Endangered Species Act (ESA) Section 7(a)(2) and 4(d) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation

Five Clearwater River Basin Spring/Summer Chinook Salmon and Coho Salmon Hatchery Programs

NMFS Consultation Number: WCR-2017-7303

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

Affected Species and Determinations:

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

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

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

Issued By: FOR

Barry A. Thom
Regional Administrator

Date: 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 Proposed Action considered in this document revolves around the operation of five spring/summer Chinook and coho salmon hatchery programs in the Clearwater River Basin of Idaho state. The Proposed Actions by the federal agencies (see Section 1.3) consist of permitting and funding of the operation and maintenance of four hatchery programs rearing and releasing Snake River spring and summer Chinook salmon and one hatchery program rearing and releasing coho salmon in the Clearwater River basin—specifically, the Kooskia, Clearwater, Nez Perce Tribal, and Dworshak Hatchery programs. Included in the Proposed Action is NMFS' consideration of the coho program under the Tribal 4(d) Rule for salmon and steelhead. Because the underlying effects of the Federal agency actions are fully described by the effects of the hatchery program operation; the details of each hatchery program are summarized in Section 1.3 below, based on Hatchery and Genetic Management Plans (HGMPs), which were submitted to NMFS for review. These HGMPs date back to 2010; therefore, the project descriptions have been gleaned from existing HGMPs, Annual Operating Plans (AOPs), and other best available data available provided by the applicants.

The National Marine Fisheries Service (NMFS) describes a hatchery program as a group of fish that have a separate purpose and that may have independent spawning, rearing, marking, and release strategies (NMFS 2008c). 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 selection in the hatchery, 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" or "segregated". They promote domestication or selection in the hatchery over selection in the wild and culture a stock of fish with different phenotypes (e.g., different ocean migrations and spatial and temporal spawning distribution) compared to the natural population.

The underlying activities that drive the Proposed Actions are the operation and maintenance of five hatchery programs rearing and releasing Snake River spring and summer Chinook salmon in the Snake River basin and one hatchery program rearing and releasing coho salmon—specifically, the Kooskia, Clearwater, Nez Perce Tribal, and Dworshak Hatchery programs.

Spring/summer Chinook and coho salmon were functionally extirpated from the Clearwater River Basin in 1985after the Lewiston Dam[1] was constructed, subsequently removed, and reintroduction efforts were attempted. Spring/summer Chinook salmon were reintroduced in 1961, and coho salmon in 1994 (Sigler and Zaroban In press). More recent efforts to reestablish

[1] Also known as Washington Water Power Diversion Dam which took place in 1927.

summer Chinook in the Clearwater basin were initiated in 2009[2]. Natural production of spring/summer Chinook and coho salmon is the result of re-introduction, and they are not ESA-listed. Hatchery stocks of spring/summer Chinook salmon and coho salmon in the Clearwater Basin are also not ESA-listed. Snake River fall Chinook salmon and steelhead in the Clearwater River are ESA-listed. This Proposed Action incorporates actions and activities related to hatchery production in the Clearwater of spring/summer Chinook and coho salmon and the Biological Opinion will evaluate the effects of these hatchery programs on ESA-listed fall Chinook and steelhead in the Clearwater River Basin.

The hatchery programs are operated by state, federal, and/or tribal agencies as described in Table 1.

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

Program	HGMP Date	Program Operator*	Funding Agency	ESA Pathway
Kooskia Spring Chinook Salmon	December 2010	NPT	USFWS	Section 7
Clearwater Hatchery Spring/Summer Chinook Salmon	November 2011	IDFG	LSRCP	Section 7
Nez Perce Tribal Hatchery Spring/Summer Chinook Salmon	April 2013	NPT	BPA/LSRCP	Section 7
Dworshak Spring Chinook Salmon**	May 2013	USFWS/NPT	USFWS/LSRCP	Section 7
Clearwater River Coho Salmon (at Dworshak and Kooskia)***	April 2016	NPT	CRITFC	Tribal 4(d) rule

* Primary operators are listed, but all programs are coordinated between Idaho Fish and Game (IDFG), Nez Perce Tribal Hatchery (NPTH), and Federal agencies collectively, including U.S. Fish and Wildlife Service (USFWS), USFWS Lower Snake Compensation Plan Office (LSRCP), Columbia River Inter-Tribal Fish Commission (CRITFC), and Bonneville Power Administration (BPA).

** USFWS shares in facility operation costs at DNFH, and LSRCP shares in infrastructure repair/replacement costs at DNFH; these cost support the LSRCP spring Chinook salmon programs at this facility.

*** The Bureau of Indian Affairs (BIA) is providing a plan for the operation and maintenance of the Clearwater River Coho Salmon program (at Dworshak and Kooskia) for consideration under the ESA Tribal 4(d) that is included in this Proposed Action.

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 USFWS, and BPA.

[2] Donor stock for summer Chinook reintroduction was segregated hatchery origin adults from the South Fork Salmon River. This hatchery stock is ESA-listed; however, ad-clipped fish are exempt from take prohibitions.

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

ESA consultations and an opinion were completed in 2007 for nine hatchery programs that produce a substantial proportion of the total number of salmon and steelhead released into the Columbia River annually. These programs are located in the LCR and MCR and are operated by the 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 2008e) and an opinion and RPAs for the FCRPS to avoid jeopardizing ESA-listed salmon and steelhead in the Columbia Basin (NMFS 2008d). The SCA environmental baseline included "the past effects of hatchery operations in the Columbia River Basin. Where hatchery consultations have expired or where hatchery operations have yet to undergo ESA section 7 consultation, the effects of future operations cannot be included in the baseline. In some instances, effects are ongoing (e.g., returning adults from past hatchery practices) and included in this analysis despite the fact that future operations cannot be included in the baseline. The Proposed Action does not encompass hatchery operations per se, and therefore no incidental take coverage is offered through this biological opinion to hatcheries operating in the region. Instead, we expect the operators of each hatchery to address its obligations under the ESA in separate consultations, as required" (see NMFS 2008e, p. 5-40).

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

On April 28, 2010 (Walton 2010), NMFS issued a letter to "co-managers, hatchery operators, and hatchery funding agencies" that described how NMFS "has been working with co-managers throughout the Northwest on the development and submittal of fishery and hatchery plans in compliance with the Federal 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 five hatchery programs is based on a series of documents submitted to NMFS by the co-managers and the funding agencies. Between 2010 and 2016, co-managers submitted final HGMPs for formal consultation (Table 1). Once submitted, NMFS reviewed the HGMPs for sufficiency, and issued letters indicating that the HGMPs were sufficient for consultation (Purcell 2017a; 2017c; 2017d; 2017b). Since that time, the co-managers have also referred to the Annual Operating Plan (AOP), other best available data provided by the applicants, and worked on project descriptions with NMFS' staff to edit minor details. The outcomes of these discussions and updates are captured below.

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 (50 CFR 402.02). For EFH consultation, "Federal action" means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a Federal Agency (50 CFR 600.910).

There are three action agencies, each with its own proposed action:

- U.S. Fish and Wildlife Service (USFWS) (is two part):

  1) the funding of the operation and maintenance, and monitoring and evaluation of the Clearwater Hatchery, Nez Perce Tribal Hatchery (for limited LSRCP releases; otherwise this is a BPA funded program), and Dworshak National Fish Hatchery programs 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) to offset losses of anadromous fish in the Snake River Basin caused by the four dam and navigation lock projects in the Lower Snake River.

2) the direct funding of the operation and maintenance, and monitoring and evaluation of Kooskia National Fish Hatchery (authorized under Public Law 87-122) and Dworshak National Fish Hatchery (authorized by the Flood Control Act of 1962 as part of the Dworshak Dam and Reservoir Project). These programs were implemented to mitigate losses to anadromous fish runs affected by water development projects in the Columbia River basin (for Kooskia National Fish Hatchery) and for construction of Dworshak Dam (for Dworshak National Fish Hatchery);

Throughout the rest of the document, “the LSRCP” refers to USFWS activities funded by the referenced Act, while “USFWS” refers to direct funding by and from the USFWS (not through LSRCP).

- Bonneville Power Administration (BPA) funding of the operation and maintenance and monitoring and evaluation of the Nez Perce Tribal Hatchery to support efforts to mitigate for effects of the development and operation of the Federal Columbia River Power System (FCRPS) on fish and wildlife in the mainstem Columbia River and its tributaries under the Pacific Northwest Electric Power Planning and Conservation Act of 1980 (Northwest Power Act) (16 USC section 839n(h)(10)(A)).

- National Marine Fisheries Service (NMFS) determination under the ESA Tribal 4(d) rule for the Clearwater River Coho Salmon program (at Dworshak and Kooskia).

The objective of this document is to document the determination of likely effects on ESA-listed salmon and steelhead and their designated critical habitat resulting from USFWS, LSRCP, and BPA funding of the programs. This document demonstrates that the actions proposed by the operators comply with the provisions of Section 7(a)(2) of the ESA and the ESA Tribal 4(d) rule. The duration of the Proposed Action is intended to be ongoing.

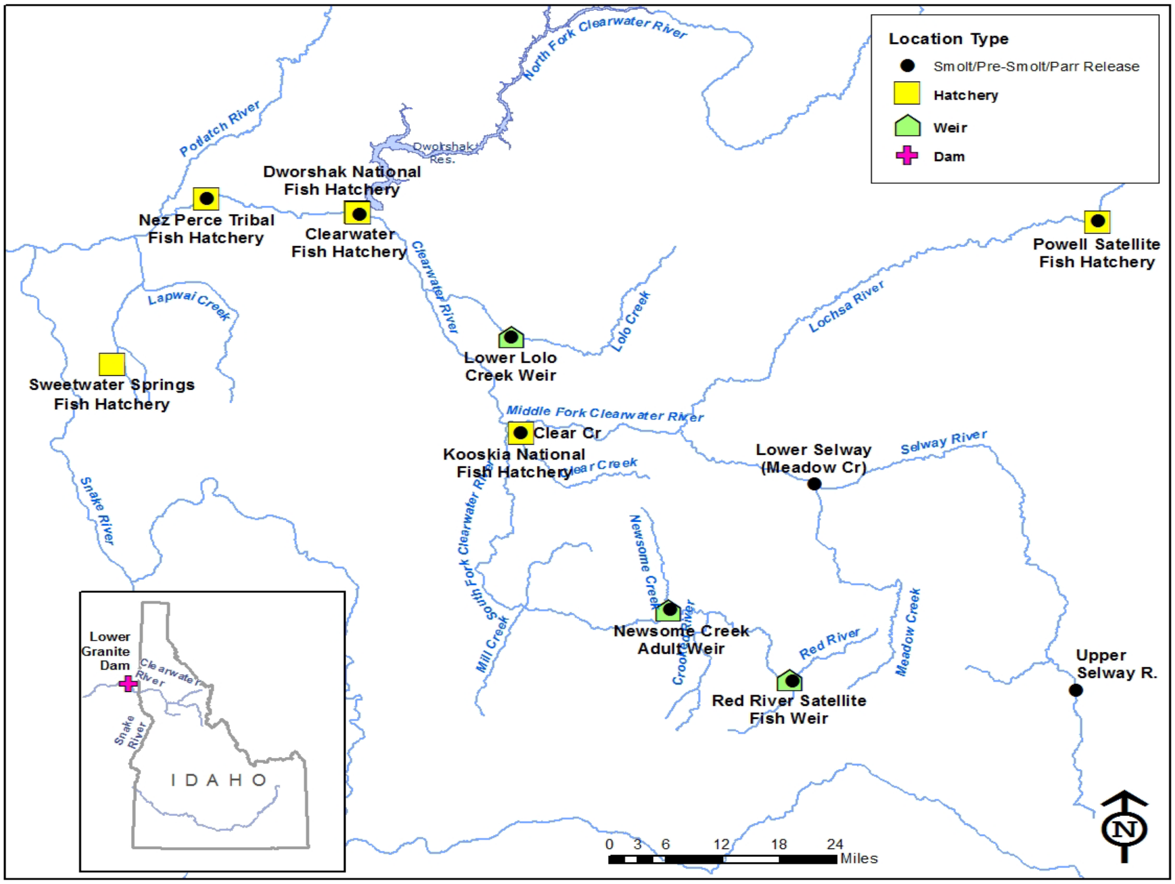

Figure 1. Location of spring and summer Chinook salmon facilities used in the Proposed Action (courtesy of IDFG).

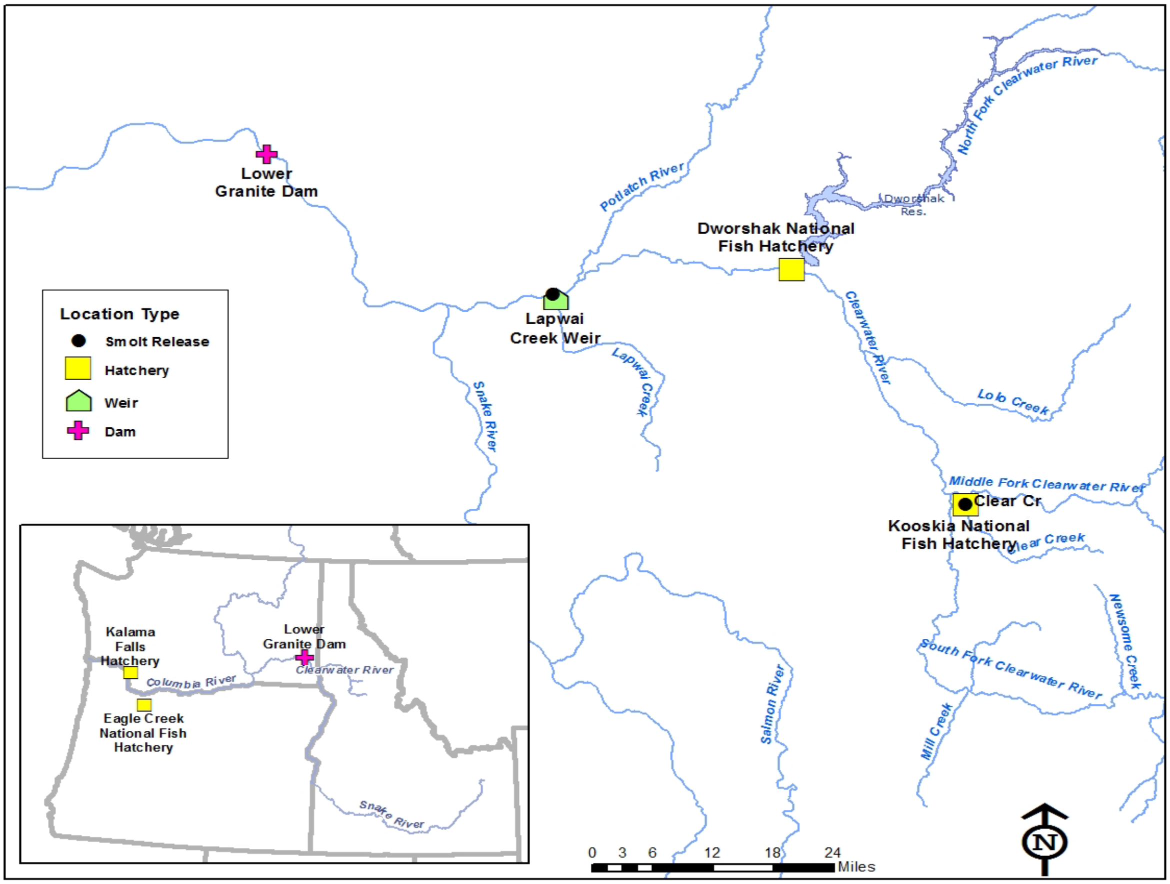

Figure 2. Location of coho salmon facilities used in the Proposed Action (courtesy of IDFG).

1.3.1. Proposed hatchery broodstock collection

Four of the spring/summer Chinook and coho salmon programs are segregated (Kooskia, Clearwater, Dworshak, and Clearwater coho), and one of the spring/summer Chinook salmon programs is a developing combination of segregated and integrated[3] (Nez Perce).

Table 2 below describes the broodstock collection plans for the five programs evaluated in this Opinion. The collection number represents an approximate number of broodstock collected at the program's facilities, not necessarily at the given collection site. The Clearwater spring Chinook salmon broodstock is managed as one stock; therefore, one facility may end up capturing more

[3]The NPTH program is a reintroduction/supplementation program for an extirpated population that uses an unlisted broodstock. The long-term goal of this program is to incorporate 50% natural-origin broodstock; until natural populations are restored, any incorporation of natural-origin broodstock is unintentional, and primarily hatchery-origin broodstock will be used for production. NPTH will report annually the number of natural-origin broodstock incorporated into production and will notify NMFS when they plan to start intentionally incorporating any natural-origin fish.

fish to use for brood at another facility to ensure all subbasin program juvenile release goals are met. The Clearwater summer Chinook salmon broodstock is managed separately, as a different stock. Generally speaking, the broodstock number (collection number) in Table 2 represents the number of adults needed at the location where the juveniles will be reared. After egg incubation, some eggs are transferred to be reared and released at a different facility. Overall, the collection number goal for all spring Chinook salmon programs (approximately 5,100 fish) is combined in Table 2, below. However, because they are operating as a complex, the numbers of adults trapped at specific facility which contribute to the 5,100 fish broodstock target may vary from numbers provided in the table. The summer Chinook salmon broodstock goal is about 434, as shown below in the table. The ratio of non-*U.S.* v. *Oregon* spring/summer Chinook salmon in the program may also change on an annual basis since the *U.S.* v. *Oregon* spring Chinook salmon production needs would be priority to meet agreement production needs.

In the event that broodstock needs for spring Chinook salmon in the Clearwater Basin facilities cannot be met, Clearwater Basin programs (excluding summer Chinook salmon) can be made up of excess Rapid River and Hells Canyon spring Chinook salmon. If this occurs, project operators will include these data in the annual reports submitted to NMFS.

Table 2. Broodstock collection plans for the four spring/summer Chinook salmon and one coho salmon hatchery program*. DNFH=Dworshak National Fish Hatchery; KNFH=Kooskia National Fish Hatchery; NPTH=Nez Perce Tribal Hatchery; CFH= Clearwater Fish Hatchery.

Program	Origin[1]	Collection Location(s)	Collection Method[2]	Collection Number*	Collection Duration	pNOB
KNFH	Clearwater River Stock[3]	Clear Creek (tributary to main stem Clearwater River)	Weir and trap	600 spring Chinook	May-August	0
CFH	Clearwater River Stock[3]	Red River Trap, Crooked River Trap, Powell Trap, DNFH, KNFH	Weirs (Red River, Crooked River, Powell (for summer Chinook salmon)), traps (DNFH, KNFH), and seine (Red River)	2,275 spring and 434 summer Chinook	May-Mid September	0

NPTH	Clearwater River Stock[3]	NPTH; Lolo and Newsome Creek Weirs	Fish ladder (NPTH), weirs (Lolo and Newsome Cr.)	478 spring Chinook	First week of May through third week of September[4]	0
DNFH	Clearwater River Stock[3]	DNFH[5]	Fish ladder and hook and line	1782 spring Chinook[6]	June-July[7]	0
Clearwater coho (Kooskia and Dworshak)[8]	Tanner and Eagle Creek Stocks[9]	Lapwai Creek Weir, Clear Creek, KNFH, DNFH	Weirs (Lapwai Cr. and Clear Creek), fish ladder (DNFH), trap (KNFH)	1,200 coho	October-December	0

[*]Because the spring Chinook salmon Clearwater broodstock is managed as one stock, these are approximate collection numbers that are occurring at each facility. However, one facility may end up capturing more fish to use for brood at another facility to ensure all subbasin program goals are met, with the exception of summer Chinook salmon.
[1] All spring Chinook salmon Clearwater stocks are managed as a single unit, with the exception of summer Chinook salmon.
[2]Primary collection methods are weirs, traps, and fish ladders for all collection locations except for secondary collection methods of a seine in Red River (Clearwater), and angling (at DNFH). In 2013 and 2017, hook and line collection methods were also used at DNFH, and the seine was used in Red River in 2017.
[3] Locally adapted stock consists primarily of Rapid River lineage.
[4]At Lolo and Newsome Creek weirs, collection occurs during time specified or until zero adults are trapped during seven consecutive days.
[5] During years when runs are low and expectations of meeting broodstock needs are uncertain, adults may be collected continuously to meet program goals. During expected high return years, trapping is delayed until mid-June in support of Tribal and sport fisheries.
[6] This number includes the eggs collected at DNFH for the NPTH transfers (152 and 138, respectively).
[7] Ladder may open early or stay open longer depending on broodstock targets, return timing, and strength of return.
[8] Broodstock collection (Collection Number) and collection activities (Collection Location and Methods) associated with the Clearwater coho program including the use of weirs has already been evaluated for effects and authorized through NMFS' 2017 Mitchell Act Biological Opinion (NMFS 2017a).
[9] Tanner Creek stock is from Bonneville Hatchery and Eagle Creek stock is from Eagle Creek Hatchery. These have been the broodstock sources for the recent history (past 6 years-with the exception of 2015 broodstock that have been collected from returns to the Snake/Clearwater River).

Weirs/Trapping and Release Locations

The following information is from a combination of the HGMPs, AOPs, and a draft Biological Assessment (BA) (HDR and USFWS 2017).

Nez Perce Tribal Hatchery (NPTH)

Trapping of adult spring Chinook salmon for broodstock occurs at the NPTH permanent fish ladder at river kilometer (RKM) 35.7 (river mile [RM] 22.2) of the Clearwater River, at seasonal weirs at RKM 21.0 (RM 13.1) and RKM 50.5 (RM 31.4) on Lolo Creek, and at RKM 0.1 (RM 0.1) on Newsome Creek in the South Fork Clearwater River watershed. Fish collected at the weirs are transported to the NPTH for holding, spawning, incubation, and rearing. These weirs are associated with facilities that operate May through September for spring Chinook salmon collection. During trapping season, the weirs are operated 24 hours, 7 days a week.

Juvenile fish are released as smolts directly into the Clearwater River from the hatchery and in the Lolo Creek watershed. Presmolts are released into the Lolo Creek watershed at the Yoosa/Camp Satellite facility at RKM 4.6 (RM 2.9) on Yoosa Creek, and into the South Fork. Clearwater River watershed at the Newsome Creek Satellite facility at RKM 10.9 (RM 6.8) of Newsome Creek. Parr are released into the Selway River watershed in the lower 32 km (20 miles) of Meadow Creek, and in the Upper Selway River near RKM 130 (RM 80.8). Presmolts acclimated at the Yoosa/Camp and Newsome Creek Satellite facilities are volitionally released over a 1-2 week period. Parr are directly released into Meadow Creek from trucks, or by helicopter, with no acclimation. Parr released in the Upper Selway River are reared at DNFH.

