incidentally taken in those fisheries. These fisheries would have negative effects to the abundance VSP parameter of the affected populations (Section 2.6). The other is when fisheries are used as a tool to prevent the hatchery fish associated with the Proposed Action, including hatchery-origin fish included in an ESA-listed ESU or steelhead DPS from spawning naturally. The effects of these fisheries can range from positive to negative.

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

For a detailed description of listed encounters during and the effects of fisheries that exist because of hatchery programs, refer to Section 2.5.3. Based on these detailed descriptions, the effects from fisheries on natural-origin spring/summer Chinook salmon are negative, and negligible for fall Chinook salmon, steelhead, and sockeye salmon.

2.6.2.7. Effects of the Action on Critical Habitat

This consultation analyzed the Proposed Action for its effects on designated critical habitat and has determined that operation of the hatchery programs will have a negligible effect on PCEs in the Action Area, and may have an overall beneficial effect in the Action Area. The beneficial effects on critical habitat, specifically freshwater spawning and rearing habitat, are from the conveyance of marine-derived nutrients from the carcasses of hatchery spawners and from conditioning of spawning gravel by hatchery spawners (Cederholm et al. 1999; Montgomery et al. 1996). Salmon carcasses provide a direct food source for juvenile salmonids and other fish, aquatic invertebrates, and terrestrial animals, and their decomposition supplies nutrients that may increase primary and secondary production. These marine-derived nutrients can increase the growth and survival of the ESA-listed species by increasing forage species (i.e., aquatic and terrestrial insects), aquatic vegetation, and riparian vegetation to name a few.

Other PCEs likely affected in the Action Area would be water quantity and water quality associated with water withdrawals and effluent return. Proposed surface water diversions for rearing juvenile fish include strict criteria for diverting water from the river and will not have any discernible effect or result in any adverse modification to critical habitat concerning freshwater spawning, rearing, and migration conditions. This is because the facilities typically divert a small proportion of the water source, water use is non-consumptive, and the distance over which water is diverted is relatively small (Table 8 and Section 2.6.2.5). In addition, all hatchery facilities have current NPDES permits, and effluent would be monitored to ensure compliance with permit requirements. All chemicals used for sanitation and for treatment of diseases would be diluted to manufacturer's instructions prior to release into the main water body.

Operation and maintenance activities would include pump maintenance, debris removal from intake and outfall structures, building maintenance, and ground maintenance. These activities would not be expected to degrade water quality or adversely modify designated critical habitat, because they would occur infrequently, and only result in minor temporary effects. Semi-routine maintenance (e.g., construction of facilities or reconstruction of in-river hatchery structures) is not considered in this opinion and would require separate consultation.

2.7. 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 Snake River Basin described in the Section2.4. To the extent ongoing activities have occurred in the past and are currently occurring, their effects are included in the environmental 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 section 10(a)(1)(B) incidental take permits in the future. The effects of such activities are treated as cumulative effects unless and until an opinion has been issued.

State, tribal, and local governments have developed plans and initiatives to benefit listed species and these plans must be implemented and sustained in a comprehensive manner for NMFS to consider them "reasonably foreseeable" in its analysis of cumulative effects. The draft Recovery Plan for Snake River Spring/Summer Chinook Salmon (NMFS 2016c) is such a plan and it describes, in detail, the on-going and proposed Federal, state, tribal, and local government actions that are targeted to reduce known threats to ESA-listed salmon and steelhead in the Snake River Basin. NMFS released this document for public comment on October 27, 2016 through February 9, 2017. It is acknowledged, however, that such future state, tribal, and local government actions will likely be in the form of legislation, administrative rules, or policy initiatives, and land use and other types of permits and that government actions are subject to political, legislative and fiscal uncertainties. A full discussion of cumulative effects can also be found in the FCRPS Biological Opinion (NMFS 2008c) and the Mitchell Act Biological Opinion (NMFS 2017a), many of which are relevant to this Action Area. It should be noted that the actions in the FCRPS Biological Opinion – the operation of the Columbia River Federal Hydropower system – and the Mitchell Act biological opinion – the operation of Columbia River hatchery programs – are included in the baseline for this opinion.

The cumulative impacts from these programs contribute to the total impacts from hatcheries in the entire Columbia River Basin, which is noted in the Mitchell Act Biological Opinion (NMFS 2017a). Between those programs which have already undergone consultation and those for which consultation is underway, it is likely (though uncertain for ongoing consultations) that the type and extent of salmon and steelhead hatchery programs and the numbers of fish released in the Columbia River Basin 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 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. Although adverse effects on natural-origin salmon and steelhead will likely not be completely eliminated, effects would be expected to decrease from current levels over time to the extent that hatchery programs are reviewed and approved by NMFS under the ESA. Where needed, reductions in effects on listed salmon and steelhead are likely to occur through changes in:

- Hatchery monitoring information and best available science
- 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
- Incorporation of new research results and improved best management practices for hatchery operations
- More accurate estimates of natural-origin salmon and steelhead abundance for abundance-based fishery management approaches

Some continuing non-Federal activities are reasonable certain to contribute to climate effects within the Action Area. However, it is difficult, if not impossible, to distinguish between the Action Area’s future environmental conditions caused by global climate change that are properly part of the environmental baseline versus cumulative effects. Therefore, all relevant future climate-related environmental conditions in the Action Area are described in the environmental baseline (Section 2.5.1.3).

These potential changes to hatchery operations combined with the ongoing operations of the hatchery programs described in the proposed action result in a net beneficial change to current conditions. While the hatchery programs around the basin, and those under review here as well, lead to negative impacts to listed salmonid species as described above, when the beneficial changes to hatchery practices are also combined with the potential negative impacts from these hatchery programs and the rest of the operations in the Columbia River basin, a net beneficial result is expected as hatchery practices continue to improve and to reduce their negative impacts.

2.8. Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the benefits and risks posed to ESA-listed species and critical habitat as a result of implementing the Proposed Action. In this section, NMFS add the effects of the Proposed Action (Section 2.6.2) to the environmental baseline (Section 2.5) and the cumulative effects (Section 2.7) to formulate the agency’s opinion as to whether the Proposed Action is likely to: (1) result in appreciable reductions in the likelihood of both survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution; or (2) reduce the value of designated or proposed critical habitat. This assessment is made in full consideration of the status of the species and critical habitat and the status and role of the affected populations in recovery (Sections 2.3.1 and 2.3.2).

In assessing the overall risk of the Proposed Action on each species, NMFS considers the benefits and risks of each factor discussed in Section 2.6.2, 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 ESA-listed species and their designated critical habitat.

