

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

Nine Snake River Steelhead Hatchery Programs and one Kelt Reconditioning Program in Idaho

NMFS Consultation Number: WCR-2017-7286

Action Agencies: National Marine Fisheries Service (NMFS)
 U.S. Fish and Wildlife Service (USFWS)
 Bonneville Power Administration (BPA)
 U.S. Army Corps and Engineers (ACOE)

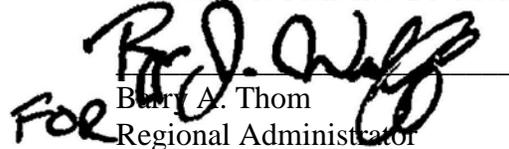
Affected Species and Determinations:

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

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

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

Issued By:


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 Regional Administrator

Date:

12/12/2017

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1. INTRODUCTION

This introduction section provides information relevant to the other sections of this document and is incorporated by reference into Sections 2 and 3 below. The underlying activities that drive the Proposed Actions are the operation and maintenance of ten hatchery programs rearing and releasing Snake River steelhead in the Snake River basin. The hatchery programs are operated by Federal, state, and/or tribal agencies as described in Table 1. Each program is described in detail in a Hatchery and Genetic Management Plan (HGMP) or proposed actions, which were submitted to the National Marine Fisheries Service (NMFS) for review, as well as the most recent Annual Operating Plans and Standard Operating Procedures available on the US Fish and Wildlife Service, Lower Snake River Compensation Plan Office (LSRCP) website (<https://www.fws.gov/lsnakecomplan/reports.html>).

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 hatchery-influenced selection, contain genetic resources that represent the ecological and genetic diversity of a species, and are included in a salmon ESU or steelhead DPS. When a hatchery program actively maintains distinctions or promotes differentiation between hatchery fish and fish from a native population, then NMFS refers to the program as “isolated” (also referred to as segregated). Isolated programs promote domestication or selection in the hatchery over selection in the wild and may culture a stock of fish with phenotypes (e.g., different ocean migrations and spatial and temporal spawning distribution) different from the natural population.

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

Program	HGMP Receipt	Program Operator¹	Funding Source	Program Type and Purpose	ESA Pathway
Steelhead Streamside Incubator (SSI) Project	June 2010	SBT	TBD ²	Segregated Supplementation	4(d) Tribal rule
Dworshak National Fish Hatchery B-Run Steelhead	April 2010	NPT and USFWS	ACOE, USFWS, and LSRCP ³	Segregated Harvest	Section 7
East Fork Salmon Natural A-run Steelhead	December 2009	IDFG	LSRCP	Integrated Recovery	4(d) Limit 6
Hells Canyon Snake River A-run Summer Steelhead	September 2011	IDFG	IPC	Segregated Harvest	4(d) Limit 6
Little Salmon River A-run Summer Steelhead	September 2011	IDFG	IPC and LSRCP	Segregated Harvest	4(d) Limit 6
Pahsimeroi A-run Summer Steelhead	September 2011	IDFG	IPC	Segregated Harvest	4(d) Limit 5
South Fork Clearwater (Clearwater Hatchery) B-Run Steelhead	November 2011	IDFG	LSRCP	Segregated Harvest	4(d) Limit 6
Upper Salmon River A-Run Steelhead	November 2011	IDFG	LSRCP	Segregated Harvest	Section 7
Salmon River B-Run Steelhead	November 2011	IDFG and SBT	LSRCP	Segregated Harvest	4(d) Limit 5
Snake River Kelt Reconditioning	Not Applicable	NPT	CRITFC and BPA	Kelt Reconditioning	4(d) Tribal rule

¹ Primary operators are listed, but all programs are coordinated between Idaho, Tribes, and Federal agencies collectively. Operators and funders are: U.S. Fish and Wildlife Service (USFWS), USFWS Lower Snake River Compensation Plan Office (LSRCP), Idaho Power Company (IPC), U.S. Army Corps of Engineers (ACOE), Idaho Fish and Game (IDFG), Nez Perce Tribe (NPT), Shoshone-Bannock Tribes (SBT), Bonneville Power Administration (BPA), and the Columbia River Inter-Tribal Fish Commission (CRITFC); TBD = To be decided.

² Future funding sources for the SSI program are under consideration. Past funders include: Bureau of Indian Affairs (638 Grant program); BPA; LSRCP; Pacific Coastal Salmon Recovery Fund.

³ FWS shares in facility operation costs at DNFH, and LSRCP shares in infrastructure repair/replacement costs at DNFH; these costs support both the COE steelhead and LSRCP spring Chinook programs at this facility.

1.1. Background

NMFS prepared the Biological Opinion (opinion) and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the ESA of 1973, as amended (16 U.S.C. 1531, et seq.), and implementing regulations at 50 CFR 402. The opinion documents consultation on the action proposed by NMFS, the U.S. Fish and Wildlife Service (USFWS), the USFWS Lower Snake River Compensation Plan (LSRCP), the U.S. Army Corps of Engineers (ACOE), and the 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 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 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 2000a). 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 ready for ESA review.

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 FWS and by the Washington Department of Fish and Wildlife (WDFW). NMFS' opinion (NMFS 2007) 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 2008d) 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 2008d, 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 Endangered Species Act (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....”

The present opinion on the operation of nine steelhead hatchery programs and a kelt reconditioning program is based on a series of documents submitted to NMFS by the co-managers and the funding agencies. Because program changes occurred as run sizes increased, regional hatchery reviews took place, and agreements were reached through forums such as *U.S. v. Oregon*, multiple informal reviews of draft HGMPs occurred between 2002 and 2011 (Table 1). In March of 2017, NMFS used these draft HGMPs as well as the most recent Annual Operating Plan for each program to draft a Proposed Action. The applicants then edited the Proposed Action for accuracy, and submitted the Proposed Action for all nine programs along with their HGMPs to NMFS to serve as the official request for formal consultation (Chandler 2017; Delarosa 2017; Hebdon 2017a; Kennedy 2017; Largo 2017; Schaller 2017; Small 2017). NMFS then drafted sufficiency letters (Purcell 2017a; Purcell 2017b; Purcell 2017c; Purcell 2017d; Purcell 2017e; Purcell 2017f).

This consultation evaluates the effects of the hatchery programs on all ESU and DPSs of salmon and steelhead in the Columbia 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 Magnuson-Stevens Fishery and Conservation Management Act.

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.

The objective of this Proposed Action is to document the determination of likely effects on ESA-listed salmon and steelhead and their designated critical habitat resulting from operation and maintenance of the nine steelhead hatchery programs, and one steelhead kelt reconditioning program. This document evaluates whether the Proposed Actions comply with the provisions of Section 7(a)(2) of the ESA, and, as pertinent, ESA Section 4(d) (Limit 5 for artificial propagation and Limit 6 for resource management plans developed jointly by states and tribes within the *U.S. v. Oregon* or *U.S. v. Washington* constructs) or the Tribal 4(d) rule. The duration of the Proposed Action is intended to be ongoing.

There are four Proposed Actions we consider in this Opinion:

- The Proposed Action for the U.S. Fish and Wildlife Service (USFWS) is its funding of the operation, maintenance, monitoring, and evaluation of the Little Salmon River A-run and), East Fork Salmon natural A-run, South Fork Clearwater (Clearwater Hatchery) B-run, Upper Salmon A-Run, and Salmon River B-run steelhead hatchery programs. Funding is provided through the Lower Snake River Compensation Plan (LSRCP), which is approved by the Water Resources Development Act of 1976, (Public Law 94-587, Section 102, 94th Congress).
- The Proposed Action for the Bonneville Power Administration (BPA) is the funding of the Kelt Reconditioning Program and associated monitoring and evaluation under the Pacific Northwest Electric Power Planning and Conservation Act of 1980 (Northwest Power Act) (16 U.S.C. sections 839 et seq.) to protect, mitigate, and enhance anadromous salmon affected by the Federal Columbia River Power System dams.
- The Proposed Action for the ACOE is the funding of the operations, maintenance, fish health monitoring, and monitoring and evaluation of the Dworshak National Fish Hatchery (DNFH) North Fork B-run Steelhead Program. The majority of DNFH smolts are released at the hatchery. In collaboration with regional partners, some DNFH steelhead are outplanted to Lolo Creek, Clear Creek, and the South Fork Clearwater River. Any additional actions associated with such outplants may require specific Congressional authority and will require further coordination between the ACOE and regional fish managers.
- The Proposed Action for NMFS is a proposed approval of hatchery programs under section 4(d) limit 5, or a determination under section 4(d) limit 6 or the Tribal 4(d) rule, for a subset of programs as defined in Table 1.

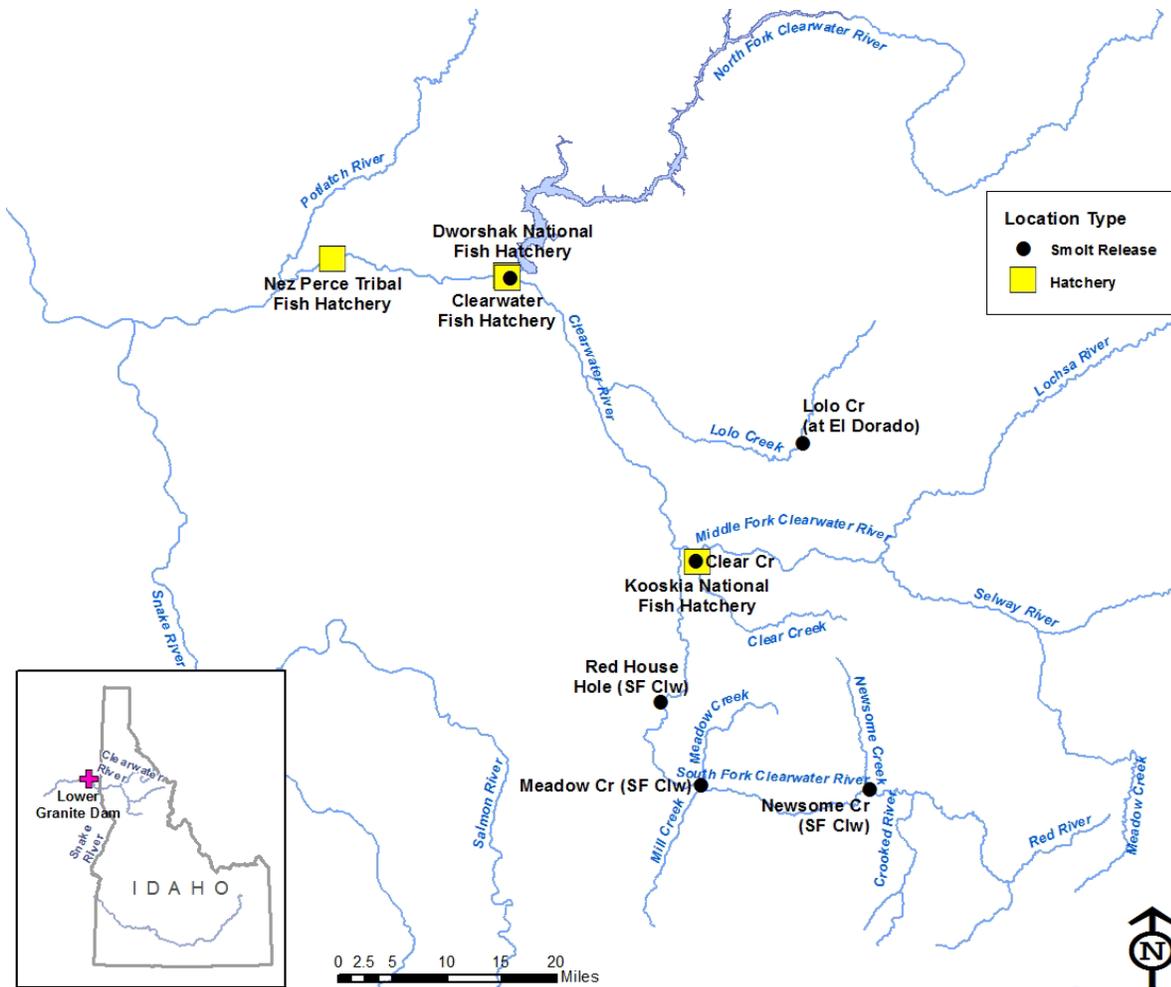


Figure 1. Location of facilities in the Clearwater River Basin used in the Proposed Action.

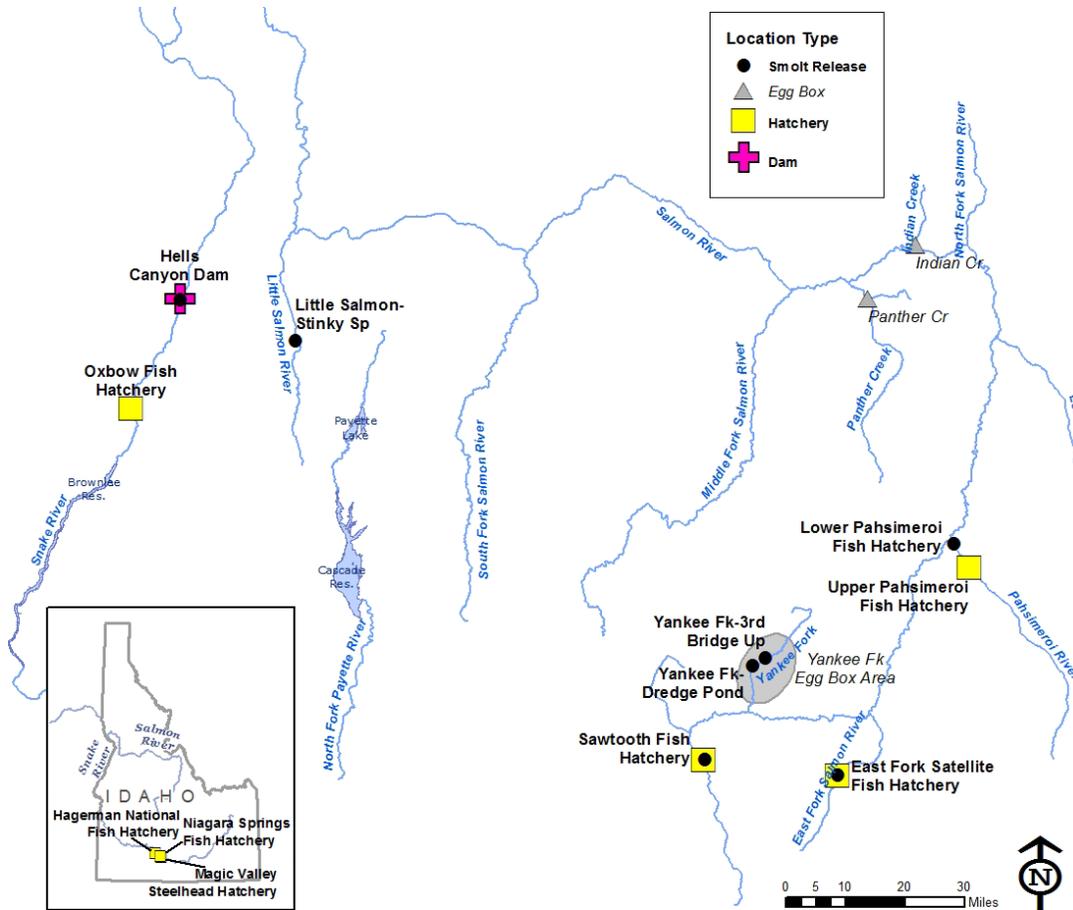


Figure 2. Location of facilities in the Salmon Basin used in the Proposed Action. Eggboxes in this figure indicate locations of steelhead streamside incubators.

1.3.1. Proposed hatchery broodstock collection

Broodstock collection occurs as depicted in Table 2. Broodstock collection for the B-run program in the Salmon Basin currently occurs primarily at Pahsimeroi Fish Hatchery (PFH) with a portion provided by DNFH and with some collection in Yankee Fork using a picket weir as needed. In the future, once the Yankee Fork weir, linked to the Shoshone-Bannock Tribes’ Crystal Springs Fish Hatchery, is operational, it is expected that Yankee Fork will serve as the primary broodstock collection location for local B-run steelhead in the Salmon Basin, and DNFH will no longer be used. The steelhead streamside incubator (SSI) B-run program receives eggs from the Salmon River B-run program. The SSI A-run program receives eggs from Pahsimeroi Fish Hatchery. The Little Salmon A-Run program receives juveniles from eggs collected at both Pahsimeroi and Oxbow fish hatcheries.

The Oxbow trap (at Hells Canyon Dam) is typically operated three days per week, up to eight hours per day, during the fall and spring periods until target brood numbers are reached; fish are processed each day. Pahsimeroi and Sawtooth traps are operated 24 hours per day, seven days

per week. Fish are processed up to five times per week. The East Fork trap is operated 24 hours per day, seven days per week, and fish are processed daily. With the exception of the East Fork Salmon River steelhead program, all natural-origin steelhead are passed upstream of the weirs (on the East Fork Salmon River, some natural-origin steelhead are retained for broodstock). The Yankee Fork picket weirs are operated and checked daily.

Table 2. Broodstock collection details. SFH = Sawtooth Fish Hatchery; PFH = Pahsimeroi Fish Hatchery; DNFH = Dworshak National Fish Hatchery; HC = Hells Canyon; SF = South Fork; NF = North Fork; EF = East Fork; KNFH = Kooskia National Fish Hatchery; SSI = Steelhead streamside incubator.

Program	Source	Collection Location(s)	Collection Method	Collection Target (females only) ¹	Collection Duration	pNOB
East Fork Salmon Natural A-run	Local hatchery- and natural-origin	EF Salmon River Satellite	Weir and trap	~14	March-May	up to 100%
Upper Salmon River A-run	Hatchery fish in Snake and Salmon Rivers	SFH 1 st ; lower PFH and HC 2 nd	Weir and trap	~447	March-April	0
Hells Canyon A-run	Hatchery fish in Snake River	Hells Canyon 1 st ; lower PFH and SFH 2 nd	Ladder and trap	~375	October-Nov, March-April	0
Pahsimeroi A-Run	Hatchery fish in Pahsimeroi River	Lower PFH; HC and SFH 2 nd	Weir and trap	~456	February-May	0
Little Salmon River A-run	Receives juveniles from the Pahsimeroi and Hells Canyon A-run programs and does not collect additional brood					
SSI A-run	Receives eggs from the Pahsimeroi A-run program and does not collect additional brood					
Dworshak B-run	NF Clearwater River B-run	DNFH ² , KNFH; SF Clearwater	Ladder and trap; Angling ³	~ 600 ⁴	October-April (DNFH); March-May (KNFH); Angling Mid Feb-Late March	0
SF Clearwater (Clearwater Hatchery) B-run	NF Clearwater River B-run	SF Clearwater River 1 st ; DNFH and KNFH 2 nd	Ladder and trap; Angling ³	~193 SF Clearwater (for CFH)	February-April (PFH, DNFH); April-May (Yankee Fork)	0
Salmon River B-run	DNFH ⁵	PFH, Yankee Fork, DNFH	Weir and trap	~347	February-April (PFH, DNFH); April-May (Yankee Fork)	0
SSI B-run	Receives eggs from the Salmon River B-run program and does not collect additional brood					

¹ Similar number of males will also be collected.

² The DNFH ladder is not open continuously throughout the collection period. The ladder is open about 10 times for less than a week each in an effort to represent fish from throughout the run.

³ The effects of angling are subsumed in the larger fishery action, which is not a part of this Proposed Action, though angling effects are considered generally as part of the baseline and cumulative effects.

⁴ Includes DNFH on-station, Lolo, and Clear Creek release groups, and eyed-eggs for Magic Valley SFH (~22 females).

⁵ Although this was the original donor source, current broodstock is primarily fish trapped in the Upper Salmon River with ~10 percent DNFH-trapped fish.

1.3.2. Proposed hatchery rearing and juvenile release

The details of hatchery juvenile rearing and release, including release numbers, marking/tagging, rearing and release locations, and release timing can be found in Table 3. Some additional detail on fish health protocols follows. Prior to hatching, dead eggs are picked on a regular schedule (approximately two times per week) to discourage the spread of fungus. During rearing, regular fish health inspections are conducted. If disease agents are suspected or identified, more frequent inspections will be conducted. Recommendations for treating specific disease agents comes from the Idaho Department of Fish and Game Fish Health Laboratory in Eagle, Idaho, or from the USFWS Pacific Region Fish Health Program Office in Orofino, Idaho. Prior to release, final pre-release fish health inspections are conducted by these offices for their respective programs. All fish production is conducted according to the USFWS - National Fish Health Policy (USFWS 2004), Pacific Northwest Fish Health Protection Committee (PNFHPC) (1989), Integrated Hatchery Operations Team (IHOT) policies and guidelines (IHOT 1995), and as described in the most recent Annual Operating Plan (<https://www.fws.gov/snakecomplan/reports.html>).