Clearwater Fish Hatchery (CFH)

Spring Chinook salmon broodstock are collected in the South Fork Clearwater River watershed at seasonal weirs at the Crooked River trap at RKM 1.0 (RM 0.6) of the Crooked River, and at the Red River Satellite at RKM 27.0 (RM 16.8) of the Red River. These traps are operated daily and fish are passed every day during operation. Broodstock are also collected in the North Fork Clearwater River watershed at DNFH at approximately RKM 1.0 (RM 0.6) on the North Fork Clearwater River, in the Middle Fork Clearwater River watershed at KNFH at RKM 1.0 (RM 0.6) on Clear Creek. Summer Chinook broodstock is collected in the Lochsa River watershed at the seasonal weir located at the Powell Satellite facility on Walton Creek. Fish trapped at the Crooked River facility are transported daily to the Red River Satellite facility, then are subsequently transferred to CFH. Fish trapped at KNFH are transported to either the CFH or DNFH at the confluence of the North Fork and mainstem Clearwater Rivers (RKM 65 [RM 40.4] of the Clearwater River) for holding, spawning, incubation, and rearing. Eggs from fish spawned at DNFH are transferred to CHF for final incubation and rearing. Fish trapped at the Powell Satellite facility are spawned there, and green eggs are transported to CFH. Similarly, broodstock collected at DNFH may be spawned there before green eggs are transported to CFH.

Juvenile spring Chinook salmon are transported and released as smolts in the South Fork Clearwater River at the Red River Satellite facility, in the Middle Fork Clearwater River at KNFH on Clear Creek, and in the Lower Selway River. Smolts released into the North Fork Clearwater which have been reared on North Fork Clearwater River water for the full rearing cycle are pumped directly from raceways into the river. Smolts transported to the Red River satellite facility are acclimated four to eight hours prior to release. The majority (600k) of smolts released at Kooskia NFH are acclimated 10-14 days. The remainder (120K) are directly released into Clear Creek. Smolts released into the Lower Selway are directly released.

In addition to spring Chinook salmon, a program was initiated in 2009 to develop a locally-adapted summer Chinook salmon stock with a run timing more similar to the historically documented wild Clearwater River Chinook salmon. Initially, eggs from the South Fork Salmon River program at McCall Hatchery were incubated and reared at the CFH, and smolts were transported and released in the Lower Crooked River in the South Fork Clearwater River watershed. Egg transfers from the South Fork Salmon River will be replaced by locally-adapted broodstock. However, if CFH fails to meet broodstock needs from the local returns, eggs from summer Chinook salmon adults in excess of brood or conservation needs in the South Fork Salmon River may be used to fill the shortage. Smolts released into the Lochsa River watershed at the Powell Satellite facility are acclimated four to eight hours prior to release.

Dworshak National Fish Hatchery (DNFH)

Broodstock are collected from the fish ladder that enters DNFH from the North Fork Clearwater River. All holding, spawning, incubation, and rearing occur at DNFH. Smolts are released from the hatchery directly into the North Fork of the Clearwater River, just upstream from the confluence with the mainstem or in the mainstem Clearwater River should conditions necessitate. . Parr that are part of the NPTH program are transported to NPTH where they are reared to smolt and released into the mainstem Clearwater and Lolo Creek watershed. One group of parr are transported and released in the Upper Selway River. There is no trapping or fish passage facility at Dworshak Dam on the North Fork Clearwater River, just upstream of the DNFH.

Kooskia National Fish Hatchery (KNFH)

Broodstock are collected at the permanent weir and trap on Clear Creek at the KNFH and transported to DNFH for holding and spawning. At spawning eggs are returned to the KNFH for incubation and rearing. All juvenile fish are reared on Clear Creek water and reuse well water and released directly from the KNFH as smolts into Clear Creek.

Coho broodstock are collected at the seasonal weir on Lapwai Creek, at DNFH, and at KNFH. Spawning occurs at KNFH or DNFH, with incubation and rearing occurring at both KNFH and DNFH. Juvenile fish reared at KNFH and DNFH are acclimated at KNFH and released as smolts directly into Clear Creek. Broodstock collection for coho at DNFH and KNFH is covered under the Mitchell Act Biological Opinion (NMFS 2017a).

1.3.2. Proposed hatchery rearing and juvenile release

The co-managers will release juvenile Snake River spring/summer Chinook and coho salmon consistent with the numbers, stages, release locations, and markings described in Table 3, below. Juvenile release levels will be dependent on obtaining adequate returns of broodstock, maintaining adequate facility rearing space, and funding. See Section 1.3.3 (Disposition of excess juvenile and adult hatchery fish) for overall release language for juveniles.

Prior to hatching, dead eggs are removed on a regular schedule (approximately two times per week) to discourage the spread of fungus. ELISA[4] optical density values for broodstock females are used to establish bacterial kidney disease (BKD) management criteria for egg culling and/or segregation needs. 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, for Clearwater Fish Hatchery and from the

[4] "Enzyme-linked immunosorbent assay"; the method used to detect *Renibacterium salmoninarum* (the causative agent of bacterial kidney disease) in salmonids.

USFWS's Pacific Region Fish Health Program (PRFHP) office located at DNFH for DNFH, KNFH, and NPTH programs. Additionally, the Clearwater Coho Restoration Program (CCRP) contracts with the PRFHP to provide a fish health specialist who monitors fish health monthly. Prior to release, a pre-release fish health inspection is conducted for their respective hatcheries. All fish production is conducted according to the USFWS - National Fish Health Policy, Pacific Northwest Fish Health Protection Committee (PNFHPC) - Model Program, and Integrated Hatchery Operations Team (IHOT) policies and guidelines.

In general, the spring Chinook salmon programs operate separately; however, because the broodstock sources all have Clearwater and/or Rapid River heritage, co-managers regularly transfer eggs and/or broodstock between the programs to achieve release goals.

For all programs in the Proposed Action, the number of fish spawned and eggs taken is currently based upon the most recent five-year running average of survival from green egg-to-smolt release. In addition, these hatcheries may take more eggs if another Clearwater basin Chinook salmon program is below production levels. Surplus eggs for spring/summer Chinook salmon may be generated (~10% above need) if average survival during hatchery rearing is above the average used to estimate broodstock needs. Broodstock may also be collected to transfer eggs to Rapid River and Hells Canyon fish hatcheries in the event of a shortage in those programs. See Section 1.3.1 above for detailed language regarding transfers. If broodstock calculator is modified for future use, it will be agreed upon through the AOP process and ensure that goals are met and excess adult collection and egg retention are avoided.

Table 3. Proposed annual release protocols for each program. AD=adipose fin clip; CWT = coded-wire tag; PIT = passive integrated transponder tag; PBT=Parental-Based Tagging. DNFH=Dworshak National Fish Hatchery; KNFH=Kooskia National Fish Hatchery; CFH= Clearwater Fish Hatchery; NPTH=Nez Perce Tribal Hatchery.

Program	Life Stage, Size and Number	Marking and Tagging[1]	Egg Incubation Location	Rearing Location	Acclimation Site; Duration	Volitional Release?	Release Location	Release Time
KNFH	650,000 smolts; 24 fpp	All AD except first 50,000 (no-AD); 100,000 CWT; 8,000 PIT; 100% PBT	KNFH/DNFH	KNFH	Reared in ambient water at KNFH	No	Clear Creek	Late March-early April
CFH	1,280,000 smolts; 16 fpp	100% AD; 120,000 AD+CWT; 17,100 PIT; 100% PBT	CFH	CFH	Red River; up to 14 days but generally less than 10 hours	No	Red River	Mid-March to mid-April
	400,000 smolts; 16 fpp	66% AD; 33% CWT only; 4.3% PIT; 100% PBT	CFH	CFH	Direct stream release-no acclimation	No	Lower Selway River	Mid-March to mid-April
	720,000 smolts; 16 fpp	100% AD; 17% AD+CWT; 1.3% PIT; 100% PBT	CFH	CFH	KNFH; up to 14 days	No	Clear Creek	Mid-March to mid-April
	750,000 smolts; 16 fpp	100% AD; 120,000 AD+CWT; 2.3% PIT; 100% PBT	CFH	CFH	Reared on NF Clearwater River (at CFH)	No	North Fork Clearwater R.	Mid-March to mid-April
	600,000 smolts (summer Chinook); 16 fpp	180,000 AD only; 120,000 (50%) AD+CWT, 120,000 CWT only; 180,000 No AD/No CWT; 25,500 PIT; 100% PBT	CFH	CFH	Powell; held in acclimation pond 6-8 hrs prior to release	No	Powell Satellite Facility (Walton Creek, Lochsa R.)	Mid-March to mid-April
NPTH[2]	400,000 fingerlings; 117 fpp	5,000 PIT; 100% PBT	NPTH	NPTH	None	No	Meadow Creek, Selway River	June-July

	150,000 fingerlings; 34 fpp	100% CWT only, 6,000 PIT; 100% PBT	NPTH	NPTH	Yoosa/Camp Satellite; late Aug/early Sept-until release	Yes	Yoosa/Camp Creek (at Lolo Creek)	October 1-15
	75,000 fingerlings; 29 fpp	100% CWT; 3,000 PIT; 100% PBT	NPTH	NPTH	Newsome Creek Satellite; September through October	Yes	Newsome Creek	October 1-15
	200,000 smolts; 20 fpp	67% CWT only; 33% AD+CWT; 600 PIT; 100% PBT	NPTH/DNFH	DNFH until Sept.	NPTH; September until release	Yes	Clearwater River at NPTH	April 1-15
	180,000 smolts; 20 fpp	33% AD+CWT; 67% AD; 1,000 PIT; 100% PBT	NPTH/DNFH	DNFH until Sept.	NPTH; September until release	No	Lolo Creek	April 1-15
DNFH	300,000 fingerlings; 100 fpp	100% PBT	DNFH	DNFH	No acclimation	No	Upper Selway River	August-September
	1,650,000 smolts; 20 fpp	100% AD; 120,000 AD+CWT; 42,000 PIT; 100% PBT	DNFH	DNFH	DNFH on NF River water from ponding to release	No	NF Clearwater River at DNFH	Late March-April
Clearwater (coho at DNFH and KNFH)	500,000 smolts; 20 fpp	16-50% CWT[3]; 100% PBT	KNFH; DNFH	KNFH; DNFH	KNFH; 3 weeks	No	Clear Creek	Late April or early May

[1] All marking (PBT, CWT and PIT tagging levels) may change based on budgets, evaluations needed, and cooperator agreement into the future. Changes for *U.S. v. Oregon* production will be approved through the process established in that forum, which includes coordination with NMFS' as a party to the agreement. Additionally, if a marking is a set number instead of a percentage, that marking number will not change regardless of the actual number of fish released.
[2] All fingerling production, 625,000, and the 200,000 smolts released from NPTH are funded by BPA. The 180,000 smolts released at Lolo Creek are funded by LSRCP.
[3] Range depends on funding levels for a given year.

1.3.3. Disposition of excess juvenile and adult hatchery fish

All hatcheries in the Clearwater Basin 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.

Clearwater Basin hatcheries use a “broodstock calculator”, which has several important benefits. First, limited trapping by hatcheries minimizes impacts on natural fish and also on area fisheries. Second, utilization of the most current in-hatchery performance data improves hatchery production accuracy over time. Last, common use of approved broodstock calculators has driven a more transparent and consistent approach to hatchery operations across all of the programs in the basin, regardless of operator or historical practice.

Within the framework of this adaptive management, Clearwater Basin managers support two operation flexibilities:

1. To ensure goals are met for parr, pre-smolt, and smolt spring/summer Chinook and coho salmon release groups, hatchery managers have agreed to target the release number as specified in the Proposed Action. These releases will not exceed 10 percent of the basin’s cumulative parr, pre-smolt, and smolt release number for any given year. This 10 percent cushion accounts for a variety of potential decreases in survival within the hatchery. Examples include 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, and many others. The cushion from 0-10 percent for each hatchery is recommended by the hatchery annually and approved by the basin managers as part of the AOP process.

2. For unanticipated surpluses of spring/summer Chinook salmon beyond the approved cushion, the Clearwater Basin hatcheries may outplant eyed eggs and/or unfed fry. Egg outplants will not exceed 20 percent of the basin’s cumulative juvenile release number for any given year. Egg outplanting is a rarity and is not a currently funded component of the LSRCP as part of their spring/summer Chinook program or of BPA funding as part of their NPTH program in the Clearwater Basin. Prior to egg outplanting, backfilling of other Clearwater Basin hatcheries and/or Rapid River/Hells Canyon Hatcheries may occur, to ensure program goals are met.

3. Clearwater coho (at Dworshak and Kooskia) fry and egg outplants released into Lolo Creek, Clear Creek, or the South Fork Clearwater River (depending on redd counts), may be released provided that no more than 20 percent (or 120 percent total) of the proposed juvenile release levels may occur in any year.

Currently, surplus adult production decisions will include notification to basin co-managers and include, but are not limited to the following:

- Transfer of surplus fish to other Clearwater subbasin programs to meet existing goals
- Recycling through active fisheries in the Clearwater
- Provision to NPT for subsistence and ceremonial use

- Provision to food banks or the public for human consumption
- Transportation to areas where Chinook salmon are not present to create fisheries within the Clearwater River Basin
- Outplanting as live fish to supplement natural spawning in the Clearwater
- Nutrient enhancement in local watersheds
- Provision to universities, government and state agencies, and other sources for scientific and educational purposes

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

Because natural-origin spring/summer Chinook and coho salmon in the Clearwater are not ESA-listed, the activities listed in Table 4 relate directly to the hatchery fish and programs in this Proposed Action. Activities that relate directly to these programs that require incidental take of fall Chinook salmon and steelhead will be evaluated further in Section 2.5.2.4 (i.e., Newsome and Lolo Creek Screw Traps).

Adverse effects on fall Chinook salmon and steelhead resulting from the implementation of program-related RM&E are expected to result, as considered in the Biological Opinion.

Table 4. Proposed RM&E for all hatchery programs.

Activity	Associated Program
Captured adults (at hatchery traps/weirs) are measured and examined for gender, various clips, tags, and marks then designated as broodstock or natural release. CWTs will be recovered. Genetic samples (tissue) are collected from all spawned adults to develop the PBT baseline. Data recorded includes: date, gender, length, origin (hatchery/natural), marks/tags, and disposition.	All programs in Proposed Action
Redd counts (spawning ground surveys) and carcass surveys are conducted to estimate number of redds and composition of spawners.	CFH and satellites; NPTH
Monitoring of survival metrics for all life stages in the hatchery from spawning to release.	All programs in Proposed Action
PIT tagging representative groups of juvenile Chinook salmon to estimate migration timing, outmigration survival rate, and adult returns. Adult PIT detections in the mainstem Columbia River and Lower Snake River dams are used to inform in-season fisheries management.	All programs in Proposed Action
Coded-wire tagging representative groups of juveniles to estimate harvest in mixed stock fisheries downstream of Idaho. Stock composition of harvest in Idaho fisheries is estimated using PBT.	All programs in Proposed Action
Genetic samples are collected from all spawned adults to develop the PBT baseline.	All programs in Proposed Action
Rearing density evaluation study in-hatchery portion is completed. This study will now use Adult returns from BY2012, BY2013, and BY 2014 releases (return years from 2015 to 2019) to determine the best rearing strategy to return the most adults at this hatchery. Based on this information, production may	DNFH

remain at current levels (at increased densities) or be reduced based on traditional densities.	
Monitoring of juvenile spring/summer Chinook salmon releases from NPTH through Newsome and Lolo Creek Screw Traps.	NPTH

1.3.5. Proposed operation, maintenance, and RM&E of hatchery facilities

Water at all facilities is withdrawn in accordance with state-issued water rights (Table 5). All facilities that rear over 20,000 pounds of fish operate comply with the National Pollutant Discharge Elimination System (NPDES) through a general permit issued by the United States Environmental Protection Agency (Table 5). DNFH facility details and analysis are not included in this consultation, as they will be analyzed in NMFS (2017b). The LSRCP is in the process of reviewing all of its facilities for compliance with the most recent NMFS screening criteria (NMFS 2011); reports have been drafted for most facilities. Following the assessment of all facilities, the LSRCP will initiate discussions with NMFS, facility operators, and co-managers to determine relative risks to listed species and the various LSRCP hatchery programs based on compliance concerns. Using this information as a backdrop, a strategy to prioritize and schedule facility upgrades will be developed and implemented contingent upon the availability of funding. Because these upgrades are not yet fully designed or scheduled, and are not included as part of the Proposed Actions, they are not included in the current analysis, and will undergo any necessary ESA section 7 consultation separately.

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 by the co-managers 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, the operators will comply with the following criteria:

- 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 (i.e., in annual reports)
- 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 at least 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 5. Facility details for those facilities that divert water for hatchery operations. (N.F.: North Fork; M.F.: Middle Fork)

Facilities	Average Surface Water Used (cfs)[1]	Ground Water (cfs)	Water Diversion Distance (km)	Surface water source	Discharge Location	Instream Structures	Meet NMFS Screening Criteria	NPDES Permit?	Water Rights Permit
KNFH	13 cfs	0.67	1.6 (upstream of main hatchery facility)	Clear Creek (90%) or wells	Clear Creek and one into the Middle Fork Clearwater River	1: intake weir on Clear Creek 2: out flow weir on Clear Creek, out flow from sediment pond into Clearwater River	No	Yes, IDG131004	Surface 81-02028 16 cfs Well #1 81-02035 1.91 cfs Well #5 81-02034 1.14 cfs
CFH	64 cfs	0	3	Dworshak Reservoir	North Fork Clearwater River	2: Intake; Outfall	Not required[2]	Yes, IDG131002	85-07593; 89 cfs
Red River Satellite	3 cfs	0	0.22	South Fork of Red River	Red River	4: Intake; Outfall; Ladder; Weir	*see below	Not required	82-07048, 3.18 cfs; 82-071568, 5 cfs
Crooked River Satellite	2.5 cfs	0	0.16	Crooked River	Crooked River	4: Intake; Outfall; Ladder; Weir	*see below	Not required	82-07185, 10 cfs total (4/1-6/30 10.0 cfs, 7/1-10/1 6.0 cfs)
Powell Satellite	5.0 cfs	0	0.15	Walton Creek	Walton Creek	4: Intake; Outfall; Ladder; Weir	*see below	Not required	81-07119, 6.24 cfs

	0	0	0.8	Colt Killed Creek	Walton Creek	1: Emergency Pump Station			81-07118, 2.67 cfs[3]
NPTH Facility (at Cherrylane)	5-6 cfs	3.85 cfs	0.018	Clearwater River	Clearwater River	3: Intake; Outfall; Ladder	Yes	Not required	86-7371, 7.0 cfs
Sweetwater Springs (Rearing Facility)	0 cfs	3.44 cfs	0.20	Sweetwater Springs	Sweetwater Creek	2: Intake	Not required[4]	Not required	86-7372, 3.85 cfs
Yoosa/Camp (Acclimation Facility)	Yoosa Cr.- 2.5 cfs; Camp Cr.- 1.91 cfs	0	Yoosa Cr.- 0.15; Camp Cr.- 0.20	Yoosa Creek; Camp Creek	Lolo Creek	6: Intakes (2); Outfall; Water Diversion Structure; Weir	Yes	Not required	Yoosa Cr.- 84-7302, 2.5 cfs; Camp Cr.- 84-7303, 1.91 cfs
Newsome (Acclimation Facility)	1.70 cfs	0	0.4	Newsome Creek	Newsome Creek	4: Intake; Outfall; Water Diversion Structure; Weir	Yes	Not required	82-7205, 1.7 cfs

[*] The 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 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.

[1]Average surface water used at each facility with the exception of Yoosa/Camp and Newsome. Averages are not available at these facilities so full water right is shown here instead.

[2]Clearwater Fish Hatchery was not included in the LSRCP assessment, as the only structures in use that could be evaluated are the intakes, and they are in the reservoir with no mechanism to affect anadromous fish (i.e., lack of ladder, trap, weir, or intake in anadromous waters).

[3] This serves as an emergency water source in case water supply from Walton Creek is interrupted.

[4]NMFS inspected this site in 2002 and determined that no screening is required.

Emergency contingency plan for early releases

In the event of an emergency, such as flooding, water loss to raceways, epizootic outbreak, or vandalism that necessitates early release of spring/summer Chinook salmon and coho salmon to prevent catastrophic mortality, any such release shall be reported ahead of time (if possible), or within 48 hours to NMFS.

1.4. Interrelated and Interdependent Actions

Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration. NMFS has not identified any interdependent or interrelated activities associated with the proposed action.

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

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 2008c). The impacts of fisheries in the action area, including those that may target fish produced by the proposed programs, on ESA-listed salmonids returning to the action area for this opinion are included in the environmental baseline.

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

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

2.1. Analytical Approach

This biological opinion includes both a jeopardy analysis and/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. In this biological opinion, we use the term PCE as equivalent to PBF or essential feature, due to the description of such features in applicable recovery planning documents, as appropriate for the specific critical habitat.

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

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 2.4 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 2.5) 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. Rangewide 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 6). 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 6. Federal Register (FR) 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 *(Oncorhynchus tshawytscha)*			
Snake River spring/summer-run	Threatened, 79 FR 20802, April 14, 2014	64 FR 57399, October 25, 1999	70 FR 37160, June 28, 2005
Snake River fall-run	Threatened, 79 FR 20802, April 14, 2014	58 FR 68543, December 28, 1993	70 FR 37160, June 28, 2005
Sockeye salmon *(O. nerka)*			
Snake River	Endangered, 79 FR 20802, April 14, 2014	70 FR 52630, September 2, 2005	Described per ESA Section 9
Steelhead *(O. mykiss)*			
Snake River Basin	Threatened, 79 FR 20802, April 14, 2014	70 FR 52769, September 2, 2005	70 FR 37160, June 28, 2005

"Species" Definition: The ESA of 1973, as amended, 16 U.S.C. 1531 *et seq.* defines "species" to include any "distinct population segment (DPS) of any species of vertebrate fish or wildlife which interbreeds when mature." To identify DPSs of salmon species, NMFS follows the "Policy on Applying the Definition of Species under the ESA to Pacific Salmon" (56 FR 58612, November 20, 1991). Under this policy, a group of Pacific salmon is considered a 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.