2.8.1. **Listed Species**

2.8.1.1. 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). That status is the result of threats to all viability parameters, particularly abundance and productivity. The NWFSC determined that there are 27 extant and four extirpated populations within this ESU. All of these extant populations except one (Chamberlain Creek in the Middle Fork MPG) were designated at a high overall risk (NWFSC 2015). Moreover, the Biological Review Team (BRT) identified the most serious risk to the ESU was low natural productivity and the decline in abundance relative to historical returns (NWFSC 2015). The South Fork Salmon River MPG within the Snake River Spring/Summer Chinook Salmon ESU has two out of four populations that are being targeted for viability. Still, after taking into account 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 will not appreciably reduce the likelihood of survival and recovery of this ESA-listed ESU in the wild, as discussed below.

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. As we continue to deal with a changing climate, management of these factors may also alleviate some of the potential adverse effects to VSP parameters (abundance, productivity, diversity, and spatial structure) covered in the Appendix (e.g., through hatcheries serving as a genetic reserve for natural populations).

The majority of the effects of the Proposed Action on this ESU are genetic and ecological in nature. This is a factor in the abundance (ecological), productivity (ecological), and diversity (genetic) parameters. Effects of facility operation and broodstock collection are small and localized, and, while RM&E requires handling of a substantial portion of the juvenile population, less than two percent are expected to die as a result of handling. In addition, the information gained from conducting the work is essential for understanding the effects of the hatchery program on natural-origin spring/summer Chinook salmon populations. NMFS will monitor whether decreased productivity, diversity, or abundance of natural-origin fish may necessitate more aggressive adult management, and/or reconsideration of hatchery program size in the future to limit impacts to these VSP parameters in these ESUs (Appendix).

The ecological and genetic effects on the adult life stage are limited by the proportion of hatchery-origin fish spawning naturally. For these five programs, this is managed through removal of adults at adult trapping locations and via fisheries in the area. The only river without an adult trap where operators are unable to remove hatchery fish is the Little Salmon River. The segregated Rapid River program releases 150,000 yearlings into this reach, which is less than 6% of the total releases from this program. Moreover, these releases are subject to very high direct harvest rates from tribal and non-tribal fisheries. Therefore, it is unlikely that hatchery-origin returns from these releases will constitute a substantial amount of the total returns into the Little Salmon River.

Efforts are underway to continue to better understand the spawning abundance and distributions of hatchery and natural-origin spawners (including pHOS) in by Rapid River and the Little Salmon River. Two of the three integrated programs (SFSR and SFCEP) are expected to result in PNI values in the SFSR population that range between 0.5 to over 0.67, depending on natural-origin returns and managed based on the sliding scale values designated by the co-operators (Table 32). The SFSR population is the only population targeted for viability that is directly affected by the two hatchery programs (SFSR and SFCEP). We expect the future PNI values in most years to exceed 0.67 (Table 32). The resulting pHOS values above and below the weir range from 0 to 0.45, depending on the amount of natural-origin returns in a given year (Table 32). This commitment to achieve PNI and pHOS values in the sliding scale is an improvement in diversity from previous operations. The JCAPE PNI values are expected to remain >0.67, and the pHOS values should be 0.45 in the mainstem Johnson Creek and could be up to 0.94 in the East Fork of the South Fork Salmon River (Table 34). This commitment to achieve PNI and pHOS values in the sliding scale is an improvement in diversity from previous operations. Because the EFSFSR had past mining activities, this limited available passage and habitat of natural-origin returns to the river. Before the JCAPE program, natural-origin returns were no longer able to spawn in the upper parts of the EFSRSR reach due to the migration blockage caused from the Glory Hole. Therefore, a high pHOS value in the EFSFSR is not a concern in this reach, and is actually beneficial to increasing fish passage and future natural-origin returns to the area. All of these actions should contribute to an increase in abundance and productivity for this population in the long-term. Overall, the combined genetic effects from the proposed hatchery programs will not result in a substantial negative effect to the diversity of Snake River spring/summer Chinook salmon ESU.

Ecological effects on natural-origin juvenile Chinook salmon associated with releases from the hatchery programs equates to a loss of equal to or less than 2.1 percent of the adult natural-origin Chinook salmon in the Snake River basin passing through LGD (Section 2.6.2.3). This includes the effects on both the Snake River spring/summer and fall Chinook salmon ESUs, because the analyses combined all Chinook effects in the model. It is likely that this percentage is even smaller because the analysis did not account for potential predation of hatchery program fish on other hatchery program fish in the Snake River Basin; thus these effects could be an overestimation (Section 2.6.2.3). Overall, this relatively small loss is unlikely to have an effect on the abundance and productivity of either the spring/summer or fall Chinook salmon ESUs in the Snake River.

Added to the Species' Status, Environmental Baseline, and effects of the Proposed Action are the effects of future state, private, or tribal activities, not involving Federal activities, within the Action Area. The recovery plan for this ESU describes the on-going and proposed state, tribal, and local government actions that are targeted to reduce known threats to ESA-listed spring/summer Chinook salmon. Such actions are improving habitat conditions and hatchery and harvest practices to protect ESA-listed spring/summer Chinook salmon ESUs, and NMFS expects this trend to continue, ultimately improving the abundance, diversity, and productivity of natural populations. Spatial structure is not likely to be affected by the proposed hatchery programs.

In summary, we considered the baseline effects (including the exacerbating effects of climate change) and species status, where we found that abundance, productivity, and diversity were the critical problems in most populations, consistent with the recovery plan's identification of limiting factors. The effects of the action are limited to a small impact on abundance, productivity, and diversity as a result of the hatchery releases, but over time the impact could provide positive benefits. The cumulative effects consist primarily of ongoing hatchery programs, harvest, hydropower, agriculture and other forms of development that have reduced habitat and productivity, problems that will be positively addressed by expected reforms though compounded to a degree by climate change (Section **Error! Reference source not found.**). Taken together, these activities are not likely to appreciably reduce the survival and recovery of listed Snake River spring/summer Chinook salmon.

2.8.1.2.Snake River Steelhead, Fall Chinook, and Sockeye Salmon DPS and ESU's

Best available information indicates that the Snake River Steelhead DPS and the Fall Chinook Salmon ESU are at high risk and remain at threatened status (NWFSC 2015). The Snake River Sockeye Salmon ESU is at high risk and remains endangered (NWFSC 2015). After taking into account 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 will not appreciably reduce the likelihood of survival and recovery of these ESA-listed ESUs in the wild, as discussed here.

Our environmental baseline analysis considers the effects of hydropower, changes in habitat (both beneficial and adverse), fisheries, and hatcheries on these ESUs. Although all may have contributed to the listing of these ESUs, all factors have also seen improvements in the way they are managed/operated. As we continue to deal with a changing climate, management of these factors may also alleviate some of the potential adverse effects to VSP parameters (abundance, productivity, diversity, and spatial structure) covered in the Appendix (e.g., hatcheries serving as a genetic reserve for natural populations).