Table 3. Proposed annual release protocols for each program. AD = adipose fin clip; CWT = coded-wire tag; PIT = passive integrated transponder tag; PBT =Parentage-Based Tagging; SSI = Steelhead Streamside Incubator; HNFH = Hagerman National Fish Hatchery; NSFH = Niagara Springs Fish Hatchery; MVFH = Magic Valley Fish Hatchery.

Program	Number, life stage, and size (fpp)	Marking and Tagging ¹	Egg incubation Location	Rearing Location	Acclimation Site; Duration	Volitional Release?	Release Location	Release Time
East Fork Salmon Natural	60,000 yearlings; 4.5	100% CWT and PBT; 8,600 PIT	SFH/HNFH	HNFH	None	No	East Fork Salmon River	Early May
Pahsimeroi A-run	800,000 yearlings; 4.5	100% ad and PBT; 9,000 PIT	NSFH/PFH	NSFH	None	No	PFH	April
Upper Salmon River, A-run	1,779,000 yearlings; 4.5	100% ad and PBT; 10% CWT; 31,700 PIT	HNFH/MVFH/SFH	HNFH/MVFH	None	No	Sawtooth Fish Hatchery Weir	March - April
SSI Project A-run	400,000 eyed-eggs	100% PBT	PFH	Panther Creek SSI	Panther Creek	Yes	Panther Creek	May-July
	100,000 eyed-eggs		PFH	Indian Creek SSI	Indian Creek	Yes	Indian Creek	
Hells Canyon	550,000 yearlings; 4.5	100% ad and PBT; 8,600 PIT	OFH/NSFH	NSFH	None	No	Snake River below Hells Canyon Dam	March-April
Little Salmon River, A-run	250,000 yearlings ; 4.5	100% ad and PBT; 2,800 PIT	OFH/NSFH	NSFH	None	No	Little Salmon River-Stinky Springs	April
	186,000 yearlings; 4.5	100% ad and PBT; 2,200 PIT	SFH/MVFH	MVFH	None	No		
	200,000 yearlings; 4.5	100% ad and PBT; 2,300 PIT	PFH/NSFH	NSFH	None	No		
Dworshak B-run	1,200,000 yearlings; 6	100% ad and PBT;	DNFH	DNFH	DNFH	No	Clearwater River	Mid-April

		~10% CWT; ~18,000 PIT						
	400,000 yearlings; 6	100% ad and PBT; ~10% CWT; ~5,600 PIT	DNFH	DNFH	DNFH	No	SF Clearwater-Red House Hole	
	300,000 yearlings; 6	100% ad and PBT; ~7% CWT; ~5,500 PIT	DNFH	DNFH	DNFH	No	Clear Creek	
	200,000 yearlings; 6	100% PBT; ~3,800 PIT	DNFH	DNFH	DNFH	No	Lolo Creek	
SF Clearwater (Clearwater Hatchery) B-run	501,000 yearlings; 4.5	100% PBT ~58% ad; 42% CWT only; 10,800 PIT	CFH	CFH	None	No	SF Clearwater-Meadow Creek	April
	219,000 yearlings; 4.5	100% ad and PBT; ~4,700 PIT	CFH	CFH	None	No	SF Clearwater-Red House Hole	
	123,000 yearlings; 4.5	~1,500 PIT 100% CWT and PBT	CFH	CFH	None	No	SF Clearwater-Newsome Creek	
Salmon River B-run	248,000 yearlings; 4.5	100% CWT and PBT; 11,400 PIT	MVFH/PFH/ CFH	MVFH	None	No	Pahsimeroi Weir ²	April
	620,000 yearlings; 4.5	400k ad; 100% CWT and PBT; 13,300 PIT	MVFH/PFH	MVFH	None and/or Yankee Fork; hours-few days	No	Yankee Fork	April-May
	217,000 yearlings; 4.5	100% ad and PBT; 2,200 PIT	MVFH/PFH	MVFH	None	No	Little salmon River	April
SSI Project B-run	500,000 eyed-eggs	100% PBT	PFH/SFH	Yankee Fork SSI	Yankee Fork	Yes	Yankee Fork	April

¹Funding for PIT tags come from multiple sources.

²To be released in Yankee Fork in the future.

1.3.3. Proposed disposition of excess juvenile and adult hatchery fish, broodstock and post-spawned carcasses

All programs strive to meet and not exceed production goals. However, given that in-hatchery survival metrics change from year to year at all life stages, and because accidental losses can occur, managers desire some flexibility to ensure the highest probability of meeting release goals, without creating significant excesses. Programs currently use the most recent 5-year average of in-hatchery performance data to determine how many adults need to be trapped to accurately meet their goals.

To ensure goals are met for each program, hatchery managers have agreed to target the release number as specified in the Proposed Action. However, because of the variability in within-hatchery survival in any given year caused by; low adult holding survival, unexpected drops in trapping success, low egg fecundity in spawned females, poor juvenile survival, fish pathogen impacts, diminished water quality, human error, power outages, etc., some flexibility is needed. Therefore the proposed action includes juvenile release targets that include a cushion, not to exceed an additional 10 percent of each program’s release target, by the hatchery annually, which must be approved by the managers as part of the AOP process.

Table 4. Proposed disposition protocols for steelhead in excess of hatchery program requirements.

Program(s)	Lifestage	Disposition
Hells Canyon, Little Salmon A	Adults	<ul style="list-style-type: none"> ● given to tribes, the public, or food banks ● trap and haul to non-anadromous waters for fisheries ● nutrient enhancement in local watersheds
	Juveniles	<ul style="list-style-type: none"> ● culled ● outplanted in local reservoirs not conducive to anadromy
Pahsimeroi A	Adults	<ul style="list-style-type: none"> ● trap and haul to non-anadromous waters for fishery, or given to tribes, the public, or food banks ● given to rendering plants or landfills for disposal ● nutrient enhancement in local watersheds
	Juveniles	<ul style="list-style-type: none"> ● outplanted in local reservoirs not conducive to anadromy
Upper Salmon A, Salmon River B	Adults	<ul style="list-style-type: none"> ● given to tribes, the public, or food banks ● given to rendering plants or landfills for disposal ● outplanted upstream for tribal fishery (Yankee Fork) ● nutrient enhancement (Yankee Fork; Salmon River)
	Juveniles	<ul style="list-style-type: none"> ● outplanted in local reservoirs not conducive to anadromy
East Fork Salmon Natural and SSI A and B	Adults	<ul style="list-style-type: none"> ● released upstream for natural production ● nutrient enhancement (strays only)
Dworshak B	Adults	<ul style="list-style-type: none"> ● outplanted for natural production ● sampled for CWTs ● released into South Fork Clearwater River for harvest ● given to tribes, the public, or food banks

		<ul style="list-style-type: none"> ● used to feed captive bears and eagles ● used for research ● nutrient enhancement
	Juveniles	<ul style="list-style-type: none"> ● used as food for the kelt reconditioning program or sturgeon projects ● outplanting of eggs into the North Fork and/or South Fork Clearwater¹ not to exceed 20 percent of the juvenile target release number in any given year
SF Clearwater (Clearwater Hatchery) B	Adults	<ul style="list-style-type: none"> ● released into South Fork Clearwater River for harvest ● sampled for CWTs ● given to tribes, the public, or food banks ● used to feed captive bears and eagles ● used for research ● given to rendering plants or landfills for disposal
	Juveniles	<ul style="list-style-type: none"> ● used as food for the kelt reconditioning program or sturgeon projects ● outplanting of eggs into the North Fork and/or South Fork Clearwater¹ not to exceed 20 percent of the juvenile target release number in any given year

¹ The location of outplanted eggs is dependent on their parentage; eggs from North Fork parents will be outplanted in the North Fork Clearwater, and eggs from South Fork parents will be outplanted in the South Fork Clearwater.

1.3.4. Proposed research, monitoring, and evaluation (RM&E)

Table 5. Proposed research, monitoring, and evaluation associated with hatchery programs.

Activity	Purpose	Associated Program
Adult trapping and tissue sampling at hatchery traps/weirs for recording: date, sex, length, origin (hatchery or natural), marks/tags, and disposition	Identify and track returns to all trapping facilities; maintain PBT genetic identification; identify potential straying of steelhead released at other locations	All programs
Monitoring of survival metrics for all life stages in the hatchery from spawning to release.	Track program performance and identify limiting factors	All programs
PIT tagging representative groups of hatchery juvenile steelhead	Estimate migration timing, outmigration survival rate, and adult returns	All programs
Inserting radio transmitters into adult steelhead	Determine distribution throughout the drainage	SF Clearwater
Direct stream versus acclimated fish releases	Evaluate homing efficiency between release strategies	Yankee Fork
Using rotary screw traps to insert PIT tags into hatchery and natural-origin juveniles	Evaluate juvenile emigration timing, survival from release to Lower Granite Dam, natural-origin abundance/productivity, and parentage	SF Clearwater, SSI

In addition to the research, monitoring and evaluation (RM&E) described in Table 5 the applicants propose developing and participating on a workgroup to evaluate the ecological and genetic effects of steelhead straying in the Snake River Basin. The goals of the workgroup are to (1) improve estimation of hatchery-origin steelhead spawning naturally with ESA-listed steelhead populations, and (2) develop biologically acceptable limits for hatchery-origin steelhead that spawn naturally with non-target ESA-listed steelhead populations. Members of the workgroup have already been assigned and three meetings have taken place since March 2017. The results from workgroup-generated efforts is intended to enhance program assessments/evaluations to allow for adaptive management of ongoing steelhead programs throughout the Snake Basin.

1.3.5. Proposed operation and maintenance of hatchery facilities

Water at all facilities is withdrawn in accordance with state-issued water rights (Table 6) except for DNFH where water withdrawals are pursuant to federally reserved water rights (Winters Doctrine). All facilities that rear over 20,000 pounds of fish and feed more than 5,000 pounds of feed at any one time operate under a National Pollutant Discharge Elimination System (NPDES) permit issued by the Environmental Protection Agency (Table 6).

Routine Maintenance

Several routine (and semi-routine) maintenance activities occur for all programs 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 material 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

Table 6. Details for those facilities that divert water for hatchery operations; SSI = steelhead streamside incubator; NA = not applicable; UD = undetermined.

Facilities	Surface Water (cfs)	Ground /Spring Water (cfs)	Water Diversion Distance (km)	Water source	Discharge Location	Instream Structures	Meet NMFS Screening Criteria?	NPDES Permit #	Water Right Permit #
Magic Valley Fish Hatchery	NA	87.2	NA	Crystal Springs	NA	NA	NA	IDG130016	36-07033
Niagara Springs Fish Hatchery	NA	120	NA	Niagara Springs	NA	NA	NA	IDG130013	36-02704
Hagerman National Fish Hatchery	NA	84.6	NA	Springs	NA	NA	NA	IDG13004	36-00128; 36-00130; 36-00132; 36-15444; 36-15446; 36-15448A; 36-15448B; 36-15449; 36-15450; 36-15451
East Fork Salmon River Satellite	15	NA	200	East Fork Salmon River	East Fork Salmon River	2: Intake, outfall	LSRCP currently evaluating ¹	NA	72-07185
Dworshak National Fish Hatchery	182 ²	NA	0.0, 3.0 ³	North Fork Clearwater River	North and Middle Fork Clearwater River	3: Intake; Outfalls (2); Ladder	No	IDG131003	NA ⁴
SSI: Panther Creek, Beaver Creek 2	0.021	NA	0.015	Beaver Creek	Panther Creek	1: Diversion	UD ⁵	NA	NA
SSI: Panther Creek, Beaver Creek 3	0.021	NA	0.015	Beaver Creek	Panther Creek	1: Diversion	UD ⁵	NA	NA
SSI: Panther Creek, Beaver Creek 4	0.021	NA	0.015	Beaver Creek	Panther Creek	1: Diversion	UD ⁵	NA	NA
SSI: Indian Creek 1	NA	0.021	0.015	Indian Creek	Indian Creek	1: Diversion	UD ⁵	NA	NA
SSI: Indian Creek 2	NA	0.021	0.1	Indian Creek	Indian Creek	2: Diversion, Headbox	UD ⁵	NA	NA

SSI: Yankee Fork, Cearly Creek	0.021	NA	0.1	Cearly Creek	Cearly Creek	2: Diversion, Headbox	UD ⁵	NA	NA
SSI: Yankee Fork, Swift Gulch	0.021	NA	0.1	Swift Gulch	Swift Gulch	2: Diversion, Headbox	UD ⁵	NA	NA
SSI: Yankee Fork, Ramey Creek	0.021	NA	0.1	Ramey Creek	Ramey Creek	2: Diversion, Headbox	UD ⁵	NA	NA
SSI: Yankee Fork, Greylock Creek	0.021	NA	0.1	Greylock Creek	Greylock Creek	2: Diversion, Headbox	UD ⁵	NA	NA
SSI: Yankee Fork, Jordan Creek	0.021	NA	0.1	Jordan Creek	Jordan Creek	2: Diversion, Headbox	UD ⁵	NA	NA

¹The existing facility and any subsequent structures (as applicable) were built to design specifications at the time of construction. Structures are currently being evaluated relative to compliance with NMFS's 2011 Screening/Passage criteria. When final assessments for LSRCP facilities are completed, the LSRCP and 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 on listed and native fish.

² Up to 154 cfs is from the North Fork River. The remainder of up to 28 cfs is sourced from the Dworshak Reservoir. The intake is located in the reservoir on the dam wall, and provides water by gravity fed pipeline.

³The surface water intake is adjacent to hatchery in North Fork Clearwater River. Dworshak Reservoir is located on the north wall of the Dworshak Dam approximately 3 km from the hatchery.

⁴ Water withdrawals to support DNFH operations are pursuant to federally reserved water rights (Winters Doctrine).

⁵The Shoshone-Bannock Tribes are actively working on meeting with a NMFS engineer to evaluate compliance of their streamside incubators.

The Oxbow Fish Hatchery, Pahsimeroi Fish Hatchery, Sawtooth Fish Hatchery, Clearwater Fish Hatchery, Nez Perce Tribal Hatchery, Clear Creek Acclimation Site, and Newsome Acclimation Site were analyzed in three other Opinions covering the Chinook salmon and coho programs in Idaho. None of these facilities were found to jeopardize the listed species or cause adverse modification of listed species' critical habitat (NMFS 2017a; NMFS 2017b; NMFS 2017d).

1.3.6. Kelt Reconditioning Program

A kelt is the term used for an adult steelhead that has spawned successfully and is returning to the ocean, with the chance to return upstream to spawn at a later time. Typically, shortly after spawning, a kelt is in fairly poor condition, and its chances of surviving the downstream migration may be low. The objective of kelt reconditioning is to improve the condition of kelts by feeding and disease treatment in a hatchery environment, so that the kelts can be returned to the river in a healthier state, when ready to spawn again (Hatch et al. 2017).

The kelt reconditioning program currently being proposed consists of the collection of up to 700 post-spawned steelhead greater than 60 cm (see Table 7), and the administration of disease-preventative medications and feed for the purpose of improving survival over what would be expected in the wild. Upon release, these fish are intended to return to natal populations, thereby increasing spawner escapement and productivity if reconditioned individuals successfully spawn.

Table 7. Kelt collection details.

Collection Location ¹	Collection Method	Expected Number Collected	Collection Duration
Lower Granite Dam	Juvenile Bypass System and collection facility	450-700	Mid-March to July, peak in May
Little Goose Dam	Juvenile Bypass System and collection facility	200 ²	Mid-March to July, peak in May
Snake River Basin	Angling, Weirs	200 ²	Mid-February to June
Dworshak National Fish Hatchery ²	Ladder and trap	100 ³	Late February to mid-April

¹From highest to lowest collection location priority order.

²Collection at these locations would only occur if the goal of up to 700 is not achieved at Lower Granite Dam.

³Mature females from this broodstock would first be air-spawned to collect eggs for production at DNFH. Air spawning is a non-lethal method of egg collection from adult fish; a needle is inserted into the female and air is gently pumped in, which expels the eggs as it compresses.

The adult fish separator of the juvenile bypass system at Lower Granite and Little Goose Dams is staffed 24 hours per day throughout the spring juvenile salmonid emigration season. At the tributary weirs, trap boxes are examined several times each day. Trapped kelts are netted, anesthetized, measured, examined, have genetic samples taken, are PIT-tagged, and receive an antibiotic injection. Rejected fish are released into the river downstream.

To minimize fish holding time, fish selected for reconditioning are transferred from the temporary holding tank at the dams every one or two days. Steelhead from offsite traps will be transferred within 24 hours to the reconditioning facilities at the Nez Perce Tribal Hatchery or at Dworshak Hatchery. At the hatchery, reconditioning of kelts includes the provision of

prophylactics and feed for the purpose of improving survival relative to the untreated condition¹. They are treated for infection, fungus, parasites, and disease and fed a specially formulated diet. Staff monitor the feeding behaviors of the kelt and modify feeding practices as needed to improve survival. Select mortalities will be necropsied and sampled for disease by fish health staff.

The kelts will be held at the hatchery until their release that same year (consecutive spawners) or the following year (skip spawners). Approximately 33% of the surviving² fish are held for up to seven months then released, while 66% may be held for up to 20 months before release. Reconditioned kelts are released from October through November when the steelhead run at large is returning from the ocean. Prior to release all steelhead kelts are scanned for PIT tags, and sampled for biological information. Kelts are released in the Snake River near Lower Granite Dam. These reconditioned fish generally mix with the run at large and proceed to over-winter locations and then to spawning grounds in the spring.

Monitoring and Evaluation

Monitoring and evaluation activities for the kelt reconditioning program are summarized in Table 8.

Table 8. Research, monitoring, and evaluation of steelhead kelts during reconditioning and after release.

Activity	Purpose
Monitoring of survival, feeding, water quality, and prophylactic treatments during reconditioning	To refine reconditioning strategies
PIT tagging of released kelts	Monitor post-release survival and run-timing, homing and straying, contribution to population escapement
Genotyping of released kelts	Allows for monitoring the relative reproductive success of released kelts

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.

¹ The mortality of kelts migrating to the ocean is very high and consequently only a small number of kelts return to repeat spawn. In the Yakima River, repeat spawners make up about 3% of the steelhead run, yet over half of the run is seen moving downstream as kelts. In the Snake River, kelts make up about 1% of the steelhead run (Lothrop 2016).

² The survival rate during reconditioning was found to be about 47% for consecutive spawners, and 24% for skip spawners.

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. This Opinion does account for the effects of fisheries, as part of the species status, baseline and cumulative effects discussions.

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, including those that may target fish produced by the proposed programs, on ESA-listed salmonids are included in the environmental baseline (Section 2.4).

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 FWS, 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, the Service provide an opinion stating how the agencies' actions will affect listed species and their critical habitat. If incidental take is expected, section 7(b)(4) requires the consulting agency to provide an ITS that specifies the impact of any incidental taking and includes reasonable and prudent measures to minimize such impacts

2.1. Analytical Approach

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

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

The designations of critical habitat for the species considered in this opinion use the terms primary constituent element (PCE) or essential features. The new critical habitat regulations (81 FR 7414, February 11, 2016) replace this term with physical or biological features (PBFs). The

shift in terminology does not change the approach used in conducting a “destruction or adverse modification” analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. We use the term PCE as equivalent to PBF or essential feature, due to the description of such features in applicable recovery planning documents.

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

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

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

Describe the environmental baseline in the action area

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

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

Section 2.5 first describes the various pathways by which hatchery operations can affect ESA-listed salmon and steelhead, then applies that concept to the specific programs considered here.

Cumulative effects

Cumulative effects, as defined in NMFS’ implementing regulations (50 CFR 402.02), are the effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area. Future Federal actions that are unrelated to the proposed action are not considered because they require separate section 7 consultation. Cumulative effects are considered in Section 2.6 of this opinion.

Integration and synthesis

Integration and synthesis occurs in Section 2.7 of this opinion. In this step, NMFS adds the effects of the Proposed Action (Section 1.3) to the status of ESA protected populations in the Action Area under the environmental baseline (Section 2.4) and to cumulative effects (Section 2.6). Impacts on individuals within the affected populations are analyzed to determine their effects on the VSP parameters for the affected populations. These impacts are combined with the overall status of the 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 2.7, the opinion determines whether the proposed action is likely to jeopardize ESA protected species or destroy or adversely modify designated critical habitat in Section 2.8.