The two Chinook salmon species listed in Table 6 each constitute an ESU (a salmon DPS) of the taxonomic species *Oncorhynchus tshawytscha*, Snake River sockeye salmon constitute an ESU of the taxonomic species *Oncorhynchus nerka*, and Snake River steelhead listed constitute a DPS of the taxonomic species *Oncorhynchus mykiss*, and as such each ESU or DPS is considered a "species" under the ESA.

2.2.1. Rangewide Status of Listed Species and Critical Habitat

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, 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).

In order to describe a species' status, it is first necessary to define what the term "species" means in this context. In addition to defining "species" as including an entire taxonomic species or subspecies of animals or plants, the ESA also recognizes listing units that are a subset of the species as a whole. As described above, the ESA allows a DPS (or, in the case of salmon, an ESU) of a species to be listed as threatened or endangered. While determining the status of a species, the Willamette Lower Columbia TRT (WLC TRT) developed a hierarchical approach for determining ESU-level viability criteria (Figure 3) that represents best available science and is used for the purposes of this Opinion.

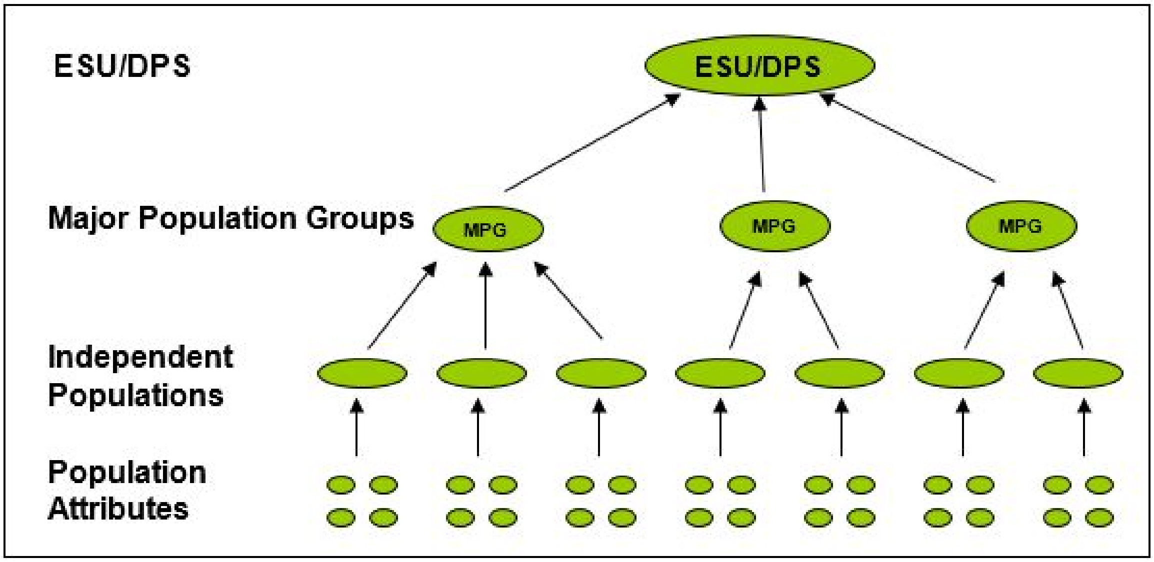

Figure 3. Hierarchical approach to ESU viability criteria.

Briefly, an ESU or DPS is divided into natural populations (McElhany et al. 2000). The risk of extinction of each population is evaluated, taking into account population-specific measures of abundance, productivity, spatial structure and diversity. Natural populations are then grouped into ecologically and geographically similar *strata* (referred to as MPG) which are evaluated on the basis of population status. In order to be considered viable, an MPG generally must have at least half of its historically present natural populations meeting their population-level viability criteria (McElhany et al. 2006). At the MPG-level, each of the ESU's MPGs also must be viable. A viable salmonid ESU or DPS is naturally self-sustaining, with a high probability of persistence over a 100-year time period.

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

The description of species statuses in this document starts with a description of the general life history characteristics and the population structure of the ESU or DPS including the MPGs where they occur. We review VSP information that is available including abundance, productivity and trends (information on trends supplements the assessment of abundance and productivity parameters), and spatial structure and diversity. We also summarize available estimates of extinction risk that are used to characterize the viability of each natural population leading up to a risk assessment for the ESU or DPS, and the limiting factors and threats. This section concludes by commenting on the status of critical habitat.

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

The following life history and status sections are primarily written using information from the 2017 Mitchell Act Biological Opinion Consultation (NMFS 2017c) and the Northeast Oregon Steelhead Biological Opinion.

2.2.1.1. **Life-History and Status of Snake River Spring/summer-Run 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). Many factors affect the abundance, productivity, spatial structure, and diversity of the Snake River Spring/summer Chinook Salmon ESU. Factors that limit the ESU's survival and recovery include migration through the Federal Columbia River Power System (FCRPS) dams, the degradation and loss of estuarine areas that help fish transition between fresh and marine waters, spawning and rearing areas that have lost deep pools, loss of cover, reductions in side-channel refuge areas, reductions in high-quality spawning gravels, and interbreeding and competition with hatchery fish that may outnumber natural-origin fish (Ford 2011). The most serious risk factor is low natural productivity (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. A more detailed description of the populations that are the focus of this consultation follows.

There are five MPGs (Grand Ronde/Imnaha, Lower Snake, Middle Fork Salmon, Upper Salmon, and South Fork Salmon) in the Snake River Spring/summer Chinook Salmon ESU. The hatchery programs in this Opinion do not directly affect any of the populations in these MPGs except for when all fish out migrate and mingle in the lower Snake River migration corridor, and when/if the hatchery fish stray into these listed populations (i.e., South Fork Salmon River population in the South Fork Salmon MPG). The overall viability ratings for each of the MPGs is either at "high" or "high risk", with the majority being the latter. All five MPGs have low or moderate risk levels for the majority of the populations in the ESU (NWFSC 2015).

There are six extant independent populations of spring/summer Chinook salmon within the Grande Ronde/Imnaha MPG: Wenaha River, Lostine River, Minam River, Catherine Creek, Upper Grande Ronde River, and the Imnaha River. The remaining two populations, Lookingglass and Big Sheep Creeks, are functionally extirpated (Figure 4). The ICTRT criteria call for a minimum of four populations at viable or highly viable status. The potential scenario identified by the ICTRT (2007) would include viable populations in the Imnaha River (run timing), the Lostine/Wallowa River (large size) and at least one from each of the following pairs: Catherine Creek or Upper Grande Ronde (large size); and Minam or Wenaha Rivers. The most recent status review by NMFS (NWFSC 2015) maintains that all extant populations remain at high risk of extinction (Table 7).

There are two independent populations within the Lower Snake River MPG: Tucannon River and Asotin Creek. The ESA Recovery Plan for SEWA (SRSRB 2011) requires that the Tucannon River population be at low risk (no more than a 1 percent risk of extinction in 100 years). The Tucannon River population is required to meet highly viable status for delisting of the ESU because the Asotin Creek population is extirpated. The most recent status review by NMFS (NWFSC 2015) maintains that the Tucannon population remains at high risk (Table 7).

There are nine independent populations within the Middle Fork Salmon River MPG: Bear Valley, Lower Middle Fork Salmon, Upper Middle Fork Salmon, Marsh, Sulphur, Loon, Camas, Big, and Chamberlain Creeks. According to NWFSC (2015), all of these populations except for Chamberlain Creek are at high risk for overall viability (Chamberlain is rated at maintained due to an increased abundance). For recovery, the ICTRT criteria call for at least five of the nine populations in this MPG to be rated as viable, with at least one demonstrating highly viable status.

In the Upper Salmon MPG, there are nine independent populations: Lower Salmon Mainstem, Lemhi River, Pahsimeroi River, Upper Salmon Mainstem, East Fork Salmon, Valley Creek, Yankee Fork, North Fork Salmon, and Panther Creek. However, the Panther Creek population is considered functionally extirpated. All other populations are considered high risk for an overall viability rating. The ICTRT recovery criteria include the Pahsimeroi River (summer Chinook life history), the Lemhi River and Upper Salmon Mainstem (very large size category), East Fork Salmon River (large size category), and Valley Creek (NWFSC 2015). All other populations should be at or above maintained status.

The South Fork Salmon MPG includes four independent populations: South Fork Salmon River, Secesh River, East Fork of the South Fork Salmon River, and the Little Salmon River. Currently, all four populations are considered high risk for an overall viability rating. The ICTRT recommends that two of the four historical populations in this MPG should be restored to viable or highly viable status. Additionally, the ICTRT recommends that the populations in the South Fork drainages should be given priority relative to meeting MPG viability objectives given the relatively small size and high level of potential hatchery integration for the Little Salmon River population (NWFSC 2015).

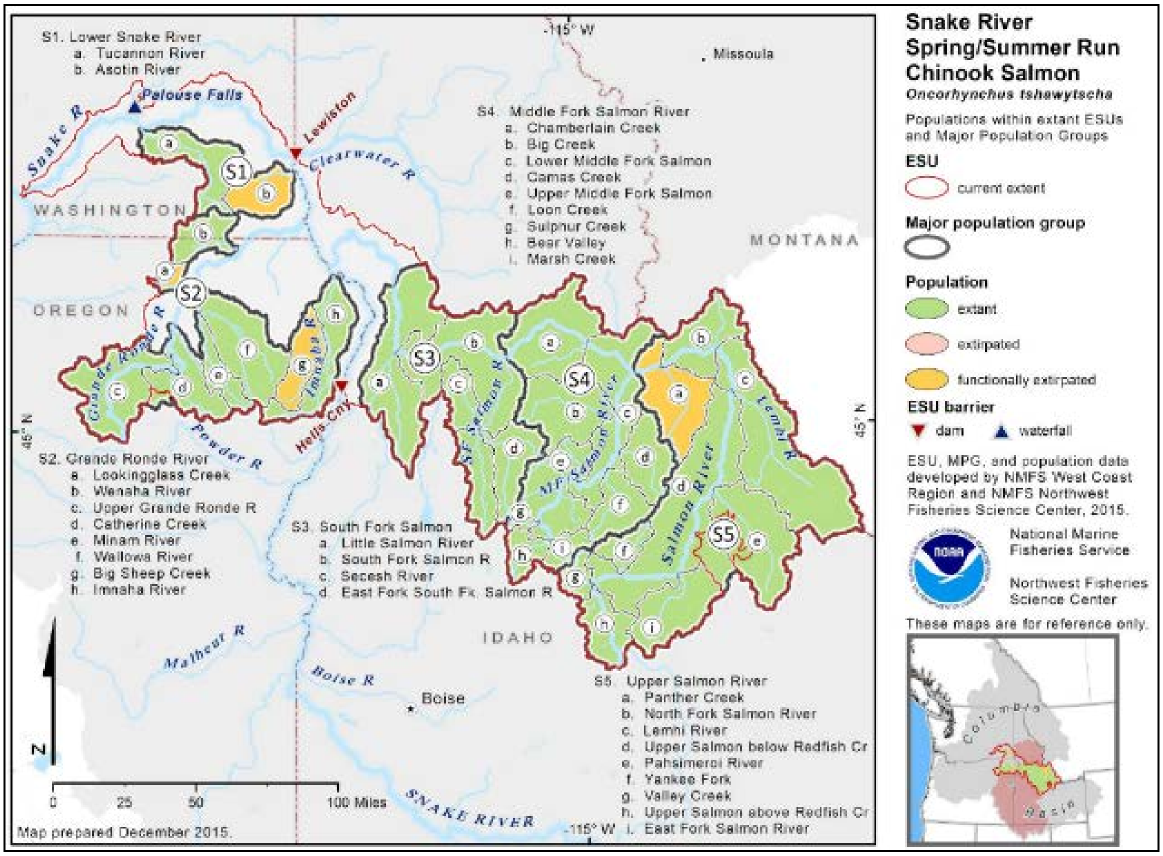

Figure 4. Snake River Spring/summer-Run Chinook Salmon ESU spawning and rearing areas, illustrating natural populations and MPGs (NWFSC 2015).

Table 7. 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. Shaded populations are the most likely combinations within each MPG to be improved to viable status. 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
Lower Snake River	Tucannon River	750	267 (0.19)	0.67	0.69 (0.23)	High	Moderate	High
	Asotin Creek	500				Extirpated		
Grande Ronde/Imnaha	Wenaha River	750	399 (0.12)	0.76	0.93 (0.21)	High	Moderate	High
	Lostine/Wallowa River	1,000	332 (0.24)	0.45	0.98 (0.12)	High	Moderate	High
	Lookingglass	500				Extirpated		
	Minam River	750	475 (0.12)	0.89	94 (0.18)	High	Moderate	High
	Catherine Creek	1,000	110 (0.31)	0.45	0.95 (0.15)	High	Moderate	High
	Upper Grande Ronde River	1,000	43 (0.26)	0.18	0.59 (0.28)	High	High	High
	Imnaha River	750	328 (0.21)	0.35	120 (0.09)	High	Moderate	High
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	7590	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
	Sulpher 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. **Life-History and Status of Snake River Fall-Run Chinook Salmon ESU**

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 two life histories; ocean-type and reservoir-type. The reservoir-type life history is likely a response to early development in cooler temperatures (mainly from fish that spawned in the Clearwater River), which prevents juveniles from reaching a suitable size to migrate out of the Snake River and on to the ocean. Juveniles exhibiting the reservoir-type life history overwinter in the pools created by the dams before migrating out of the Snake River.

The Snake River Fall-run Chinook Salmon ESU consists of a single MPG with one extant population; the 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, with a low risk for abundance/productivity and a moderate risk for spatial structure and diversity (Figure 5).

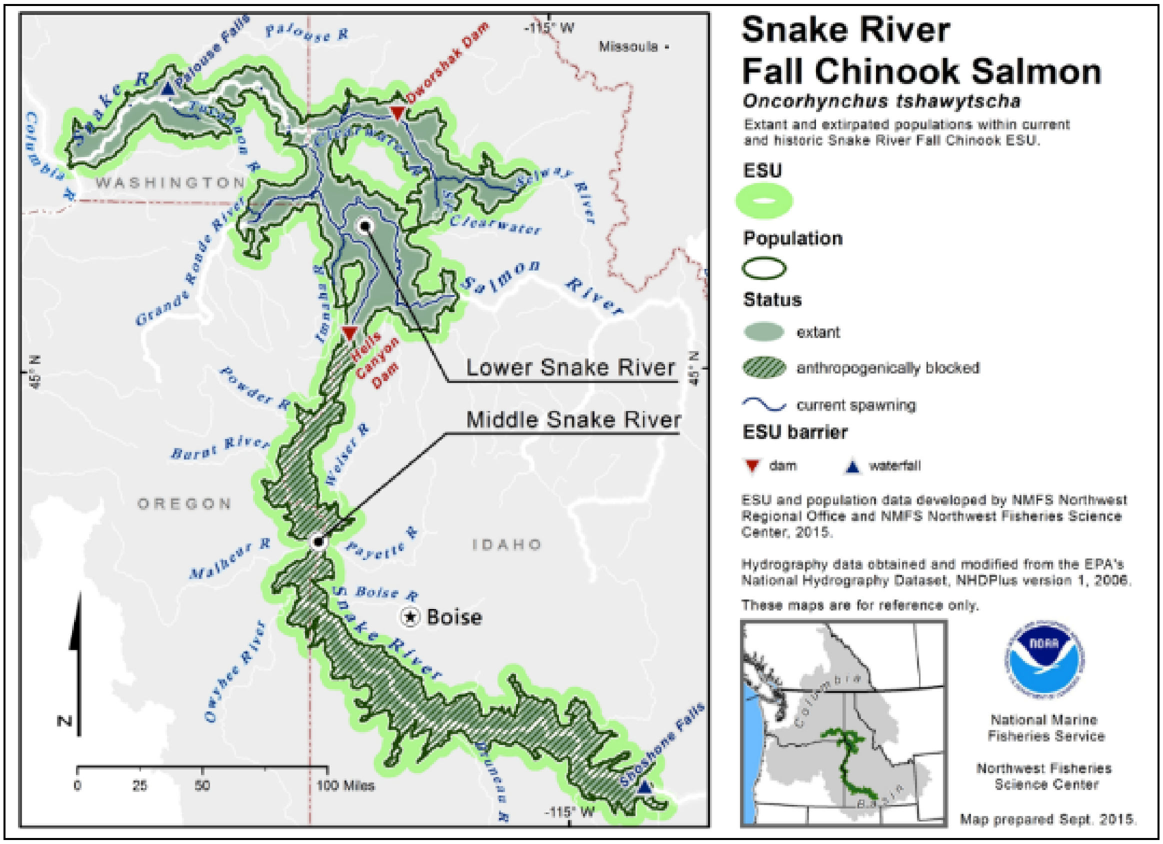

Figure 5. Map of the Snake River Fall-Run Chinook Salmon ESU's spawning and rearing areas, illustrating populations and MPGs (NWFSC 2015).

The Snake River Fall-run Chinook Salmon ESU remains at threatened status (NWFSC 2015) which is based on a low risk rating for abundance/productivity, and a moderate risk rating for spatial structure/diversity. Factors that limit the ESU's survival and recovery include: hydropower projects, predation, harvest, degraded estuary habitat, and degraded mainstem and tributary habitat (Ford 2011). Ocean conditions have also affected the status of this ESU. Ocean conditions affecting the survival of Snake River fall-run Chinook salmon were generally poor during the early part of the last 20 years (NMFS 2012b).

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

Overall population viability rating for the Lower Mainstem Snake River fall Chinook salmon population is determined based on the combination of ratings for current abundance and productivity and combined spatial structure diversity. Based on this information, the population has been rated as “viable”, but the recovery plan identifies the need to meet or exceed minimum requirements for “highly viable” with a high degree of certainty (NWFSC 2015).

The recently released Proposed NMFS Snake River Fall Chinook Recovery Plan (NMFS 2015b) proposes that a single population viability scenario could be possible given the unique spatial complexity of the Lower Mainstem Snake River fall-run Chinook salmon population; the recovery plan notes that such scenario could be possible if major spawning areas supporting the bulk of natural returns are operating consistent with long-term diversity objectives in the proposed plan. Under this single population scenario, the requirements for a sufficient combination of natural abundance and productivity could be based on a combination of total population natural abundance and relatively high production from one or more major spawning areas with relatively low hatchery contributions to spawning, i.e., low hatchery influence for at least one major natural spawning production area. According to the most recent information available (i.e., escapements through 2014), there is no indication of a strong differential distribution of hatchery returns among major spawning areas, given the widespread distribution of hatchery releases and the lack of direct sampling of reach-specific spawner compositions.

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

2.2.1.3. **Life-History and Status of Snake River Sockeye Salmon ESU**

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 (Figure 6). 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 2015a).

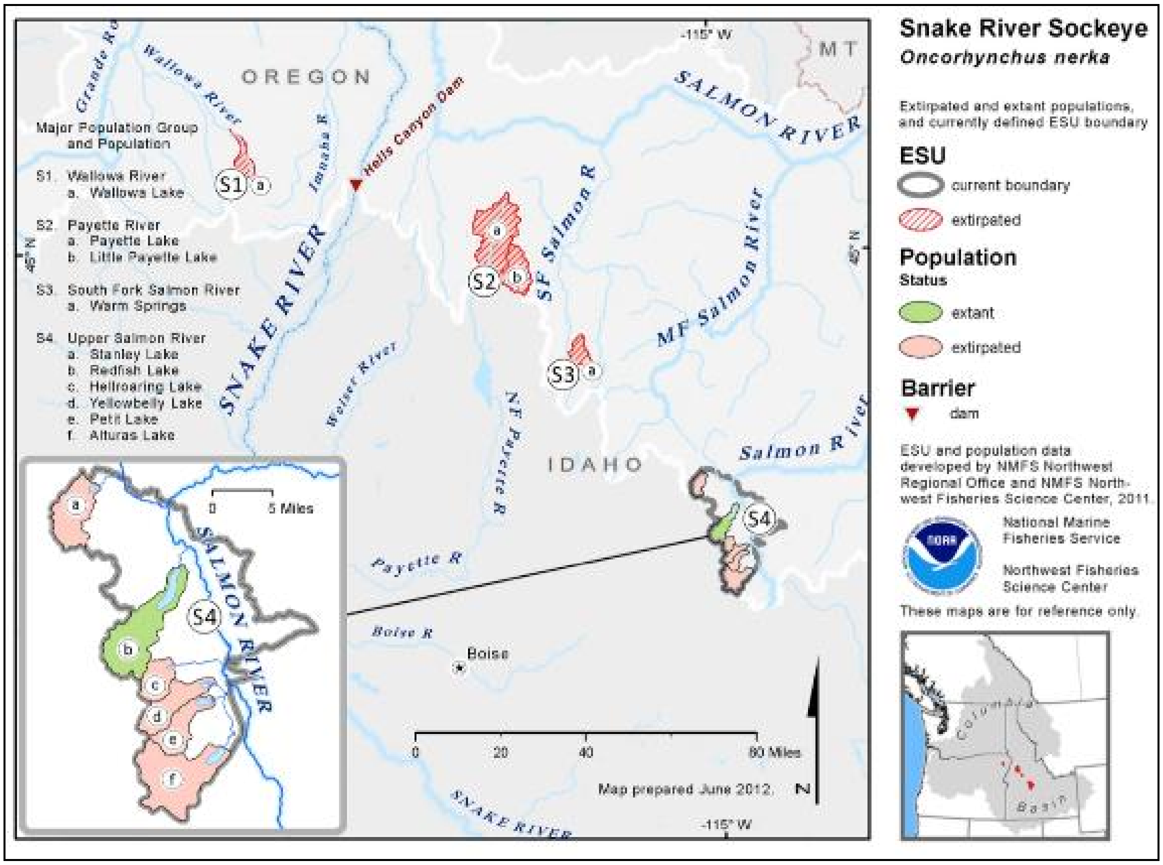

Figure 6. Map of the Snake River Sockeye Salmon ESU's spawning and rearing areas, illustrating populations and MPGs (NWFSC 2015).

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). At this stage of the recovery efforts, there is only one extant population, and 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 2015a).