The effects of our Proposed Action on these DPS and ESUs is limited to ecological effects, broodstock collection, and RM&E. These effects may result in changes to the abundance and productivity of natural-origin fish. Adverse ecological effects on adults are small because of the differences in spatial and temporal overlap of these three species with spring/summer Chinook salmon. However, juveniles may potentially undergo larger effects because of the overlap in outmigration timing. The ecological effects on juvenile natural-origin fall Chinook salmon from the hatchery programs were included in Section 2.8.1.1. Our analysis showed that the impacts of these programs on sockeye salmon were around 2 percent and steelhead between 1.5 to 1.6 percent on the Snake River ESU and DPS; however, these values are likely to be overestimates based on many of the assumptions in the model analyses. The small percentage loss within these ESU and DPS is unlikely to affect the productivity of these natural-origin fish in the Snake River Basin.

These would equate to a potential loss of ~ 2.1-2.2, 1.5-1.6, and 2 percent (range of values for Chinook salmon, steelhead, and sockeye salmon for the 2008 and 2015 aggregate runs) of the potential adult return from competition and predation during the juvenile life stage. NMFS will monitor whether decreased productivity or abundance of natural-origin fish may necessitate reconsideration of hatchery program size in the future to limit impacts to these VSP parameters in these ESUs (Appendix).

Effects of RM&E and broodstock collection targeting spring/summer Chinook salmon are also small because monitoring and collection targeting the other species generally occurs using the same traps in the same locations, and is therefore a direct effect associated with a different hatchery program. Thus, there is very little incidental effect on other Snake River ESA-listed species. Therefore, it is unlikely that these activities would lead to a decrease in the abundance, productivity, diversity, or spatial structure of the Snake River steelhead, fall Chinook salmon, or sockeye salmon ESUs.

Added to the Species’ Status, Environmental Baseline, and effects of the Proposed Action are the effects of future state, private, or tribal activities, not involving Federal activities, within the Action Area. 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 conditions, and hatchery and harvest practices to protect listed salmon ESUs, and NMFS expects this trend to continue.

We considered the baseline effects (including the exacerbating effects of climate change) and species status, where we found that abundance, productivity, and diversity were the critical problems in most populations, consistent with the recovery plan’s identification of limiting factors. The effects of the action are limited to a small impact on abundance, productivity, and diversity as a result of the hatchery releases, but over time the impact could provide positive benefits. The cumulative effects consist primarily of ongoing hatchery programs, harvest, hydropower, agriculture and other forms of development which have reduced habitat and productivity, problems which will be positively addressed by expected reforms though compounded to a degree by climate change (Section **Error! Reference source not found.**). Taken together, these activities are not likely to appreciably reduce the survival and recovery of listed Snake River steelhead, fall Chinook salmon, or sockeye salmon.

2.8.2. **Critical Habitat**

The hatchery water diversion and the discharge pose a negligible effect on designated critical habitat in the Action Area (Section 2.6.2.7). Existing hatchery facilities have not contributed to altered channel morphology and stability, reduced and degraded floodplain connectivity, excessive sediment input, or the loss of habitat diversity. The operation of the weirs and other hatchery facilities may impact migration PBFs due to delay at these structures and possible rejection. However, the number of natural-origin adults delayed is expected to be small and the delay would be for only a short period. Thus, the impact on the spawning, rearing, and migration PBFs will be small in scale, and will not appreciably diminish the capability of the critical habitat to satisfy the essential requirements of the species.

Climate change may have some effects on critical habitat as discussed in Section 2.5.1.3. With continued losses in snowpack and increasing water temperatures, it is possible that increases in the density and residence time of fish using cold-water refugia could result in increases in ecological interactions between hatchery and natural-origin fish of all life stages, with unknown but likely small effects

2.9. .Conclusion

After reviewing the current status of the listed species, the environmental baseline within the Action Area, the effects of the Proposed Action, including effects of the Proposed Action that are likely to persist following expiration of the Proposed Action, and cumulative effects, it is NMFS' biological opinion that the Proposed Action is not likely to jeopardize the continued existence or recovery of any of the ESUs and DPSs listed in the Columbia River Basin (Table 9), or destroy or adversely modify designated critical habitat.

2.10. Incidental Take Statement

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by regulation to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering (50 CFR 17.3). Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not prohibited under the ESA, if that action is performed in compliance with the terms and conditions of the ITS.

2.10.1. **Amount of Extent of Take**

The primary form of take of ESA-listed spring/summer Chinook salmon is direct take, under the 4(d) Authorizations for the SFSR, SFCEP, and JCAPE programs. However, NMFS also expects incidental take of ESA-listed salmonids will occur as a result of the Proposed Action for the following factors.

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

Effects of hatchery fish on the genetics of natural-origin fish can occur through a reduction in genetic diversity, outbreeding depression, and hatchery-influenced selection. There is further take caused by ecological interactions between hatchery- and natural-origin adults; specifically, spawning site competition and redd superimposition. These genetic and ecological effects cannot be directly measured because it is not possible to observe gene flow or interbreeding between hatchery and natural fish in a reliable way.

For each form of take described above, NMFS will therefore rely on a single surrogate take indicator, the proportion of hatchery-origin spawners in the natural population above the weir. The take surrogate will be the proportion of hatchery-origin spawners associated with the release of hatchery-origin adults passed above the weir. This metric is rationally connected to incidental take in the form of genetic effects, because those effects only happen when and to the extent that both hatchery- and natural-origin fish occur simultaneously on the spawning grounds, and limiting the extent of hatchery fish on the spawning grounds reduces take by genetic effects. The take associated with genetic effects will be considered to have been exceeded when the proportion of hatchery-origin spawner limits in Table 3 and Table 4 above have been exceeded. For example, under the sliding scale management plan, if adult natural-origin returns to the weir is forecasted to be 700 to 999, the maximum percentage of hatchery-origin fish above the weir would be 45 percent of the total escapement above the weir. Through spawning ground surveys and PIT tags, the take surrogate can be reliably measured and monitored.

Listed salmonids will also be taken as a result of the capture and handling associated with operation of the adult trap. The extent of take expected by this pathway is summarized in Table 49.

Table 48. Incidental mortality of all ESA listed salmonids (natural-origin and adipose intact hatchery-origin) resulting from adult trapping for broodstock collection activities (e.g., adult traps).

Program	Species and origin	Life stage	Maximum number captured and handled	Maximum incidental mortality number[1]
Rapid River	SR spring/summer Chinook salmon; natural- and hatchery origin	Adult	400	5
Hells Canyon	SR spring/summer Chinook salmon; natural- and hatchery origin	Adult	50	5
SFSR	SR spring/summer Chinook salmon; natural- and hatchery origin	Adult	5,000	100
	SR steelhead; natural-origin	Adult	10	1
JCAPE	SR spring/summer Chinook salmon; natural- and hatchery origin	Adult	2,000	75
	SR steelhead; natural-origin	Adult	10	1

[1]Maximum incidental mortality rate of ten percent.