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 a RPA or RPAs to the proposed action.

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

This opinion examines the status of each species and designated critical habitat that would be affected by the Proposed Action (Table 9). Status of the species is the level of risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and ESA listing determinations. This informs the description of the species’ likelihood of both survival and recovery. The species status section helps to inform the description of the species’ current “reproduction, numbers, or distribution” as described in 50 CFR 402.02. The opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the current function of the essential PBFs that help to form that conservation value.

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

Species	Listing Status	Critical Habitat	Protective Regulations
Chinook salmon (<i>Oncorhynchus tshawytscha</i>)			
Snake River spring/summer	Threatened, 79 FR 20802, April 14, 2014	64 FR 57399, October 25, 1999	70 FR 37160, June 28, 2005
Snake River fall	Threatened, 79 FR 20802, April 14, 2014	58 FR 68543, December 28, 1993	70 FR 37160, June 28, 2005

Sockeye salmon (<i>O. nerka</i>)			
Snake River	Endangered, 79 FR 20802, April 14, 2014	70 FR 52630, September 2, 2005	Issued under ESA Section 9
Steelhead (<i>O. mykiss</i>)			
Snake River	Threatened, 79 FR 20802, April 14, 2014	70 FR 52769, September 2, 2005	70 FR 37160, June 28, 2005

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

2.2.1. Status of Listed Species

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

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

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

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

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

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).

2.2.1.1. Snake River Spring/Summer Chinook Salmon ESU

Spring/summer-run Chinook salmon from the Snake River basin exhibit stream-type life history characteristics. 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 emigrate 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.

The Snake River Spring/Summer Chinook Salmon ESU remains listed as threatened (NWFSC 2015). 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, cover, side-channel refuge areas, 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 (spawner-to-spawner return rates) 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.

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). A more detailed description of the populations that are the focus of this consultation follows.

There are four independent populations within the South Fork MPG, nine independent populations in the Middle Fork MPG, and nine independent populations in the Upper Salmon River MPG. Only the Panther Creek population is extirpated (Table 10). The most recent status review by NMFS (NWFSC 2015) maintains that all but the Chamberlain Creek population remain at high risk (Table 10).

Table 10. Risk levels and viability ratings for Snake River spring/summer Chinook salmon populations (NWFSC 2015); ICTRT = Interior Columbia Technical Recovery Team; MPG = Major Population Group. Data are from 2005-2014. Current abundance and productivity estimates expressed as geometric means (standard error).

MPG	Population	ICTRT minimum threshold	Natural spawning abundance	Proportion natural-origin spawners	Productivity	Abundance and productivity risk	Spatial structure and diversity risk	Overall viability risk rating
South Fork (SF)	SF Mainstem	1000	791 (0.18)	0.77	1.21 (0.2)	High	Moderate	High
	Secesh River	750	472 (0.18)	0.98	1.25 (0.2)	High	Low	High
	East Fork/Johnson Creek	1000	208 (0.24)	0.61	1.15 (0.2)	High	Low	High
	Little Salmon River	750	Insufficient data				Low	High
Middle Fork (MF)	Chamberlain Creek	750	641 (0.17)	1.0	2.26 (0.45)	Moderate	Low	Maintained
	Big Creek	1000	154 (0.23)	1.0	1.1 (0.21)	High	Moderate	High
	Loon Creek	500	54 (0.1)	1.0	0.98 (0.4)	High	Moderate	High
	Camas Creek	500	38 (0.2)	1.0	0.8 (0.29)	High	Moderate	High
	Lower mainstem MF	500	Insufficient data				Moderate	High
	Upper mainstem MF	750	71 (0.18)	1.0	0.5 (0.72)	High	Moderate	High
	Sulphur Creek	500	67 (0.99)	1.0	0.92 (0.26)	High	Moderate	High
	Marsh Creek	500	253 (0.27)	1.0	1.21 (0.24)	High	Low	High
Bear Valley Creek	750	474 (0.27)	1.0	1.37 (0.17)	High	Low	High	
Upper Salmon River	Salmon Lower main	2000	108 (0.18)	1.0	1.18 (0.17)	High	Low	High
	Salmon upper main	1000	411 (0.18)	0.7	1.22 (0.19)	High	Low	High
	Pahsimeroi River	1000	267 (0.24)	0.93	1.37 (0.2)	High	High	High
	Lemhi River	2000	143 (0.18)	1.0	1.3 (0.23)	High	High	High
	Valley Creek	500	121 (0.18)	1.0	1.45 (0.15)	High	Moderate	High
	Salmon East Fork	1000	347 (0.24)	1.0	1.08 (0.28)	High	High	High
	Yankee Fork	500	44 (0.18)	0.39	0.72 (0.39)	High	High	High
	North Fork	500	Insufficient data				Low	High
Panther Creek	750	Extirpated						

2.2.1.2. Snake River Steelhead DPS

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. 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 *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. However, summer run steelhead can be divided into two sub-types; A-run steelhead, which return to spawning areas beginning in the summer, and B-run steelhead, which exhibit a larger body size and begin their migration in the fall (NMFS 2011a). After holding over the winter, summer steelhead spawn the following spring (March to May).

The Snake River Steelhead DPS remains threatened (NWFSC 2015). Factors that limit the DPS's survival and recovery include: 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, high quality spawning gravels, and; interbreeding and competition with hatchery fish that outnumber natural-origin fish. Factors affecting habitat conditions are likely to affect most if not all populations within the DPS. Hatchery effects are likely more pronounced when the program occurs on a listed population. Those populations within the DPS with hatchery fractions > 50 percent are the Tucannon, Asotin Creek, Lolo Creek, South Fork Clearwater, Little Salmon River, Pahsimeroi, Lemhi, East Fork Salmon and Upper Salmon River based on a preliminary run reconstruction model (see Table 29; NWFSC 2015). Those in the Clearwater and Salmon River Basins are most likely to be affected by the programs in this Proposed Action.

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 extant populations within five MGPs comprise the Snake River Basin Steelhead DPS. In addition, a number of populations may have existed above Hells Canyon Dam, constituting a sixth MPG. Four out of the five extant MGPs are not meeting the specific objectives in the draft Snake River Recovery Plan, and the status of many individual populations remains uncertain. Within the geographic range of the DPS, 19 steelhead hatchery programs are currently operational. Six of these artificial programs are included in the DPS. 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 (NWFSC 2015). A more detailed description of the populations that are the focus of this consultation follows.

There are five independent populations within the Clearwater River MPG, and twelve independent populations in the Salmon River MPG. Abundance and productivity estimates for most of these populations are unknown, although most populations are thought to be maintained (Table 11). 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 of A-run versus B-run (NWFSC 2015).

Table 11. Risk levels and viability ratings for Snake River steelhead Major Population Groups (MPGs) (NWFSC 2015). Data are from 2004-2015. ICTRT = Interior Columbia Technical Recovery Team. Current abundance and productivity estimates expressed as geometric means (standard error).

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

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

2.2.1.3. Snake River Fall Chinook Salmon

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; 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.

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 along with a single natural-origin population that is currently viable, but at moderate risk, with a low risk for abundance/productivity and a moderate risk for spatial structure and diversity.

The moderate risk rating was driven by changes in major life history patterns, shifts in phenotypic traits, and high levels of genetic homogeneity in 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. However, the overall adult abundance has been increasing from the mid-1990s, with substantial growth since the year 2000 (NMFS 2012b).

The Snake River Fall-run Chinook Salmon ESU remains at threatened status (NWFSC 2015). 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). Hatcheries mitigating for losses caused by the dams have played a major role in the production of Snake River fall-run Chinook salmon since the 1980s (NMFS 2012b). Since the species were originally listed in 1992, fishery impacts have been reduced in both ocean and river fisheries. Total exploitation rate has been relatively stable in the range of 40% to 50% since the mid-1990s (NWFSC 2015). Poor ocean conditions over the last 20 years have also negatively affected the survival of Snake River fall-run Chinook salmon (NMFS 2012b).

Overall, the status of Snake River fall Chinook salmon has clearly improved compared to the time of listing and since the time of prior status reviews. Although the single extant population in the ESU is considered viable, 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).

2.2.1.4. Snake River Sockeye Salmon

While there are very few sockeye salmon currently following an anadromous life cycle in the Snake River, the small remnant run of the historical population migrates 900 miles downstream from the Sawtooth Valley through the Salmon, Snake, and Columbia Rivers to the ocean. 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 and to a higher elevation (6,500 ft.) than any other sockeye salmon population. They are the southernmost population of sockeye salmon in the world (NMFS 2015).

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). 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, Pettit, Stanley, and Yellowbelly Lakes). 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). At this stage of the recovery efforts, the ESU remains endangered with a high risk for spatial structure, diversity, abundance, and productivity (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 2015).

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, 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 2015; 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 2015).

2.2.2. 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 steelhead DPS. The Snake River Steelhead DPS's range includes 291 watersheds. The CHART assigned low, medium, and high conservation value ratings to 14, 43, and 230 watersheds, respectively (NMFS 2005a). They also identified 4 watersheds that had no conservation value.

Of these, 26 watersheds occur in the Upper Salmon River where the majority of Salmon River steelhead releases occur. 19 of the 26 are ranked as high, with 6 and 1 ranked as medium and low respectively. The Pahsimeroi had no watersheds with a conservation value ranking. The Little Salmon River was divided into 5 watersheds, with 3 ranked as high and 2 ranked as low. In the Clearwater Subbasin, the one watershed in the Lower Clearwater was ranked as low, but the three in Lolo Creek were considered high. The lower North Fork Clearwater River watershed did not have any PBF's to support steelhead (NMFS 2005a) The following are the major factors limiting the conservation value of critical habitat for Snake River steelhead:

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

2.3. 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 entire Clearwater and Salmon River Basins downstream to its confluence with the Snake River, and the mainstem Snake River down to Ice Harbor Dam. The action area includes locations where fish are captured, reared, and released, as well as areas where they may be monitored, or stray.

We decided to limit our action area to the Snake River Basin down to Ice Harbor Dam. We did not extend the action area to the estuary/plume for two reasons. The first was that steelhead move relatively quickly through the migratory corridor and estuary to the ocean, and therefore would be expected to have a low potential for interacting meaningfully with fish migrating through the mainstem or utilizing the estuary for rearing. Second, the NMFS (2017) opinion on Mitchell Act funding 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. Together these reasons suggest 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.

2.4. Environmental Baseline

Under the Environmental Baseline, NMFS describes what is affecting listed species and designated critical habitat before including any effects resulting from the Proposed Action. The 'Environmental Baseline' includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area 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).

2.4.1. Habitat and Hydropower

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

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

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

Currently, salmon and steelhead occupy only a portion of their former range in the Snake Basin. Starting in the 1800s, dams blocking anadromous fish from their historical habitat were

constructed for irrigation, mining, milling, and hydropower. Construction of the Hells Canyon Complex of impassable dams along the Idaho-Oregon border in the 1960s completed the extirpation of anadromous species in the upper Snake River and its tributaries above Hells Canyon Dam. Major tributaries upstream from Hells Canyon Dam that once supported anadromous fish include the Wildhorse, Powder, Burnt, Weiser, Payette, Malheur, Owyhee, Boise, Bruneau, and Jarbidge Rivers, and Salmon Falls Creek. These tributaries supported most of the sockeye salmon and fall Chinook salmon populations in the basin and an estimated 15 steelhead populations and 25 spring/summer-run Chinook salmon populations (McClure et al. 2005).

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

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

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

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

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.

2.4.2. 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 1°C since 1900, or about 50 percent more than the global average over the same period (ISAB 2007). The latest climate models project a warming of 0.1 °C to 0.6 °C 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 snowpacks 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, watersheds will see their runoff diminished earlier in the season, resulting in lower streamflows from June through September
- 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 streamflows co-occur with warmer air temperatures

Recently, researchers examining data from 1990-2009 found that temperatures in the Snake Basin region, including the action area, are increasing, while average streamflows are slightly decreasing (Dittmer 2013). However, basins in northeast Oregon saw an increase in summer flows, despite an average annual decrease (Dittmer 2013). Warming winter temperature and decreasing snowpack have been observed in the Blue Mountains and the Pacific Northwest in general (Mote et al. 2005), which has an impact on the snowmelt-driven basins in northeast Oregon and southeast Washington. This is problematic because snowpack rather than man-made reservoirs are the primary form of water storage in the region. Thus, peak flows in the Snake Basin could occur earlier in the year, and would likely lead to even lower flows during the summer months.

Climate change is also predicted to cause a variety of impacts on Pacific salmon as well as their ecosystems (Crozier et al. 2008a; Martins et al. 2012; Mote et al. 2003; Wainwright and Weitkamp 2013). 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 (e.g., stream flow variation in freshwater). The complex life cycles of anadromous fishes including salmon rely on productive freshwater, estuarine, and marine habitats for growth and survival, making them particularly vulnerable to environmental variation (Morrison et al. 2016). Ultimately, the effect of climate change on salmon and steelhead across the Pacific Northwest will be determined by

the specific nature, level, and rate of change and the synergy between interconnected terrestrial/freshwater, estuarine, nearshore and ocean environments. The primary effects of climate change on Pacific Northwest salmon and steelhead are:

- Direct effects of increased water temperatures on fish physiology
- Temperature-induced changes to stream flow patterns
- Alterations to freshwater, estuarine, and marine food webs

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). Dittmer (2013) suggests that juveniles may outmigrate earlier with less tributary water. Returning adults may be challenged by lower and warmer summer flows. In addition, the warmer water temperatures in the summer months may persist for longer and more frequently reach and exceed thermal tolerance thresholds for salmon and steelhead (Mantua et al. 2009). Larger winter streamflows may increase redd scouring for those adults that do reach spawning areas and successfully spawn. Climate change may also have long-term effects that include accelerated embryo development, premature emergence of fry, and increased competition among species (ISAB 2007). The uncertainty associated with these potential outcomes of climate change do provide some justification for hatchery programs as reservoirs for some salmon stocks. For more detail on climate change effects please see (NMFS 2017c).

2.4.3. Hatcheries

Included in the Environmental Baseline are the ongoing effects of hatchery programs or facilities which have undergone Federal review under the ESA, as well as the past effects of programs which have not yet undergone such review, including those found in the proposed action. A more comprehensive discussion of hatchery programs in the Columbia Basin can be found in our opinion on Mitchell Act funded programs (NMFS 2017). 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 2.2.1 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 also can 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 here on the history of the steelhead hatchery programs included in our proposed action. All are currently ongoing, and were initiated under the LSRCF, Hells Canyon Settlement Agreement or the BPAs Fish and Wildlife Program to mitigate for the construction and operation of the four lower Snake River dams, the Hells Canyon Complex, and the Federal Columbia River Power System on salmon and steelhead in the Snake River basin.

Salmon River Basin

The Streamside Incubator Supplementation Program began outplanting eyed-eggs in 1995. Eggs are provided to the SBT from spawning of excess A-run steelhead adults returning to the Sawtooth and Pahsimeroi Hatcheries. Steelhead A-run eyed-eggs are then outplanted in Indian and Panther Creeks. However, recently the 500,000 eggs outplanted into Yankee Fork were changed from A-run to a local B-run stock. From 1995-2009, about 82.3 percent of the eggs outplanted into Yankee Fork have survived to the fry stage (SSI HGMP). This program continues to be a part of the *U.S. v. Oregon* Management Agreement.

Smolts produced from eggs collected at DNFH have been released into the Upper Salmon River since the 1970s to increase the number of large two-ocean B-run fish returning to the upper Salmon River. The program to develop a locally adapted steelhead release started in 1980s. These releases first occurred in the Pahsimeroi River, but then shifted to the East Fork of the Salmon River. From the mid-1980s through the late-1990s, large B-run adults were collected at the East Fork Satellite Facility. The offspring of these fish were released at the satellite facility to perpetuate the locally adapted East Fork B-run stock. However, adults did not readily return to this location, and, in 1998, IDFG started releasing DNFH and East Fork B-run smolts into Squaw Creek to improve broodstock collection. Squaw Creek has also not proven effective for broodstock collection. Thus, managers have implemented a phased transition to a local broodstock. The first phase of this transition involves releasing unclipped B-run juveniles at Pahsimeroi Fish Hatchery, and clipped and unclipped juveniles in Yankee Fork. Adult returns from these releases will be used to establish the local broodstock. An additional release of B-run fish also occurs in the Little Salmon River using local Salmon B-run when available. The longer-term goal includes phasing out the use of Pahsimeroi for Yankee Fork when infrastructure in Yankee Fork becomes available. A portion of this program continues to be a part of the *U.S. v. Oregon* Management Agreement.

The Upper Salmon A-run program began in 1985 to mitigate for the four lower Snake River Dams. Broodstock for this program originated from fish returning to the Snake and Salmon Rivers, and are collected at Sawtooth Fish Hatchery. Historically, fish from this program were released at five mainstem Salmon River sites in addition to releases at Sawtooth Fish Hatchery. The current proposal consolidates all the release locations to just Sawtooth Fish Hatchery. A portion of this program continues to be a part of the *U.S. v. Oregon* Management Agreement.

The Pahsimeroi and Hells Canyon A-run steelhead programs began in 1966. The Hells Canyon Settlement Agreement calls for the production of 400,000 pounds of summer steelhead smolts (1.8 million smolts at 4.5 fish per pound). This represents the combined production for the Pahsimeroi A-run, and Hells Canyon steelhead A-run programs, along with releases beginning in 1983 of A-run fish into the Little Salmon River. Recently, the smolt release at Pahsimeroi Hatchery has decreased from 830,000 to 800,000, while the Hells Canyon component has increased from 525,000 to 550,000.

The East Fork steelhead program is the only integrated steelhead program in Idaho, and began in 2000. The purpose of the program is to increase the abundance of the natural population. It is part of the Lower Snake River Compensation Plan, a federally mandated program to mitigate for fish losses caused by the construction and operation of the four lower Snake River federal dams.

The need for the conservation program was also identified in the 2008 Federal Columbia River Power System Biological Opinion (RPA 42). Production from this program continues to be a part of the *U.S. v. Oregon* Management Agreement. As of 2013, smolt production was decreased from 170,000 to 60,000, largely to increase the proportion of natural-origin fish used in the broodstock.

Clearwater River Basin

The DNFH steelhead program began in 1970 to replace adult steelhead and rainbow trout lost by construction and operation of Dworshak dam and reservoir on the North Fork Clearwater River in Idaho. This hatchery program is part of the U.S. Army Corps of Engineer's Dworshak Dam and Reservoir Fish and Wildlife Mitigation Program. A total of 2.1 million smolts are released at four locations in the Clearwater Basin: 1.2 million directly from Dworshak Hatchery, 200,000 to Lolo Creek, 300,000 to Clear Creek (Kooskia Hatchery) and 400,000 in the South Fork Clearwater. Production from this program continues to be a part of the *U.S. v. Oregon* Management Agreement.

The South Fork Clearwater program began in 1991. The purpose of the South Fork Clearwater summer steelhead hatchery program is to mitigate for fish losses caused by the construction and operation of the four lower Snake River federal dams. In addition to harvest mitigation, approximately 40 percent of the steelhead production at Clearwater Fish Hatchery is dedicated to producing steelhead intended to supplement natural spawners in the upper South Fork Clearwater River. Fish that are part of the supplementation effort are released with adipose fins intact and are not intended for harvest in mark-selective fisheries.

Historically, the program has been sourced exclusively from broodstock collected at the Dworshak National Fish Hatchery. A total of 840,000 steelhead smolts were released at five locations in the South Fork Clearwater drainage: the Crooked River (83,000 smolts), Red River (150,000 smolts), Red House Hole in the mainstem South Fork Clearwater (260,000 smolts), Peasley Creek (250,000 smolts) and Newsome Creek (100,000 smolts) each year. Currently there are now three release sites in Meadow Creek, Red House Hole and Newsome Creek for the 843,000 proposed total smolt release. However, since 2010, managers have implemented a transition to a local segregated broodstock collected in the South Fork Clearwater River. Hatchery production associated with this program continues to be included in the *U.S. v. Oregon* Management Agreement.

2.4.4. Harvest

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 12 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 Lower Granite Dam natural-origin return estimate does not include those fish that return to tributaries of the Snake River below Lower Granite Dam (e.g., Tucannon River).

Table 12. 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.