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

Between 1999 and 2007, more than 355 adults returned from the ocean from captive brood releases – almost 20 times the number of natural-origin fish that returned in the 1990s (this total is primarily due to large returns in the year 2000). Adult returns in the last six years have ranged from a high of 1,579 fish in 2014 (including 453 natural-origin fish) to a low of 257 adults in

2012 (including 52 natural-origin fish). Sockeye salmon returns to Alturas Lake ranged from one fish in 2002 to 14 fish in 2010. No fish returned to Alturas Lake in 2012, 2013, or 2014 (NMFS 2015a).

The large increases in returning adults in recent years reflect improved downstream and ocean survivals, as well as increases in juvenile production, starting in the early 1990s. Although total sockeye salmon returns to the Sawtooth Valley in recent years have been high enough to allow for some level of natural spawning in Redfish Lake, the hatchery program remains at its initial phase with a priority on genetic conservation and building sufficient returns to support sustained outplanting and recolonization of the species historic range (NMFS 2015a; NWFSC 2015). Ford (2011) determined that the Snake River sockeye salmon captive broodstock-based program has made substantial progress in reducing extinction risk, but that natural production levels of anadromous returns remain extremely low for this species (NMFS 2012b).

At present, anadromous returns are dominated by production from the captive spawning component. The ongoing reintroduction program is still in the phase of building sufficient returns to allow for large scale reintroduction into Redfish Lake, the initial target for restoring natural program (NMFS 2015a). At this stage of the recovery efforts, the ESU remains rated at high risk for spatial structure, diversity, abundance, and productivity (NWFSC 2015).

Factors that limit the ESU have been, and continue to be, impaired mainstem and tributary passage, historical commercial fisheries, population level reduction as the result of chemical treatment of Sawtooth Valley lakes in the 1950s and 1960s, poor ocean conditions, Snake and Columbia River hydropower system, and reduced tributary stream flows and high temperatures. The decline in abundance itself has become a major limiting factor, making the remaining population vulnerable to catastrophic loss and posing significant risks to genetic diversity (NMFS 2015a; NWFSC 2015). However, some limiting factors have improved since the listing. Fisheries potentially impacting Snake River sockeye salmon are now better regulated through ESA constraints and management agreements, substantially reducing harvest-related mortality. Potential habitat-related threats to the fish, especially in the Sawtooth Valley, pose limited concern since most passage barriers have been removed and much of the natal lake area and headwaters remain protected. Hatchery-related concerns have also been reduced through improved management actions (NMFS 2015a).

2.2.1.4. **Life-History and Status of Snake River Basin 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. A non-anadromous form of *O. mykiss* (redband trout) co-occurs with the anadromous form in this DPS, and juvenile life stages of the two forms can be very difficult to differentiate. Steelhead can spend up to 7 years in fresh water prior to smoltification, and then spend up to 3 years in salt water prior to first spawning. This species can also spawn more than once (iteroparous), whereas all other species of *Oncorhynchus,* except *O. clarkii,* spawn once and then die (semelparous). Snake River steelhead are classified as summer-run because they enter the Columbia River from late June to October. After holding over the winter, summer steelhead spawn the following spring (March to May).

Factors that limit the DPS's survival and recovery include: juvenile and adult migration through the FCRPS; the degradation and loss of estuarine areas that help fish transition between fresh and marine waters; spawning and rearing areas that have lost deep pools, cover, side-channel refuge areas, high quality spawning gravels, and; interbreeding and competition with hatchery fish that outnumber natural-origin fish. A more detailed description of the populations that are the focus of this consultation follows.

There are six extant MPGs (Grande Ronde, Imnaha, Clearwater, North Fork Salmon, and Lower Snake River, and the Hells Canyon tributaries (which are no longer considered their own MPG)) in the Snake River Steelhead DPS. The ICTRT concluded that steelhead in small tributaries entering the mainstem Snake River below Hells Canyon Dam may have historically been part of a larger population with a core area currently cut off from anadromous access. That population would have been part of one of the historical upstream MPGs. According to NWFSC (2015), four out of the five MPGs (excluding Hells Canyon tributaries) are not meeting the specific objectives in the draft Recovery Plan based on the updated status information available for the review, and that status of many individual populations remain uncertain.

There are two independent populations within the Lower Snake River MPG: Tucannon River and Asotin Creek (Figure 7). The ESA Recovery Plan for southeast Washington (SRSRB 2011) requires that the Tucannon River population be at moderate risk and for the Asotin Creek population to be at low risk of extinction. The most recent status review (NWFSC 2015) found that the Tucannon River population remains at high risk, and the Asotin Creek population is maintained (Table 8). However, both populations have insufficient data on abundance and productivity to assess accurately these metrics.

There are four independent populations of steelhead within the Grand Ronde River MPG: Joseph Creek, Lower Grand Ronde River, Upper Grand Ronde River, and Wallowa River. The Draft ESA Recovery Plan for northeast Oregon (NMFS 2012a) requires that the Upper Grand Ronde and Wallowa River populations have a minimum of moderate risk, the Joseph Creek population maintain its current low risk status, and the Lower Grand Ronde population achieve low or moderate risk. Although these populations are close to achieving recovery requirements, there is a large amount of uncertainty in the data.

There is one independent population of steelhead within the Imnaha River MPG, the Imnaha River population. The Draft ESA Recovery Plan for northeast Oregon (NMFS 2012a) requires that the Imnaha River population achieve low risk. NMFS' status review (NWFSC 2015) found that information for this population is insufficient to be able to assess risk reliably, but estimates the population is most likely at moderate risk of extinction (Table 8).

The Proposed Action's greatest effect is expected to be on the Clearwater River MPG, especially in relation to spatial structure, abundance, and productivity. Based on the updated risk assessments, the Clearwater River MPG does not meet the ICTRT criteria for a viable MPG. Although the more explicit information on natural-origin spawner abundance indicates that, within this MPG, the Lower Clearwater, Lochsa, and Selway River populations are improved in overall status relative to prior reviews, and the South Fork Clearwater and Lolo Creek populations have not achieved maintained status due in part to uncertainties regarding productivity and hatchery spawner composition (NWFSC 2015).

The relatively large Salmon River MPG has six populations that have been prioritized for viable status in the draft Idaho Management Unit Recovery Plan. The recovery scenario in this recovery plan is consistent with the ICTRT recommendations and includes the two MF populations, the South Fork River, the Chamberlain Creek, the Panther Creek, and the North Fork Salmon River populations (NWFSC 2015).

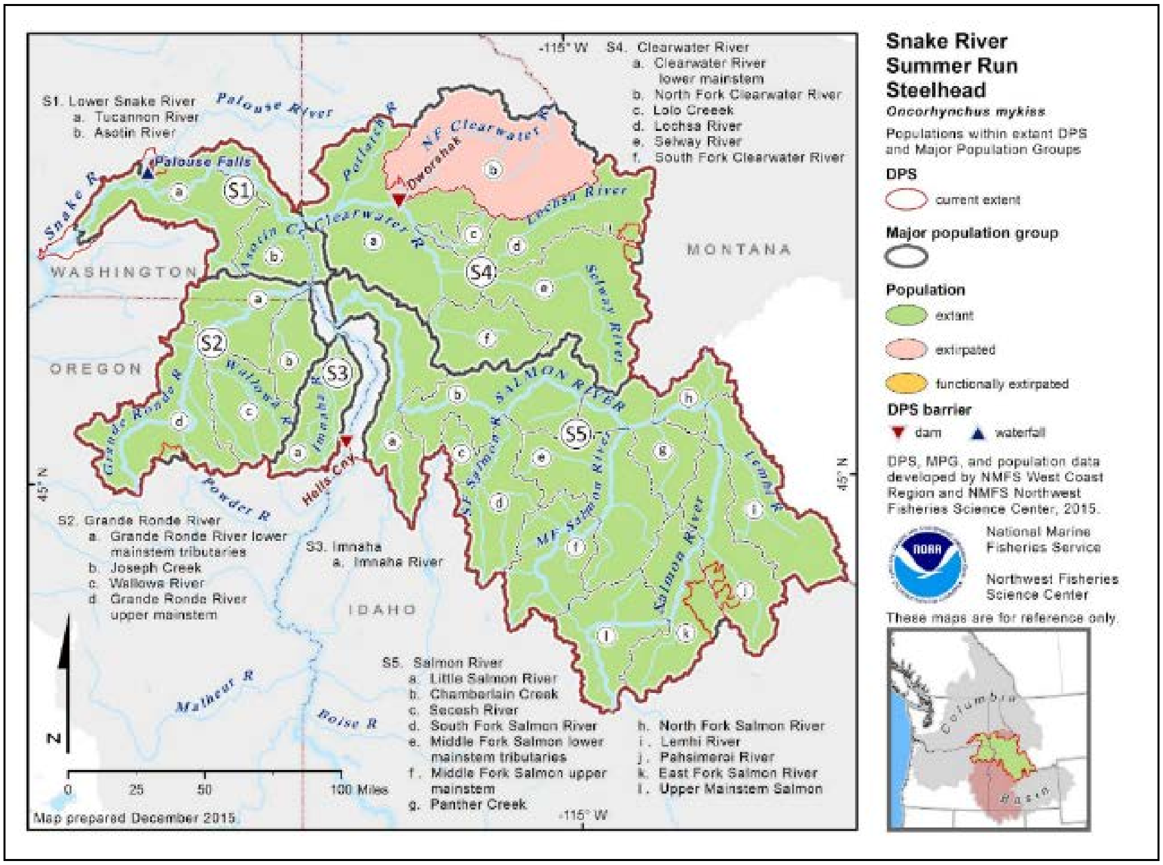

Figure 7. Snake River Basin Steelhead DPS spawning and rearing areas, illustrating natural populations and MPGs (NWFSC 2015).

Table 8. Risk levels and viability ratings for Snake River steelhead populations (NWFSC 2015). Parentheses indicate range. Data are from 2004-2015. ID = insufficient data; ICTRT = Interior Columbia Technical Recovery Team.

Population	ICTRT minimum threshold	Natural spawning abundance	Productivity	Abundance and productivity risk	Spatial structure and diversity risk	Overall risk viability rating

Tucannon River	1000	ID	ID	High[1]	Moderate	High[1]
Asotin Creek	500	ID[2]	ID	Moderate[1]	Moderate	Moderate[1]
Lo. Grande Ronde	1000	ID	ID	[1]	Moderate	Moderate[1]
Joseph Creek	500	1839	1.86	Very low	Low	Low
Up. Grande Ronde	1500	1649 (0.21)	3.15 (0.4)	Moderate	Moderate	Moderate
Wallowa River	1000	ID	ID	High[1]	Moderate	High[1]
Imnaha River	1000	ID	ID	Moderate[1]	Moderate	Moderate[1]

[1]Uncertain due to lack of data, only a few years of data, or large gaps in data series.
[2]Monitoring beginning in 2005 suggests that the average annual natural-origin population seems is ~900-1100 (J. Bumgarner, WDFW, personal communication, April 6, 2017).

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 between listed salmon and steelhead; specific differences can be found in the critical habitat designation for each species (Table 6).

(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 two Snake River Chinook Salmon ESUs and Snake River Sockeye Salmon ESU, but one was done for the Snake River Steelhead DPS. The Snake River Steelhead DPS's range includes 291 watersheds. The CHART assigned low, medium, and high conservation value ratings to 14, 43, and 230 watersheds, respectively (NMFS 2005a). They also identified 4 watersheds that had no conservation value. The following are the major factors limiting the conservation value of critical habitat for Snake River steelhead:

- Agriculture
- Channel modifications/diking
- Dams
- Forestry

- Fire activity and disturbance
- Grazing
- Irrigation impoundments and withdrawals,
- Mineral mining
- Recreational facilities and activities management
- Exotic/ invasive species introductions

2.3. Action Area

The “action area” means all areas to be affected directly or indirectly by the federal action, and not merely the immediate area involved in the action (50 CFR 402.02), where the effects of the action can be meaningfully detected, measured, and evaluated. The action area resulting from this analysis includes the entire Clearwater River Basin downstream to its confluence with the Snake River, and the Snake River from that confluence downstream 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 to which they may stray, and areas (such as in the Snake River mainstem) where program fish may interact with other fish during juvenile and adult migration.

We decided to limit our action area to the Clearwater River Basin and the mainstem Snake River down to Ice Harbor Dam on the Snake River. We did not extend the action area to the estuary/plume for several reasons. The first was that all of the programs in the Proposed Action combined release fewer than 7.5 million spring/summer Chinook salmon and 500,000 coho salmon, a small proportion (for the purposes of detecting and attributing effects) of the ~150 million hatchery fish released into the Columbia and Snake River Basins annually. Secondly, spring/summer Chinook and coho salmon move relatively quickly through the migratory corridor and estuary to the ocean, and therefore would be expected to have low potential for interacting meaningfully with fish migrating through the mainstem or utilizing the estuary for rearing. Together these reasons suggest that the likelihood of detecting effects from the releases of hatchery spring/summer Chinook and coho salmon considered in this Opinion on natural-origin fish downstream of Ice Harbor Dam have already been examined in the Mitchell Act Biological Opinion (NMFS 2017c) to the best of our ability.

Fisheries

The action area is not described specifically based on fisheries, since fisheries are not part of the Proposed Action (see Section 2.7, and above).

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 (NMFS 2012a)

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

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

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

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

While harmful land-use practices continue in some areas, many land management activities, including forestry practices, now have fewer impacts on salmonid habitat due to raised awareness and less invasive techniques. For example, timber harvest on public land has declined drastically since the 1980s and current harvest techniques (e.g., the use of mechanical harvesters and forwarders) and silvicultural prescriptions (i.e., thinning and cleaning) require little, if any, road construction and produce much less sediment. In addition, the Federal Conservation Reserve and Enhancement Program (CREP) began in the 1990's nearly 80 percent of all salmonid bearing streams in the area have been re-vegetated with native species and protected from impacts. Under the CREP, highly erodible and other environmentally sensitive lands that have produced crops are converted to a long-term resource-conserving vegetative cover. Participants in the CREP are required to seed native or introduced perennial grasses or a combination of shrubs and trees with native forbs and grasses. For example, some of the streams in the action area (e.g., Tucannon), have seen an effort to increase channel complexity and reconnect natural floodplains by the addition of large wood to the streams. In the Tucannon River, through these and other land use actions, there has been an overall increase in summer base flows over the last 10 years.

2.4.2. Climate Change

Climate change has negative implications for designated critical habitats in the Pacific Northwest (Climate Impacts Group 2004; Scheuerell and Williams 2005; Zabel et al. 2006; ISAB 2007). Average annual Northwest air temperatures have increased by approximately 1ºC 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 ºC to 0.6 ºC per decade over the next century. According to the Independent Scientific Advisory Board (ISAB), these effects pose the following impacts generally, across the greater landscape, 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 in the June through September period.
- 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 are increasing, while average stream flows are slightly decreasing (Dittmer 2013). However, basins in northeast Oregon saw an increase in summer flows, despite an average overall 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.

Climate change is predicted to cause a variety of impacts on Pacific salmon as well as their ecosystems (Mote et al. 2003; Crozier et al. 2008a; Martins et al. 2012; 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 impacts (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 if they are faced with less tributary water. Lower and warmer summer flows may be challenging for returning adults. In addition, the warmer water temperatures in the summer months may persist for longer periods 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

A more comprehensive discussion of hatchery programs in the Snake River Basin can be found in our opinion on Mitchell Act funded programs (NMFS 2017c). 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 on the history and purpose of the spring and summer Chinook and coho salmon hatchery programs included in our proposed action: Kooskia NFH, Clearwater Hatchery (CFH), Nez Perce Tribal, Dworshak NFH (DNFH), and Clearwater River coho (at Dworshak and Kooskia). All are currently ongoing, and several were initiated under various entities (i.e., LSRCP, BPA, USFWS, CRITFC) to mitigate for the construction and operation of the lower four Snake River dams on salmon and steelhead in the Snake River basin (i.e. all programs except KNFH and Clearwater coho salmon).

Dams (hydroelectric and flood control) extirpated the Clearwater River salmon runs. In 1927, Lewiston Dam was built at the mouth of the Clearwater River and prevented passage of spring, summer and fall Chinook from at least 1927 until about 1973 (Fulton 1970; Cramer and Neeley 1992). Even though Lewiston Dam was removed in 1973, which made most of the Clearwater River a free-flowing system again, Dworshak Dam was completed in 1974 at the mouth of the North Fork Clearwater River resulting in blocked passage from that large river. DNFH has several programs that operate out of this facility, and all operations at DNFH, including that portion of operations that is needed for the programs considered in this opinion, are analyzed in the Snake River Steelhead Biological Opinion (NMFS 2017b). DNFH has different water rights than most facilities; water withdrawals are pursuant to federally reserved water rights (Winters Doctrine). Concerning the facility effects which may be related in part to the proposed action of this Opinion, this analysis found that the operation of DNFH which diverts a maximum of 9% of the water from the Clearwater River, did not result in jeopardy of the listed species or adverse modification of critical habitat. This analysis also determined that there was potential effects on juvenile listed salmonids due to the intake screens at the entrance to the hatchery and NMFS recommended further evaluation of the intake screens.

Reintroductions of spring Chinook salmon in the Clearwater Basin occurred using Carson, Leavenworth, Rapid River, and other various stocks. The 4 spring Chinook salmon hatchery programs in this Opinion (KNFH, DNFH, NPT, and CFH) are currently managed as an unlisted Clearwater stock, which is what is identified in the *U.S. v. Oregon* agreement.

The KNFH spring Chinook salmon program was started using a variety of stocks from the Lower Columbia River and Rapid River SFH. However, from 1973 through 1980, smolt releases had a very strong Carson stock influence[5]. Egg transfers of Carson type stock from DNFH in 1985 and 1986 resulted in smolt releases in 1987 and 1988 that were a mixed stock, referred to as Clearwater stock. Since the KNFH program already had stock made up primarily of Carson derivatives, the resultant program (1989 and later) is still considered a Carson type stock, but is referred to as Kooskia stock. This program does not use any natural-origin spring Chinook salmon for broodstock production.

Initial plans for KNFH called for the rearing of 2,000,000 spring Chinook salmon and 1,000,000 steelhead annually. However, because of inadequate water supply and poor rearing temperatures, many adjustments were made in the production program. Through various changes including a formation of a Complex with DNFH and HRT recommendations, KFNH restated the program goal to identify adult goal including production and harvest components. Currently, KNFH releases 600,000 yearlings for supplementation and harvest purposes.

[5] From 1955 through 1964, approximately 500 spring Chinook salmon were trapped annually at Bonneville Dam on the Washington side of Columbia River and transported to the holding ponds at Carson National Fish Hatchery. Genetic data indicate that the Carson stock was derived from a mixture of upper Columbia and Snake River populations passing Bonneville Dam (USFWS and NPT 2010).

The DNFH spring Chinook salmon program was initially started using Chinook salmon stock from the Leavenworth and Little White Salmon NFH programs. Since these stocks were very strongly influenced by transfers to their programs from Carson NFH, the early Dworshak Chinook salmon stock was considered a Lower Columbia River Carson derivative. The Chinook programs for brood years 1985 and 1986 consisted entirely of eggs that had been transferred from Rapid River stock, shifting the program away from using the Lower Columbia River Carson Chinook salmon stock. Since then, DNFH has maintained its program from returns to its own rack. The recent returns to DNFH (1989 and later) are referred to as Dworshak stock, since they are progeny of returns to DNFH, rather than direct product of transfers of Rapid River stock. The baseline production target was 1,770,000 total spring Chinook salmon smolts to be released on-site and in the Selway River. Currently, DNFH releases 1,650,000 yearlings on-site and 300,000 fingerlings in the Selway River for supplementation and harvest purposes.

Clearwater River coho were abundant in the lower Snake River Basin and were known to spawn in the Clearwater, NF and SF Clearwaters, Lochsa, and Selway Rivers (Schoning 1940; 1947; Fulton 1970). The Clearwater coho were extirpated due to the construction of the Harpster and Lewiston Dams. However, the removal of both dams in 1963 and 1973 did not improve the success of the reintroduction efforts and the Snake River coho were considered to be extinct after 1986 when one adult coho was encountered at Lower Granite Dam. From 1987 to 1996 not one adult coho was counted at Lower Granite Dam. Clearwater River coho salmon were extinct before any Snake River basin anadromous fish were listed on the ESA.

In 1995, the NPT began coho reintroduction programs in the Clearwater River subbasin using a variety of lower Columbia River stocks. From 2002 through 2011, smolt releases had a very strong Eagle Creek stock influence. The Eagle Creek stock was selected because of its early run timing that was similar to historical Clearwater River runs. The current management emphasis is a full production program with returning Clearwater River coho (NPT 2016). Currently, this program releases up to 500,000 yearlings from DNFH and KNFH for supplementation and harvest purposes[6].

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 9 below shows that an average of ~ 5% of the Snake River spring/summer Chinook salmon ESU is killed by fisheries. This may be an overestimate of the percentage impact because the LGD natural-origin return estimate does not include those fish that return to tributaries of the Snake River below LGD (e.g., Tucannon River).

[6] These are the releases being covered in this consultation. The rest of the releases from the Clearwater coho HGMP including broodstock collection for these releases were covered in the Mitchell Act Biological Opinion (NMFS 2017c).

Table 9. Number of ESA-listed natural-origin spring/summer Chinook salmon encountered and incidentally killed (catch and release mortality is estimated at 10 percent of those caught) in fisheries from 2011-2016. (LGD: Lower Granite Dam)

Fishery Manager	Average Incidental Mortality take Authorization	Average Encounter	Average Incidental Mortality	Average natural-origin estimated 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: (Petrosky 2012; Petrosky 2013; IDFG 2014; Petrosky 2014; IDFG 2016; Hurst 2017; IDFG 2017; Oatman 2017b)

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

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

Steelhead

Steelhead fisheries above LGD typically occur from September through March of the following year. Although steelhead bound for Idaho enter the Columbia River from about June 1 through October 1 each year, a portion of the run spends the winter in the Columbia and Snake rivers downstream of LGD, and migrates into Idaho in the spring of the following year. Similar to spring/summer Chinook salmon fisheries, the non-tribal fisheries selectively target hatchery fish with a clipped adipose fin. Tribal fisheries target both hatchery and natural-origin fish regardless of external marking, meaning there is no incidental take of the target species for their fisheries. Table 10 below shows that an average of ~ 4.1 % of the Snake River steelhead DPS is killed annually in fisheries above LGD. This may be an overestimate of the percentage impact because the LGD natural-origin return estimate does not include those fish that return to tributaries in the Snake below LGD (i.e., Tucannon River, Asotin Creek).