Factor 3: Hatchery fish and the progeny of naturally spawning hatchery fish in juvenile rearing areas

Predation and competition, collectively referred to as ecological interactions, between natural-origin juvenile Chinook and sockeye salmon and steelhead and hatchery steelhead smolts could result in take of natural-origin Chinook and sockeye salmon and steelhead. This take occurs as a result of, and in proportion to, the co-occurrence of hatchery- and natural-origin juvenile fish in the juvenile rearing areas and having the opportunity to compete for resources or prey on each other. However, it is difficult to quantify this take because ecological interactions cannot be directly or reliably measured and/or observed. Thus, NMFS will rely on two surrogate take variables; one for outmigrants and one for potential non-migrants.

For outmigrants, NMFS applies a surrogate take variable that relates to the median travel time for hatchery-origin spring/summer Chinook to reach LGD after release. Specifically, the extent of take from interactions between hatchery and natural-origin juvenile salmonids released in "viable" and "maintain" populations above LGD will be the take that occurs when the travel time[5] for emigrating juvenile hatchery-origin spring/summer Chinook salmon is more than five days longer than the median travel time value (which equates to 50% of the fish) following hatchery release (Table 43) for each program. Take will be considered to have been exceeded if travel times exceed the five-year median by five or more days in at least three of the five years used to establish the median. NMFS will begin calculating each five-year running medians beginning in 2018 with data from 2018 to 2022. This is a reasonable, reliable, and measurable surrogate for incidental take because if travel rate is five days more than previous estimates, it is a sign that fish are not migrating as quickly as expected, and therefore the expected take from interactions has likely been exceeded as a result of greater overlap between hatchery and natural-origin fish. This threshold will be monitored using emigration estimates from PIT tags, screw traps, or other juvenile monitoring techniques developed by the operators and approved by NMFS.

To account for take occurring as a result of competition and predation associated with residualism, NMFS applies one of the two take variables described below, depending on the program concerned, for hatchery-origin spring/summer Chinook salmon based on programs.

- The surrogate for measuring take from this pathway associated with the Rapid River, Hells Canyon, and JCAPE hatchery programs, which release fish in "maintained" populations (Table 22), is the cumulative number of PIT tag detections 60 days after release measured until one year post-release. Specifically, the number of detections should not exceed five percent of the total number of PIT-tagged spring/summer Chinook salmon hatchery smolts released that year from those three programs. This surrogate has a rational connection to the amount of take expected from ecological effects associated with residualism because non-migrating spring/summer Chinook salmon may residualize

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[5] NMFS recognizes that this metric can be influenced by factors other than hatchery operation. Therefore, we are relying on a surrogate measurement of take whereby the travel time should be within the limit in three of every five years.

after release from the hatchery. This will be described as a five-year running average[6] beginning with the 2018 release, with data from 2018 to 2022. This threshold will be monitored using emigration estimates from PIT tags, screw traps, or other juvenile monitoring techniques developed by the operators and approved by NMFS.

- The surrogate measure of take resulting from the presence of residuals for the SFSR and SFCEP programs, is the percentage of spring/summer Chinook salmon juveniles of those programs that are observed to be precociously mature prior to release. This surrogate has a rational connection to the amount of take expected from residualism because precocious spring/summer Chinook salmon may residualize at higher rates than normal, and these observations would be sufficient to detect a trend of increasing residualization potential. NMFS considers, for the purpose of this take surrogate, that no more than five percent of program fish should be observed to be precociously mature (based on visual observation at pre-release sampling), using a running five-year average beginning with the 2018 release[7]. The take surrogate can be reliably measured and monitored through assessment of precocious maturation rates prior to release. This assessment relies on visual observation at pre-release sampling with a reasonable sample size determined by hatchery staff.

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

Take associated with research, monitoring, and evaluation is summarized in Table 49.

Table 49. Incidental mortality of all ESA listed salmonids resulting from RM&E activities (e.g., screw traps). Capture, handling, and sampling is considered direct take and is included under the direct take 4(d) Authorization.

Program	Species and origin	Life stage	Maximum captured/handled and incidental mortality number (juveniles)		Maximum captured/handled and incidental mortality number (adult equivalents)	
JCAPE	SR spring/summer Chinook salmon; natural-origin	Adult	206	0	206	NA
		Juvenile/smolt	25,595	104	154	1
	SR spring/summer Chinook salmon; listed hatchery-origin	Adult	0	0	NA	NA
		Juvenile/smolt	3,394	4	9	0
	SR summer steelhead; natural-origin	Adult	0	0	NA	NA
		Juvenile/smolt	4,700	18	33	0

[6] However if it is apparent, from numbers observed in years prior to the fifth year, that the average limit is certain to be triggered, co-managers will contact NMFS in the year the likely trigger is discovered.

2.10.2. **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 Spring/summer Chinook Salmon ESU, Snake River Fall Chinook Salmon ESU, Snake River Sockeye Salmon ESU, and Snake River Basin Steelhead DPS or result in the destruction or adverse modification of their designated critical habitat.

2.10.3. **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. The NMFS, BPA, and the USFWS (i.e., LSRCP) shall ensure the following measures:

1. BPA shall ensure that NPT's activities are consistent with the BPA-funded portion of the Proposed Action.
2. USFWS shall ensure that IDFG's activities are consistent with the LSRCP-funded portion of the Proposed Action.
3. The applicants implement the hatchery programs and operate the hatchery facilities, including monitoring, as described in the Proposed Action (Section 1.3) and in the submitted HGMPs. The applicants provide reports to SFD annually for all hatchery programs, and associated RM&E.

2.10.4. **Terms and Conditions**

The terms and conditions described below are non-discretionary, and the Action Agencies must comply with them in order to implement the reasonable and prudent measures (50 CFR 402.14), where applicable to each entity as specifically directed. The Action Agencies, to the extent directed below, have 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 incidental take statement (50 CFR 402.14). If the following terms and conditions outlined below are not complied with, the protective coverage of section 7(o)(2) will lapse.

1. BPA shall take the following measures:

> 1a. Review and approve the NPT's activities as described in the annual contracts between BPA and NPT for JCAPE to ensure they are consistent with the BPA-funded portion of the Proposed Action.

2. USFWS shall take the following measures:

> 2a. Review IDFG's activities as described in the Annual Operating Procedures for the SFSR (McCall) and the SFCEP to ensure they are consistent with the LSRCP-funded portion of the Proposed Action, as approved through annual statements of work

3. NMFS shall ensure that:

3a. All reports, along with other required notifications, are submitted by applicants electronically to NMFS, West Coast Region, Sustainable Fisheries Division, APIF Program. The current point of contact for document submission is Natasha Meyers-Cherry (natasha.meyers-cherry@noaa.gov, 503-231-2178).