Fishery Manager	Average Incidental Mortality take Authorization	Average Encounter	Average Mortality	Average natural-origin escapement above LGD	% Average natural-origin incidental mortality above LGD
IDFG	774	2,260	260	19,788	1.3
SBT ¹	Not Applicable	407	407	19,788	2.1
NPT	Not Applicable	326	326	19,788	1.6

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

¹In 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 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 Lower Granite Dam typically occur from July 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 Lower Granite Dam, 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 12 below shows that an average of ~ 4.1 % of the Snake River steelhead DPS is killed annually in fisheries.

Table 13. 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 2017a; IDFG 2014; IDFG 2016; IDFG 2017; Oatman 2017a; Petrosky 2012; Petrosky 2013; Petrosky 2014)

¹For 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 14 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 2017a; IDFG 2014; IDFG 2016; IDFG 2017; Oatman 2017a; Petrosky 2012; Petrosky 2013; Petrosky 2014)

¹For the state fishery, all mortality of natural-origin fish is incidental (catch and release mortality).

Fall Chinook Salmon Fisheries

The fall Chinook salmon fishery typically takes place from September through November. 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 15 below shows that an average of ~ 4.5 % of the Snake River Fall Chinook Salmon ESU is killed in fisheries above Lower Granite Dam.

Table 15. 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 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 2016; IDFG 2017; 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, assuming that sockeye salmon represent 29 percent of the *O. nerka* population (kokanee and sockeye salmon are phenotypically indistinguishable) (IDFG 2014; IDFG 2016; IDFG 2017).

2.5. Effects of the Action on ESA Protected Species and on Designated Critical Habitat

This section describes the effects of the Proposed Action, independent of the Environmental Baseline and Cumulative Effects. The methodology and best scientific information NMFS follows for analyzing hatchery effects is summarized in Appendix A and application of the methodology and analysis of the Proposed Action is in Section 2.4.2. The “effects of the action” means the direct and indirect effects of the action on the species and on designated critical habitat, together with the effects of other activities that are interrelated or interdependent, 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 Proposed Action, the status of ESA-protected species and designated critical habitat, the Environmental Baseline, and the Cumulative Effects are considered together later in this document to determine whether the Proposed Action is likely to appreciably reduce the

likelihood of survival and recovery of ESA protected species or result in the destruction or adverse modification of their designated critical habitat.

2.5.1. 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 2006; McElhany et al. 2000; NMFS 2004b; NMFS 2005c; NMFS 2008a; NMFS 2011d). 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 and productivity 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 2.5.2), 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
- (7) the kelt reconditioning program

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.

2.5.2. Effects of the Proposed Action

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

Only the East Fork Steelhead Hatchery Program removes fish from the local natural population for broodstock, leading to a negative effect for steelhead return numbers. However, the removal of natural-origin broodstock is limited by abundance-based sliding scales to reduce risk to the naturally spawning population, which are explained and analyzed in detail below (2.5.2.2.1). At most, 28 natural-origin fish will be removed from the naturally-spawning population. At this time, NMFS most recent status review found that there was insufficient data to provide an estimate of natural-origin population abundance for the East Fork Salmon River population (Table 11). However, data from IDFG for our genetic analyses in the following section suggest that between 52 and 151 natural-origin steelhead returned to the East Fork River from 2013 to 2016 (Table 19).

Although 28 fish of 52 would lead to a large proportion of natural-origin fish used for broodstock, the weir is about 18 river miles from the mouth, and more fish may naturally spawn below the weir than above. Thus, fewer than half of the natural-origin steelhead returning are likely to make it to the weir and be available for broodstock collection. In addition, all of the fish used for broodstock are spawned in the hatchery, leading to higher egg-to-smolt survival rates than they would have in the wild, and, when their progeny return as adults, the intent is to pass them above the weir to spawn naturally, increasing the abundance of naturally-spawning steelhead in the East Fork population. The net effect is anticipated to be an increase in

abundance—potential adverse effects of naturally spawning hatchery fish are discussed in the following subsection.

There is no effect of factor 1 on spring/summer Chinook, fall Chinook, or sockeye salmon because none of these species are propagated by these programs.

2.5.2.2. 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

The proposed hatchery programs pose both genetic and ecological risks, and, although there is some benefit to the species from the integrated program designed to supplement the East Fork population, the net effect on steelhead is negative. Ecological and adult collection effects are relevant only for spring Chinook, fall Chinook, and sockeye salmon because these programs do not propagate these species. The overall effect of this factor on these species is negligible.

2.5.2.2.1. Genetic effects

For each program, NMFS considers three major areas of genetic effects: within-population diversity, outbreeding effects, and hatchery-influenced selection. The within-population diversity area covers such topics as effective size and mating protocols. It is usually not a concern, especially in segregated programs, because the purpose of segregated programs is not for maintaining genetic diversity. We see no concerns with respect to within-population diversity in any of the programs comprising the Proposed Action. Assessment of the other two categories occurs simultaneously using the pHOS metric. For segregated programs, including the eight in the Proposed Action, genetic effects are assessed by considering how many fish from each program may spawn naturally. Because supplementation of the natural population is not typically an objective for this type of program, the number/proportion of hatchery-origin spawners should ideally be zero, since the hatchery population will be highly adapted to the hatchery environment. However, this is not a realistic goal. As explained in the appendix, the Hatchery Scientific Review Group (HSRG) has developed guidelines for allowable pHOS levels in populations, scaled by the population's conservation importance, recommending a maximum of 5% in "primary" populations, 10% for "contributing" populations, and at a level required to maintain "sustaining" populations (e.g., HSRG 2014). Listed salmonid populations in the Snake are classified by recovery expectation (ICTRT 2007a) rather than by the HSRG classification scheme, but "viable" and "highly viable" equate to "primary", and "maintain" equates to "contributing" and "sustaining."

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 composition, 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.³

We will now consider pHOS for the eight segregated programs in the Proposed Action. Because fish stray⁴ into areas that are under different management authorities and may have different approaches to monitoring naturally-spawning fish, it is difficult to assess the proportion of total pHOS attributable to the Idaho steelhead programs for all populations where fish from these programs may occur. Spawning surveys to recover spent carcasses are not the best approach to monitoring steelhead spawning naturally, because flows are high when steelhead spawn making conditions for surveyors unsafe at times, and many steelhead attempt to return to the ocean as kelts, and make it difficult to collect carcasses, a necessary step for recovering coded-wire tags and/or genetic tissue samples for parentage-based tagging analyses.

Over the past five years, a multiagency workgroup in the Snake Basin has been developing a data analysis framework with the primary goal of estimating the abundance of hatchery and wild steelhead returning to the Snake Basin, the spatial distribution of spawners, and the fates of these fish (Copeland et al. 2013). Efforts from this workgroup began with the 2010-2011 steelhead return and refinements to the model have been incorporated annually through the 2014-2015 return. The model utilizes direct estimates of stock specific hatchery and wild adults returns to Lower Granite Dam based on the fish ladder window counts and systematic sampling of adults as they pass upstream of the dam. Fates of these fish are based on harvest sampling programs and hatchery trap and weir counts and incorporate movement and survival probabilities as fish transition upstream to the natal or hatchery release locations for wild and hatchery fish respectively.

One output from the model is an estimate of the number of hatchery and wild fish available for spawning in each of the six Snake River Major Population Groups. A comparison of run reconstruction model outputs to independent estimates for wild fish escapements in a subset of populations over the five years of this effort has been variable but generally results in similar numbers of populations being either overestimated or underestimated relative to the independent estimates (Copeland et al. 2015; Copeland et al. 2013; Copeland et al. 2014; Stark et al. 2016).

However, there are a number of assumptions/critical uncertainties in the model calculations that require improvement. For example, the number of hatchery steelhead harvested in the Snake River mainstem fisheries, and the genetic classification of fish to the population or even MPG level (Copeland et al. 2015; NWFSC 2015). Thus, the model continues to undergo refinement, with one proposed change being the use of Parentage Based Tagging assignments from hatchery fish sampled in the fisheries to estimate the stock and release site specific harvest numbers,

³ The only exception to date is the case of steelhead programs using highly domesticated broodstocks, where NMFS has imposed more stringent guidelines NMFS. 2016a. Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. National Marine Fisheries Service (NMFS) Evaluation of Two Hatchery and Genetic Management Plans for Early Winter Steelhead in the Snohomish River basin under Limit 6 of the Endangered Species Act Section 4(d) Rule. April 15, 2016. NMFS Consultation No.: WCR-2015-3441. 189p.

⁴ For this analysis, a stray means a fish that returns to a location that is geographically distinct from that of its population of origin. We use straying as a way to understand the composition of pHOS, but straying is really only of concern when fish actually spawn in those areas because of potential genetic and ecological effects.

instead of assuming that all hatchery stocks are harvested in proportion to their abundance in each river reach throughout their return to the release site. Other possible improvements to the model include refinements to the GSI baseline to improve resolution of population assignments of wild fish, use of telemetry results to improve movement rates, and incorporation of PIT array and weir estimates. Because of these critical uncertainties and potential refinements, we will not use the estimates derived from this modeling effort to inform our analysis of pHOS at this time. NMFS will remain engaged with this run reconstruction effort and will consider the modeled outcomes when all parties agree the model functions well enough to be used to inform the management of steelhead programs in Idaho.

Thus, for now, our analysis focuses on straying of steelhead from the programs included in the Proposed Action into areas where we would not expect them to occur (steelhead from Sawtooth Hatchery into the Clearwater River). Best available information suggests that steelhead that stray from these programs represent a small proportion of natural-origin steelhead in each population where straying occurs above Lower Granite Dam. We used three methods to assess straying.

The first uses PIT tag detection of both wild and hatchery steelhead to determine what percentage of the total number of detections comes from steelhead originating from the Idaho steelhead programs included in our Proposed Action. One complication of this analysis is that the program origin of fish PIT-tagged as adults or juveniles at dams or mainstem traps (e.g., Lower Granite Dam, Snake River juvenile trap), is largely unknown because these fish are adipose-fin clipped, but often carry no other distinguishing mark to differentiate between programs. Thus, we have treated these fish as potential strays when detected in areas where hatchery fish are released, but they could just as easily be the hatchery fish originating from that area. This has likely overestimated our percentage of all fish detected that are potential strays from Proposed Action programs (last row in Table 16). However, we use this conservative approach in case this is offset to some degree by the differences in tagging rates among programs and between hatchery and natural fish. This could cause an underestimation of hatchery fish when extrapolating the number of detections to numbers of fish; we have not extrapolated the detections to estimate numbers of fish here, but how to do this is a topic of discussion for the workgroup. The two exceptions for this are the SF Salmon and Big Creek areas because no releases of hatchery fish occur in either of these areas, so any hatchery-origin fish detected originate from outside these areas and thus are known strays.

Table 16 indicates that, based on this stray calculation method, straying is relatively low. Although we do not currently have the ability to resolve our calculations to the population level, the data indicate that straying is likely within the range of HSRG recommendations. Although the SF Clearwater and Upper Salmon River areas have a higher estimated stray pHOS, the SF Clearwater population and the Upper Salmon River population are both designated as maintained in the current recovery scenario, and are close to the recommendation provided by the HSRG for maintained populations.

Table 16. Average potential steelhead strays into various subbasins within the action area, based on adult and juvenile fish tagged at traps and dams. Italicized numbers indicate those values where release site is unknown and therefore program origin cannot be traced.

Release/Tag Site	SF Salmon River (4 arrays 2011-2015)	Big Creek (1 array 2011-2015)	Imnaha River (5 arrays, 2011-2015)	Grande Ronde	SF Clearwater	Upper Salmon River (5 arrays, 2013-2015)
Bonneville Dam	0	0	2.8	0	0	0
Lower Monumental Dam	0	0	0.2	0	0	0
Upper Columbia	0	0	4.8	2.7	0	37.3
Middle Columbia	0	0	0	0	0	2.3
Lower Granite Dam adult trap	1.2	0.6	3.8	7	156.3	124.7
Lower Granite Dam juvenile trap	0.8	0.2	5.6	1.2	10.3	29.7
Sawtooth Trap	0	0.2	0	0	0	0
Little Salmon River	0	0	0.2	0	0	0
Snake River juvenile trap	0	0	0.2	0	0	3.6
Salmon River juvenile trap	0	0	0	0	0	3
Dworshak Hatchery	0	0	0	0	0.2	0
Lolo Creek	0	0	0	0	0.5	0
Clear Creek	0	0	0	0	1	0
Wild Detections	206	58	422	574	443	305
Total Detections	209	59	563	611	711	752
% of Detections that are potential strays from Proposed Action programs	1.4	1.7	3.1	1.8	23.7	26.7

Source: (Vogel 2017)

By summing the data in Table 16, we also have some indication of the proportion of detections that are attributable to hatchery-origin fish. This does not necessarily mean that these fish spawned, and is likely an overestimate of pHOS. The data suggests that for the populations in the Middle Fork Salmon River (as represented by the Big Creek array), pHOS is likely low, with 58 out of the 59 detections being from natural fish. In the other areas where hatchery-fish from this consultation may be detected (i.e., SF Salmon, Upper Salmon, and SF Clearwater), hatchery-origin fish represent between 1.4, 59, and 38 percent of the detections, respectively, calculated by dividing the number of wild detections into the number of total detections. However, these

fish are still vulnerable to harvest after detection, and may also be removed at various traps and weirs, so pHOS is much lower than the detection percentages.

The second method for assessing straying is to determine where adults return that are detected with a PIT tag at Lower Granite Dam, and thus have a known destination. Between 2011 and 2016, 6484 PIT tagged hatchery fish of know release location detected at Lower Granite Dam were included in this analysis. For example, if we detect 100 adults originating from Pahsimeroi Hatchery at Lower Granite Dam, and 60 of them are detected at the Pahsimeroi Hatchery, 2 are detected in Big Creek, and 38 are never detected again, then we would assume that 2 out of 100 strayed into Big Creek and 38 were likely harvested in terminal area fisheries. Although many PIT tag arrays exist throughout the Snake River Basin, there are some places where a potential stray may not be detected for lack of infrastructure. However, where arrays exist, their detection efficiency typically exceeds 80 percent. Table 17 indicates those fish that were detected and then stray; the remainders either returned to the hatchery or were intercepted in fishery. However this assessment method is limited by sample size because there are likely many adults returning to Lower Granite Dam that are identified as hatchery fish, but do not have a PIT tag. Thus, the hatchery of origin for these fish is unknown, which limits the sample size for this method and may lead to higher uncertainty for program straying overall.

Table 17. Average number of PIT tag detections at Lower Granite Dam and the number of those detected that stray from 2011-2016.

Juvenile Release Location	Average Number of program PIT tagged fish detected at LGD	Average Number of Strays detected upstream of LGD	% of program detections that classify as strays
South Fork Clearwater River	112.0	3.3 ¹	3.0
Dworshak National Fish Hatchery	150.7	0.8	0.6
Red River Satellite	16.5	0.5	3.0
East Fork Salmon River	37.7	0.5	1.3
Little Salmon River	168.2	0.5	0.3
Pahsimeroi Hatchery	195.7	1.0	0.5
Sawtooth Hatchery	140.7	0.7	0.5
Yankee Fork	39.8	0.2	0.4

Source: (Leth 2017a)

¹ All of these were recovered at DNFH (within the Clearwater River) and had been reared at DNFH or CFH on the same water source.

A third technique using returns of hatchery fish to adult collection facilities to determine how much of program broodstock is composed of non-program fish. This assessment was based on parentage-based tagging of all broodstock from 2012-2015. Table 18 demonstrates that for those programs where data is available, returns to collection facilities mostly fish from the target program. For example, no fish from any of the Salmon Basin programs were detected at DNFH.

The highest numbers of fish from other programs are encountered at Pahsimeroi Hatchery. However, we anticipate that the number of steelhead from the Upper Salmon A program will decrease as the majority (43 of 56) of these fish were returns from the releases of Sawtooth fish at McNabb Point on the mainstem Salmon River—this release site has been discontinued, with all releases of the Upper Salmon A-run program occurring only at Sawtooth Hatchery.

Together, these three analyses suggest that very few fish from Idaho Steelhead programs return to a place from which they were not released. Assuming this also reflects straying in natural spawning areas, our conclusion would be that there is low to no straying of steelhead from these programs.

Table 18. The origin of fish returning to adult collection locations compared to their program assignment via Parentage-based tagging, summed for years 2012-2015.

Adult Collection Location	Program origin-based on collection location	Program origin based on PBT assignment					
		Dworshak/SF Clearwater	East Fork Natural	Hells Canyon	Pahsimeroi A	Upper Salmon A	Salmon River B
Dworshak National Fish Hatchery	Dworshak/SF Clearwater	6405	0	0	0	0	0
East Fork Salmon River Weir	East Fork Natural	0	62	0	0	0	0
Hells Canyon Weir	Hells Canyon	0	0	1410	0	0	0
Pahsimeroi Hatchery	Pahsimeroi A	0	1	0	4364	56	4
Sawtooth Hatchery	Upper Salmon A	0	2	0	2	2717	0
Pahsimeroi Hatchery	Salmon River B ²	1	11	0	11	1	755

Source: (Hebdon 2017b)

²Data are only available from 2013-2015.

Furthermore, the most recent status review information suggests that, for those populations in the Salmon and Clearwater Subbasins where enough data is available to calculate abundance and productivity estimates, those populations are doing relatively well. For example, the minimum abundance threshold for the lower mainstem Clearwater population is 1,500 steelhead, and abundance was most recently estimated at 2,099 steelhead. In addition, an indicator of a population that is increasing in size is one that has a productivity value above replacement (> 1). The lower mainstem Clearwater population has a productivity of 2.38 (Table 11). In fact, although abundance estimates for the rest of the populations did not always exceed minimum abundance threshold levels, all had productivity estimates that exceeded 1. Because the majority of these steelhead hatchery programs have been ongoing for quite some time, and the effects of any hatchery-origin fish spawning naturally are likely reflected to some degree in the status review data, we believe this demonstrates that the effects of hatchery steelhead straying are low and are not prohibiting the population recovery.

Despite all three methods indicating straying is low, we still have some concerns when analyzing this type of data. The first is that the proportion of juveniles PIT tagged at release is small, typically between 1 and 5 percent. Thus, there are likely many fish returning that do not have a PIT tag, making their ultimate destination impossible to determine. Second, and related to the first, is that, in many years, detections of hatchery fish in the different areas can be zero, and we are unsure at this time how to interpret multiple years of zeros; this could be an indicator of very little straying/low pHOS or it could mean that tagging/detection rates are not robust enough to reliably detect hatchery fish in some years. Thus, the continuation of the work by the steelhead workgroup is necessary for addressing these uncertainties in the future; studying such uncertainties is related to the broader workgroup objectives of determining (1) appropriate methodologies for assessing hatchery-origin steelhead composition in receiving populations throughout the action area, and (2) target levels at which hatchery program modifications will be discussed and changes may be triggered.

Gene Flow Assessment for the East Fork Salmon River Population

The East Fork Salmon River Natural Steelhead Program's evaluation is necessarily different from evaluation of the segregated programs because of the use of natural-origin broodstock. The potential negative genetic effects from this program are considered along with the demographic benefit of increasing abundance. To perform our analysis, we will use models that consider the best available information for the target population to determine the likely PNI of the population based on the applicants' proposed proportion of natural-origin broodstock (pNOB) and the pHOS in natural spawning areas. A PNI of > 0.5 indicates that natural selection outweighs hatchery-influenced selection.

Best available data suggests that the East Fork Salmon River Natural program is likely to obtain a PNI of > 0.5 . For example, data from 2013-2016 indicates that PNI ranged from 0.39 to 0.52 based on the multi-population model analysis tool developed by Busack (2015), despite very low natural-origin returns (Table 19). In addition, smolt releases were reduced in 2013 from a goal of 170,000 to 60,000 steelhead. Therefore, 2016 would have been the first year where returns from this reduction were realized. Because of this, we calculated the proportional decrease in smolt numbers from those released in 2010 through 2012, which corresponded with return years 2013-2015, to 60,000 and also applied this proportional decrease to the returning adult East Fork

Natural hatchery-origin steelhead. This allowed us to estimate what pHOS and pNOS would have been for years 2013-2015 if only 60,000 smolts had been released, under the assumption that natural-origin return numbers are the same. With this approach, PNI would range from 0.44 to 0.52, and we anticipate that this will increase in the future as long as returns of natural-origin fish increase.

Table 19. Proportionate Natural Influence (PNI) for the East Fork Salmon River Natural Population; pHOS = proportion of hatchery-origin spawners, pNOS = proportion of natural-origin spawners, pNOB = proportion of natural-origin broodstock.