Table 10. Number of ESA-listed natural-origin steelhead encountered and killed in fisheries in the Snake River basin 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]	25,960	3.1
SBT[1]	< 100	< 100	25,960	0.4
NPT	167	157	25,960	0.6

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

Table 11. 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 in the Snake River basin 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 salmon fisheries below			

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

Fall Chinook Salmon Fisheries

The fall Chinook salmon fishery typically takes place from September through October. Similar to spring/summer Chinook salmon and steelhead fisheries, the non-tribal fisheries selectively target hatchery fish with a clipped adipose fin. Tribal fisheries target both hatchery and natural-origin fish regardless of external marking, meaning there is no incidental take of the target species for their fisheries. Table 12 below shows that an average of ~ 4.5 % of the Snake River fall Chinook salmon ESU is killed in fisheries above LGD.

Table 12. Number of ESA-listed natural-origin fall Chinook salmon encountered and incidentally killed (catch and release mortality is estimated at 10 percent of those caught) in fall Chinook salmon fisheries from 2011-2016.

Fishery Manager	Average Encounter	Average Mortality	Average natural-origin estimated escapement above LGD	% Average natural-origin mortality above LGD

IDFG	853	85	10,819	0.8
SBT	Not Applicable			
NPT	400	397	10,819	3.7

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

Other Fisheries

In some years, Idaho opens a kokanee salmon fishery in Redfish Lake to help offset intra-specific competition in Redfish Lake between resident kokanee and sockeye salmon. From 2014 to 2016, an average of 0.5 percent of the sockeye salmon population in Redfish Lake were incidentally harvested in this fishery (Kokanee and sockeye salmon are phenotypically indistinguishable), assuming that sockeye salmon represent 29 percent of the *O. nerka* population (IDFG 2014; 2016; 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 2.5.2. 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; McElhany et al. 2000; NMFS 2004b; 2005c; Jones Jr. 2006; NMFS 2008b; 2011). 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 2.8).

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

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

(2) hatchery fish and the progeny of naturally spawning hatchery fish on spawning grounds and encounters with natural-origin and hatchery fish at adult collection facilities

(3) hatchery fish and the progeny of naturally spawning hatchery fish in juvenile rearing areas, migratory corridor, estuary, and ocean

(4) RM&E that exists because of the hatchery program

(5) the operation, maintenance, and construction of hatchery facilities that exist because of the hatchery program

(6) fisheries that exist because of the hatchery program, including terminal fisheries intended to reduce the escapement of hatchery-origin fish to spawning grounds

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

2.5.2. 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

None of the proposed hatchery programs remove fish from the local natural population for broodstock. However, the NPTH program is considered a reintroduction program for an extirpated population that uses an unlisted broodstock. Therefore, the long-term goal of this program is to incorporate 50 percent natural-origin broodstock, but until natural populations are restored, primarily hatchery-origin broodstock will be used for production. NPTH will report annually the number of natural-origin broodstock incorporated into production and will notify NMFS when they plan to start intentionally incorporate natural fish at any percentage. However, at this time, the program is being evaluated as a segregated program that does not remove fish from the local natural population for broodstock.

There is no effect on ESA-listed spring/summer Chinook, fall Chinook, or sockeye salmon or steelhead, because none of these natural-origin species are incorporated into the hatchery broodstock.

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, although the genetic risks are much less than the potential ecological risks. The net effect on ESA-listed spring/summer Chinook salmon in the Salmon Basin is negligible. CWT recoveries from Idaho between 2011-2015 resulted in no more than 2 fish in 1 year and 1 fish in the same year (2011) that strayed from two release sites in this Opinion (Powell and Selway, respectively) into the Salmon Basin. Fish from the hatchery programs in this Opinion did not stray into any other population where there are ESA-listed species.

The programs consulted on in this document only propagate spring/summer Chinook and coho salmon, therefore only ecological and adult collection effects are relevant for ESA-listed fall Chinook salmon, steelhead, and sockeye salmon.

2.5.2.2.1. **Genetic Effects**

NMFS has not strictly adopted HSRG gene flow (i.e., pHOS, pNOB, PNI) standards. However, at present the HSRG standards and the 5 percent stray standard from Grant (1997) are the only widely acknowledged quantitative standards available, so NMFS considers them a useful screening tool[7]. Programs must be evaluated individually. For a particular program, NMFS may, based on specifics of the program, broodstock, and environment, consider a pHOS or PNI level to be a lower risk than the HSRG would but, generally, if a program meets HSRG standards, NMFS will consider the risk it poses to be acceptable.

Because supplementation of the natural population is not an objective for this type of program, the number/proportion of hatchery-origin spawners should be limited, and ideally be as close as possible to zero. Because fish stray into areas that are under different management authorities and that may have different approaches to monitoring naturally-spawning fish, it is difficult to assess pHOS for all populations where fish from these five programs may occur.

There are no ESA-listed coho salmon populations in the Snake River Basin; therefore, stray analyses for potential genetic effects resulting from operation of the coho program in this Opinion are not included in this analysis.

Analyses based on recipient populations is what is really needed to assess pHOS attributable to these hatchery programs. However, the only ESA-listed spring/summer Chinook salmon population in the Snake River that is geographically close to the programs in this Opinion, and that also has a pHOS of concern, is the South Fork Salmon population; potential for straying to this population is discussed below. Stray recovery data from 2001 to 2015 in the Imnaha, Lostine, Grande Ronde, and Tucannon Basins (Snake River) showed only 1 recovery of a Clearwater River Basin spring/summer hatchery-origin Chinook salmon into the Grande Ronde Basin, out of >21,000 entries (Feldhaus 2015). Furthermore, spring/summer Chinook salmon CWT recoveries from 2011-2015 recovered by IDFG in sport fisheries, on spawning grounds, and at hatchery traps were analyzed for stray data involving the 5 programs in this Opinion. Table 13 summarizes the data relevant to this analysis; it shows recoveries of the 4 spring/summer Chinook salmon programs in this Opinion in other basins where ESA-listed populations in the Action Area are occurring. Other recoveries were found in basins with non-ESA listed populations; for the purpose of this analysis, we do not analyze those recoveries.

The South Fork Salmon River population has a recovery goal of Viable or Highly Viable, based on the Viability Scenario (NMFS 2016b), and has an average pHOS of 23 percent based on 2010-2014 data (NOAA Salmon Population Summary (SPS) Database[8]). As demonstrated in the table below, only 2 stray CWTs produced by programs in the Proposed Action were recovered (out of a total of >500 stray CWT recoveries) at the SF Salmon River Trap in 2011, which originated from fish released at Powell and Selway River (part of the Clearwater spring/summer Chinook salmon program). When these CWT recoveries are expanded, this essentially equates to no more than 2 fish in 1 year from Powell and 1 fish in the same year from the Selway River

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[7] In addition, HSRG standards have been incorporated into policy by Washington's Fish and Wildlife Commission (Washington Fish and Wildlife Commission 2009).
[8] SPS Database: https://www.webapps.nwfsc.noaa.gov/apex/f?p=261:1:#, last accessed April, 2017.

recovered in the Salmon River Basin. In 2012-2015, no CWT recoveries from hatcheries in this Opinion occurred in an ESA-listed population within the Action Area. Therefore, NMFS anticipants that in the future no more than an average of 5 CWT's (pre-expansion) will be recovered annually within a 5-year period in ESA-listed populations in the Action Area.

Table 13. Chinook salmon stray CWT recoveries recovered in sport fisheries, on spawning grounds, and at hatchery traps in 2011-2015 in Idaho (Cassinelli et al. 2012; 2013; Sullivan et al. 2015; Sullivan et al. 2016).

Year	Basin of Recovery	Recovery Type	Recovery Location	Release Location	Number of CWT Recovered	Expanded for Tagging Rate
2011	Salmon River	Hatchery Trap	South Fork Salmon River Trap	Powell	1	2
				Selway R.	1	1
2012	No recoveries from hatcheries in this Opinion in an ESA-listed population within Action Area					
2013	No recoveries from hatcheries in this Opinion in an ESA-listed population within Action Area					
2014	No recoveries from hatcheries in this Opinion in an ESA-listed population within Action Area					
2015	No recoveries from hatcheries in this Opinion in an ESA-listed population within Action Area					

Unlike steelhead, spring/summer Chinook salmon die after spawning, therefore spawning ground surveys are relatively encompassing and can provide substantial data. Additionally, it is likely that the populations with the greatest number of fish from the hatchery programs are those that are in close geographic proximity (e.g., fish released in the Clearwater are most likely to spawn naturally with the Clearwater populations) (ICTRT 2003). This is a natural phenomenon, can be highly variable, and it is important to remember that straying is often an overestimate for the number of fish that are able to spawn successfully because some are harvested, some return to a hatchery rack, and others may spawn in unsuitable habitat.

All of this information and data suggest that spring/summer Chinook salmon straying from these programs compose a very small proportion of the natural-origin ESA-listed spring/summer Chinook salmon.

2.5.2.2.2. **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 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 that, in the Action Area, tend to be low in nutrients. 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 (Kline et al. 1990; Piorkowski 1995; Larkin and Slaney 1996; Gresh et al. 2000; Murota 2003; Quamme and Slaney 2003; Wipfli et al. 2003). As a result, the growth and survival of juvenile salmonids may increase (Hager and Noble 1976; Bilton et al. 1982; Holtby 1988; Ward and Slaney 1988; Hartman and Scrivener 1990; Johnston et al. 1990; Larkin and Slaney 1996; Quinn and Peterson 1996; Bradford et al. 2000; Bell 2001; Brakensiek 2002).

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 spawn on top of the nests (or redds) of naturally spawning fish ("redd superimposition"), potentially destroying 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).

Nutrient contribution

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

The propagation and release of hatchery-origin fish and eggs from the five proposed programs potentially adds 841 kg (Table 14) of phosphorus annually into the environment in addition to what is typically added to the system by natural-origin fish. This is likely an overestimation of nutrients added to the system, because hatchery-origin returns are subjected to removal from harvest, broodstock collection, and gene flow management. Regardless, these added hatchery-origin fish may add additional beneficial nutrients into the system. The SAR data is a weighted SAR from LGR back to LGR for the most recent years where data is available for each of the hatchery programs, except for NPTH analysis. For NPTH fingerlings, the SAR is representative of fish returning to the hatchery, above LGR, which is an underrepresentation of SAR compared to the other program SAR's in this analysis. For NPTH smolts (and for KNFH), DNFH SAR is used as a surrogate because they are released at a different time of year and are larger at release.

Table 14. Total phosphorous imported by adult returns from the proposed hatchery Chinook and coho salmon programs based on the equation (Imports= hatchery adults*mass*phosphorous concentration) in Scheuerell et al. (2005).

Program	Release Number	SAR[1]	Estimated number of hatchery-origin adults[2]	Adult Mass (kg)	Phosphorous concentration (kg/adult)	Phosphorous imported (kg/year)
KNFH[3]	650,000	0.0047	3,055	5.5	0.0038	63.85
CFH (sp.)[4]	3,150,000	0.0054	17,010			355.51
CFH (su.)[4]	600,000	0.003	1,800			37.62
NPTH (fingerlings)[5]	625,000	0.0015	938			19.59
NPTH (smolts)[6]	380,000	0.0047	1,786			37.32
DNFH[7]	1,950,000	0.0047	9,165			191.54
Clearwater (coho)[8]	500,000	0.013	6,500			135.85
					Total:	**841.28**

[1] Smolt-to-adult survival rate: median weighted SAR (combination of transport and control, based on the percentage of fish that get transported or left in the river) from Lower Granite Dam to Lower Granite Dam. Little or no information available on SAR from release location to release location. Most data is from the Comparative Survival Study (CSS). Years of data varies.
[2] Calculated by multiplying the release number by the smolt-to-adult survival rate (SAR) values.
[3] Using Dworshak surrogate for SAR; best available data (Kooskia program not evaluated in the CSS)
[4] Data from CSS: Spring Chinook salmon, data is from 2006-2013; summer Chinook salmon, data is from 2011-2014 (Chockley 2016a).
[5] Released through NPTH at Meadow, Yoosa/Camp, and Newsome Creeks. Data from 2004-2008 (Johnson 2017e). SAR is an average from Newsome Creek fingerling releases and applied as surrogate for Meadow and Yoosa/Camp Creeks.
[6] Released through NPTH at Clearwater River (at NPTH) and Lolo Creek. Using Dworshak SAR surrogate, best available data for smolts.
[7] Data from CSS and from 1997-2013 (Chockley 2016b).
[8] Data from 2011-2017 (Johnson 2017d).

Spawning site competition and redd superimposition

According to the program HGMPs, run and spawn timing between hatchery-origin and natural-origin Snake River spring/summer Chinook salmon is very similar. Therefore, hatchery-origin fish that make it onto spawning grounds may compete with natural-origin spring/summer Chinook salmon for spawning sites and redd superimposition may also occur.

There is unlikely to be spawning site competition or redd superimposition with hatchery-origin Chinook salmon and the other three listed species (Table 15). This is because their spawn timings, and for sockeye and fall Chinook salmon spawning areas, largely do not overlap; therefore, there is limited opportunity for these potential ecological interactions to occur. It is possible that hatchery-origin spring/summer Chinook salmon could compete with natural-origin fall Chinook salmon because there is a slight overlap in spawn timings in late-September.

However, the Snake River Fall Chinook Salmon ESU only overlaps with a portion of the Snake River Spring/summer Chinook Salmon ESU. This overlap primarily occurs in the South Fork of the Salmon River MPG Little Salmon River population, but there is also a small portion of overlap with the South Fork of the Salmon River population. Therefore, the releases from the five programs may create opportunities for spawning site competition and redd superimposition between hatchery-origin fish and Snake River fall Chinook salmon, but we would expect these effects to be minimal to zero. Because of this, there are not likely to be an adverse effects on ESA-listed salmonids and steelhead. Hatchery operators are familiar with identifying morphological differences between fall and spring/summer Chinook salmon; therefore, it is unlikely that they use incorrect species broodstock. Additionally, all broodstock are sampled with PBT and any mis-classification would be identified. The ongoing PBT analyses will indicate any spawning overlap between fall and spring/summer Chinook salmon, which would determine levels of spawning site competition and redd superimposition between these species.

Table 15. Run and spawn timing of Snake River spring and summer Chinook salmon, steelhead, fall Chinook salmon, and sockeye salmon.

Species		Run timing	Spawning
spring/summer Chinook salmon		March to mid-August	late July to September
steelhead		September to November	April to May
fall Chinook salmon		late-August to November	late-September to October
sockeye salmon	resident life form I	NA	late-fall
	resident life form II: kokanee	NA	late-summer to early-fall
	anadromous	mid-summer	late-fall

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

2.5.2.2.3. **Disease**

The risk of pathogen transmission to natural-origin salmon and steelhead is negligible for these adult Chinook and coho salmon. During the last 3 years (2014-2016), spring/summer Chinook and coho salmon from the programs in this Opinion have been infected with *Saprolegniasis* (causes white/grey patches), *Renibacterium salmoninarum* (causes a bacterial kidney disease), infectious hematopoietic necrosis virus (IHNV), *Aeromonas salmonicida* (causes furunculosis), and *Flavobacterium psychrophilum* (causes coldwater disease) (Table 16). Despite these detections with pathogens that could be transmitted to natural-origin salmon and steelhead, all are treatable and are endemic to the Columbia Basin. Only one outbreak occurred during the last 3 years at the programs in the Proposed Action: *Saprolegniasis* outbreak at KFNH (Clear Creek release site) in 2014 (Table 17), which was reported and treated by a Formalin Drip. An outbreak is defined as an infectious disease that results in a higher than normal mortality within a specific rearing unit for five consecutive days (NWIFC and WDFW 2006).

Additionally, spring Chinook salmon reared at KFNH have had BKD problems in past years, though the past two decades have seen a decrease in the pathogen to very low levels in recent years. The potential still exists for a horizontal transmission of BKD and other diseases from spring Chinook salmon released from KNFH to wild fish. Strict adherence to Integrated Hatchery Operations Team (IHOT) guidelines and not releasing fish undergoing a disease epizootic are measures implemented to minimize potential disease transfer from hatchery fish to natural salmon and steelhead (HDR and USFWS 2017).

For all programs under the Proposed Action, hatchery operations monitor the health status of hatchery-produced Chinook and coho salmon from the time they are ponded at rearing facilities, until their release. For example, prior to hatching, dead eggs are removed on a regular schedule (approximately two times per week) to discourage the spread of fungus. ELISA optical density values for broodstock females are used to establish *Renibacterium salmoninarum* (BKD) management criteria for egg culling and/or segregation needs. 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 IDFG Fish Health Laboratory in Eagle, Idaho, for Clearwater Fish Hatchery and from the USFWS's Pacific Region Fish Health Program office located at DNFH for DNFH, KNFH, and NPTH programs. Prior to release, a pre-release fish health inspection is conducted for their respective hatcheries. All fish production is conducted according to the USFWS - National Fish Health Policy, PNFHPC - Model Program, and IHOT policies and guidelines.

Adherence to these fish health policies limits the disease risks associated with hatchery programs (IHOT 1995; USFWS 2004; NWIFC and WDFW 2006). 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 nonreportable, spread and amplification are minimized through regular monitoring (typically monthly), removal of mortalities, and disinfection of all eggs. Vaccines, if necessary, can provide additional protection from certain pathogens (NPT 2016). If a pathogen is determined to be the cause of fish mortality, treatments (e.g., antibiotics) are used to limit further pathogen transmission and amplification (HDR and USFWS 2017).

The following information has been incorporated by reference from HDR and USFWS (2017).

Measures to minimize potential effects during incubation and rearing include:

- Use pathogen-free well where possible, to eliminate exposure of eggs and fry to the disease pathogens
- Apply strict biosecurity protocols to minimize horizontal and vertical disease transmission
- Ensure proper disinfection protocols are in place for equipment used during rearing, and that indoor rearing vats/outdoor ponds are disinfected following use

Measures to minimize potential effects on non-target fish species during acclimation and release, include:

- Release hatchery juveniles that are physiologically ready to migrate, or when flows and hydropower system operations would enhance outmigration success, to reduce potential residualism and ecological interactions with non-target fish

- Continue development of culling and rearing segregation guidelines and practices relative to BKD and other pathogens
- Attempt to program time of smolt releases to mimic natural fish emigration, or when flows and hydropower system operations would enhance outmigration success

Table 16. Pathogen detections for Chinook and coho salmon programs that are a part of the proposed action, for the most recent three years; IHNV = infectious hematopoietic necrosis virus.

Facility	Program	Lifestage	Pathogen Detected		
			2014	2015	2016
KNFH	Clear Creek	Adult	*Saprolegniasis*	None	None
CFH	S.F. Clearwater	Adult	*Renibacterium salmoninarum*	*R. salmoninarum*	*R. salmoninarum*
			None	IHNV	
	Dworshak/Kooskia	Adult	None	None	*R. salmoninarum*
					IHNV
	Crooked River (summer Chinook)	Adult	*R. salmoninarum*	None	None
			IHNV		
	S.F. Salmon (summer Chinook)	Adult	None	*R. salmoninarum*	None
	Powell	Adult	*R. salmoninarum*	*R. salmoninarum*	*R. salmoninarum*
NPTH	Nez Perce Tribal Hatchery (NPTHC)	Adult	*R. salmoninarum*; IHNV; *Aeromonas salmonicida*	*A. salmonicida; R. salmoninarum;* IHNV; *Flavobacterium psychrophilum*	*R. salmoninarum;* IHNV; *A. salmonicida*
DNFH	Dworshak/Kooskia	Adult	*R. salmoninarum*	None	None
			IHNV	IHNV	IHNV
	Dworshak	Adult	None	*R. salmoninarum*	*R. salmoninarum*
	Kooskia	Adult	None	*R. salmoninarum*	*R. salmoninarum*
Clearwater (coho)	Dworshak and Kooskia	Adult	IHNV; *R. salmoninarum*	IHNV; *R. salmoninarum*	IHNV; *R. salmoninarum; A. salmonicida*

Sources: Penney (2017); Munson (2017a); Blair (2017); Tuell (2017a); Munson (2017b)

Table 17. Disease outbreak history for Chinook and coho salmon programs that are a part of the proposed action, for the most recent three years.

Facility	Program	Pathogen	Date(s)	Treatment/ Control Regime

KNFH	Clear Creek	*Saprolegniasis*	August-September, 2014	Formalin Drip

Source: Munson (2017b)

In summary, although natural-origin ESA-listed salmon and steelhead have the potential to occur in the rivers near existing hatchery facilities, satellites, and release sites, several factors reduce the likelihood of disease and pathogen transmission between hatchery fish and natural fish. The proportion of facility surface water withdrawal and subsequent discharge at most sites represents only a portion of the total stream flow (see Section 2.5.2.5), which reduces, via dilution, the potential for transmission of pathogens from effluent. Smolt release strategies promote distribution of hatchery fish throughout the system and rapid outmigration (in most cases), which reduces the concertation of hatchery-released fish, and, therefore, the potential for a diseased hatchery fish to encounter natural-origin ESA-listed salmon and steelhead. Lastly, fish health protocols currently in place to address pathogens are expected to minimize the potential for disease and pathogen effects on natural-origin ESA-listed salmon and steelhead (HDR and USFWS 2017).

2.5.2.2.4. **Adult Collection**

The operation of weirs and traps for broodstock collection would result in the capture and handling of both natural- and hatchery-origin salmon and steelhead. Samples for parental-based tagging and relative reproductive success analyses may also be taken from all steelhead regardless of origin at the time of collection. There is no effect of collection of spring/summer Chinook and coho salmon at weirs and traps on listed salmon because there are no ESA-listed spring/summer Chinook and coho salmon in the Clearwater. However, steelhead and fall Chinook have been encountered during weir and/or trap operation specifically for spring/summer Chinook and coho salmon. There is separate ESA coverage for fall Chinook salmon and steelhead captured and handled at weirs and or traps associated with these programs (Table 19).

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. 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.

The following information has been incorporated by reference from HDR and USFWS (2017).