3b. An annual monitoring and evaluation report is submitted by applicants no later than December 15, of the year following the monitoring and evaluation activities (i.e., surveys conducted in 2017, report due December 2018) to NMFS. The annual report should include:

i. A calculation of quantifiable encounter and mortality take for each species across all HGMP activities

ii. *Hatchery Environment Monitoring and Reporting (for all programs unless specified)*

- Number and composition of broodstock, and dates of collection
- Numbers, pounds, dates, locations, and tag/mark information of released fish
- Coefficient of variation around the average (target) release size immediately prior to their liberation from acclimation sites
- Survival rates of hatchery-origin fish life stages
- Disease occurrence at facilities and the acclimation sites
- Precocious maturation rates for SFSR and SFCEP programs
- Any problems that may have arisen during hatchery activities
- Any unforeseen effects on listed fish

iii. *Natural Environment Monitoring Reporting (for all programs unless specified)*

- The number of returning hatchery and natural-origin adults and age structure
- The number and species of listed fish encountered at each adult collection location, and the number that die
- Distribution of hatchery- and listed natural-origin spawners
- pHOS; pNOB for the SFSR, SFCEP, and JCAPE programs; PNI for the SFSR, SFCEP, and JCAPE programs
- Survival rates of all life stages for hatchery-origin fish from the SFCEP and natural-origin fish
- Smolt-to-adult survival rate
- The contribution of fish from these programs into other populations
- Post release out-of-basin migration timing (median travel time and residual rates) of juvenile hatchery-origin fish to LGD
- Mean length, coefficient of variation, number, and age of natural-origin juveniles

2.11. 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 three conservation recommendations appropriate to the Proposed Action:

1. Obtain/improve estimates of egg-to-smolt survival, smolt-to-adult returns, and program strays to other areas from the SFCEP.
2. In years where natural-origin summer Chinook salmon exceed 500 fish in the SFSR, limit the number of program outplants into the SFSR mainstem in the SFSR program (this recommendation does not include limitation on outplants into the EFSFSR).
3. Continue to monitor the Rapid River and Little Salmon River to better understand hatchery and natural-origin spawning abundance and distributions in the Rapid River program.

2.12. Reinitiation of Consultation

As provided in 50 CFR 402.16, 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 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.

Among other considerations, NMFS may reinitiate consultation if there is significant new information indicating that impacts on ESA-listed species, beyond those considered in this opinion, are occurring from the operation of the proposed hatchery programs, including the operation of weirs and traps, and RM&E in support of the hatchery programs, or if the specific RM&E activities listed in the terms and conditions are not implemented.

If the amount or extent of take considered in this opinion is exceeded, NMFS may reinitiate consultation. SFD will consult with the operators to determine specific actions and measures that can be implemented to address the take or implement further analysis of the impacts on listed species. If the amount and extent of take cannot be reduced to levels considered in this opinion, NMFS will reinitiate consultation.

3. Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation

The consultation requirement of 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 effects include the direct or indirect physical, chemical, or biological alterations 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 EFH, 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 2003) 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 five spring/summer Chinook salmon hatchery programs, as described in Section 1.3. The Action Area (Section 2.4) 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.

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. HAPC 1 and 3 are potentially affected by the Proposed Action.

3.2. Adverse Effects on Essential Fish Habitat

The Proposed Action has small effects on the major components of EFH. As described in Section 2.6.2.5, water withdrawal for hatchery operations can adversely affect salmon by reducing streamflow, impeding migration, or reducing other stream-dwelling organisms that could serve as prey for juvenile salmonids. Water withdrawals can also kill or injure juvenile salmonids through impingement upon inadequately designed intake screens or by entrainment of juvenile fish into the water diversion structures. The proposed hatchery programs include designs to minimize each of these effects. In general, water withdrawals are small enough in scale that changes in flow would be undetectable, and impacts would not occur.

The PFMC (2003) recognized concerns regarding the "genetic and ecological interactions of hatchery and wild fish… [which have] been identified as risk factors for wild populations." The biological opinion describes in considerable detail the impacts hatchery programs might have on natural populations of Chinook salmon (Section 2.6.2.2; Appendix A); the effects on coho salmon are typically much smaller, due to the species-specific nature of many of the interactions and relatively small overlap in habitat usage by the two species. Ecological effects of juvenile and adult hatchery-origin fish on natural-origin fish are discussed in Sections 2.6.2.2 and 2.6.2.3. Hatchery fish returning to the Lower Salmon River Subbasin are expected to largely spawn and rear near the hatchery and not compete for space with coho salmon. Some spring/summer Chinook salmon from the programs would stray into other rivers but not in numbers that would exceed the carrying capacities of natural production areas, or that would result in increased incidence of disease or predators. Predation by adult hatchery spring/summer Chinook salmon on juvenile natural-origin Chinook salmon has been analyzed in Section 2.6.2.2. It is unlikely that hatchery spring/summer Chinook salmon would prey on coho salmon due to timing differences and because adult salmon typically stop feeding by the time they reach spawning areas. Predation and competition by juvenile hatchery spring/summer Chinook salmon on juvenile natural-origin Chinook or coho salmon is small (Section 2.6.2.3) because these fish outmigrate relatively quickly and at sizes that limit these types of interactions.

3.3. Essential Fish Habitat Conservation Recommendations

For each of the potential adverse effects by the Proposed Action on EFH for Chinook and coho salmon, NMFS believes that the Proposed Action, as described in the HGMPs and the ITS (Section 2.10) includes the best approaches to avoid or minimize those adverse effects. Thus, NMFS has no conservation recommendations specifically for Chinook and coho salmon EFH. However, the Reasonable and Prudent Measures and Terms and Conditions included in the ITS sufficiently address potential EFH effects.

3.4. Supplemental Consultation

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

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

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 opinion addresses these DQA components, document compliance with the Data Quality Act, and certifies that this opinion has undergone pre-dissemination review.

4.1. Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. NMFS has determined, through this ESA section 7 consultation, that implementation of the Proposed Actions will not jeopardize ESA-listed species and will not destroy or adversely modify designated critical habitat. Therefore, NMFS can issue an ITS. The intended users are NMFS, BPA, LSRCP and the program operators and their co-operators. The scientific community, resource managers, and stakeholders benefit from the consultation through the anticipated increase in returns of salmonids, and through the collection of data indicating the potential effects of the operation on the viability of natural populations of ESA-listed salmon and steelhead in the Snake River Basin. This information will improve scientific understanding of hatchery salmon and steelhead effects that can be applied broadly within the Pacific Northwest area for managing benefits and risks associated with hatchery operations.