Return Year	Natural-origin Returns	Below Weir		Above Weir			PNI
		pHOS	pNOS	pHOS	pNOS	pNOB	
Current Conditions							
2013	52	0.95	0.05	0.98	0.02	0.68	0.39
2014	151	0.88	0.12	0.93	0.07	0.63	0.43
2015	102	0.95	0.05	0.98	0.02	0.76	0.45
2016	129	0.84	0.16	0.9	0.1	0.97	0.52
Future (releases reduced from 170,000-60,000)							
2013	52	0.89	0.11	0.94	0.06	0.68	0.44
2014	151	0.69	0.31	0.93	0.07	0.63	0.44
2015	102	0.89	0.11	0.95	0.05	0.76	0.46
2016	129	0.84	0.16	0.9	0.1	0.97	0.52

Source: (Leth et al. 2017)

However, because estimated natural-origin returns for this population are so low, we believe at this time that demographic concerns outweigh genetic concerns for the population. This is because the minimum abundance threshold for the East Fork Salmon River population is 500 natural-origin spawners (NWFSC 2015); abundance over the last five years has ranged from about 10-30 percent of this value (Table 19). In addition, in the current recovery scenario, this population is not targeted for viability or high viability, but for maintained status. Thus, NMFS believes a PNI of 0.5 is adequate for maintaining the population, and a PNI < 0.5 is acceptable when natural-origin abundance is low (i.e. < 250 fish), to ensure enough fish are available to spawn regardless of fish origin.

2.5.2.2.2. Ecological effects

Adult nutrient contribution

The return of hatchery fish likely contributes nutrients to the action area. Table 20 shows that adult hatchery fish, if all estimated returning fish spawn naturally, contribute an estimated 913 kg of phosphorous to the action area annually. Such transport by anadromous fish of nutrients from the marine environment to freshwater is important because temperate freshwater environments like that of the action area are typically low in available nutrients and relatively unproductive (Cederholm et al. 2000). Because some fish are removed from the environment in mark-selective fisheries and for broodstock, and because the iteroparous life history of steelhead means that some adults may return more than once before dying and contributing nutrients, the true

contribution is likely less than this value, perhaps ~30 percent less or 274 kg. Regardless, hatchery-origin fish increase phosphorous concentrations, which likely compensates for some marine-derived nutrients lost from declining numbers of natural-origin fish.

Table 20. Total phosphorous imported by adult returns from the proposed hatchery programs based on the equation (Imports= hatchery adults*mass*phosphorous concentration) in Scheuerell et al. (2005).

Program	Release number	SAR (years of data)	Estimated number of hatchery-origin adults ³	Adult mass (kg)	Phosphorous concentration (kg/adult)	Phosphorous imported (kg/year)
East Fork Salmon A-run	60,000	0.0084 ¹	504			7.7
Upper Salmon River A-run	1,779,000	0.0084 (1995-2005)	14,944			227.1
Hells Canyon	550,000	0.0059 (1995-2005)	3,245			49.3
Pahsimeroi A-Run	800,000	0.0092 (1994-2005)	7,360			111.9
Little Salmon River A-run	636,000	0.0084 ¹	5,342			81.2
SSI A-run	500,000 eggs	0.0084 ¹	8	4	0.0038	0.1
Dworshak	2,100,000	0.0098 (1995-2002)	20,580			312.8
South Fork Clearwater	843,000	0.0043 (1994-2003)	3,625			55.1
Salmon River B-run	1,065,000	0.0042 (1999-2004)	4,473			68.0
SSI B-run	500,000 eggs	0.0042 ²	4			0.1

¹ We used the Upper Salmon A-run values as a surrogate for SARs from these programs.

² We used the Salmon River B-run SAR as a surrogate for this program.

³ Calculated by multiplying the release number by the smolt-to-adult survival rate (SAR) values. For the SSI A-run and B-run programs, we multiplied the number of eggs by the egg-to-smolt survival rate (0.002; HGMP), and then multiplied this by the Upper Salmon River A-run SAR, or Salmon River B-run SARs, respectively.

Competition with natural-origin steelhead for spawning sites

Natural-origin and naturally-spawning hatchery-origin steelhead are likely to overlap in their selection of spawning sites due to similar niche requirements. This is a desired result of the two supplementation programs to ensure sufficient gene flow. However, a consequence of having any hatchery fish on the spawning grounds is the potential for spawning site competition and redd

superimposition. Although these are difficult effects to assess—especially for steelhead, which tend to spawn when flows are highest during the spring, making sampling difficult and at times unsafe—the analysis on straying/pHOS above (2.5.2.2.1, Genetic Effects) suggests that straying is low, and that, while some hatchery fish may spawn naturally, this spawning primarily occurs within populations that are not targeted for viability of the DPS. Thus, competition with natural-origin steelhead may occur, but is likely to have a low effect assuming straying/pHOS approximate the extent of possible competition. Additionally, similar to the discussion of straying above, the populations most at risk of negative effects attributable to competition have high productivity and increasing abundance, which further supports the conclusion that the evidence indicating low rates of competition can be reasonably relied upon.

Competition with ESA-listed salmon for spawning sites

Competition between adult hatchery-origin spring/summer Chinook salmon and summer steelhead is likely negligible due to differences in run-timing, holding, and spawn timing. Steelhead begin their entry into freshwater during the last portion of the Chinook salmon migration and reach the action area after spring/summer Chinook salmon have held over the summer and spawned (Table 21). Although sockeye and fall Chinook salmon overlap with the steelhead run, Snake River sockeye salmon only spawn in lakes in the Salmon River Basin in Idaho, and both complete their spawning before steelhead spawning begins (Table 21). Chinook salmon and steelhead are also likely to have different spawning site preferences because of the larger size of Chinook salmon. Thus, there is unlikely to be any competition effect between steelhead and other listed salmon species.

Table 21. Run-timing, holding, and spawn timing of adult salmon and steelhead (ODFW 2011).

Species	Run Timing	Holding	Spawning
Spring/Summer Chinook Salmon	March-May	April-July	Early August-mid September
Summer Steelhead	May-August	October-April	March-early June
Fall Chinook Salmon	July-October	August to October	Late October-early December
Sockeye Salmon	June-September	August to October	September to November

Disease

Over the last three years, a variety of pathogens endemic to the Snake Basin have been detected in adult steelhead intended for broodstock, but none of these detections have resulted in a disease outbreak. Although all three pathogens listed in Table 22 have no known treatment, fish health protocols are designed to prevent and control outbreaks with these pathogens. For example, to prevent outbreaks and reduce amplification in natural environments, hatchery staff may decide to cull individuals with high infection loads (IHOT 1995; NWIFC and WDFW 2006; ODFW 2003; Pacific Northwest Fish Health Protection Committee (PNFHPC) 1989). These control measures have proven effective in controlling pathogens as demonstrated by the lack of outbreaks in the

broodstock population for the various programs. NMFS believes the risk of hatchery-origin adults transmitting pathogens to listed salmon and steelhead or amplifying pathogen levels in the natural environment is negligible.

Table 22. Pathogen detections in steelhead program adults that are part of the proposed action; IHNV = infectious hematopoietic necrosis virus.

Facility	Program	Pathogen Detected		
		2014	2015	2016
Pahsimeroi Hatchery	Pahsimeroi A	None	IHNV	<i>Myxobolus cerebralis</i>
	Salmon River B	IHNV; <i>Renibacterium salmoninarum</i>	<i>R. salmoninarum</i>	<i>R. salmoninarum</i> ; <i>M. cerebralis</i>
Sawtooth Hatchery	Upper Salmon A	<i>Renibacterium salmoninarum</i>	<i>R. salmoninarum</i>	<i>R. salmoninarum</i> ; <i>M. cerebralis</i>
	EF natural	<i>R. salmoninarum</i>	None	<i>R. salmoninarum</i> ; <i>M. cerebralis</i>
Oxbow	Hells Canyon	None	IHNV	None
DNFH	DNFH	IHNV	IHNV	IHNV

2.5.2.2.3. Adult collection

The operation of weirs and traps for broodstock collection may result in the capture and handling of both natural- and hatchery-origin steelhead (Table 23). Samples for parentage-based tagging and relative reproductive success analyses may also be taken from all steelhead regardless of origin at the time of collection. There is likely to be a small negative effect of collection on listed salmon because a relatively small number are handled at these facilities when used for steelhead (Table 24). Encounters with sockeye salmon during the operation of these weirs and traps for steelhead broodstock collection is a rare occurrence; the effects of such capture and handling on sockeye salmon was evaluated in the opinion on issuance of ESA section 10 permits 1450 and 1455 (NMFS 2013) and determined to not result in jeopardy of the species or adverse modification of critical habitat.

Other effects of weir operation are the potential for delayed migration and changes in spatial distribution of listed species. Though adult passage may be delayed slightly, weir operation guidelines and monitoring of weirs by the co-managers (Section 1.3) minimize the delays to and impacts on fish; fish generally are not delayed for more than 24 hours throughout the trapping season. In addition, the spatial distribution of juvenile and adult listed species is not expected to be affected by weir operation in these areas because the weirs are designed to allow juvenile passage, and natural-origin adults are passed upstream when not required for broodstock.

Table 23. Number of ESA-listed steelhead handled by origin. Mortalities, if any, are shown in parentheses and exclude those used as broodstock; these mortalities are attributed only to the act of collecting, handling and holding adults.

Facility	Origin	Average Actual Handling; min and max (mortalities)	Proposed Handling (incidental mortality) ¹
Pahsimeroi Hatchery Weir	Natural	125; 22-378 (0)	400 (4)
	Hatchery	283; 110-567 (0)	900 (5)
Sawtooth Hatchery Weir	Natural	48; 15-115 (0)	200 (2)
	Hatchery	0	10 (1)
East Fork Weir	Natural	30; 2-94 (0)	200 (2)
	Hatchery	285; 3-1115 (2)	1200 (12)
Yankee Fork Hook-and-Line Angling ²	Natural	Not available	142 (8)
	Hatchery	Not available	220 (11)
Yankee Fork Weir ³	Natural	17 (0)	60 (1)
	Hatchery	35 (0)	2000 (20)
Hells Canyon Weir	Natural	63; 2-186 (1)	200 (2)
	Hatchery	0	10 (1)
Dworshak Hatchery ⁴	Natural	31; 1-4 (2)	75 (8)
	Hatchery	3463; 3255-3723 (104)	3900 (200)
Kooskia Hatchery ⁵	Natural	8; 0-22	25 (2)
	Hatchery	Not available	300 (30)
SF Clearwater (Clearwater Hatchery) ⁶	Natural	Not available	10 (1)
	Hatchery	Not available	400 (4)

Sources: (Izbicki 2017; Leth 2017c)

¹ Up to 100% of the fish returning to the weir will be handled.

² Angling is conducted by SBT staff to supplement brood collections at the weir. Based on brood need, PIT tag detections of hatchery- and natural-origin fish in Yankee Fork and an estimated catch and release mortality of 5 percent (Ebel 2017).

³ Because the SBT has only operated a temporary side-channel weir on Yankee Fork in 2017, and that was only for 17 out of the 60 days they are likely to operate the weir in the future, we have scaled up these values to reflect this longer use period. Hatchery numbers are based on an SAR of 0.003 for a 620,000 smolt release.

⁴ Average handling, and min and max mortalities information for DNFH based on actual values for the most recent three years (2015-2017). Values only pertain to volunteers to DNFH, SF adults collected are not included.

⁵ Because this is a back-up collection location for DNFH that is rarely needed, actual data on the number of hatchery steelhead collected annually was not available. Natural fish data is for years 2001-2009 from USFWS and NPT (2010).

⁶ Fish are provided to the hatchery by anglers.

Table 24. Number of fall Chinook and spring/summer Chinook salmon handled during steelhead broodstock collection by origin. Mortalities, if any, are shown in parentheses these mortalities are attributed only to the act of handling adults intended for re-release.

Facility	Origin	Fall Chinook salmon		Spring/summer Chinook Salmon	
		Average Actual Handling; min and max (mortalities)	Proposed Handling (mortalities)	Average Actual Handling; min and max (mortalities)	Proposed Handling (mortalities)

Pahsimeroi Hatchery Weir	Natural	0	0	0	0
	Hatchery	0	0	0	0
Sawtooth Hatchery Weir	Natural	0	0	0	0
	Hatchery	0	0	0	0
East Fork Weir	Natural	0	0	0	10 (1)
	Hatchery	0	0	0	10 (1)
Yankee Fork Weir	Natural	0	0	0	0
	Hatchery	0	0	0	0
Hells Canyon Trap	Natural	14; 1-42	50 (1)	0	0
	Hatchery	100; 10-239	300 (3)	0	0
Dworshak Hatchery Ladder ¹	Natural	0; 0 (0)	10 (2)	Not applicable	
	Hatchery	27; 0-81 (0)	100 (5)		

Sources: (Izbicki 2017; Leth 2017c)

¹Average handling, and min and max mortalities information for Dworshak Hatchery based on actual values for the most recent three years (2015-2017).

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

The effects of this factor on all four listed species is negative, as discussed in greater detail below.

2.5.2.3.1. Hatchery release competition and predation effects

We used the PCDRisk model of Pearsons and Busack (2012) PCDRisk, 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 Tables 25-27.

For our model runs, we assumed a 100-percent population overlap between hatchery steelhead and all natural-origin species present. Hatchery steelhead are released from mid-March to May, and may overlap with natural-origin Chinook and sockeye salmon and steelhead in the action area. However, our analysis is limited to assessing effects on listed species, and this limits overlap of those species in certain areas. To address this, we modified residence times for hatchery steelhead if they did not overlap completely with certain natural-origin species, by adjusting the total distance traveled. For example, Snake River sockeye juveniles do not inhabit the Clearwater Subbasin and thus effects on sockeye salmon from hatchery steelhead released as part of the proposed action would not occur until they comingled in the mainstem Snake River (more detailed calculations can be found in Hurst (2017b)). We believed it was better to address overlap by adjusting residence time than by adjusting population overlap, because the population overlap parameter represents microhabitat overlap not basinwide-scale overlap. We acknowledge that a 100-percent population overlap in microhabitats is likely an overestimation.

In addition, our model does not include age-0 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. A lack of spatial overlap with age-0 sockeye salmon rearing in Redfish, Petit and Alturas Lakes, provide the basis for our decision to also not include this age-class in our model. In addition, we did not analyze the effects of hatchery steelhead on age-1 steelhead below Lower Granite Dam because these fish are not yet smolted and migrating downstream. Including them in our analyses all the way to Lower Granite Dam is also probably an overestimate of effects, as this steelhead age class is unlikely to move out of tributary rearing areas until the following year. We also excluded age-1 natural-origin Chinook salmon from our model runs in the Clearwater Basin because spring/summer Chinook salmon are unlisted there, and listed fall Chinook outmigrate as age-0 fish.

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 27) to represent the range of possible barging proportions, which vary annually. To do this we had to estimate survival and travel times from each release site down to Lower Granite Dam. We then estimated the number of hatchery steelhead that made it down to Lower Granite Dam, summed them up, and ran this number through the model as an aggregate with new inputs for survival and travel time from Lower Granite Dam to Ice Harbor Dam (Table 27).

Table 25. Parameters in the PCDRisk 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 steelhead, 0.6 for all other species
Dominance mode	3
Hatchery fish size (mm)	200
Piscivory	0.0023
Maximum encounters per day	3
Predator:prey length ratio for predation	0.25 ¹
Average temperature across release sites	10.5°C ²

¹Daly et al. (2014)

²DART, accessed on May 15, 2017.

Table 26. Age and 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	86 (7)
	2	128 (8)

Sources: HETT (2014; for sockeye salmon); (Rabe 2017; Young 2017)

Table 27. Hatchery fish parameter values for the PCDrisk model; SSI = steelhead streamside incubator.

Program	Release Site	Release #	Survival to LG Dam	Residence/Travel Time to LG Dam (days; from 2010-2016) ¹	Proportion Barged in 2008	Proportion Barged in 2015	Survival from LG to ICH Dam	Travel Time from LG to ICH Dams (days)
East Fork Salmon A	East Fork River	60,000	0.7	18	0.485	0.135		
Pahsimeroi A	Pahsimeroi Hatchery	800,000	0.85	26				
Upper Salmon River A	Sawtooth Hatchery	1,779,000	0.77	18				
SSI Project A	Panther Creek	800	0.77	12				
	Indian Creek	200	0.77	12				
Hells Canyon A	Hells Canyon Dam	550,000	0.72	35	0.557	0.214	0.86	3
Little Salmon River A	Little Salmon River: Stinky Springs	636,000	0.95	19				
	Little Salmon River: Stinky Springs	217,000	0.91	20				
Salmon River B	Pahsimeroi Hatchery	248,000	0.82	18				
SSI Project B	Yankee Fork	620,000	0.69	21				
	Yankee Fork	1,000	0.69	21				
Dworshak B	Dworshak Hatchery	1,200,000	0.81	15 (3)	0.304	0.078		
	Clear Creek	300,000	0.73	14 (4)				
	Lolo Creek	200,000	0.66	10 (3)				
	Red House Hole	400,000	0.84	12 (4)				
SF Clearwater (Clearwater Hatchery) B	Meadow Creek	501,000	0.79	17 (4)				
	Red House Hole	219,000	0.84	12 (3)				
	Newsome Creek	123,000	0.8	28 (6)				

Sources: (Griffith 2017; Leth 2017b; McCann 2017)

¹This value has been altered for sockeye salmon (shown in parentheses) to reflect when natural-origin sockeye salmon are likely to be encountered (i.e., only once Clearwater fish reach the mainstem Snake River). For the streamside incubator programs we used the travel rate for the egg source program to estimate travel time.

Based on the data above, our model results show that hatchery steelhead are likely to have the largest effect on natural-origin steelhead, followed by Chinook salmon, and sockeye salmon. The maximum numbers of fish lost are also shown in Table 28, 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 composes 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).

Using the average number from 2011-2016 of each species that pass over Lower Granite Dam which is 30,607 for natural-origin Chinook salmon (both fall and spring/summer runs combined; Table 12 and Table 14 in Harvest baseline section), 25,991 for steelhead (Table 13 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 maximum potential loss of ~ 1.8, 4.6, and 2.6 percent of the potential adult return for Chinook salmon, steelhead, and sockeye salmon respectively, 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.

Travel time of juvenile hatchery fish can have a substantial effect on the outcome of the model. This is because the slower fish travel, the more time available for preying and competing on the natural-origin juveniles in the area. Thus, in the future, NMFS recommends monitoring of this input parameter to identify any potential increase in ecological effects. Specifically, we anticipate the 5 year running median of the travel time to Lower Granite Dam to slow by no more than three days beyond the median travel time identified in Table 27.

Table 28. Maximum numbers and percent of juvenile natural-origin salmon and steelhead lost annually to competition and predation with hatchery-origin steelhead smolts released from the Proposed Action.

Program	Chinook		Steelhead		Sockeye	
	P	C ¹	P	C ¹	P	C ¹
Release to Lower Granite Dam						
East Fork Salmon Natural A-run	184	650	26	1036	0	368
Pahsimeroi A-run	4314	13510	690	21712	0	536
Upper Salmon River A-run	7328	19590	1932	31673	0	371
SSI Project A-run	2	7	1	12	0	5
Hells Canyon A-run	3548	11619	559	18661	0	722

Little Salmon River A-run	2554	8308	415	13375	0	391
Salmon River B-run	4278	13374	631	21353	0	1053
SSI Project B-run	5	13	1	20	0	8
Dworshak B-run	6735	11318	977	29669	0	97
SF Clearwater B-run	4814	9053	429	14418	0	69
Lower Granite Dam to Ice Harbor Dam						
Aggregate-large barged proportion	2495	6699	214	9399	0	62
Aggregate-small barged proportion	4447	10085	702	13022	0	62
Total Juveniles Lost	130398-135736		167203-171314		5847	
SAR²	0.004		0.007		0.005	
Adult Equivalents	522-543		1170-1199		29	

¹Competition 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.

²Smolt-to-adult survival rate for Chinook salmon averaged across all spring/summer Chinook salmon programs in Idaho (NMFS 2017a; NMFS 2017b; NMFS 2017d), steelhead (Table 20), and sockeye salmon (IDFG 2012).

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 steelhead are those fish that do not emigrate to the ocean after release from the hatchery. These fish have the potential to compete with and prey on natural-origin fish for a longer period of time relative to fish actively outmigrating, and could impart some genetic effects when they spawn naturally. Although residualism is a natural life history, hatchery programs have the potential to increase residualism rates through hatchery rearing. The SSI project is an exception in that we do not anticipate any effects from residuals beyond naturally occurring residualism levels. This is because these fish are placed into the natural environment as eggs and are allowed a more natural feeding and growth regime as opposed to fish reared in a hatchery.