Measures applied to minimize potential effects during broodstock collection activities include:

- Direct and coordinate all program adult collection activities through annual planning meetings
- Operate all traps in accordance with their design standards to minimize risk to all fish in general and non-target species in particular
- Check the adult traps at least daily and more often during peak Chinook salmon and coho salmon returns. Remove fish quickly from the trap and return all non-target fish to the stream immediately with minimal holding and handling

- Ensure that fish ladders receive sufficient flow in all seasons to attract and effectively pass fish of all life stages
- Handle all fish in accordance with adult handling criteria (NMFS 2008a; USFWS and WFWO 2012)

Table 2 in Section 1.3.1 includes adult collection locations for broodstock for the five programs in this Opinion. Each of these traps is operated at intermittent periods throughout the year for broodstock collection for specific programs (Table 18). See HDR and USFWS (2017) Section 8.2.1.1. for detailed information on the following traps, weirs, and ladders, and see below for a summary of this information and it's pertinence to the current analysis.

Table 18. Adult collection periods (shaded) for hatchery programs in the Proposed Action (typical and approximate). Adapted from HDR and USFWS (2017).

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Facility	**Program Association(s)**	**Adult Collection Period**											
NPTH Trap	Nez Perce Spring Chinook Salmon												
Lower Lolo Weir	Nez Perce Spring Chinook Salmon												
Newsome Creek Weir	Nez Perce Spring Chinook Salmon												
DNFH Trap	Dworshak National Fish Hatchery Spring Chinook Salmon[a]												
DNFH Trap	Clearwater River Coho Salmon Restoration												
Crooked River Trap	Clearwater Spring and Summer Chinook Salmon												
Red River Trap	Clearwater Spring and Summer Chinook Salmon												
Powell Trap	Clearwater Spring and Summer Chinook Salmon												
KNFH Trap and Weir (Clear Creek)	Clear Creek (Clearwater) Spring/Summer Chinook Salmon												
KNFH Trap and Weir (Clear Creek)	Clearwater River Coho Salmon Restoration												
KNFH Trap and Weir (Clear Creek)	Kooskia National Fish Hatchery Spring Chinook Salmon												

[a] Broodstock for the Clearwater Fish Hatchery spring Chinook Salmon program are collected at Dworshak National Fish Hatchery, if needed. The timing of collection is identical to that for the Dworshak Chinook Salmon program. At times, if needed, the Dworshak ladder may be operated in January.

Table 19. ESA-listed salmon and steelhead handled by origin at adult collection facilities. Mortalities, if any, are shown in parentheses.

Facility	Origin	Fall Chinook salmon (hatchery- and natural-origin)		Steelhead (hatchery- and natural-origin)		Spring/Summer Chinook salmon	
		Average Actual Handling; min and max (mortalities)	Proposed Number Handled (mortalities)	Average Actual Handling; min and max (mortalities)	Proposed Number Handled (mortalities)	Average Actual Handling; min and max (mortalities)	Proposed Max Number Handled (mortalities)
NPTH Trap	Natural	Covered in Snake River Fall Chinook Salmon Biological Opinion (cite) and Section 10 (a)(1)(A) permit (NMFS 2012c; 2012b)					
	Hatchery						
Lolo Creek Weir (Lower weir)[1]	Natural	0	0	0	0	0	5
	Hatchery	0	0	0	0	0	5
Newsome Creek Weir[1]	Natural	0	0	0	0	0	5
	Hatchery	0	0	0	0	0	5
DNFH Trap	Natural	Covered in Snake River Steelhead Biological Opinion (NMFS 2017b)					
	Hatchery						
Lapwai Creek Weir[3]	Natural	N/A				0	5
	Hatchery					0	5
Red River Trap[2]	Natural	0	5 (0)	6 (0)	20 (1)	0	5
	Hatchery	0	5 (0)	0	20 (1)	0	5
Powell Trap[2]	Natural	0	5 (0)	7 (0)	20 (1)	0	5
	Hatchery	0	5 (0)	0	20 (1)	0	5
KNFH Trap and Weir (Clear Creek[3])	Natural	0	0	7 (0)	20 (1)	0	5
	Hatchery	0	0	0	20 (1)	0	5

Sources: Personal comm., Becky Johnson; Hebdon (2017); Vogel (2017b)
[1]Data from years 2011-2016 (except for Newsome Creek Weir for steelhead: data is from 2011-2014)
[2]Data from 2008 (Red River) and 2011 (Powell). No other fish caught between 2006-2016.
[3]The effects from Lapwai and Clear Creek weirs on fall Chinook salmon and steelhead were analyzed in the Mitchell Act Biological Opinion, where a no effect determination was concluded (NMFS 2017a).
[4] The take for spring/summer Chinook salmon covers potential take from listed spring/summer Chinook salmon ESU's, e.g. populations in the Salmon River Basin (South Fork Salmon River).

In addition to weirs, adult hatchery-origin spring and summer Chinook salmon may be collected via angling or seins in the Clearwater River. These are secondary methods which are used only when a broodstock shortfall is projected. See Table 20 below for information on adult collection and take for these backup collection methods. In the future, a variety of methods (activities) and collection locations (in the Clearwater River Basin) may be used for Clearwater brood collection and similar effects are anticipated.

Table 20. Salmon and steelhead handled by origin through alternative broodstock collection methods. Mortalities, if any, are shown in parentheses.

Activity	Spring/Summer Chinook salmon (hatchery-origin)	ESA-listed Fall Chinook salmon (hatchery- and natural-origin)		ESA-listed Steelhead (hatchery- and natural-origin)	
	Average Actual Collected; min and max (mortalities)	Average Actual Handling; min and max (mortalities)	Proposed Number Handled (mortalities)	Average Actual Handling; min and max (mortalities)	Proposed Number Handled (mortalities)
Angling at DNFH	363; 152-574 (0)	0	2 (1)[1]	0	2 (1)[1]
Seine at Red River	186	0	5(2)[1]	0	5 (2)[1]

Source: Leth (2017c)
[1]Applied to each type (natural- or hatchery-origin) fish.

In summary, the effects of operation at the DNFH trap on ESA-listed fall Chinook salmon and steelhead, including handling of fish during activities considered in this Opinion, were analyzed in the Snake River Steelhead Biological Opinion (NMFS 2017b). It was determined the operation of this facility and the others analyzed in this Opinion would not reduce appreciably the likelihood of both the survival and recovery of the species in the wild.

Brood Transfer

In the event that spring Chinook salmon broodstock needs for Clearwater Basin facilities cannot be met, Clearwater Basin programs can be made up of excess spring Chinook salmon Rapid River and Hells Canyon fish. In the event that these Rapid River and Hells Canyon fish will be used in Clearwater spring Chinook salmon broodstock, project operators will contact NMFS in advance for coordination as soon as operators anticipate that there might be a shortage. We expect the need to use Rapid River and Hells Canyon broodstock to be infrequent (not every year) (Table 21). The opposite is also true; Clearwater spring Chinook salmon broodstock may be used to fill shortfalls in Rapid River and Hells Canyon spring Chinook salmon brood. However, we expect the need to use Clearwater broodstock at Rapid River and Hells Canyon facilities to be a rare occurrence only used in “emergency” situations. Table 21 below includes all data for spring Chinook salmon brood transfers from Rapid River hatchery to CFH. The number of eyed-eggs transferred from Rapid River to be reared at CFH were converted to number of estimated smolts produced (by using a 90 percent eyed-egg to smolt survival metric). These estimated smolt production numbers from eyed-eggs from Rapid River hatchery range from 3.6-16.2 percent of the total smolt releases of spring Chinook salmon in the Clearwater Basin (Leth 2017b).

Table 21. Brood years and number of eyed-eggs reared at the Clearwater Fish Hatchery that were sourced from Rapid River or Hells Canyon spring Chinook salmon broodstock (Leth 2017b; 2017a)

Brood Year	Number of eyed eggs reared at Clearwater Fish Hatchery	Source hatchery	Rapid River smolts released	Total Clearwater spring Chinook salmon released	Percentage of total release in Clearwater Basin comprised of Rapid River stock
2007	578,457	Rapid River	520,611	4,475,156	10.2%
2009	935,000	Rapid River	841,500	5,091,664	16.2%
2010	658,195	Rapid River	592,376	5,194,507	11.4%
2013	245,722	Rapid River	221,150	6,134,363	3.6%

There are three main reasons as to why we expect the transfer of spring Chinook salmon Rapid River and Hells Canyon brood into the Clearwater Basin spring Chinook salmon stocks to have a minimal effect on the four ESA-listed species analyzed in this Opinion: (1) the Rapid River and Hells Canyon brood display the "spring" life history type, like the unlisted spring Chinook salmon and unlike the fall Chinook salmon; (2) there are no ESA-listed spring Chinook or coho salmon in the Clearwater Basin; and (3) the Clearwater Basin spring Chinook salmon stocks were founded on Rapid River and Hells Canyon brood. Again, this is not proposed as a typical practice, but would be used when there are shortfalls in the Clearwater Basin facilities.

2.5.2.3. Factor 3. Hatchery fish and the progeny of naturally spawning 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 and migratory corridors. This factor can have effects on the productivity VSP parameter (Section 2.5) of the natural population. The effect of this factor on all four ESA-listed species is negative. It is important to keep in mind that the results of the model below are an overestimation of interaction and predation values for ESA-listed Chinook salmon because it includes spring/summer Chinook and coho salmon, which are not listed in the Clearwater River.

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

2.5.2.3.1. Hatchery release competition and predation effects

We used the PCDRisk model of Pearsons and Busack (2012) to quantify the potential number of natural-origin salmon and steelhead juveniles lost to competition and predation from the release of hatchery-origin juveniles. The original version of the model suffered from operating system conflicts that prevented completion of model runs and was suspected of also having coding errors. As a result, the program was modified by Busack in 2017 into a considerably simpler version to increase supportability and reliability. At present, the program does not include disease effects and probabilistic output. Parameter values used in the model runs are shown in Table 22-Table 24.

For our model runs, we assumed a 100 percent population overlap between hatchery spring/summer Chinook and coho salmon and all natural-origin species present. Hatchery spring/summer Chinook and coho are released from mid-March to mid-September, with the bulk of releases from mid-March through mid-April. These releases may overlap with natural-origin Chinook, 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 to certain areas. To address this, we modified residence times for hatchery spring/summer Chinook and coho salmon 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 spring/summer Chinook and coho salmon releases as part of the Proposed Action would not occur until they comingled in the mainstem Snake River (more detailed calculations can be found in Reynolds (2017). 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 like an overestimation.

In addition, our model does not include age-0 steelhead because steelhead spawn from March to June (with a peak from April to May) in the Action Area (Busby et al. 1996). Thus, it is unlikely that any age-0 steelhead would have emerged in time to interact with the hatchery spring/summer Chinook and coho salmon smolts as they migrate downstream. A lack of spatial overlap with age-0 sockeye salmon rearing in Redfish, Petit, and Alturas Lakes provides 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 spring/summer Chinook and coho salmon 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 salmon outmigrate as age-0 fish at a size of 55 mm (Rabe 2017). These Chinook salmon specific-model runs were separated into two components before the aggregate Lower Granite to Ice Harbor Dam model runs: (1) release site to mouth of Clearwater River, and (2) mouth of Clearwater River to Lower Granite Dam.

For the first Chinook-specific model run (release site to mouth of Clearwater River), we assumed that the hatchery fish (both Chinook and coho salmon) are only interacting with listed sub-yearling natural-origin Chinook salmon (no listed yearlings present). Travel time was proportional to what the fish’s travel time was from release to Lower Granite Dam (i.e., if the fish took 100 days to travel from release to Lower Granite Dam, and swam at a rate of 5 miles/day, that rate of 5 miles/day was applied to the distance from release to the mouth of the

Clearwater River, to get the new travel time; see Reynolds (2017) for more details). Also, survival of the hatchery-origin fish was assumed to be the same as from release to Lower Granite Dam; this assumption means all loss due to ecological interactions is likely to occur in the tributary rearing areas.

For the second Chinook-specific model run (mouth of Clearwater River to Lower Granite Dam), we assumed that the hatchery fish are migrating smolts, and therefore justified combining all surviving Chinook salmon hatchery fish releases into one aggregate run of size class 149 mm; however, the coho salmon hatchery releases were considered separately. We assumed that both sub-yearling and yearling natural-origin Chinook salmon will be present; therefore, they are both accounted for in the model, equally. Survival of the hatchery-origin fish was assumed to be 100% for this reach. Travel time is proportional to the travel rates calculated using travel times from Lower Granite Dam to Ice Harbor Dam (since fish are now assumed to be larger, and therefore likely traveling faster, see Reynolds (2017) for more details).

Fish released from Newsome Creek, Camp/Yoosa Creek, Meadow Creek, and the Upper Selway River have shown a slower travel time from their respective release sites to Lower Granite Dam (anywhere from 178-306 days compared to 19-40 days by other released fish), the combined barging model runs from Lower Granite Dam to Ice Harbor Dam assume all these fish are of the largest hatchery release size (149 mm) by the time they reach Lower Granite Dam. This is a worst-case scenario as they are as large as we would expect hatchery fish to be in the natural environment. These fish likely overwinter, which is why their travel time from release site to Lower Granite Dam is so long, but we assume they are smolts by the time they reach the Dam, then continue to move downstream as fast as any other smolt fish would, since they are now larger and faster.

When we model these fish releases, we take into account that the mouth of the Clearwater is the end of the hatchery-fishes' rearing area, which is also the time when they begin to overlap in habitat with natural-origin sockeye. Because they are larger fish by the time they reach this area, we make the assumption that they are traveling faster and therefore will not be spending as much time interacting with sockeye as they would when they are first released and over-wintering in the rearing area.

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 25) 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 spring/summer Chinook and coho salmon 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 25).

Table 22. Parameters from the PCDRisk model that are generally consistent across all programs. All values from HETT (2014) unless otherwise noted.

Parameter	Value

Habitat complexity	0.1
Population overlap	1.0
Habitat segregation	0.3 for Chinook salmon, 0.6 for all other species
Dominance mode	3
Hatchery fish size (4 groups)	149 mm, 125 mm and 83 mm for Chinook salmon; 132 mm for coho
Piscivory	0.002 for Chinook salmon, 0 for all other species
Maximum encounters per day	3
Predator:prey length ratio for predation	0.25[1]
Average temperature across release sites	7.8-10.5°C depending on release times[2]

[1]Daly et al. (2014)
[2]Data from: Fish Passage Center, last accessed: May 19, 2017 (median temps for respective release dates from 2007-2016); USGS Gauge 13341050 for Yoosa/Camp, Meadow Creek, Newsome Creek, and Upper Selway release sites, last accessed September 5, 2017. See Table 24 below for more detailed data.

Table 23. 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 (10)
Steelhead	1	71 (10)
	2	128 (30)
Sockeye Salmon	1	86 (7)
	2	128 (8)

Sources: HETT (2014);Young (2017)Young (2017); Rabe (2017).

Table 24. Hatchery fish parameter values for the PCDRisk model. (N.F.: North Fork; M.F.: Middle Fork)

<table>
<tr><th rowspan="2">Program</th><th rowspan="2">Release Site</th><th rowspan="2">Release Number</th><th rowspan="2">Size in mm (SD) at release</th><th colspan="2">Survival Rate Dam (median)</th><th colspan="2">Travel (Residence) Time in median days</th><th colspan="2">Proportion Barged from LGD to ICH in 2008[3]</th><th rowspan="2">Temperature (°C) (median 2007-2016)[5]</th></tr>
<tr><th>Release to LGD[1]</th><th>LGD to ICH[2]</th><th>Release to LGD[3]</th><th>LGD to ICH[2]</th><th>2008[4]</th><th>2015[4]</th></tr>
<tr><td>KNFH</td><td>Clear Creek</td><td>650,000</td><td>149</td><td>0.66*</td><td rowspan="13">0.835</td><td>37*</td><td rowspan="13">9</td><td rowspan="13">0.338</td><td rowspan="13">0.073</td><td rowspan="6">7.8</td></tr>
<tr><td rowspan="5">CFH</td><td>Red River</td><td>1,280,000</td><td>149</td><td>0.59*</td><td>39*</td></tr>
<tr><td>Lower Selway River</td><td>400,000</td><td>149</td><td>0.71*</td><td>31*</td></tr>
<tr><td>Clear Creek</td><td>720,000</td><td>149</td><td>0.80*</td><td>27*</td></tr>
<tr><td>N.F. Clearwater River (at CFH)</td><td>750,000</td><td>149</td><td>0.93 (2016 data only)</td><td>9 (2016 data only)</td></tr>
<tr><td>Powell Satellite (Lochsa River) (su. Chinook salmon)</td><td>600,000</td><td>149</td><td>0.74 (2014-2016 data)</td><td>23 (2014-2016 data)</td></tr>
<tr><td rowspan="5">NPTH</td><td>Meadow Creek (Selway River)</td><td>400,000 (parr)</td><td>83</td><td>0.023**</td><td>290**</td><td>10.5</td></tr>
<tr><td>Yoosa/Camp Cr. (at Lolo Cr.)</td><td>150,000 (pre-smolt)</td><td>125</td><td>0.07**</td><td>188**</td><td rowspan="2">10.5</td></tr>
<tr><td>Newsome Creek</td><td>75,000 (pre-smolt)</td><td>125</td><td>0.14**</td><td>178**</td></tr>
<tr><td>Clearwater River at NPTH</td><td>200,000 (smolts)</td><td>149</td><td>0.76**</td><td>19**</td><td rowspan="2">7.8</td></tr>
<tr><td>Lolo Creek</td><td>180,000 (smolts)</td><td>149</td><td>0.54 (2016 data)</td><td>22 (2016 data)</td></tr>
<tr><td rowspan="2">DNFH</td><td>Upper Selway River</td><td>300,000</td><td>83</td><td>0.034 (2009-2015 data)</td><td>306 (2009-2015 data)</td><td>10.5</td></tr>
<tr><td>N.F. Clearwater River (at DNFH)</td><td>1,650,000</td><td>149</td><td>0.77*</td><td>30*</td><td>7.8</td></tr>
</table>

Clearwater (coho)	Clear Creek	500,000	132	0.58*		30*				9.8

*Median data from 2010-2016

**Median data from 2012-2016

Sources: PTAGIS database; Reynolds (2017); NMFS (2016a)

[1]Sources: Sprague (2017); Hills and Griffith (2017); Leth (2017d);Tuell (2017b)

[2] Dworshak and Kooskia data averaged to get this value and applied as surrogate across all programs. Source: Hills and Griffith (2017)

[3]Sources: See footnote 1. This value has been altered for sockeye salmon (shown in parentheses) to reflect when natural-origin sockeye salmon are likely to be encountered.

[4]Data is for Dworshak Hatchery Chinook salmon but is used as surrogate because it is the best available data across all programs. Barging does not begin until May 1, so some fish have already passed by LGR before barging begins. The percentage barged is out of the total number of fish that passed through LGR. Source: McCann (2017)

[5] Data is from the Fish Passage Center (FPC). Last accessed: May 19, 2017. Data from USGS Gauge USGS 13341050 for Yoosa/Camp, Meadow Creek, Newsome Creek, and Upper Selway release sites, last accessed September 5, 2017. For aggregate model, 10.5°C is used.

Based on the data above, our model results show that hatchery Chinook salmon are likely to have the largest effect on natural-origin Chinook, followed by steelhead, and sockeye salmon. The maximum numbers of fish lost are also shown in Table 25 and would not change if more natural-origin fish were present throughout the action area because we ran the model with natural-origin fish numbers at the point where all possible hatchery fish interactions are exhausted at the end of each day. The exception to this is for sockeye salmon because we have data for natural-origin abundance for the one population that comprises the entire ESU that demonstrates that, from 2006-2016, the maximum number of natural-origin sockeye salmon produced was ~61,000. Thus, we used this value in the model along with the actual proportions of each age-class (87 percent age-1, and 13 percent age-2) available (Kozfkay 2017).

The total number of natural-origin Chinook salmon (both fall and spring/summer runs combined, Table 9), steelhead (Table 10), and both hatchery- and natural-origin sockeye salmon (1,115[9]) that pass over Lower Granite Dam are used to calculate the maximum potential loss of adult returns for each of these species based on results from the model runs. The model results indicate that the adult losses equate to a maximum potential loss of ~4, 2.8, and 1.7 percent of 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 compose the Snake River ESUs/DPSs, and also include the unlisted spring/summer Chinook salmon originating from the Clearwater Subbasin.

[9] DART: 10 year average from 2007-2016. Accessed August 2, 2017.