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 described in the references 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. APPENDIX A-FACTORS CONSIDERED WHEN ANALYZING HATCHERY EFFECTS

NMFS' analysis of the Proposed Action is in terms of effects the Proposed Action would be expected to have on ESA-listed species and on designated critical habitat, based on the best scientific information available. The effects, positive and negative, for the two categories of hatchery programs are summarized in Table 1. Generally speaking, effects range from beneficial to negative when programs use local fish for hatchery broodstock, and from negligible to negative when programs do not use local fish for broodstock. Hatchery programs can benefit population viability, but only if they use genetic resources that represent the ecological and genetic diversity of the target or affected natural population(s). When hatchery programs use genetic resources that do not represent the ecological and genetic diversity of the target or affected natural population(s), NMFS is particularly interested in how effective the program will be at isolating hatchery fish and at avoiding co-occurrence and effects that potentially disadvantage fish from natural populations. NMFS applies available scientific information, identifies the types of circumstances and conditions that are unique to individual hatchery programs, then refines the range in effects for a specific hatchery program. Analysis of a Proposed Action for its effects on ESA-listed species and on designated critical habitat depends on six factors. These factors are:

(1) the hatchery program does or does not remove fish from the natural population and use them for hatchery broodstock,

(2) hatchery fish and the progeny of naturally spawning hatchery fish on spawning grounds and encounters with natural-origin and hatchery fish at adult collection facilities,
(3) hatchery fish and the progeny of naturally spawning hatchery fish in juvenile rearing areas, the migration corridor, estuary, and ocean,
(4) RM&E that exists because of the hatchery program,
(5) operation, maintenance, and construction of hatchery facilities that exist because of the hatchery program, and
(6) fisheries that exist because of the hatchery program, including terminal fisheries intended to reduce the escapement of hatchery-origin fish to spawning grounds.

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

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

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

Table 34. An overview of the range of effects on natural population viability parameters from the two categories of hatchery programs.

Natural population viability parameter	Hatchery broodstock originate from the local population and are included in the ESU or DPS	Hatchery broodstock originate from a non-local population or from fish that are not included in the same ESU or DPS
Productivity	**Positive to negative effect** Hatcheries are unlikely to benefit productivity except in cases where the natural population's small size is, in itself, a predominant factor limiting population growth (i.e., productivity) (NMFS 2004c).	**Negligible to negative effect** Productivity is dependent on differences between hatchery fish and the local natural population (i.e., the more distant the origin of the hatchery fish, the greater the threat), the duration and strength of selection in the hatchery, and the level of isolation achieved by the hatchery program (i.e., the greater the

		isolation, the closer to a negligible effect).
Diversity	**Positive to negative effect** Hatcheries can temporarily support natural populations that might otherwise be extirpated or suffer severe bottlenecks and have the potential to increase the effective size of small natural populations. On the other hand, broodstock collection that homogenizes population structure is a threat to population diversity.	**Negligible to negative effect** Diversity is dependent on the differences between hatchery fish and the local natural population (i.e., the more distant the origin of the hatchery fish, the greater the threat) and the level of isolation achieved by the hatchery program (i.e., the greater the isolation, the closer to a negligible effect).
Abundance	**Positive to negative effect** Hatchery-origin fish can positively affect the status of an ESU by contributing to the abundance of the natural populations in the ESU (70 FR 37204, June 28, 2005, at 37215). Increased abundance can also increase density dependent effects.	**Negligible to negative effect** Abundance is dependent on the level of isolation achieved by the hatchery program (i.e., the greater the isolation, the closer to a negligible effect), handling, RM&E, and facility operation, maintenance and construction effects.
Spatial Structure	**Positive to negative effect** Hatcheries can accelerate re-colonization and increase population spatial structure, but only in conjunction with remediation of the factor(s) that limited spatial structure in the first place. "Any benefits to spatial structure over the long term depend on the degree to which the hatchery stock(s) add to (rather than replace) natural populations" (70 FR 37204, June 28, 2005 at 37213).	**Negligible to negative effect** Spatial structure is dependent on facility operation, maintenance, and construction effects and the level of isolation achieved by the hatchery program (i.e., the greater the isolation, the closer to a negligible effect).

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

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

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

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

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

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

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

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

5.2.1. **Genetic effects**

Hatchery fish can have a variety of genetic effects on natural population productivity and diversity when they interbreed with natural-origin fish. Although there is biological interdependence between them, NMFS considers three major areas of genetic effects of hatchery programs: within-population diversity, outbreeding effects, and hatchery-induced selection. As we have stated above, in most cases, the effects are viewed as risks, but in small populations these effects can sometimes be beneficial, reducing extinction risks.
First, within-population genetic diversity is a general term for the quantity, variety, and combinations of genetic material in a population (Busack and Currens 1995). Within-population diversity is gained through mutations or gene flow from other populations (described below under outbreeding effects) and is lost primarily due to genetic drift, a random loss of diversity due to population size. The rate of loss is determined by the population's effective population size (N_e), which can be considerably smaller than its census size. For a population to maintain genetic diversity reasonably well, the effective size should be in the hundreds (e.g., Lande 1987), and diversity loss can be severe if N_e drops to a few dozen.

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

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

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

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

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

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

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

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

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

Critical information for analysis of hatchery-induced selection includes the number, location, and timing of naturally spawning hatchery fish, the estimated level of gene flow between hatchery-origin and natural-origin fish, the origin of the hatchery stock (the more distant the origin compared to the affected natural population, the greater the threat), the level and intensity of hatchery selection and the number of years the operation has been run in this way. Efforts to control and evaluate the risk of hatchery-influenced selection are currently largely focused on gene flow between natural-origin and hatchery-origin fish. The Interior Columbia Technical Recovery Team (ICTRT) developed guidelines based on the proportion of spawners in the wild consisting of hatchery-origin fish (pHOS) (Figure 13).

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

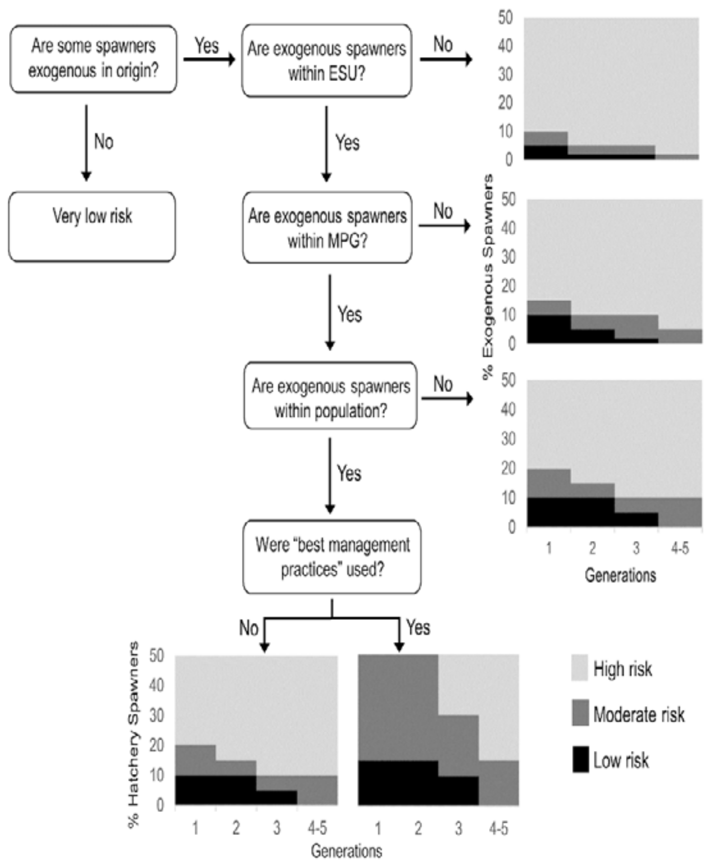

Figure 5. ICTRT (2007b) risk criteria associated with spawner composition for viability assessment of exogenous spawners on maintaining natural patterns of gene flow. Exogenous fish are considered to be all fish hatchery origin, and non-normative strays of natural origin.