Residuals are not explicitly accounted for in our model at this time, but NMFS recommends the applicants monitor this phenomenon through visual assessment of juvenile fish prior to release. Supporting methods of estimating residual rates, such as comparing survival values between volitional migrant and forced-out releases and assessment of sexual development via gonadosomatic index (GSI), may be conducted to provide reliable estimates for some release groups. We anticipate the number of residual

fish to be no more than 5 percent based on a 5-year running average of the number of fish within each release group, leading to a small negative effect on listed natural-origin salmon and steelhead. This threshold is based on a study conducted by IDFG (2003) that demonstrated that of three hatcheries rearing steelhead (Hagerman NFH, Niagara Springs, and Magic Valley), a maximum of ~5 percent of the males sampled were precocially mature. Females were sampled, but few, if any, were found to be precocially mature. NMFS recommends expanding this metric to include both parr and precocially mature fish, which are more likely to residualize, and to include female samples in the calculation. Additionally, similar to the discussion of straying above, populations most at risk of negative effects attributable to residualism have high productivity and increasing abundance. This information supports the conclusion that maintaining residualism potential similar to the 2003 study is unlikely to inhibit the growth of listed steelhead populations.

2.5.2.3.2. Naturally-produced progeny competition

Naturally spawning hatchery-origin steelhead 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 for those areas where hatchery-origin steelhead are allowed to spawn naturally. This is actually a desired result of the integrated recovery programs. Therefore, the only expected effect of this added production is a density-dependent response of decreasing growth and increased competition/predation when habitat capacity is being approached. However, ecological impacts on both listed Chinook salmon and steelhead may increase in the future if the steelhead populations grow.

Because spring/summer and fall Chinook salmon and sockeye salmon historically coexisted in substantial numbers with steelhead, it follows that there must have been adequate passage and habitat to allow all 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 all four species are so depleted that they are listed under the ESA. Should the situation arise where steelhead natural production is limiting natural production of listed salmon species, 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 ITS and reporting requirements (Section 2.9) to ensure that appropriate monitoring takes place.

2.5.2.3.3. Disease

The risk of pathogen transmission to natural-origin salmon and steelhead is negligible for these steelhead programs. This is because juvenile rearing for all steelhead programs in the Salmon Basin occurs on spring or well water, with minimal, if any, exposure to pathogens through the water source. In addition, none of the rearing facilities for steelhead released in the Salmon Basin are in anadromous areas. Thus, even though detections and outbreaks with endemic pathogens do occur (Table 29 and Table 30), it would be very unlikely that any listed salmon or steelhead could be exposed to pathogens

shed from hatchery fish during rearing. In addition, treatments for the pathogens responsible for outbreaks in Table 30 below usually are effective within 3-10 days after treatment begins. Thus, the amount of time available over which shedding of pathogens could occur is limited.

There are a few pathogens in the tables below for which there is no known treatment; *Renibacterium salmoninarum* (causes bacterial kidney disease), *Myxobolus cerebralis* (causes whirling disease), and infectious hematopoietic necrosis virus (IHNV; causes infectious hematopoietic necrosis). However, fish health protocols are designed to prevent and control outbreaks with these pathogens. For example, to prevent outbreaks and reduce the amplification of IHNV in natural environments, hatchery staff drain the coelomic fluid from females during spawning and treat eggs with an iodophor solution, control the transmission of IHNV (IHOT 1995; NWIFC and WDFW 2006; ODFW 2003; Pacific Northwest Fish Health Protection Committee (PNFHPC) 1989). Culling of fish with *R. salmoninarum* and *M. cerebralis* infections is also an option. These control measures have proven effective in controlling pathogens as indicated by the outbreak of IHNV twice at one facility over the past three years, in association with another bacterial pathogen. Given this information, NMFS believes the risk of hatchery-origin adults transmitting pathogens to listed salmon and steelhead or amplifying pathogen levels in the natural environment is negligible.

Table 29. Pathogen detections in hatchery steelhead juveniles that are part of the proposed action; IHNV = infectious hematopoietic necrosis virus.

Facility	Program	Pathogen Detected		
		2014	2015	2016
Magic Valley Hatchery	Pahsimeroi A	None	None	<i>Flavobacterium psychrophilum</i> (x2)
	Salmon River B	<i>F. psychrophilum</i>	None	<i>F. psychrophilum</i> (x2)
Niagara Springs Hatchery	Hells Canyon	None	IHNV, <i>F. psychrophilum</i>	<i>Aeromonas hydrophila</i> ; <i>Flavobacterium sp.</i>
	Pahsimeroi A	None	None	<i>A. hydrophila</i>
Hagerman NFH	Upper salmon A	<i>Nucleospora salmonis</i> ; <i>F. psychrophilum</i> ; <i>A. hydrophila</i> ; <i>Gyrodactylus spp.</i>	<i>N. salmonis</i> ; <i>F. psychrophilum</i> , <i>Ichthophthorius multifiliis</i> ; <i>A. hydrophila</i> ; <i>Gyrodactylus spp.</i> ; <i>Chilodonella spp.</i> ; <i>Pseudomonas fluorescens</i> ; <i>Ichthyobodo sp.</i>	<i>N. salmonis</i> ; <i>F. psychrophilum</i> ; <i>A. hydrophila</i> ; <i>Gyrodactylus spp.</i>
	East Fork Natural	<i>N. salmonis</i> ; <i>R. salmoninarum</i> ; <i>Ambiphyra spp.</i> ; <i>Gyrodactylus spp.</i>	<i>N. salmonis</i> ; <i>F. psychrophilum</i> , <i>I. multifiliis</i>	<i>N. salmonis</i> ; <i>R. salmoninarum</i> ; <i>Ambiphyra spp.</i> ; <i>Gyrodactylus spp.</i>

DNFH	DNFH	IHNV, <i>F. psychrophilum</i>	IHNV, <i>F. psychrophilum</i>	IHNV
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Sources: (Blair 2017; Eaton 2017; Munson 2017a; Munson 2017b; Munson 2017c)

Table 30. Disease outbreaks in steelhead program juveniles that are part of the proposed action; IHNV = infectious hematopoietic necrosis virus.

Facility	Program	Pathogen	Date(s)	Treatment/ Control Regime
Clearwater Hatchery	SF Clearwater	<i>Flavobacterium psychrophilum</i>	September 2015	Medicated feed
Magic Valley Hatchery	Salmon River B-run	<i>F. psychrophilum</i>	June 2015	Medicated feed
Niagara Springs Hatchery	Hells Canyon	<i>F. psychrophilum</i>	July-August 2014; July 2015; August 2015	Medicated feed
	Hells Canyon	<i>Aeromonas hydrophila</i>	August-September 2014	Medicated feed
	Hells Canyon	IHNV, <i>F. psychrophilum</i>	November 2014; February 2015	Medicated feed
	Pahsimeroi A-run	<i>A. hydrophila</i>	August-September 2014	Medicated feed
	Pahsimeroi A-run	<i>F. psychrophilum</i>	June 2015; September 2015	Medicated feed
	Hells Canyon	<i>F. branchiophilum</i>	July 2016	Chloramine-T
Hagerman National Fish Hatchery	Upper Salmon A and East Fork Natural	<i>Icthyophthirius multifiliis</i>	October – December 2016	Potassium permanganate
		<i>F. columnare</i>	March 2015	Potassium permanganate/chlor maine T
		<i>I. multifiliis</i>	December 2015- January 2016	Formalin
		<i>I. multifiliis</i>	August-December 2014	Formalin

Sources: (Blair 2017; Eaton 2017; Munson 2017a; Munson 2017b; Munson 2017c)

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

RM&E actions included in the proposed action are described in Table 5 above. Although there is a great deal of additional RM&E that takes place in the action area to assess the effects of these programs on listed species, the effects of this RM&E on listed species is largely included in the Environmental Baseline. For example, run size, PBT sampling, and PIT tagging of adults all takes place at the Lower Granite Dam Trap, which is covered in the NMFS’ Opinion on the Federal Columbia River Power System (NMFS 2014). Although the analyses in that Opinion resulted in a jeopardy conclusion, the RM&E associated with the present Opinion is largely part of the Reasonable and Prudent Alternatives for the jeopardy analysis, and was not the factor contributing to the jeopardy conclusion.

There is also a variety of section 10 permits and 4(d) authorizations currently in place to allow the operators to assess natural-origin juvenile abundance, productivity and migration timing through the use of screw traps and electrofishing, and to conduct spawning ground/redd surveys for estimating escapement to individual populations. 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, 1127-4R, 16298-3R, and 1454. The expected impacts of each of the RM&E activities were previously analyzed by NMFS in the Biological Opinions associated with these 4(d) authorizations and Section 10 permits. None of these analyses resulted in jeopardy, and the overall effects from RM&E activities have both beneficial and negative effects.

Some of the take associated with screw trap operation and electrofishing in the Snake Basin was previously covered by Section 10 permits, but is included as part of the proposed action here. The effects of the South Fork Clearwater, Yankee Fork, and Panther Creek screw traps are detailed in Table 31. The effects of electrofishing on steelhead in Yankee Fork and Panther Creek are detailed in Table 32. In addition, a few spring/summer Chinook salmon adults (10 hatchery, 5 natural) may be encountered at each screw trap during operation annually, resulting in mortality of up to 2 adults of each origin. The total number of natural steelhead adult equivalents potentially handled and incidentally killed by these activities is 113 and 6, respectively, a small negative effect.

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 East Fork Salmon River Natural, South Fork Clearwater (Clearwater Hatchery) B-run, DNFH B-run, and Salmon River B-run programs. Green egg-to smolt survival rates have been about 55 percent from 2002-2008 (IDFG 2009; IDFG 2011a; IDFG 2011b; USFWS and NPT 2010). 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)).

For each program, a proportion of the juvenile releases (Table 3) are PIT-tagged to assess outmigration survival and travel time. These tags also aid in estimating adult distribution upon return. For the Salmon River B-run program, operators are conducting a study to assess which release strategy, direct or acclimated, results in better adult homing to Yankee Fork through the use of PIT tags and PBT. In the South Fork Clearwater, researchers are also tracking distribution of adults through the use of radio telemetry and up to 50 hatchery and 50 natural steelhead will have radio tags inserted for this purpose annually. Because the intent of RM&E is to improve our understanding of listed population status, the information gained outweighs the risks to the populations based on the small proportion of fish encountered, resulting in an overall beneficial effect of RM&E on steelhead. Incidental effects resulting from tagging such as injury, on fall and spring/summer Chinook salmon and sockeye salmon are negligible.

Table 31. Number of juvenile Chinook salmon and steelhead handled/tagged and that incidentally die due to handling/tagging and trap operation during juvenile rotary screw trapping.

Trap Site	Fish Species	Fish origin	Average, minimum, and maximum of observed handling/tagging (incidental mortality)	Proposed handling/tagging (incidental mortality)	Adult Equivalents handled (incidental mortality)
SF Clearwater smolt trap ¹	Steelhead	Natural	2476 (0)	3000 (30)	21 (0)
		Hatchery	0 (0)	10 (1)	0 (0)
	Chinook salmon ³	Natural	357 (0)	400 (4)	2 (0)
		Hatchery	143 (0)	300 (3)	1 (0)
Yankee Fork ²	Steelhead	Natural	1099; 858-1448 (25; 18-32)	5000 (100)	36 (2)
		Hatchery	206; 41-442 (0)	2000 (20)	14 (0)
Panther Creek ⁴	Steelhead	Natural	Not applicable	2500 (50)	18 (1)
		Hatchery	Not applicable	1000 (10)	7 (0)

¹ Based on one year of trapping in 2016, was previously covered in permit 1134-4R.

² Based on trapping from 2014-2016, was previously covered in permit 1127-4R. The proposed values were derived from past data and based on a potential trap efficiency doubling from 5-10 percent due to use of a bigger trap and a new trap location in the near future (Jonathan Ebel, SBT, personal communication).

³ Includes both fall and spring/summer Chinook salmon runs.

⁴ Was previously covered in permit 19391, but no actual take was available in the Apps database.

Table 32. Number of juvenile steelhead handled/tagged and that incidentally die from handling/tagging during electrofishing.

Electrofishing Site	Fish origin	Actual handling/tagging (incidental mortality)	Proposed handling/tagging (incidental mortality)	Adult Equivalents handled (incidental mortality)
Yankee Fork ¹	Natural	1663; 377-2560 (101; 33-148)	4000 (200)	28 (2)
	Hatchery	0 (0)	100 (2)	1 (0)
Panther Creek ²	Natural	Not applicable	4000 (200)	28 (2)
	Hatchery	Not applicable	100 (2)	1 (0)

¹ Based on trapping from 2014-2016, was previously covered in permit 1127-4R.

² Was previously covered in permit 19391, but no actual take was available in the Apps database.

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

Operation and maintenance of the facilities associated with the hatchery programs included in the Proposed Action would have a negligible effect on ESA-listed spring Chinook salmon and Snake River steelhead or their designated critical habitat. No construction is included as part of the Proposed Action.

Table 33. Program water source and use; NA = not applicable; SSI = steelhead streamside incubator

Facility	Maximum Surface Water Use (cfs)	Maximum Ground or Spring Water Use (cfs)	Surface Water Source/ Discharge Location	Diversion Distance (km)	Minimum Mean Monthly Surface Water Flow During Operation (cfs)	Maximum Percent Surface Water Diverted
Magic Valley Fish Hatchery	NA	87.2	Crystal Springs	NA	NA	NA
Niagara Springs Fish Hatchery	NA	120	Niagara Springs	NA	NA	NA
Hagerman National Fish Hatchery	NA	84.6	Springs	NA	NA	NA
East Fork Salmon River Satellite	15	NA	East Fork Salmon River	0.06	143.1 (March) ¹	10.5
Dworshak National Fish Hatchery	182	NA	Clearwater River	3.0	1,938 (October) ²	9
SSI: Panther Creek, Beaver Creek 2	0.021	NA	Beaver Creek	0.015	74 (July) ³	< 1
SSI: Panther Creek, Beaver Creek 3	0.021	NA	Beaver Creek	0.015		< 1
SSI: Panther Creek, Beaver Creek 4	0.021	NA	Beaver Creek	0.015		< 1
SSI: Indian Creek 1	NA	0.021	Indian Creek	0.015	NA	NA
SSI: Indian Creek 2	NA	0.021	Indian Creek	0.1	NA	NA
SSI: Yankee Fork, Cearly Creek	0.021	NA	Cearly Creek	0.1	155 (July) ⁴	< 1
SSI: Yankee Fork, Swift Gulch	0.021	NA	Swift Gulch	0.1		< 1
SSI: Yankee Fork, Ramey Creek	0.021	NA	Ramey Creek	0.1		< 1
SSI: Yankee Fork, Greylock Creek	0.021	NA	Greylock Creek	0.1		< 1
SSI: Yankee Fork, Jordan Creek	0.021	NA	Jordan Creek	0.1		< 1

¹ Idaho Power Company Gauge 13298050 flow data from 2014-2017; accessed July 25, 2017.

² Data from HDR and USFWS (2017).

³ United States Geological Survey (USGS) gauge 13306370 flow data from 2012-2016; accessed July 25, 2017.

⁴ USGS gauge 13296000 flow data from 2012-2016; accessed July 25, 2017.

Under the Proposed Action, because there is no change in water withdrawals from current operation, water withdrawals are expected to have similar effects into the future. For Niagara Springs, Magic Valley, and Hagerman, all three hatcheries are not in anadromous waters and no surface water is used, thus the facilities will not cause a change in habitat use or decrease availability of water in rearing or spawning areas (Table 33). Of those facilities included in the Proposed Action and considered in this Opinion, surface water usage is estimated to be less than 15 percent of the total surface water available at each location, even during the month of operation with the lowest surface water flow (Table 33). In addition, water at all facilities is diverted over a relatively short distance, the degree of reduced flow over that distance is not enough to interfere with passage or rearing through that reach, and the water usage is ultimately non-consumptive.

Low flows during the summer months may affect juvenile rearing. Only the steelhead streamside incubators use surface water and are operated during the summer months (May through July). However, these facilities use less than one percent of the water available in either Yankee Fork or Panther Creek. In addition, few juveniles are present during the summer as most spring Chinook and steelhead smolts would have emigrated in the late spring to early summer. Juveniles may also choose to move to deeper pools for holding during periods of low flow. Because climate change trends indicate that juveniles may outmigrate earlier with less tributary water available, the risk of dewatering juvenile rearing habitat during the summer months under likely changes in climate conditions is non-existent (Dittmer 2013).

One issue at DNFH, the only hatchery in anadromous waters, is the potential for listed steelhead and fall Chinook salmon juveniles to enter the hatchery system via the hatchery North Fork River water intake. Because the intake screen was installed in 1968, it does not adhere to the most recent NMFS screening criteria (NMFS 2011b). While this alone may not be a problem, there have been documented instances of natural-origin juveniles, largely fry, within the hatchery water system, and some mortalities. Mortalities are usually newly emerged fry (fewer than 200 per year), but occasionally larger juveniles are found. The hatchery has not kept a record of mortalities, and species identification has been hampered by the small size and deteriorated condition of the specimens (Nemeth 2017).

Recently, natural-origin entrants were collected in the headboxes of the Chinook salmon raceways. Using parentage-based tagging, 28 fish were checked to determine if they were offspring from DNFH parents. Thirteen of the samples were *O. mykiss* and the remaining samples were Chinook salmon (the race was not identified). None of the samples were from fish spawned at DNFH hatchery (Nemeth 2017). Thus, they could be either listed fall Chinook salmon or listed natural-origin steelhead returning to the North Fork Clearwater River. Although the numbers encountered to date seem low, consistent recording may identify > 200 natural-origin fish mortalities annually. In addition to recording, modifications to the intake screen could prevent entry of natural-origin fish

altogether. Given this information, NMFS recommends that one of our engineers evaluate the intake screen at DNFH in the context of our most recent screening criteria and that the hatchery staff annually record the number, species, race, and lifestage of any natural-origin fish mortalities identified within the hatchery to the best of their ability. Inspection needs to be coordinated with the ACOE Engineering Division, as they will be tasked with design of a new, compliant intake system that meets NMFS recommendations.

The facilities discharge proportionally small volumes of water with waste (predominantly biological waste) into a larger water body, which results in temporary and 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).

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. Facility effluent is monitored to ensure compliance with permit requirements. Though compliance with NPDES permit conditions is not an assurance that effects on ESA-listed salmonids will not occur, the facilities use the water specifically for the purposes of rearing steelhead, which have a low mortality during hatchery residence compared to survival in the natural-environment (~55 percent compared to 7 percent (Bradford 1995)). Because the same water used for rearing (where survival is high compared to the natural environment) is then discharged into the surrounding habitat and then further diluted once it is combined with the river water, we believe effluent will have a minimal impact on ESA-listed salmonids in the area.

Hatchery maintenance activities may displace juvenile fish through noise and instream activity or expose them to brief pulses of sediment as activities occur instream. The Proposed Action includes best management practices that limit the type, timing, and magnitude of allowable instream activities. In general, the measures would limit effects to short-term sublethal effects such as fish displacement, and/or startling of fish, and would not result in any deviation beyond normal fish behavioral responses to

environmental disturbances. Therefore, routine maintenance effects do not result in harm, harassment or mortality of any listed individuals.

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

Because fisheries in the action area are ongoing, the description of the fisheries and the effects of the fisheries on listed species are described in Section 2.4.4, Harvest, in the Environmental Baseline.

2.5.2.7. Factor 7. Kelt Reconditioning Program

Snake Basin steelhead are iteroparous, meaning they are able to spawn more than once. In contrast to a semelparous life history strategy (a single reproductive event followed by death, as exhibited by most salmon species), iteroparous individuals invest less energy in reproductive events, meaning less energy is spent per spawning season. The construction of hydropower dams in the Columbia River basin has substantially restricted downstream steelhead migration (Busby et al. 1996), thus minimizing the ability of steelhead to utilize the iteroparous life history strategy. Moreover, the current mortality of downstream-migrating post-spawned steelhead is as high as 96 percent in the Columbia River (Wertheimer and Evans 2005), meaning rates of iteroparity are low (1.7 to 17 percent). The disruption of this life history strategy could threaten population and species level viability. Thus, a kelt reconditioning project was proposed by BPA, CRITFC, and the NPT to increase the rates of repeat spawning in steelhead from the Snake Basin.