Table 25. Maximum numbers of natural-origin salmon and steelhead lost to competition (C) and predation (P) with hatchery-origin spring/summer Chinook and coho salmon released from the Proposed Action. (N.F.: North Fork; M.F.: Middle Fork)

Program	Release Location	Chinook		Steelhead[3]	Sockeye
		Predation[1]	Competition[2]	Competition[2]	Competition[2]
From Release To Mouth of Clearwater River[4]					
KNFH	Clear Creek	5,474	19,834	NA	NA
CFH	Red River	7,323	18,160		
	Lower Selway River	1,030	11,065		
	Clear Creek	4,833	17,531		
	N.F. Clearwater River	2,113	5,157		
	Powell Satellite (Lochsa R., summer Chinook salmon)	4,320	14,136		
NPTH	Meadow Creek (Selway R.)	210	29,101		
	Yoosa/Camp Creek (at Lolo Creek)	0	8,734		
	Newsome Creek	0	5,593		
	Clearwater Creek at NPTH	147	1,770		
	Lolo Creek	254	3,121		
DNFH	Upper Selway River	11	56,263		

	N.F. Clearwater River (at DNFH)	3,488	28,023		
Clearwater (coho)	Clear Creek	751	10,340		
***From Mouth of Clearwater River to Lower Granite Dam*[5]**					
Aggregate Chinook salmon (all Chinook salmon release sites and programs combined)		6,715	17,457	NA	NA
Clearwater (coho)		23	585		
From Release To Lower Granite Dam					
KNFH	Clear Creek	NA	NA	7,532	160
CFH	Red River			14,823	87
	Lower Selway River			3,875	102
	Clear Creek			6,645	125
	N.F. Clearwater River			2,477	58
	Powell Satellite (Lochsa R., summer Chinook salmon)			4,554	58
NPTH	Meadow Creek (Selway R.)			16,373	208
	Yoosa/Camp Creek (at Lolo Creek)			6,204	245
	Newsome Creek			3,654	215
	Clearwater Creek at NPTH			1,271	174
	Lolo Creek			1,138	87

DNFH	Upper Selway River				20,632	328
	N.F. Clearwater River (at DNFH)				16,601	190
Clearwater (coho)	Clear Creek				6,950	211
From Lower Granite Dam To Ice Harbor Dam						
	Hatchery species and size class	**Barging Year and Number of Fish**				
Aggregate-large (33.8%) barged proportion	Chinook salmon; 145 fpp	2008; 3,141,720 fish	7,785	32,288	7,911	1,771
Aggregate-small (7.3%) barged proportion	Chinook salmon; 145 fpp	2015; 4,399,357 fish	9,491	45,020	11,089	1,770
Aggregate-large (33.8%) barged proportion	Coho salmon; 132 fpp	2008; 191,980 fish	43	1,068	310	152
Aggregate-small (7.3%) barged proportion	Coho salmon; 132 fpp	2015; 268,830 fish	61	1,056	433	152
Totals						
	Hatchery Species		***Chinook***		***Steelhead***	***Sockeye***
Total Juveniles Lost [6]	Chinook salmon		409,123-423,561		120,640-123,818	4,019
	Coho salmon		12,916-13,372		7,260-7,383	363
SAR[7]			0.004		0.007	0.005

Adult Equivalents	Chinook salmon	1,183-1,243	662-684	17
	Coho salmon	51-53	50-51	2

[1]Predation values only shown for Chinook salmon interactions because no predation according to HETT database for chinook or coho salmon on steelhead or sockeye salmon.
[2]Competition as used here is the number of natural-origin fish lost to competitive interactions assuming that all competitive interactions that result in body weight loss are applied to each fish until death occurs (i.e., when a fish loses 50% of its body weight). This is not reality, but does provide a maximum mortality estimate using these parameter values.
[3]For the aggregate runs, we only used age-2 steelhead in the model, because age-1 fish are not likely to occur at that reach (cite).
[4,5]See explanation above tables.
[6]Total juveniles lost represents fish lost from release to Lower Granite Dam plus fish lost from Lower Granite Dam to Ice Harbor Dam from the years 2008-2015.
[7]Smolt-to-adult survival rate for Chinook Salmon (Table 14), steelhead (NMFS 2017b), 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, if a hatchery fish is piscivorous and stomach capacity allows the fish to consume prey, the model assumes that prey will be natural-origin fish. 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” fish are those fish that do not emigrate post-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 migrants, and could impart some genetic effects when they spawn naturally. Residual hatchery spring/summer Chinook salmon are not explicitly accounted for in our model at this time, but NMFS recommends the applicants monitor this phenomenon through visual assessment of migrant 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 five percent based on a five-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. In addition, NMFS expects the applicants to continue work on minimizing residualism of hatchery fish.

2.5.2.3.2. **Naturally-produced progeny competition**

Because spring/summer Chinook salmon historically coexisted in substantial numbers with steelhead, it follows that there must have been adequate passage and habitat to allow both species to be productive and abundant. It does not follow automatically, however, that the historical situation can be assumed under present-day conditions. Habitat and passage conditions have changed considerably over time to the point that both species are so depleted that they are listed under the ESA. However, ecological impacts may increase in the future if the steelhead populations grow. Should the situation arise where steelhead natural production is limiting spring/summer Chinook salmon natural production, recovery planners would have to prioritize one species over another. NMFS expects that the monitoring efforts would detect negative impacts before they reach problematic levels, and we include language in the ITS (Section 2.9.4) 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 juvenile Chinook and coho salmon. During the last 3 years (2014-2016), spring/summer Chinook and coho salmon from the programs in this Opinion have been infected with *Icthyophthiriasis* (causes white spots), *Phoma herbarum* (causes fungal infections), *Flavobacterium psychrophilum* (causes coldwater diseases), infectious hematopoietic necrosis virus (IHNV), *Renibacterium salmoninarum* (causes a bacterial kidney disease), *Aeromonas salmonicida* (causes furunculosis), *Yersinia ruckeri* (causes redmouth disease), bacterial gill disease, and *Aeromonas hydrophila* (causes tissue damage) (Table 26). Despite these detections with pathogens that could be transmitted to natural-origin salmon and steelhead, all are treatable (except IHNV) and are endemic to the Columbia Basin. No outbreaks have occurred during the last 3 years at the programs in the Proposed Action.

For all programs under the Proposed Action, hatchery operations monitor the health status of hatchery-produced Chinook and coho salmon from the time they are ponded at rearing facilities, until their release. For example, prior to hatching, dead eggs are removed on a regular schedule (approximately two times per week) to discourage the spread of fungus. ELISA optical density values for broodstock females are used to establish *Renibacterium salmoninarum* (BKD) management criteria for egg culling and/or segregation needs. 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 IDFG Fish Health Laboratory in Eagle, Idaho, for Clearwater Fish Hatchery and from the USFWS's Pacific Region Fish Health Program office located at DNFH for DNFH, KNFH, and NPTH programs. Prior to release, a pre-release fish health inspection is conducted for their respective hatcheries. All fish production is conducted according to the USFWS - National Fish Health Policy, PNFHPC - Model Program, and IHOT policies and guidelines.

See Section 2.5.2.2 for more information about fish health policies.

Table 26. Pathogen detections for Chinook and coho salmon programs that are a part of the proposed action, for the most recent three years; IHNV = infectious hematopoietic necrosis virus.

Facility	Program	Lifestage	Pathogen Detected		
			2014	2015	2016
KNFH	Clear Creek	Juvenile	None	*Icthyophthiriasis*	*Icthyophthiriasis*
CFH	Red River	Juvenile	*Phoma herbarum*	None	None
CFH	S.F. Clearwater	Juvenile	None	None	*Flavobacterium psychrophilum*
NPTH	NPTHC/Dworshak	Juvenile (smolts)	IHNV; *R. salmoninarum*	IHNV	IHNV
NPTH	Meadow Cr. /Selway	Juvenile (parr)	None	IHNV; *R. salmoninarum*	*Aeromonas salmonicida*
NPTH	Newsome Creek	Juvenile (pre-smolts)	None	None	*Yersinia ruckeri*
DNFH	Dworshak	Juvenile	*Renibacterium salmoninarum*; IHNV	*R. salmoninarum*; IHNV	IHNV; *Phoma herbarum;* Bacterial Gill Disease
Clearwater (coho)	Dworshak and Kooskia	Juvenile	*F. psychrophilum; Aeromonas hydrophila*	*F. psychrophilum; Aeromonas hydrophila*	*F. psychrophilum*

Sources: Penney (2017); Munson (2017a); Tuell (2017a); Blair (2017); Munson (2017b)

In summary, similar to the situation with adult fish, although natural-origin ESA-listed salmon and steelhead have the potential to occur in the rivers near existing hatchery facilities, satellites, and release sites, several factors reduce the likelihood of disease and pathogen transmission between juvenile hatchery fish and natural fish. The proportion of facility surface water withdrawal and subsequent discharge at most sites comprises only a portion of the total stream flow (see Section 2.5.2.5), which reduces, via dilution, the potential for transmission of pathogens from effluent. Smolt release strategies promote distribution of hatchery fish throughout the system and rapid outmigration (in most cases), which reduces the concentration of hatchery-released fish, and, therefore, the potential for a diseased hatchery fish to encounter natural-origin ESA-listed salmon and steelhead. Lastly, fish health protocols currently in place to address pathogens are expected to minimize the potential for disease and pathogen effects on natural-origin ESA-listed salmon and steelhead (HDR and USFWS 2017).

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

Although there is a great deal of research, monitoring, and evaluation (RM&E) that takes place to assess the effects of these programs on listed species, the effects of this RM&E on listed species is considered elsewhere. 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). With the exception of some juvenile trapping activities, many RM&E efforts exist independently from hatchery programs and the effects of these actions have been covered in previous Section 10 Permits and 4(d) Authorizations in the Snake River Basin. These include the Section 10 permit numbers 1339-4R and 1134-6R. The expected take from each of the RM&E activities were previously analyzed under these Permits. None of these analyses resulted in jeopardy, and the overall effects from RM&E activities were thought to have both beneficial and negative effects, resulting in negligible overall effects. Additionally, there are several studies that are ongoing but do not need specific coverage in this Opinion because they are not encountering or affecting any ESA-listed species. However, it is important to document the ongoing studies and activities in the areas (and their associated program(s)):

- Captured adults (at hatchery traps/weirs) are measured and examined for gender, various clips, tags, and marks then designated as broodstock or natural release. CWTs will be recovered. Genetic samples (tissue) are collected from all spawned adults to develop the PBT baseline. Data recorded includes: date, gender, length, origin (hatchery/natural), marks/tags, and disposition (All programs in Opinion)
- Redd counts (spawning ground surveys) and carcass surveys are conducted to estimate number of redds and composition of spawners. (CFH and satellites; NPTH)
- Monitoring of survival metrics for all life stages in the hatchery from spawning to release (All programs in Opinion)
- PIT tagging representative groups of juvenile Chinook salmon to estimate migration timing, outmigration survival rate, and adult returns. Adult PIT-tag detections in the mainstem Columbia River and Lower Snake River dams are used to inform in season fisheries management (All programs in Opinion)

- Coded-wire tagging representative groups of juveniles to estimate harvest in mixed stock fisheries downstream of Idaho. Stock composition of harvest in Idaho fisheries is estimated using PBT (All programs in Opinion)
- Genetic samples are collected from all spawned adults to develop the PBT baseline (All programs in this Opinion)
- Rearing density evaluation study in-hatchery portion is completed. This study will now evaluate adult returns from BY2012, BY2013, and BY 2014 releases (return years from 2015 to 2019) to determine the best rearing strategy to return the most adults. Based on this information, production may remain at current levels (at increased densities) or be reduced based on traditional densities (DNFH).

For each program (excluding the 180,000 spring Chinook salmon release from NPTH into Lolo Creek and the 500,000 coho release into Clear Creek), a proportion of the juvenile releases (Table 3) are PIT-tagged to evaluate emigration survival and travel time. These tags also aid in estimating adult distribution upon return. For the CFH and satellite locations, operators are conducting a survey to estimate migration timing, outmigration survival rate, and adult returns by PIT-tagging a representative group of juvenile spring/summer Chinook salmon. Additionally, they are using adult PIT-tag detections in the mainstem Columbia River and Lower Snake River dams to inform in-season fisheries management. 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 non-ESA listed spring/summer Chinook and coho salmon. Incidental effects on ESA-listed Snake River fall Chinook, steelhead, and sockeye are negligible.

Actual (incidental) and proposed handling of ESA-listed fall Chinook salmon and steelhead at the Lolo and Newsome Creek Screw Traps during their time of operation for spring/summer Chinook salmon are shown below in Table 27. They are used to monitor juvenile releases from NPTH. There have been no documented mortalities since 2007.These traps are in operation in both the spring and fall. In the spring, Lolo and Newsome Creek screw traps are generally in the creek by mid-March and early April, respectively. Both traps are run through late June or early July. In the fall, both traps are in by mid-September and are operated through mid-late November.

Table 27. Juvenile salmon handled by origin at RM&E facilities. Mortalities, if any, are shown in parentheses.

Facility	Origin	Fall Chinook salmon (hatchery- and natural-origin)		Steelhead (hatchery- and natural-origin)		Adult Equivalence
		Average Actual Handling/Marking; min and max (mortalities)[1]	Proposed Handling (mortalities)	Average Actual Handling/Marking; min and max (mortalities)[1]	Proposed Handling (mortalities)	SAR *x* Avg. Handling/Marking Numbers (min and max)[2]
Lolo Creek Screw Trap*	Natural	0	0	1,062; 0-268-2,792 (0)	3,000 (10)	2-12 steelhead

	Hatchery	0	0	4,366; 0-12,851 (0)	13,100 (10)	0-90 steelhead
Newsome Creek Screw Trap*	Natural	0	0	1,034; 121-1,890 (0)	2,200 (10)	1-14 steelhead
	Hatchery	0	0	5; 0-28 (0)	35 (1)	0-1 steelhead

*Data from years 2007-2016

[1]Numbers include direct take from marking fish. Source: Personal comm., Becky Johnson; spreadsheet from Jason (Vogel 2017a).

[2] SAR values for steelhead (0.007, or 0.7%) and fall Chinook salmon (0.0015, or 1.5%) are from NMFS (2017b) and Young et al. (2017), respectively.

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 fall Chinook salmon, steelhead, and proposed ESA-listed summer Chinook salmon, or their designated critical habitat. No construction is included as part of the Proposed Action.

All operations at DNFH, including that portion of operations that is needed for the programs considered in this opinion, are analyzed in NMFS (2017b) This analysis found that the operation of DNFH which diverts a maximum of 9% of the water from the Clearwater River, did not result in jeopardy of the listed species or adverse modification of critical habitat. This analysis also determined that there was potential effects on juvenile listed salmonids due to the intake screens at the entrance to the hatchery and NMFS recommended further evaluation of the intake screens.

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. At Sweetwater Springs, no surface water is used (but they have a right up to 3.85 cfs), and thus the facility will cause, at most, only a small change in habitat use and is not expected to decrease availability of water or passage or rearing (Table 28). Of those facilities included in the Proposed Action and considered in this Opinion, surface water usage is estimated to be less than 40 percent of the total surface water available, even during the month of operation with the lowest surface water flow, in most cases (Table 28). However, there are exceptions to address at the following facilities, including Crooked River Satellite (although withdrawing less than 40 percent):

- Red River Satellite: Gauge data is not readily available at this location. However, in-stream flow measurements were taken on September 6, 2017, in the South Fork Red River to provide accurate data during low flow months. The flow measured upstream of the intake was 4.2 cfs, which is estimated to be lower than average stream flows, as below-average flows were documented in the mainstem South Fork Clearwater River. Because the flows are below average currently in the South Fork Clearwater, we would expect the flow in Red River to be lower than average as well (Leth 2017e). Although the water right of 8.18 cfs may de-water the stream, the average use of water for the hatchery is approximately 3 cfs surface-water (Leth 2017e), resulting in an expectation that no more than approximately 71 percent of the stream would be diverted (worst-case scenario). High amounts of water diversion could have a result of increased water temperature, impaired passage, or reduced prey availability. IDFG has indicated that they will not de-water the stream. Although Snake River fall Chinook salmon are not present in this stream, Snake River steelhead have been documented in this stretch.

- Crooked River Satellite: Gauge data is not readily available at this location. However, in-stream flow measurements were taken on September 6, 2017, in the Crooked River to provide accurate, real-time data during low flow months. The flow measured upstream of the intake was 15.05 cfs, which is estimated to be lower than average year-long stream flows, as below-average flows were documented at the same time in the mainstem South Fork Clearwater River. September is typically a low-water period. Because the flows are below average currently in the South Fork Clearwater River, we would expect the flow in the hydrologically connected Crooked River to be respectively, lower than average as well (Leth 2017e). Although the surface water right for this facility is 10 cfs, the average use of water for the hatchery is less than 3 cfs surface water, on average, and the maximum surface-water use on record has been 4 cfs (Leth 2017e). If the average cfs is pulled from in-stream, the hatchery would only divert about 16 percent of the stream. Because the maximum percent surface water diverted for Crooked River is fairly low using the average surface water hatchery use, when we calculate the maximum water diversion using the full water right of 10 cfs, the facility can withdraw between 16 and 66 percent of the stream during the minimum in-stream flow months (August/September). High amounts of water diversion could have a result of increased water temperature, impaired passage, or reduced prey availability. Although Snake River fall Chinook salmon are not present in this stream, Snake River steelhead have been documented in this stretch.

- Powell Satellite: There is no gauge in Walton Creek. However, in-stream flow measurements were taken on September 7, 2017, in Walton Creek to provide accurate data during low flow months. On average, the facility uses 5 cfs of water from Walton Creek, but there are no ESA-listed salmon or steelhead in the creek, and the effects of temporary water withdrawal are not expected to extend beyond the immediate facility area (beyond the mouth of Walton Creek) (Personal Comm., Brian Leth). Therefore, the effects of withdrawal here will not be further evaluated. A pump located at Colt Killed Creek serves as a backup surface water source for emergency situations—e.g., a fire nearby contaminated Walton Creek in a previous year, so Colt Killed Creek surface water was used.

Each rearing facility discharges proportionally small volumes of water with waste (predominantly biological waste) into a larger body of water, which results in temporary, very low, or undetectable levels of contaminants in the natural streams. General effects of various wastes in hatchery effluent are summarized in NMFS (2004a), though the biological waste at NPT, KNFH and CFH facilities are not likely to have a detectable effect on listed species because of a clarifier that treats waste, and abatement ponds, respectively, 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, and so would be expected to have essentially disappeared before the water in which it was present is discharged into the stream. 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 in the table below (Table 28) are either operated under NPDES permits, or do not need a NPDES permit because rearing levels in the acclimation pond are below permit minimums. DNFH's facility will not be discussed in this section because it is analyzed in NMFS (2017b). 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 spring/summer Chinook salmon and coho salmon, which have a low mortality during hatchery residence compared to survival in the natural-environment (~90 percent compared to 7 percent (Bradford 1995). This suggests that the effects of effluent, which is further diluted once discharged, will have a minimal impact on ESA-listed salmonids in the area.

Certain hatchery maintenance activities may displace juvenile fish through noise and instream activity or expose them to brief pulses of sediment as activities occur instream. However, these types of activities are rare, infrequent, and generally of short duration at established facilities. The Proposed Action includes best management practices that limit the type, timing, and magnitude of allowable instream activities. In general, the measures would result in discountable short-term sub-lethal effects such as fish displacement, and/or startling of fish, which are not outside of normal fish behavioral responses to environmental disturbances. Therefore, routine maintenance effects do not result in harm, harassment, or mortality of any listed individuals.

Table 28. Program water source and use; NA= not applicable. (N.F.: North Fork; M.F.: Middle Fork)

<table>
<tr><th>Facility</th><th>Surface Water Hatchery Use Water Right (Avg.) (cfs)</th><th>Maximum Ground or Spring Water Use (cfs)</th><th>Surface Water Source</th><th>Discharge Location</th><th>Diversion Distance (km)</th><th>Minimum Mean Monthly Surface Water Flow in Stream During Operation (cfs)</th><th>Months of Operation</th><th>Maximum Percent Surface Water Diverted*</th></tr>
<tr><td>KNFH</td><td>16 (13)</td><td>3.05</td><td>Clear Creek (90%) or wells</td><td>Clear Creek and M.F. Clearwater River</td><td>1.6</td><td>19.4 (Jan)[1]</td><td>Year-round</td><td><82%[1]</td></tr>
<tr><td>CFH</td><td>89 (64) (5,372.99 ac-ft/month)</td><td>NA</td><td>Dworshak Reservoir</td><td>N.F. Clearwater River</td><td>3</td><td>2,295,288 (ac-ft)[2]</td><td>Year-round</td><td><0.2%[2]</td></tr>
<tr><td>Red River Satellite</td><td>8.18 (3)</td><td>NA</td><td colspan="2">Red River</td><td>0.22</td><td>4.20 (Sept)[3]</td><td>May-September</td><td>71%[3]</td></tr>
<tr><td>Crooked River Satellite</td><td>10 (2.5)</td><td>NA</td><td colspan="2">Crooked River</td><td>0.16</td><td>15.05 (Sept)[4]</td><td>May-September</td><td>66%[4]</td></tr>
<tr><td rowspan="2">Powell Satellite</td><td>6.24 (5)</td><td rowspan="2">NA</td><td colspan="2">Walton Creek</td><td>0.15</td><td>7.87 (Sept)[5]</td><td>May-September</td><td>63%[5]</td></tr>
<tr><td>2.67 (0)</td><td>Colt Killed Creek</td><td>Walton Creek</td><td>0.8</td><td>NA[6]</td><td>NA</td><td>NA[6]</td></tr>
<tr><td>NPTH (Cherrylane Facility)</td><td>7.0 (5-6)</td><td>3.85</td><td colspan="2">Clearwater River</td><td>0.018</td><td>4,001[7]</td><td>Year-round</td><td>0.1%[7]</td></tr>
<tr><td>Sweetwater Springs (Rearing Facility)</td><td>0</td><td>3.44</td><td>Sweetwater Springs</td><td>Sweetwater Creek</td><td>0.20</td><td>NA</td><td>NA</td><td>NA</td></tr>
<tr><td rowspan="2">Yoosa/Camp (Acclimation Facility)</td><td>Yoosa: 2.5 (1.25)[8]</td><td rowspan="2">NA</td><td>Yoosa Creek</td><td rowspan="2">Lolo Creek</td><td>Yoosa: 0.15</td><td rowspan="2">6.77[9]</td><td>Sept-Oct</td><td rowspan="2"><37%[9]</td></tr>
<tr><td>Camp: 1.91[8]</td><td>Camp Creek</td><td>Camp: 0.20</td><td>Sept-Oct</td></tr>
<tr><td>Newsome (Acclimation Facility)</td><td>1.70 (1.12)[8]</td><td>NA</td><td colspan="2">Newsome Creek</td><td>0.4</td><td>5.6[9]</td><td>Sept-Oct</td><td>30%[9]</td></tr>
</table>

*Maximum percent surface water diverted is the surface water hatchery use max (or average, in certain cases) divided by the minimum in stream surface water flow during operation months. Average surface water hatchery use is used instead of the maximum water right for Red River, and Powell Satellites, where the average used is substantially lower than the maximum water right.

[1] January flow in 2017. Source: United States Geological Survey (USGS) Gauge 13337099 (newly installed, flow data only available from April 2016-July 2017 as of September 2017). While this hatchery diverts 82% (leaving 3 cfs in the stream if hatchery were to their entire water right), it is not likely to adversely affect the listed Snake River steelhead in this area (no Snake River fall Chinook salmon observed) because the steelhead do not enter Clear Creek until the spring (Johnson 2017b). The hatchery does not use Clear Creek water from June through September because the temperatures are in the 70s and 80s (°F). Typically no adult spring Chinook salmon are collected past July, so no surface water diversion needed (Johnson 2017a).
[2] Source: USGS Gauge 13340950 data not readily available; HDR and USFWS (2017). Surface water use max and average shown in both cfs and ac-ft/month. Maximum surface water flow during the lowest month is shown above-data is average ac-ft for the month of January from 1971-2016.
[3, 4] and [5] See text above for more information.
[6] Pumps at Colt Killed Creek are only used as an emergency back-up when water in Walton Creek is contaminated or unavailable.
[7] Data from HDR and USFWS (2017). Surface water flow is lowest during October which is the value used above although the facility operates year-round (data from 2003-2016).
[8] Average surface water hatchery use data from Johnson (2017c). One average (1.21 cfs) for Yoosa/Camp Creek combined (data not available individually).
[9] Gauge data not available. See HDR and USFWS (2017) for calculation methods and sources. Flow is diverted from both Yoosa and Camp Creeks, with no more than one half of either creek diverted (BPA 2017).