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

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

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

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

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

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

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

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

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

Additional perspective on pHOS that is independent of HSRG modelling is provided by a simple analysis of the expected proportions of mating types. Figure 14 shows the expected proportion of mating types in a mixed population of natural-origin (N) and hatchery-origin (H) fish as a function of the census pHOS, assuming that N and H adults mate randomly. For example, at a census pHOS level of 10 percent, 81 percent of the matings will be NxN, 18 percent will be NxH, and 1 percent will be HxH. This diagram can also be interpreted as probability of parentage of naturally produced progeny, assuming random mating and equal reproductive success of all mating types. Under this interpretation, progeny produced by a parental group with a pHOS level of 10 percent will have an 81 percent chance of having two natural-origin parents, etc.

Random mating assumes that the natural-origin and hatchery-origin spawners overlap completely spatially and temporally. As overlap decreases, the proportion of NxH matings decreases; with no overlap, the proportion of NxN matings is 1 minus pHOS and the proportion of HxH matings equals pHOS. RRS does not affect the mating type proportions directly but changes their effective proportions. Overlap and RRS can be related. For example, in the Wenatchee River, hatchery spring Chinook salmon tend to spawn lower in the system than natural-origin fish, and this accounts for a considerable amount of their lowered reproductive success (Williamson et al. 2010). In that particular situation the hatchery-origin fish were spawning in inferior habitat.

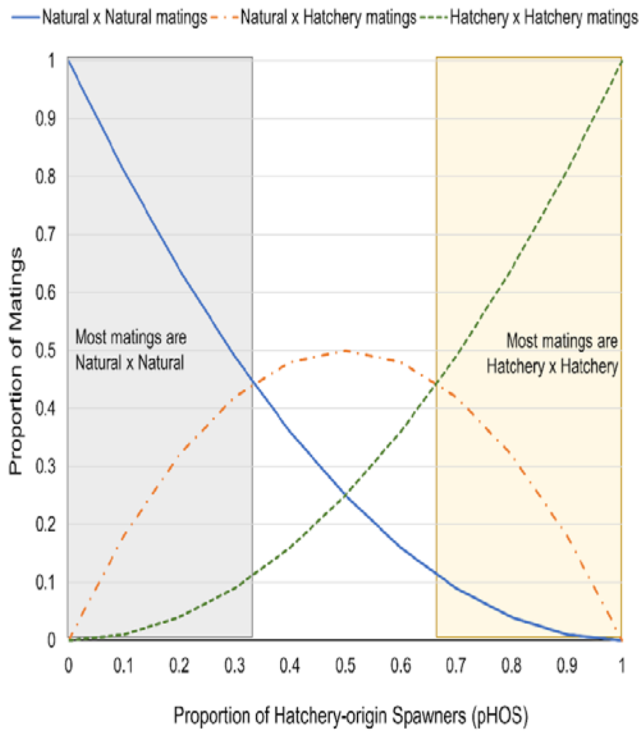

Figure 6. Relative proportions of types of matings as a function of proportion of hatchery-origin fish on the spawning grounds (pHOS).

5.2.2. Ecological effects

Ecological effects for this factor (i.e., hatchery fish and the progeny of naturally spawning hatchery fish on the spawning grounds) refer to effects from competition for spawning sites and redd superimposition, contributions to marine-derived nutrients, and the removal of fine sediments from spawning gravels. Ecological effects on the spawning grounds may be positive or negative. To the extent that hatcheries contribute added fish to the ecosystem, there can be positive effects. For example, when anadromous salmonids return to spawn, hatchery-origin and natural-origin alike, they transport marine-derived nutrients stored in their bodies to freshwater and terrestrial ecosystems. Their carcasses provide a direct food source for juvenile salmonids and other fish, aquatic invertebrates, and terrestrial animals, and their decomposition supplies nutrients that may increase primary and secondary production (Gresh et al. 2000; Kline et al. 1990; Larkin and Slaney 1996; Murota 2003; Piorkowski 1995; Quamme and Slaney 2003; Wipfli et al. 2003). As a result, the growth and survival of juvenile salmonids may increase (Bell 2001; Bilton et al. 1982; Bradford et al. 2000; Brakensiek 2002; Hager and Noble 1976; Hartman and Scrivener 1990; Holtby 1988; Johnston et al. 1990; Larkin and Slaney 1996; Quinn and Peterson 1996; Ward and Slaney 1988).

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

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

5.3. Adult Collection Facilities

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

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

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

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

5.4.1. **Competition**

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

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

Several factors influence the risk of competition posed by hatchery releases: whether competition is intra- or interspecific; the duration of freshwater co-occurrence of hatchery and natural-origin fish; relative body sizes of the two groups; prior residence of shared habitat; environmentally induced developmental differences; and density in shared habitat (Tatara and Berejikian 2012). Intraspecific competition would be expected to be greater than interspecific, and competition would be expected to increase with prolonged freshwater co-occurrence. Hatchery smolts are commonly larger than natural-origin fish, and larger fish usually are superior competitors. However, natural-origin fish have the competitive advantage of prior residence when defending territories and resources in shared natural freshwater habitat. Tatara and Berejikian (2012) further reported that hatchery-influenced developmental differences from co-occurring natural-origin fish are variable and can favor both hatchery- and natural-origin fish. They concluded that of all factors, fish density of the composite population in relation to habitat carrying capacity likely exerts the greatest influence.

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

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

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

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

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

5.4.2. **Predation**

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

(Rensel et al. 1984) rated most risks associated with predation as unknown because there was relatively little documentation in the literature of predation interactions in either freshwater or marine areas at the time. More studies are now available, but they are still too sparse to allow many generalizations to be made about risk. Newly released hatchery-origin yearling salmon and steelhead may prey on juvenile fall Chinook and steelhead and other juvenile salmon in the freshwater and marine environments (Hargreaves and LeBrasseur 1986; Hawkins and Tipping 1999; Pearsons and Fritts 1999). Low predation rates have been reported for released steelhead juveniles (Hawkins and Tipping 1999; Naman and Sharpe 2012). Hatchery steelhead release timing and protocols used widely in the Pacific Northwest were shown to be associated with negligible predation by migrating hatchery steelhead on fall Chinook fry, which had already emigrated or had grown large enough to reduce or eliminate their susceptibility to predation when hatchery steelhead entered the rivers (Sharpe et al. 2008). Hawkins (1998) documented hatchery spring Chinook salmon yearling predation on naturally produced fall Chinook salmon juveniles in the Lewis River. Predation on smaller Chinook salmon was found to be much higher in naturally produced smolts (coho salmon and cutthroat, predominately) than their hatchery counterparts.