Steelhead recovery may be enhanced through increased productivity from kelt reconditioning efforts through the artificial manipulation of maturation timing and mating strategies. The primary goal of reconditioning is to regenerate vigor in kelts in order to increase the chances of repeat spawning, thereby increasing productivity. This is accomplished by capturing, holding, and feeding post-spawned steelhead in an artificial rearing environment until they are ready to be released to spawn again. In addition, providing steelhead with diverse, high lipid content diets during the reconditioning process may encourage repeat spawning activity and reduce the potential for skipped spawners (i.e., fish that require more than a year of conditioning to be able to spawn again). While this project would not eliminate migration challenges for steelhead kelts in the Snake and Columbia Rivers, it may help increase repeat spawning events in fish that have participated in the program.

Recent data for the program (Table 34) has shown that, despite some early set-backs, in recent years the proportion of kelts successfully reconditioned and released has exceeded natural rates of iteroparity of 2-17 percent. From 2011 to 2016 the average percent survival for kelts in the program was 32.8 percent, with 177 released into the Snake Basin to spawn naturally. It is likely that as personnel running the program become more experienced and more permanent facilities are constructed, survival could continue to increase, resulting in an even larger beneficial effect on the Snake River steelhead DPS.

The applicants are also conducting research on reconditioning strategies using spawned steelhead from DNFH. The goal of this work is to determine what program

modifications, if any, may improve reconditioning survival of steelhead, before testing these modifications with natural-origin steelhead. None of the reconditioned hatchery fish are released back into the Snake River Basin. On average, over the last five years, about 154 steelhead have been collected and reconditioned with an average 20 percent survival rate over years 2012-16 (Table 35). Because these hatchery-origin fish would be lethally spawned otherwise, their use in this research provides a beneficial effect on the Snake Basin Steelhead DPS through potential improvements to reconditioning strategies for natural-origin steelhead kelts.

Table 34. Summary of number of natural-origin steelhead kelts collected and released in the Snake River; LGD = Lower Granite Dam; TBD = to be decided.

Year	Collection Location	Number Collected	Number Survived Reconditioning	% Survival	Consecutive Spawners Released	Number Retained	Mature Skip Spawners Released	Total Release by Year
2011 ¹	LGD	111	2	1.8	2	0	0	2
2012 ¹	LGD	124	10	8.1	10	0	0	10
2013	LGD, SF Clearwater	134	69	51.5	69	0	0	69
2014	LGD, SF Clearwater	122	37	30.3	35	2	2	35
2015	LGD, SF Clearwater	140	43	30.7	22	21	18	24 ²
2016	LGD	227	120	52.9	19	101	TBD	37 ²

Sources: Hatch et al. (2017)

¹ Survival was compromised by poor water quality. A domestic water source was inadvertently mixed with the kelt water supply line that resulted in chlorinated water in the tanks.

² Includes skip spawners from previous year.

Table 35. Summary of number of hatchery-origin steelhead spawned at Dworshak National Fish Hatchery collected and reconditioned; TBD = to be decided.

Year	Number Collected	Number Survived Reconditioning	% Survival	Number Consecutive Spawners	Number Retained	Number Skip Spawners
2012 ¹	143	5	3.5	4	0	0
2013	163	61	37.4	12	47	22
2014	149	19	12.8	2	17	5
2015	149	43	28.9	13	30	TBD
2016	165	30	18.2	12	18	TBD

Sources: Hatch et al. (2017)

¹ Survival was compromised by poor water quality. A domestic water source was inadvertently mixed with the kelt water supply line that resulted in chlorinated water in the tanks.

The effects of collection of downstream migrating steelhead kelts at the adult fish separator systems of Lower Granite Dam’s juvenile bypass facility was previously analyzed and authorized in the NMFS (2014) Opinion on the Federal Columbia River

Power System. This activity is an ongoing operational element of the dam for providing downstream fish migration.

The kelt reconditioning program requires a year-round water supply. This water comes directly from the Clearwater River and is part of the water supply to the Nez Perce Tribal Hatchery. This facility was consulted on in the Clearwater spring/summer Chinook and coho salmon Opinion (NMFS 2017a). Facilities consulted on in this opinion took a relatively small proportion of the water from the Clearwater River for hatchery use, and its use was non-consumptive. Extra precautions are taken for the kelt water supply, including the use of sand and micron filters to remove large particles and an ultraviolet light to disinfect the water of pathogens. Water is also chilled as needed to ensure water temperature does not exceed 60°F, at which level the quality of egg production is reduced. Thus, fish that are released are likely to have few, if any, pathogen infections that could pose a risk to natural-origin steelhead they may encounter on the spawning grounds.

While the proposed handling of Snake Basin steelhead kelts is invasive and potentially harmful to individual kelts (up to 700 are proposed to be collected and reconditioned), this is not a negative impact overall for the species because the majority of these fish would not be expected to survive after initial spawning. In addition, up to 700 kelts are likely to be PIT-tagged, with genetic samples taken for genotyping annually to monitor kelt distribution and spawning success. It is expected that the reconditioning and subsequent release of kelts will increase the proportion of steelhead that are repeat spawning in the Snake Basin, outweighing any harm done to individual fish. Therefore, these efforts would only be beneficial to the survival, future reproduction, and productivity of Snake Basin steelhead. No additional encounters with listed species will occur from this factor beyond those described for Factor 2 (take at adult collection facilities).

2.5.2.8. Effects of the Action on Critical Habitat

This consultation analyzed the Proposed Action for its effects on designated critical habitat. NMFS has determined that operation of the hatchery programs would have a minor effect on designated critical habitat PCEs in the action area.

The existing hatchery facilities have not led to altered channel morphology and stability, reduced and degraded floodplain connectivity, excessive sediment input, or the loss of habitat diversity since their construction. In addition, no new facilities are proposed. Hatchery maintenance activities are expected to retain existing conditions, and would have minimal adverse effects on designated critical habitat.

Most facilities that use surface water diversions return that water to the river a short distance from the diversion point and use only a small proportion of the total surface water volume (Table 33). Because the uses are non-consumptive and are less than 15 percent of the total flow available, these withdrawals would not have a large enough effect to destroy or adversely modify adult spawning and juvenile rearing critical habitat

of ESA-listed Chinook salmon, sockeye salmon, or steelhead. These effects are discussed in more detail above.

Another potential effect on critical habitat is the use of chemicals for cleaning or treating pathogens that are present in the hatchery effluent. At this time, no information exists to suggest the use of the chemicals and their subsequent dilution to manufacturer's instructions would cause adverse effects on listed fish. Furthermore, the use of abatement ponds to allow chemical degradation into less toxic components, and the mixing of effluent with the remaining water in the creek or river is not likely to lead to a detectable change in water quality. Thus, the effects on water quality in spawning and rearing critical habitat are negligible. Furthermore, the steelhead programs may actually provide a beneficial effect on critical habitat in the form of marine-derived nutrients (see section 2.5.2.2.2) and as prey for larger natural-origin salmon and steelhead in the action area.

2.6. Cumulative Effects

“Cumulative effects” are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02). For the purpose of this analysis, the action area is that part of the Columbia River Basin described in Section 1.4. To the extent ongoing activities have occurred in the past and are currently occurring, their effects are included in the baseline (whether they are Federal, state, tribal or private). To the extent those same activities are reasonably certain to occur in the future (and are tribal, state or private), their future effects are included in the cumulative effects analysis. This is the case even if the ongoing tribal, state or private activities may become the subject of a section 10 permit or section 4(d) determination in the future until an opinion for the permit or 4(d) plan has been completed.

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. It is acknowledged, however, that such future state, tribal, and local government actions would 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.

Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult, if not impossible, to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline versus cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the Environmental Baseline section.

More detailed discussion of Cumulative effects for the Columbia River basin can be found in our biological opinion on the funding of Mitchell Act hatchery programs (NMFS 2017). In summary, it is likely that the type and extent of salmon and steelhead hatchery programs and the numbers of fish released in the analysis area and throughout

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

- Hatchery monitoring information
- Times and locations of fish releases to reduce risks of competition and predation
- Management of overlap in hatchery- and natural-origin spawners to meet gene flow objectives
- Decreased use of isolated hatchery programs
- Increased use of integrated hatchery programs for conservation purposes
- Incorporation of new research results and improved best management practices for hatchery operations
- Creation of wild fish only areas
- Changes in hatchery production levels
- Increased use of marking of hatchery-origin fish
- Improved estimates of natural-origin salmon and steelhead abundance for abundance-based fishery management.

The cumulative changes of climate change on ESA-listed salmon and steelhead are difficult to predict, but are assumed in the status of the ESA-listed species affected by the Proposed Action. The Proposed Action addresses climate change effects by aligning future hatchery operations with recovery, primarily by ensuring that natural populations are capable of improving in productivity, abundance, and diversity, which will allow them to adapt to changing environments. Pacific anadromous fish are adapted to natural cycles of variation in freshwater and marine environments, and their resilience to future environmental conditions depends both on characteristics of individual populations and on the level and rate of change. However, the life history types that will be successful in the future are neither static nor predictable, therefore maintaining or promoting existing diversity that is found in the natural populations of Pacific anadromous fish is the wisest strategy for continued existence of populations.

In addition, NMFS anticipates that human development activities will continue to have adverse effects on listed species in the Action Area. On the other hand, NMFS is also certain that available scientific information will continue to grow at a fast pace and tribal, public, and private support for salmon recovery will remain high and this will fuel the upward trend in habitat restoration and protection actions as well as hatchery, harvest, and hydropower reforms that are likely to result in improvements in fish survival.

2.7. Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the Proposed Action. In this section, NMFS adds the effects of the Proposed Action (Section 1.3) to the environmental baseline (2.4) and to cumulative effects (2.6) to formulate the agency's opinion as to whether the Proposed Action is likely to: (1) reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated or proposed critical habitat for the conservation of the species.

In assessing the overall risk of the Proposed Action on each species, NMFS considers the risks of each factor discussed in Section 2.5.2, 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 listed species and how their designated critical habitat would be affected.

2.7.1. Snake River Steelhead DPS

Best available information indicates that the Snake River Steelhead DPS is at high risk and remains at threatened status (NWFSC 2015). Ford (2011) determined that all populations remain below minimum natural-origin abundance thresholds. In addition, the biological review team identified the lack of direct data on spawning escapements and pEOS in the individual population tributaries as a key uncertainty, rendering quantitative assessment of viability for the DPS difficult (Ford 2011). However, for populations where estimates of the status of abundance, productivity, spatial structure and diversity exist, abundances are close or exceed minimum abundance thresholds and productivity are well over replacement (i.e. 1).

Our environmental baseline analysis considers the effects of hydropower, changes in habitat (both beneficial and adverse), fisheries, and hatcheries on Snake River steelhead. Although all may have contributed to the listing of the DPS, 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 (e.g., hatcheries serving as a genetic reserve for natural populations).

The majority of the effects of the Proposed Action on this DPS are genetic and ecological in nature. Effects from facility operation and broodstock collection are small and localized, and while RM&E requires handling of a substantial portion of the juvenile population, only a small percentage (i.e., < 2) 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 programs on natural-origin steelhead populations.

The ecological and genetic effects on the adult life stage are limited by the proportion of hatchery-origin fish spawning naturally. Our straying analysis concluded that straying is low for all of the programs in the proposed action, and is not expected to affect the abundance, productivity, diversity or spatial structure of the DPS because of the low potential for interbreeding and competition for spawning space between hatchery and natural-origin steelhead. The East Fork Salmon River Natural program is the only integrated program. Genetic effects on the East Fork population are limited by the use of natural-origin broodstock and an expected PNI of < 0.5 on average is a reasonable target for a population targeted for “maintained” in the recovery scenario (NMFS 2016b). NMFS believes this to be an appropriate PNI goal for a population designated as maintained in the latest version of the draft recovery plan, and is likely to benefit the DPS through increased abundance and productivity for the East Fork population.

Ecological effects on natural-origin juvenile steelhead associated with releases from the hatchery program are equivalent to loss of about 4.6 percent from the adult return to Lower Granite Dam. Based on current information, this is likely to be a maximum loss because of the assumptions and simplicity inherent in the model, and while it could result in a decrease in adult abundance, this decrease is at a level that is likely insignificant to the DPS. In addition, as we continue to improve the model, these estimates will become more refined in the future, and will likely decrease the percentage of adults that are lost from this worst case scenario.

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 DPS describes the on-going and proposed state, tribal, and local government actions that are targeted to reduce known threats to ESA-listed steelhead. Such actions include improving habitat conditions, and hatchery and harvest practices to protect listed steelhead DPSs, and NMFS expects this trend to continue, and could lead to increases in abundance, productivity, spatial structure and diversity.

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 DPS in the wild.

2.7.2. Snake River Salmon ESUs

Best available information indicates that the Snake River Spring/Summer and Fall Chinook Salmon ESUs are at high risk and remain threatened. The Snake River Sockeye Salmon ESU is at high risk and remains endangered (NWFSC 2015). For both the fall Chinook and sockeye salmon ESUs the hatchery programs have played a large role in at least maintaining and likely improving species status. The sockeye salmon hatchery program, in particular, is a necessary component of the sockeye salmon recovery plan (NMFS 2015).

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 (e.g., hatcheries serving a genetic reserve for natural populations).

The effects of our proposed action on these ESUs are limited to ecological effects, broodstock collection, and RM&E. Adverse ecological effects on adults are small because of the differences in spatial and temporal overlap of these three species with steelhead. However, juveniles may potentially undergo larger effects because of the overlap in outmigration timing. Our analysis showed that the impacts of these programs are equivalent to a maximum potential loss of adults at Lower Granite Dam of ~2.6 percent for sockeye salmon, and ~1.8 percent for Chinook salmon. In addition, pending the improved parameter inputs and model version we anticipate in the future (as explained above for steelhead) should serve to refine our modeled estimates, estimates for effects on ESA-listed Chinook salmon are also likely overestimated by the presence of unlisted spring/summer Chinook from the Clearwater Subbasin. Future estimates of the proportion of juveniles' from this Subbasin in the total outmigration may better inform what portion of the Chinook salmon numbers pertain to listed species; this is likely to be less than what we modeled for this analysis. Thus, the ~ 2 percent loss of potential adults does not have a substantial effect on ESU abundance or productivity for either Chinook or sockeye salmon.

Effects of RM&E and broodstock collection targeting steelhead 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 listed species.

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. NMFS expects this trend to continue and could lead to increases in abundance, productivity, spatial structure and diversity.

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 small effects of the Proposed Action on abundance, productivity, spatial structure, and diversity, will not appreciably reduce the likelihood of survival and recovery of these ESA-listed ESUs in the wild.

2.7.3. Critical Habitat

The hatchery water diversion and the discharge pose a negligible effect on designated critical habitat in the action area (Section 2.5.2.5). 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 PCEs 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 PCEs will be small in scale, would not alter PCEs essential to the conservation of a species or preclude or significantly delay development of such features.

Climate change may have some effects on critical habitat as discussed in Section 2.4.2. 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. However, the continued restoration of habitat, should alleviate some of this potential pressure for suitable rearing and spawning habitat. After reviewing the Proposed Action and conducting the effects analysis, and considering future anticipated effects of climate change, NMFS has determined that the Proposed Action would not diminish the conservation value of this critical habitat for the Snake River Basin steelhead DPS, or the Snake River Fall and Spring/Summer Chinook Salmon and Sockeye Salmon ESUs.

2.8. Conclusion

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

2.9. 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 by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). For purposes of this consultation, we interpret "harass" to mean an intentional or negligent action that has the potential to injure an animal or disrupt its normal behaviors

to a point where such behaviors are abandoned or significantly altered. 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.

2.9.1. Amount or Extent of Take

The primary form of take of ESA-listed summer steelhead is direct take, authorized in the 4(d) authorizations. However, NMFS also expects incidental take of ESA-listed salmon and steelhead will occur as a result of the proposed action for the following factors. The take pathways discussed below are:

- Genetic and ecological effects of hatchery adults on the spawning grounds
- Handling/tagging of adults at adult collection facilities
- Ecological effects of juveniles during emigration
- Ecological and genetic effects of juveniles that residualize
- Incidental handling/tagging, and mortality of juveniles while conducting RM&E
- Incidental handling and mortality of juveniles entering DNFH

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

There is take for this factor due to three forms of harm: genetic effects, ecological effects and adult handling/tagging and incidental mortality at adult collection facilities. Specifically, take occurs for genetic effects through a reduction in genetic diversity, outbreeding depression, and hatchery-influenced selection. Additionally, take occurs through ecological effects of hatchery adults on the spawning grounds such as competition for spawning sites and redd superimposition. Take due to these two pathways cannot be directly measured because it is not possible to observe gene flow or interbreeding between hatchery and wild fish in a reliable way, or to quantify spawning site competition or redd superimposition. For these two take pathways, NMFS will therefore rely on a single common set of surrogate take indicators: the number of hatchery-origin steelhead on the spawning grounds as defined here:

- A five-year running average⁵ PNI of 0.5 or higher for the East Fork Salmon River steelhead population beginning in 2021. Until 2021, NMFS will apply the PNI as a five-year running average of 0.4 in years when natural-origin steelhead abundance to the mouth of the East Fork River is estimated to be at least 250 steelhead.
- For other steelhead populations in the action area where infrastructure exists, hatchery-origin steelhead straying (only considering fish of a known program origin) is expected to be no more than five percent of the returns to a non-target

⁵ However, if it is apparent from natural-origin steelhead abundances observed in years prior to the fifth year that the average is certain to fall below the PNI value before five years, operators will contact NMFS in the year the likely shortfall is discovered.

population targeted for viability or high viability, measured as a 5-year rolling average beginning in 2018. For example, if 200 fish are detected in the South Fork Salmon River where no hatchery fish are expected to return, than only 10 of those detections should be from hatchery-origin steelhead.

This set of take surrogate measurements is logically related to both the genetic and ecological take pathways through assessment of hatchery-origin fish on the spawning grounds. If these fish spawn, they can cause both ecological and genetic effects on natural-origin spawners. Moreover, through weir collections and PIT tag arrays, the take surrogate can be reliably measured and monitored.

The third take pathway for this factor is the handling/tagging of listed hatchery and natural-origin steelhead at adult collection facilities to facilitate broodstock collection, and sampling of fish for monitoring and evaluation. The extent of incidental take of ESA-listed steelhead and spring/summer and fall Chinook salmon expected to occur as a result of the proposed action by this pathway is contained in Table 23 and Table 24.

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

Predation, competition, or pathogen transmission, 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. However, it is difficult to quantify this take because ecological interactions cannot be directly or reliably measured and/or observed. Thus, we will quantify the extent of take of juvenile salmonids by ecological effects using two different surrogates, one specifically addressing the effects of residualism of hatchery steelhead and the second related to take caused by the presence of hatchery steelhead which leave the system.

Residualism causes take in two forms. The first is harm or mortality associated with the potential of residual steelhead to compete with and prey on juvenile natural-origin fish for an extended period of time. The second is harm from genetic effects caused by residual steelhead that spawning naturally (particularly precocial males).

For both of these forms of take associated with residualism, the surrogate take measurement is the percentage of steelhead from the release that are observed to be either parr, precociously maturing, or precociously mature immediately prior to release. This surrogate has a rational connection to the amount of take expected from residualism because precocious steelhead and parr may residualize after release from the hatchery. NMFS expects that no more than five percent of program fish by stock observed from each program⁶ should be precociously mature or parr (based on visual observation), using

⁶ The SSI project is an exception in that we do not anticipate any effects from residuals beyond naturally occurring residualism levels. This is because these fish are placed into the natural environment as eggs and are allowed a more natural feeding and growth regime as opposed to fish reared in a hatchery.

a running five-year average beginning with the 2018 release⁷. Between 2017 and 2022, if the annual rate exceeds five percent, NMFS will be notified and discussion with NMFS will take place. The take surrogate can be reliably measured and monitored through visual assessment of the hatchery population and/or migrant fish prior to release.

For ecological effects of competition and predation caused by emigrating hatchery steelhead, NMFS applies a surrogate take measurement that relates to the median travel time⁸ for hatchery steelhead to Lower Granite Dam after release. Specifically, the extent of take from interactions between hatchery and natural-origin juvenile salmonids released above Lower Granite Dam will be the take that occurs when the travel time for emigrating juvenile steelhead is five days longer than the median value (which equates to 50% of the fish) identified in Table 27 for each program for 3 of the next 5 years of 5-year running medians. For example, if the 5-year running median of the median values in Table 27 is 20 days, and then the median for the next three years for a particular release group is 25 days, this would exceed the take threshold. This is a reasonable, reliable, and measurable surrogate for incidental take because, if travel time 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.

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

Maximum incidental take of ESA-listed spring/summer and fall Chinook at the SF Clearwater juvenile screw trap can be found in Table 31.

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

Incidental take in the form of handling and mortality of juvenile salmon and steelhead at DNFH through intake screen entrance is < 200 juveniles each of either steelhead or fall Chinook salmon.

2.9.2. Effect of the Take

In Section 2.7, NMFS determined that the level of anticipated take, coupled with other effects of the Proposed Action, is not likely to jeopardize the continued existence of the Snake River Spring/summer Chinook Salmon ESU, Snake River Fall Chinook Salmon

⁷ However, if it is apparent, from numbers observed in years prior to the fifth year, that the average is certain to exceed 5 percent before five years, operators will contact NMFS in the year the likely exceedance is discovered.

⁸ NMFS recognizes that this metric can be influenced by factors other than hatchery operation (i.e., environmental variables, hydrosystem operation).

ESU, Snake River Sockeye Salmon ESU, or Snake River Basin Steelhead DPS or result in the destruction or adverse modification of their designated critical habitat.

2.9.3. Reasonable and Prudent Measures

“Reasonable and prudent measures” are nondiscretionary measures to minimize the amount or extent of incidental take (50 CFR 402.02).

NMFS concludes that the following reasonable and prudent measures are necessary and appropriate to minimize incidental take. The ACOE, USFWS, and the LSRCP shall ensure that:

1. The ACOE, USFWS, and the LSRCP shall ensure that the applicants’ activities are consistent with the funder’s portion of the Proposed Action.
2. The NMFS shall ensure that the applicants follow all conditions specified in each authorization issued as well as guidelines specified in this opinion for their respective programs.
3. The NMFS shall ensure that the applicants provide reports to SFD annually for all hatchery programs, and associated RM&E.
4. The BPA shall review and approve CRITFC’s and/or NPT’s activities as described in the annual RM&E statements of work for the Snake Basin Kelt Reconditioning Program to ensure they are consistent with the BPA-funded portion of the Proposed Action.

2.9.4. Terms and Conditions

1. The terms and conditions described below are non-discretionary, ACOE, USFWS, LSRCP, BPA, and NMFS must comply with them in order to implement the reasonable and prudent measures (50 CFR 402.14). Action Agencies 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 entity to whom a term and condition is directed does not comply, protective coverage for the proposed action would likely lapse. ACOE, USFWS, and the LSRCP shall ensure for their respective programs that the applicants implement the hatchery programs as described in the Proposed Action (Section 1.3), the submitted HGMPs, and the Annual Operating Procedures to ensure they are consistent with the funder’s portion of the Proposed Action, as approved through annual statements of work including:
 - a. Providing advance notice of any change in program operation and implementation that potentially increases the amount or extent of take, or results in an effect of take not previously considered.
 - b. Providing notice if monitoring reveals an increase in the amount or extent of take, or discovers an effect of the Proposed Action not considered in this opinion.
 - c. Notifying NMFS SFD within 48 hours after knowledge of exceeding any authorized take. The applicants shall submit a written report, and/or convene a discussion with NMFS to discuss why the authorized take was

exceeded within two weeks of the event. These discussions will consider the role of each population in the recovery scenario.

- d. Evaluating intake screens at DNFH in conjunction with NMFS' engineer staff for compliance with NMFS' most recent screening criteria (NMFS 2011) within one year of opinion signature (USFWS and ACOE only).
 - e. Continuing to work collaboratively with operators on weir/adult management in Yankee Fork to ensure that the majority of the steelhead run can be managed.
2. NMFS shall ensure that the applicants follow all implementation terms prescribed in the 4(d) authorizations for each program.
 3. NMFS shall ensure that the applicants provide reports to SFD annually for their respective programs, and associated RM&E. All reports and required notifications are submitted electronically to the NMFS, West Coast Region, Sustainable Fisheries Division, APIF Branch. The current point of contact for document submission is Charlene Hurst (503-230-5409, charlene.n.hurst@noaa.gov).
 - a. An annual RM&E report(s) is submitted by applicants no later than December 15 of the year following releases and associated RM&E (e.g., release/RM&E in year 2017, report due December 2018), and should include:
 - i. The number and origin (hatchery and natural) of each listed species handled and incidental mortality across all activities
 - ii. Hatchery Environment Monitoring Reporting
 - Number and composition of broodstock, and dates of collection
 - Numbers, pounds, dates, locations, size (and coefficient of variation), and tag/mark information of released fish
 - Survival rates of all life stages (i.e., egg-to-smolt; smolt-to-adult)
 - Disease occurrence at hatcheries
 - Annual residualism rates prior to release by stock for each program
 - Any problems that may have arisen during hatchery activities
 - Any unforeseen effects on listed fish
 - iii. Natural Environment Monitoring Reporting
 - The number of returning hatchery and natural-origin adults to all ESA-listed populations, where infrastructure exists
 - 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 in all ESA-listed populations, where infrastructure exists
 - The contribution of fish from these programs into all ESA-listed populations where infrastructure exists
 - Post-release out-of-basin migration timing of each juvenile hatchery-origin fish release to Lower Granite Dam

- Mean length, coefficient of variation, number, and age of natural-origin juveniles during RM&E activities
 - Number and species of listed juveniles and adults encountered and the number that die during RM&E activities
- b. Annual reports to SFD for the kelt reconditioning program should include:
- i. The number of each ESA-listed species handled and incidental mortality across all activities (kelt collection, holding, release)
 - ii. The number of kelts collected, their specific collection location, and origin (hatchery or natural)
 - iii. The number of kelts released to spawn naturally and their specific release location any collected pit tag or genetic data, as available, providing indication of immigration to spawning area
4. BPA shall review and approve CRITFC's and/or NPT's activities as described in the annual RM&E statements of work for the Snake Basin Kelt Reconditioning Program to ensure they are consistent with the BPA-funded portion of the Proposed Action.

2.9.5. 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 one conservation recommendation appropriate to the Proposed Action:

1. Estimate the proportion of spring/summer Chinook salmon juveniles outmigrating from the Clearwater Subbasin into all of the spring/summer Chinook salmon in the Snake River to allow NMFS to partition the Chinook estimates in the PCDRisk model for ecological effects.

2.10. Re-initiation of Consultation

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

3. MAGNUSON-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 ten steelhead hatchery programs, as described in Section 1.3. The action area (Section 2.3) of the Proposed Action includes habitat described as EFH for Chinook and coho salmon (PFMC 2003) within the Snake River Basin. Because EFH has not been described for steelhead, the analysis is restricted to the effects of the Proposed Action on EFH for Chinook and coho salmon. For Chinook salmon, EFH encompasses all available watersheds in Idaho. For coho salmon, EFH in Idaho occurs in the Lower Salmon River, and throughout the Clearwater Subbasin with the exception of the Lochsa and Lower North Fork Clearwater Rivers (PFMC 2014)

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

3.2. Adverse Effects on Essential Fish Habitat

The Proposed Action has small effects on the major components of EFH. As described in Section 2.5.2, 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.” Adult hatchery steelhead returning to the Snake River Basin are expected to largely return to hatcheries or be caught in fisheries and not be available to compete for spawning habitat with Chinook or coho salmon. In addition, salmon spawn in the fall and winter, whereas summer steelhead spawn in the spring, making redd superimposition very unlikely. However, the one exception is the East Fork Salmon River natural program where hatchery-fish are intended to spawn naturally. No coho exist in this system, and it is likely that habitat partitioning has occurred for steelhead and Chinook salmon that have co-existed together for a long time.

Some predation by adult hatchery steelhead on juvenile natural-origin Chinook or coho salmon may occur as steelhead hold for a potentially long period of time before spawning in freshwater EFH. Predation and competition by juvenile hatchery steelhead on juvenile natural-origin Chinook or coho salmon is likely small. Our analysis in Section 2.5.2.3.1 shows that fewer than 530 Chinook salmon adult equivalents are likely to be lost to predation and competition with hatchery steelhead at the juvenile stage within our action area for this consultation. Although our ecological model did not account for effects on unlisted fish, such as coho salmon, sizes of Chinook and coho salmon are similar and, thus, we anticipate similar adult equivalents for coho salmon as Chinook salmon.

NMFS has determined that the Proposed Action is not likely to adversely affect EFH for Pacific salmon.

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 2.9) includes the best approaches to avoid or minimize those adverse effects in most areas. Thus, NMFS has no conservation recommendations specifically for Chinook and coho salmon EFH. However, the Reasonable and Prudent Measures, and Terms and Conditions are likely to address potential EFH effects.

3.4. Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, the Federal action agencies must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation from NMFS. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH Conservation Recommendations, unless NMFS and the Federal agency have agreed to use an alternative time frame for the Federal agency response. The response must include a description of measures proposed by the agency for avoiding, mitigating, or offsetting the impact of the activity on EFH. In the case of a response that

is inconsistent with NMFS Conservation Recommendations, the Federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(k)(1)).

In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, we ask that in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

3.5. Supplemental Consultation

The Federal action agencies 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(1)).

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 operation of the nine steelhead hatchery programs and one kelt reconditioning program, as proposed, 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 of this opinion are the NMFS (permitting entity), and the BPA, ACOE, LSRCP, and USFWS (funding entities) as well as IDFG, NPT, SBT, and CRITFC (operating entities). The scientific community, resource managers, and stakeholders benefit from the consultation through the anticipated increase in returns of salmonids to the Snake Basin and through the collection of data indicating the potential effects of the operation on the viability of natural populations of Snake River steelhead, Chinook salmon, and sockeye salmon. This information will improve scientific understanding of hatchery-origin steelhead effects that can be applied broadly within the Pacific Northwest area for managing benefits and risks associated with hatchery operations. This opinion will be posted on NMFS' West Coast Region web site (<http://www.westcoast.fisheries.noaa.gov>). The format and naming adheres to conventional standards for style.

4.2. Integrity

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

4.3. Objectivity

Information Product Category: Natural Resource Plan

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

Best Available Information: This consultation and supporting documents use the best available information, as 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 36. Generally speaking, effects range from beneficial to negative when programs use local fish⁹ for hatchery broodstock, and from negligible to negative when programs do not use local fish for broodstock¹⁰. 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

⁹ The term "local fish" is defined to mean fish with a level of genetic divergence relative to the local natural population(s) that is no more than what occurs within the ESU or steelhead DPS (70 FR 37215, June 28, 2005).

¹⁰ Exceptions include restoring extirpated populations and gene banks.

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 36. 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	<p>Positive to negative effect</p> <p>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).</p>	<p>Negligible to negative effect</p> <p>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).</p>
Diversity	<p>Positive to negative effect</p> <p>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.</p>	<p>Negligible to negative effect</p> <p>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).</p>
Abundance	<p>Positive to negative effect</p> <p>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.</p>	<p>Negligible to negative effect</p> <p>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.</p>
Spatial Structure	<p>Positive to negative effect</p> <p>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).</p>	<p>Negligible to negative effect</p> <p>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).</p>

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., 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)¹¹ 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

¹¹ It is important to reiterate that as NMFS analyzes them, outbreeding effects are a risk only when the hatchery fish are from a different population than the naturally produced fish. If they are from the same population, then the risk is from hatchery-influenced selection.

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 fish¹². 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 3).

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)¹³. 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

¹² Gene flow between natural-origin and hatchery-origin fish is often interpreted as meaning actual matings between natural-origin and hatchery-origin fish. In some contexts, it can mean that. However, in this document, unless otherwise specified, gene flow means contributing to the same progeny population. For example, hatchery-origin spawners in the wild will either spawn with other hatchery-origin fish or with natural-origin fish. Natural-origin spawners in the wild will either spawn with other natural-origin fish or with hatchery-origin fish. But all these matings, to the extent they are successful, will generate the next generation of natural-origin fish. In other words, all will contribute to the natural-origin gene pool.

¹³ PNI is computed as $pNOB/(pNOB+pHOS)$. This statistic is really an approximation of the true proportionate natural influence, but operationally the distinction is unimportant.

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 3. 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 unresponsive” 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:

$$\text{pHOS}_{\text{eff}} = \text{RRS} * \text{pHOS}_{\text{census}}$$

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:

$$\text{PNI} = \frac{\text{pNOB}}{(\text{pNOB} + \text{pHOS}_{\text{eff}})}$$

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 4 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 randomly¹⁴. 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

¹⁴ These computations are purely theoretical, based on a simple mathematical binomial expansion $((a+b)^2=a^2 + 2ab + b^2)$.

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.

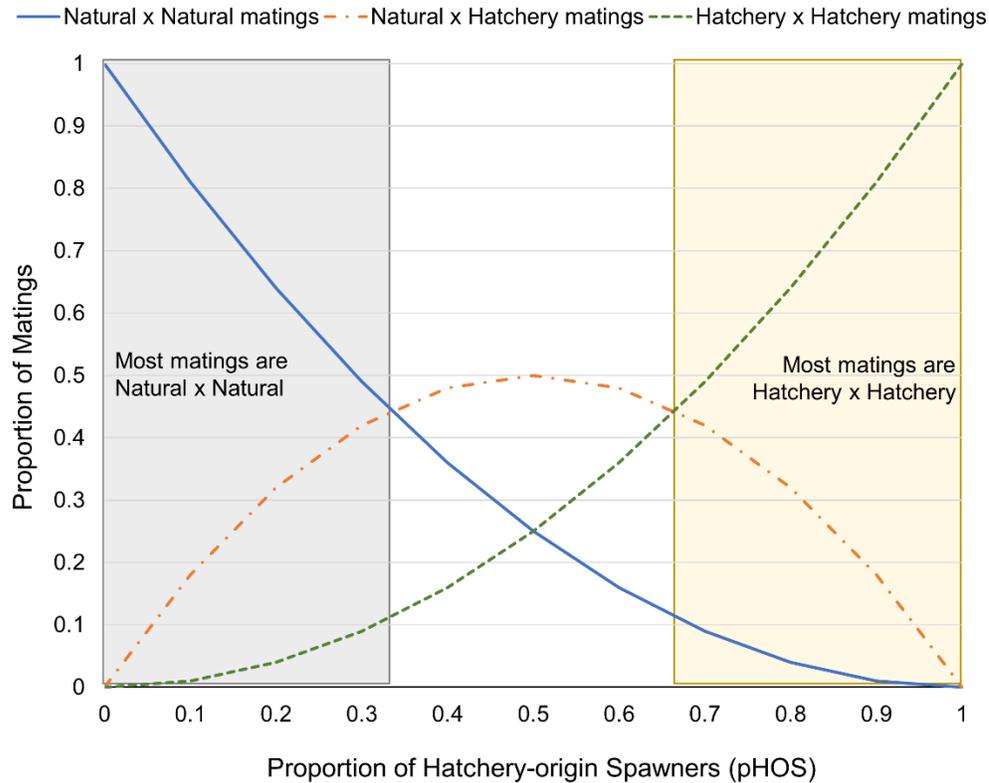


Figure 4. Relative proportions of types of matings as a function of proportion of hatchery-origin fish on the spawning grounds (pHOS).

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).

5.2.3. Adult Collection Facilities

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

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

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

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

5.3.1. Competition

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

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

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

En masse hatchery salmon smolt releases may cause displacement of rearing natural-origin juvenile salmonids from occupied stream areas, leading to abandonment of advantageous feeding stations, or premature out-migration by natural-origin juvenile

salmonids. Pearsons et al. (1994) reported small-scale displacement of juvenile naturally produced rainbow trout from stream sections by hatchery steelhead. Small-scale displacements and agonistic interactions observed between hatchery steelhead and natural-origin juvenile trout were most likely a result of size differences and not something inherently different about hatchery fish.

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

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

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

Critical to analyzing competition risk is information on the quality and quantity of spawning and rearing habitat in the action area,¹⁵ 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.

¹⁵ “Action area” means all areas to be affected directly or indirectly by the action in which the effects of the action can be meaningfully detected and evaluated.

5.3.2. Predation

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

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

5.3.3. Disease

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

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

- Introduction of exotic pathogens
- Introduction of endemic pathogens to a new watershed
- Intentional release of infected fish or fish carcasses

- Continual pathogen reservoir
- Pathogen amplification

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

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

In addition to the state, federal and tribal fish health policies, disease risks can be further minimized by preventing pathogens from entering the hatchery facility through the treatment of incoming water (e.g., by using ozone) or by leaving the hatchery through hatchery effluent (Naish et al. 2008). Although preventing the exposure of fish to any pathogens prior to their release into the natural environment may make the hatchery fish more susceptible to infection after release into the natural environment, reduced fish densities in the natural environment compared to hatcheries likely reduces the risk of fish encountering pathogens at infectious levels (Naish et al. 2008). Treating the hatchery effluent would also minimize amplification, but would not reduce disease outbreaks within the hatchery itself caused by pathogens present in the incoming water supply. Another challenge with treating hatchery effluent is the lack of reliable, standardized guidelines for testing or a consistent practice of controlling pathogens in effluent (LaPatra 2003). However, hatchery facilities located near marine waters likely limit freshwater

pathogen amplification downstream of the hatchery without human intervention because the pathogens are killed before transmission to fish when the effluent mixes with saltwater.

Noninfectious diseases are those that cannot be transmitted between fish and are typically caused by genetic or environmental factors (e.g., low dissolved oxygen). Hatchery facilities routinely use a variety of chemicals for treatment and sanitation purposes. Chlorine levels in the hatchery effluent, specifically, are monitored with a National Pollutant Discharge Elimination System (NPDES) permit administered by the Environmental Protection Agency. Other chemicals are discharged in accordance with manufacturer instructions. The NPDES permit also requires monitoring of settleable and unsetttable 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.

5.3.4. **Acclimation**

One factor that 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 1999; Quinn 1997; YKFP 2008).

(Dittman and Quinn 2008) reference numerous experiments that indicated that a critical period for olfactory imprinting is during the parr-smolt transformation, which is the period when the salmonids go through changes in physiology, morphology, and behavior in preparation for transitioning from fresh water to the ocean (Beckman et al. 2000; Hoar 1976). Salmon species with more complex life histories (e.g., sockeye salmon) may

imprint at multiple times from emergence to early migration (Dittman et al. 2010). Imprinting to a particular location, be it the hatchery, or an acclimation pond, through the acclimation and release of hatchery salmon and steelhead is employed by fisheries managers with the goal that the hatchery fish released from these locations will return to that particular site and not stray into other areas (Bentzen et al. 2001; Fulton and Pearson 1981; Hard and Heard 1999; Kostow 2009; Quinn 1997; Westley et al. 2013). However, this strategy may result in varying levels of success in regards to the proportion of the returning fish that stray outside of their natal stream. (e.g., (Clarke et al. 2011; Kenaston et al. 2001).

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

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

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

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

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

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

5.4.1. Observing/Harassing

For some parts of the proposed studies, listed fish would be observed in-water (e.g., by snorkel surveys, wading surveys, or observation from the banks). Direct observation is the least disruptive method for determining a species' presence/absence and estimating their relative numbers. Its effects are also generally the shortest-lived and least harmful of the research activities discussed in this section because a cautious observer can effectively obtain data while only slightly disrupting fishes' behavior. Fry and juveniles

frightened by the turbulence and sound created by observers are likely to seek temporary refuge in deeper water, or behind/under rocks or vegetation. In extreme cases, some individuals may leave a particular pool or habitat type and then return when observers leave the area. At times, the research involves observing adult fish, which are more sensitive to disturbance. These avoidance behaviors are expected to be in the range of normal predator and disturbance behaviors. Redds may be visually inspected, but would not be walked on.

5.4.2. Capturing/handling

Any physical handling or psychological disturbance is known to be stressful to fish (Sharpe et al. 1998). Primary contributing factors to stress and death from handling are excessive doses of anesthetic, differences in water temperatures (between the river and holding vessel), dissolved oxygen conditions, the amount of time fish are held out of the water, and physical trauma. Stress increases rapidly if the water temperature exceeds 18°C 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.

5.4.3. Fin clipping and tagging

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

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

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

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

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

NMFS has developed general guidelines to reduce impacts when collecting listed adult and juvenile salmonids (NMFS 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.

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

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

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

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

“Many hatchery programs are capable of producing more fish than are immediately useful in the conservation and recovery of an ESU and can play an important role in fulfilling trust and treaty obligations with regard to harvest of some Pacific salmon and steelhead populations. For ESUs listed as threatened, NMFS will, where appropriate, exercise its authority under section 4(d) of the ESA to allow the harvest of listed hatchery fish that are surplus to the conservation and recovery needs of the ESU, in accordance with approved harvest plans” (NMFS 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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