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

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

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

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

5.4.3. **Disease**

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

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

- Introduction of exotic pathogens
- Introduction of endemic pathogens to a new watershed

- Intentional release of infected fish or fish carcasses
- Continual pathogen reservoir
- Pathogen amplification

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

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

In addition to the state, federal and tribal fish health policies, disease risks can be further minimized by preventing pathogens from entering the hatchery facility through the treatment of incoming water (e.g., by using ozone) or by leaving the hatchery through hatchery effluent (Naish et al. 2008). Although preventing the exposure of fish to any pathogens prior to their release into the natural environment may make the hatchery fish more susceptible to infection after release into the natural environment, reduced fish densities in the natural environment compared to hatcheries likely reduces the risk of fish encountering pathogens at infectious levels (Naish et al. 2008). Treating the hatchery effluent would also minimize amplification, but would not reduce disease outbreaks within the hatchery itself caused by pathogens present in the incoming water supply. Another challenge with treating hatchery effluent is the lack of reliable, standardized guidelines for testing or a consistent practice of controlling pathogens in effluent

(LaPatra 2003). However, hatchery facilities located near marine waters likely limit freshwater pathogen amplification downstream of the hatchery without human intervention because the pathogens are killed before transmission to fish when the effluent mixes with saltwater.

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

5.4.4. **Acclimation**

One factor the can affect hatchery fish distribution and the potential to spatially overlap with natural-origin spawners, and thus the potential for genetic and ecological impacts, is the acclimation (the process of allowing fish to adjust to the environment in which they will be released) of hatchery juveniles before release. Acclimation of hatchery juvenile before release increases the probability that hatchery adults will home back to the release location, reducing their potential to stray into natural spawning areas. Acclimating fish for a period of time also allows them to recover from the stress caused by the transportation of the fish to the release location and by handling. (Dittman and Quinn 2008) provide an extensive literature review and introduction to homing of Pacific salmon. They note that, as early as the 19th century, marking studies had shown that salmonids would home to the stream, or even the specific reach, where they originated. The ability to home to their home or “natal” stream is thought to be due to odors to which the juvenile salmonids were exposed while living in the stream (olfactory imprinting) and migrating from it years earlier (Dittman and Quinn 2008; Keefer and Caudill 2013). Fisheries managers use this innate ability of salmon and steelhead to home to specific streams by using acclimation ponds to support the reintroduction of species into newly accessible habitat or into areas where they have been extirpated (Dunnigan 2000; Quinn 1997; YKFP 2008).

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

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

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

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

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

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

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

5.5.1. **Observing/Harassing**

For some parts of the proposed studies, listed fish would be observed in-water (e.g., by snorkel surveys, wading surveys, or observation from the banks). Direct observation is the least disruptive method for determining a species' presence/absence and estimating their relative numbers. Its effects are also generally the shortest-lived and least harmful of the research activities discussed in this section because a cautious observer can effectively obtain data while only slightly disrupting fishes' behavior. Fry and juveniles frightened by the turbulence and sound created by observers are likely to seek temporary refuge in deeper water, or behind/under rocks or vegetation. In extreme cases, some individuals may leave a particular pool or habitat type and then return when observers leave the area. At times, the research involves observing adult fish, which are more sensitive to disturbance. These avoidance behaviors are expected to be in the range of normal predator and disturbance behaviors. Redds may be visually inspected, but would not be walked on.

5.5.2. **Capturing/handling**

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

5.5.3. **Fin clipping and tagging**

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

In addition to fin clipping, PIT tags and CWTs are included in the Proposed Action. PIT tags are inserted into the body cavity of the fish just in front of the pelvic girdle. The tagging procedure requires that the fish be captured and extensively handled, so it is critical that researchers ensure that the operations take place in the safest possible manner. Tagging needs to take place where there is cold water of high quality, a carefully controlled environment for administering anesthesia, sanitary conditions, quality control checking, and a recovery holding tank.

Most studies have concluded that PIT tags generally have very little effect on growth, mortality, or behavior. Early studies of PIT tags showed no long-term effect on growth or survival (Prentice et al. 1987; Prentice and Park 1984; Rondorf and Miller 1994). In a study between the tailraces of Lower Granite and McNary Dams (225 km), (Hockersmith et al. 2000) concluded that the performance of yearling Chinook salmon was not adversely affected by orally or surgically implanted sham radio tags or PIT tags. However, (Knudsen et al. 2009) found that, over several brood years, PIT tag induced smolt-adult mortality in Yakima River spring Chinook salmon averaged 10.3 percent and was at times as high as 33.3 percent.

Coded-wire tags are made of magnetized, stainless-steel wire and are injected into the nasal cartilage of a salmon and thus cause little direct tissue damage (Bergman et al. 1968; Bordner et al. 1990). The conditions under which CWTs should be inserted are similar to those required for PIT tags. A major advantage to using CWTs is that they have a negligible effect on the biological condition or response of tagged salmon (Vander Haegen et al. 2005); however, if the tag is placed too deeply in the snout of a fish, it may kill the fish, reduce its growth, or damage olfactory tissue (Fletcher et al. 1987; Peltz and Miller 1990). This latter effect can create problems for species like salmon because they use olfactory clues to guide their spawning migrations (Morrison and Zajac 1987).

Mortality from tagging is both acute (occurring during or soon after tagging) and delayed (occurring long after the fish have been released into the environment). Acute mortality is caused by trauma induced during capture, tagging, and release—it can be reduced by handling fish as gently as possible. Delayed mortality occurs if the tag or the tagging procedure harms the animal. Tags may cause wounds that do not heal properly, may make swimming more difficult, or may make tagged animals more vulnerable to predation (Howe and Hoyt 1982; Matthews and Reavis 1990; Moring 1990). Tagging may also reduce fish growth by increasing the energetic costs of swimming and maintaining balance.

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

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

Hatchery actions also must be assessed for masking effects. For these purposes, masking is when hatchery fish included in the Proposed Action mix with and are not identifiable from other fish. The effect of masking is that it undermines and confuses RM&E and status and trends monitoring. Both adult and juvenile hatchery fish can have masking effects. When presented with a proposed hatchery action, NMFS analyzes the nature and level of uncertainties caused by masking and whether and to what extent listed salmon and steelhead are at increased risk. The analysis also takes into account the role of the affected salmon and steelhead population(s) in recovery and whether unidentifiable hatchery fish compromise important RM&E.

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

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

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

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

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

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