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. **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 negligible effect on designated critical habitat PCEs in the action area. We believe this is the case for several reasons. The first is that 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. Second, no new facilities are proposed. Third, hatchery maintenance activities are expected to retain existing conditions, and would have minimal adverse effects on designated critical habitat. Fourth, most facilities that use surface water diversions return that water to the river a short distance away from the diversion point and use only a small proportion of the total surface water volume (Table 28)—because the uses are non-consumptive and are within water rights, these withdrawals would not affect adult spawning or juvenile rearing critical habitat of ESA-listed Chinook, sockeye salmon, or steelhead. Fifth, 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 ESA-listed fish. Last, the use of abatement ponds at CFH and NPTH 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 spring/summer Chinook salmon and coho programs may actually provide a beneficial effect to 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). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

For the purpose of this analysis, the action area is that part of the Columbia River Basin described in Section 2.3. To the extent ongoing activities have occurred in the past and are currently occurring, their effects are included in the baseline (whether they are Federal, state, tribal or private). To the extent those same activities are reasonably certain to occur in the future (and are tribal, state or private), their future effects are included in the cumulative effects analysis. This is the case even if the ongoing tribal, state or private activities may become the subject of section 10(a)(1)(B) incidental take permits in the future until an opinion for the take permit has been issued. State, tribal, and local governments have developed plans and initiatives to benefit listed species and these plans must be implemented and sustained in a comprehensive manner for NMFS to consider them “reasonably foreseeable” in its analysis of cumulative effects. 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 2.4).

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 2017c).

2.7. Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the Proposed Action. In this section, NMFS adds the effects of the Proposed Action (Section 2.5.2) to the environmental baseline (2.3) and to cumulative effects (2.6) taking into account the status of the species and critical habitat (Section 2.2) to formulate the agency’s biological opinion as to whether the proposed action is likely to: (1) Reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably 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 appreciable reduce the likelihood of survival and recovery of the listed species and their designated critical habitat would be affected.

2.7.1. Snake River Spring/summer Chinook Salmon ESU

Because there are no ESA-listed spring/summer Chinook salmon in the Clearwater River subbasin, the only effects of the Proposed Action on this species would occur as a result of interactions during upstream or downstream passage between the Snake and Clearwater River confluence and Ice Harbor Dam.

Best available information indicates that the Snake River Spring/summer Chinook Salmon ESU is at high risk and remains threatened (NWFSC 2015). The NWFSC determined that there are 27 extant and four extirpated populations within this ESU. All of these extant populations except one (Chamberlain Creek in the Middle Fork MPG) were designated at a high overall risk (NWFSC 2015). Moreover, the Biological Review Team (BRT) identified the most serious risk to the ESU was low natural productivity and the decline in abundance relative to historical returns (NWFSC 2015). The South Fork Salmon River MPG within the Snake River Spring/summer Chinook Salmon ESU has two out of four populations that are being targeted for viability. Still, after taking into account the current viability status of these species, the Environmental Baseline, and other pertinent cumulative effects, including any anticipated Federal, state, or private projects, NMFS concludes that the effects of the Proposed Action will not appreciably reduce the likelihood of survival and recovery of this ESA-listed ESU in the wild, as discussed below.

Our environmental baseline analysis considers the beneficial and adverse effects of hydropower, changes in habitat, fisheries, and hatcheries on this ESU. Although all may have contributed to the listing of this ESU, all factors have also seen improvements in the way they are managed/operated. For example, a recent improvement in hatcheries is the use of PIT tags to better track movement and survival of hatchery-origin fish, whereas the dams contribute to habitat degradation, flow of water, and spill patterns. As we continue to deal with a changing climate, management of these factors may also alleviate some of the potential adverse effects on VSP parameters (abundance, productivity, diversity, and spatial structure) (e.g., through hatcheries serving as a genetic reserve for natural populations).

The majority of the effects of the Proposed Action on this ESU are ecological in nature, but genetic effects could also occur in certain cases. This is a factor in the abundance (ecological), productivity (ecological), and diversity (genetic) parameters. Facility operation, broodstock collection, and RM&E have no effect on this ESU because spring/summer Chinook salmon in the Clearwater River Basin are not in the ESU.

The ecological and genetic effects on the adult life stage are influenced by the proportion of hatchery-origin fish spawning naturally in each area of the river. For these four programs, this is managed through removal of adults at adult trapping locations and via fisheries in the area. Because all of these programs are currently segregated, pHOS is not evaluated and stray data were the main source of genetic effects in this Opinion. Stray and CWT recovery data between 2001 and 2015 indicated up to 1 stray and 2 CWTs, respectively, recovered by IDFG from fish released through programs in this Proposed Action. See Section 2.5.2.2.1 for more information. Other recoveries were found in basins with non-ESA-listed populations; however, those recoveries are in basins with only non-ESA listed fish. As demonstrated in Table 13, only 2 CWT tags were recovered (out of a total of >500) at the SF Salmon River Trap in 2011, which originated from fish released at Powell and Selway River (part of the Clearwater spring/summer Chinook program). In 2012-2015, no CWT recoveries from hatcheries in this Opinion occurred in an ESA-listed population within the Action Area.

Ecological effects on natural-origin juvenile Chinook salmon associated with releases from the hatchery programs (spring/summer Chinook and coho salmon) equates to a loss ranging from 3.8 to 4 percent of the adult natural-origin Chinook salmon in the Snake River basin passing through Lower Granite Dam. This includes the effects on both the Snake River Spring/summer and Fall Chinook Salmon ESUs, and the unlisted spring/summer Chinook salmon in the Clearwater. Even if all these effects were on one listed ESU, NMFS still believes this is unlikely to have an effect on the abundance and productivity of either the spring/summer or fall Chinook salmon ESU's in the Snake River. Furthermore, it is likely that this percentage is even smaller because the analysis did not account for potential predation of hatchery program fish on other hatchery program fish in the Snake River Basin, and the model assumed other worst case scenarios (e.g., 100 percent habitat overlap and 100 percent hatchery survival from Clearwater River mouth to Lower Granite Dam); thus, these effects are most likely to be an overestimation. It is important to also note that some levels of competition and predation are likely to occur within hatchery and natural-origin juvenile groupings as well as between them; within-group interactions are not currently accounted for in our model, but aren't applicable here since they would involve non-ESA-listed fish..

The recovery plan for this ESU describes the on-going and proposed state, tribal, and local government actions that are targeted to reduce known threats to ESA-listed spring/summer Chinook salmon. Such actions are improving habitat conditions and hatchery and harvest practices to protect ESA-listed spring/summer Chinook salmon, and NMFS expects this trend to continue, ultimately improving the abundance, diversity, and productivity of natural populations. Spatial structure is not likely to be affected by the proposed hatchery programs.

2.7.2. Snake River Basin Steelhead DPS and Fall Chinook and Sockeye Salmon ESU's

Best available information indicates that the Snake River Steelhead DPS and the Fall Chinook Salmon ESU are at high risk and remain at threatened status (NWFSC 2015). The Snake River Sockeye Salmon ESU is at high risk and remains endangered (NWFSC 2015). After taking into account the current viability status of these species, the environmental baseline, and other pertinent cumulative effects, including any anticipated Federal, state, or private projects, NMFS concludes that the effects of the Proposed Action will not appreciably reduce the likelihood of survival and recovery of these ESA-listed species.

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 (see Section 2.7.4 below), management of these factors may also alleviate some of the potential adverse effects to VSP parameters (abundance, productivity, diversity, and spatial structure) covered in the Appendix (e.g., hatcheries serving as a genetic reserve for natural populations).

The effects of our proposed action on these DPS and ESUs is limited to ecological effects, broodstock collection, and RM&E. Effects of RM&E and broodstock collection targeting spring/summer Chinook and coho salmon are 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. RM&E requires handling of a small portion of the ESA-listed juvenile population (fall Chinook salmon and steelhead), which was analyzed in Section 2.5.2.4. When compared to adult equivalents, a small number of adults are expected to die because of handling for RM&E, with no expected take for fall Chinook salmon and 0-90 steelhead at both Lolo and Newsome Creek Screw Traps, combined. This equates to less than 0.5 percent of both the average adult returns for fall Chinook and steelhead (above

Lower Granite Dam). There are no ESA-listed sockeye in the areas where RM&E occurs but the ecological effects on sockeye are included in following paragraphs. Therefore, is very little incidental effect on other Snake River ESA-listed species and it is unlikely that these activities would lead to a decrease in the abundance, productivity, diversity or spatial structure of the ESUs. These effects may result in changes to the abundance and productivity of natural-origin fish.

Our ecological analysis showed that the impacts of these programs equates to a loss of ~3.9 (Chinook salmon), 2.75 (steelhead), and 1.7 (sockeye) percent of the potential adult returns from competition and predation during the juvenile life stage. Because the model differentiates fish by size and not by run timing, these percentages could also include the unlisted spring/summer Chinook salmon as well, and so the estimated maximum impacts on the ESA-listed steelhead DPS and the fall Chinook and sockeye salmon ESUs from ecological effects are likely to be a conservative estimate. Adverse ecological effects on adults are small because of the differences in spatial and temporal overlap of these species with spring/summer Chinook salmon and coho. NMFS will monitor whether decreased productivity or abundance of natural-origin fish may necessitate reconsideration of hatchery program size in the future to limit impacts to these VSP parameters in these ESUs (see Appendix). The small percentage loss within these ESUs and DPS, is unlikely to affect the productivity of the Snake River Basin Steelhead DPS.

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 and steelhead, and NMFS expects this trend to continue.

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 2.5.2.7). Existing hatchery facilities have not contributed to altered channel morphology and stability, reduced and degraded floodplain connectivity, excessive sediment input, or the loss of habitat diversity. The operation of the weirs and other hatchery facilities may impact migration PBFs due to delay at these structures and possible rejection. 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. The number of natural-origin adults delayed is expected to be small to none (see Table 19) and the delay would only be for a short period (≤ 24 hours) and all listed species are passed upstream. Thus, the impact on spawning, rearing, and migration PBFs will be small in scale, and would not alter physical or biological features essential to the conservation of a species or preclude or significantly delay development of such features.

2.7.4. Climate Change

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., with unknown but likely small adverse effects on abundance and productivity as a result of this potential change in the habitat and resulting ecological effects. As changing climate conditions alter the hydrology of streams in the action area, it is possible that the amount of water available for withdrawal at different stages of hatchery operation could be decreased, potentially to the extent that average water withdrawals described in the Proposed Action would reduce stream flows to levels harmful to natural-origin fish and the ecosystem. However, given the intention of the hatchery managers to not de-water streams, if such a situation arises, hatchery operations would need to be re-considered at that time.

The continued restoration of habitat may also provide additional refugia for fish, which might reduce the magnitude of interactions between program fish and natural-origin fish due to reduced densities of program fish in such refugia despite any potential increases in the need for such refugia due to climate changes. 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 Spring/summer Chinook, Fall Chinook, and Sockeye Salmon ESUs or the Snake River Basin Steelhead DPS.

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 Spring/summer-run Chinook Salmon ESU, Snake River Fall-run Chinook Salmon ESU, Snake River Sockeye Salmon ESU, and Snake River Basin Steelhead DPS 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

NMFS expects incidental take of ESA-listed salmonids will occur as a result of the Proposed Action for the following factors.

No take is anticipated that would fall under Factor 1, by definition, because the only fish that would be collected for broodstock would be non-ESA-listed. Effects on ESA-listed fish as a result of operation of the collection activities (e.g. incidental handling and mortality of listed individuals) are addressed under Factor 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

There is take for this factor due to three take pathways; genetic effects, ecological effects, and adult handling/tagging and incidental mortality at adult collection facilities. Effects of hatchery-origin fish on the genetics of natural-origin fish can occur through a reduction in genetic diversity, outbreeding depression, and hatchery-influenced selection. Similarly, take due to ecological effects of hatchery adults on the spawning grounds such as competition for spawning sites and redd superimposition. The hatchery programs in this Opinion are all segregated (and a portion of each program is marked with a CWT, along with 100% PBT marked). The only ESA-listed spring/summer Chinook salmon population in the Snake River that is likely to experience take through interbreeding and genetic introgression is the South Fork Salmon population (see Section 2.5.2.2.1 for more details).

Take due to these genetic and ecological effects in the South Fork Salmon River cannot be directly measured because it is not possible to observe gene flow or interbreeding between hatchery and wild fish (genetic effects) in a reliable way, nor is it possible to accurately quantify the extent of spawning ground competition for spawning sites or redd superimposition (ecological effects). NMFS will therefore rely on a take surrogate of coded wire tag (CWT) recoveries on the spawning grounds. This is logical because both of these take forms occur as a result of and to the extent of the presence of adult hatchery-origin fish on the spawning grounds, and while CWT recoveries do not establish the full extent of that presence, they give some indication of the extent and trends in pHOS. Specifically, NMFS will use a take surrogate for both take pathways that estimates the number of CWT recoveries into the South Fork Salmon population to a total of no more than 5 tags recovered annually from the five Clearwater River hatchery programs (actual number recovered, not expanded) averaged over a running 5-year period. This total represents the extent of hatchery influence in the past, and therefore going forward. The discovery of more than five tags per year suggests that take has exceeded that previously assessed as resulting from the proposed action. This threshold can be reliably monitored using CWT recoveries from sport fisheries, on spawning grounds, and at hatchery traps.

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. Table 29 below shows the expected incidental handling and mortality numbers for adult fall Chinook salmon and steelhead at four adult collection facilities (DNFH is analyzed in NMFS (2017b)). These numbers are based off actual data, which is in Table 19.

Table 29. ESA-listed adult salmon and steelhead handled by origin at (adult) collection facilities. Mortalities, if any, are shown in parentheses.

Facility	Origin	Fall Chinook salmon (hatchery- and natural-origin)	Steelhead (hatchery- and natural-origin)
		Proposed Number Handled[1] (mortalities)	Proposed Number Handled[1] (mortalities)
Red River Trap[2]	Natural	5 (0)	20 (1)
	Hatchery	5 (0)	20 (1)
Powell Trap[2]	Natural	5 (0)	20 (1)
	Hatchery	5 (0)	20 (1)

[1]Inclusive of sampling and trapping.
[2]The effects from Lapwai and Clear Creek weirs on fall Chinook salmon and steelhead were analyzed in the Mitchell Act Biological Opinion, where a no effect determination was concluded (NMFS 2017a).

Table 30 below shows the expected incidental handling and mortality numbers for adult hatchery-and natural-origin fall Chinook salmon and steelhead collected via various collection activities in the Clearwater River Basin (secondary methods used only when broodstock shortfall is projected). These numbers are based on actual data, which can be seen in Table 20.

Table 30. ESA-listed adult salmon and steelhead handled by origin through alternative adult collection methods. Mortalities, if any, are shown in parentheses.

Method	Fall Chinook salmon (hatchery- and natural-origin)	Steelhead (hatchery- and natural-origin)
	Proposed Number Handled (mortalities)	Proposed Number Handled (mortalities)
Angling in Clearwater River Basin	**2 (1)[1]**	**2 (1)[1]**
Seining/Netting in Clearwater River Basin	**5 (2)[1]**	**5 (2)[1]**

[1]Applied to each type (natural- or hatchery-origin) fish.

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 Chinook and coho salmon parr and smolts (yearlings) 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, NMFS will rely on two surrogate take variables: one for outmigrants and one for potential non-migrants.

For outmigrants, NMFS applies a surrogate take measurement that relates to the median travel time for hatchery-origin spring/summer Chinook to reach 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 spring/summer Chinook salmon is five days longer than the median value (which equates to 50% of the fish) identified in Table 24 for each program for three of the next five years of five-year running medians beginning in 2018 with data from 2018 to 2022. For example, if the five-year running median of the median values in Table 24, is 20, and then the median for the next three years for a particular release group is 25 or greater, this would exceed the expected take level. 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.

To account for effects of residualism, NMFS applies a surrogate take measurement for hatchery-origin spring/summer Chinook salmon that is the percentage of spring/summer Chinook salmon in the release that are either parr, precociously maturing, or precociously mature prior to release. This surrogate has a rational connection to the amount of take expected from residualism because precocious spring/summer Chinook salmon and parr may residualize after release from the hatchery. This take surrogate covers one take pathway: the potential of residual spring/summer Chinook salmon to compete with and prey on juvenile natural-origin fish for an extended period of time. NMFS considers, for the purpose of this take surrogate, that no more than five percent of program fish should be precociously mature, using a running five-year average, beginning with the 2018 release[10]. This is a common level known to occur through review of other yearling programs (IDFG 2003). Between 2017 and 2022, the annual rate should be no more than five percent. The take surrogate can be reliably measured and monitored through visual assessment of the hatchery population and/or migrant fish prior to release.

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

Table 31 shows the proposed incidental handling and mortality numbers for juvenile fall Chinook salmon and steelhead at the Lolo and Newsome Creek Screw Traps, which are a part of the RM&E for programs in this Opinion. These numbers are based off actual data, which is in Table 27. NMFS considers mortality numbers to be the result of injury or killing during handling, and that non-mortalities would be subjected to capture not resulting in harm or harassment.

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

Table 31. Juvenile salmon and steelhead handled by origin at RM&E facilities. Estimated mortalities are shown in parentheses.

Facility	Origin	Fall Chinook salmon (hatchery- and natural-origin)	Steelhead (hatchery- and natural-origin)
		Proposed Number Handled (mortalities)	Proposed Number Handled (mortalities)
Lolo Creek Screw Trap	Natural	0	3,000 (10)
	Hatchery	0	13,100 (10)
Newsome Creek Screw Trap	Natural	0	2,200 (10)
	Hatchery	0	35 (1)

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

Take of listed steelhead by nearby hatchery facilities (specifically Red and Crooked River satellites) that exist because of the programs in this Proposed Action is likely to occur in the form of harm caused when the stream is partially dewatered, resulting in an increase in water temperature, impaired passage, or reduced prey availability. This take cannot be reliably observed, therefore NMFS will rely on a take surrogate. Specifically, NMFS will rely on the volume of water withdrawn from the Red River and Crooked River for their associated sites (Red River Satellite and Crooked River Satellite, respectively), which is not expected to exceed 71% of the Red River flow and 66% of the Crooked River flow.

Table 32. Program water source and use; NA= not applicable.

Facility	Surface Water Hatchery Use Water Right (Avg) (cfs)	Maximum Ground or Spring Water Use (cfs)	Surface Water Source	Discharge Location	Diversion Distance (km)	Minimum Mean Monthly Surface Water Flow in Stream During Operation (cfs)	Months of Operation	Maximum Percent Surface Water Diverted*
Red River Satellite	8.18 (3)	NA	Red River		0.22	4.20 (Sept)	May-September	71%
Crooked River Satellite	10 (2.5)	NA	Crooked River		0.16	15.05 (Sept)	May-September	66%

[*] Average surface water hatchery use is used instead of the maximum water right for Red River where the average used is substantially lower than the maximum water right.

The percent of river diverted has a causal link to the take associated with dewatering, since that take occurs in proportion to the extent to which the river is dewatered. Moreover, this can be meaningfully monitored, by visual observations (i.e. photos) referencing and correlating with previously measured physical in-stream flows measurements (seen in Table 32).

2.9.2. Effect of the Take

In the biological opinion, NMFS determined that the amount or extent of anticipated take, coupled with other effects of the Proposed Action, is not likely to jeopardize the continued existence of the Snake River Spring/summer Chinook Salmon ESU, Snake River Fall Chinook

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

2.9.3. 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 NMFS, BPA, USFWS, and LSRCP shall ensure that:

1. The applicants implement the hatchery programs and operate the hatchery facilities as described in the Proposed Action (Section 1.3) and in the submitted HGMPs.

2. The applicants provide reports to SFD annually for all hatchery programs and associated RM&E.

2.9.4. Terms and Conditions

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

NMFS, BPA, USFWS, and LSRCP shall ensure for their respective programs that:

1. The applicants implement the hatchery programs as described in the Proposed Action (Section 1.3) and the submitted HGMPs including:
    a. Providing advance notice of any change in program operation and implementation that potentially increases the amount of extent of take, or results in an effect of take not previously considered.
    b. Providing notice if monitoring reveals an increase in the amount of extent of take, or discovers an effect of the Proposed Action not considered in this Opinion.
    c. Continued visual observation (e.g. photos) of in-stream flow at South Fork Red River and Crooked River during low flow months (August and September) to inform facility water usage relative to availability in the stream. These visual observations (e.g. photos) will be compared to previously taken photos that also correlate with physically measured in-stream flow measurements taken during September of 2017, during an anomalously low-flow year. LSCRP will report data to NMFS on an annual basis starting in 2018 by the end of the calendar year (i.e., August and September 2018 data is to NMFS by December 31, 2018). At this point in time, this visual assessment method will serve to determine in-stream water usage and confirm that dewatering will not occur, unless NMFS, LSCRP,

and IDFG agree that stream water usage is no longer a concern or a different method will suffice to measure in-stream flows. In any year in which facility operation is anticipated to exceed the take values in the surrogate above, applicants will discuss with NMFS before operating to discuss other options (i.e., use another facility) (see Section 2.5.2.5) (LSRCP only).

2. Ensure the applicants provide reports to SFD annually for all programs, and associated RM&E, as identified in the Proposed Action. The information required below (in subsections i. and ii.) can appear in reports prepared for other purposes (i.e., reports submitted to LSCRP or BPA), as long as those reports are also identified as addressing this ITS, and the information summarized.
    a. Reports shall be submitted to SFD by March 31st of the year following release (e.g., brood year 2015, release year 2017, report due March 2017).
    b. All reports and notifications should be submitted electronically to the NMFS point of contact for this Opinion: Emily Reynolds (503) 231-6290, emily.reynolds@noaa.gov
    c. Applicants will notify NMFS SFD within 48 hours of knowledge of exceeding any authorized take. The applicants shall submit a written report or discuss with NMFS at the discretion of NMFS, detailing why the authorized take was exceeded within two weeks of the event.
    d. Annual reports to SFD for hatchery programs should include:
        i. The number and origin (hatchery and natural) of each listed species handled and incidental mortality across all activities Hatchery Environment Monitoring Report
            - 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
            - Precocious maturation rates prior to release
            - Any problems that may have arisen during hatchery activities
            - Any unforeseen effects on listed fish

        ii. Natural Environmental Monitoring Report
            - The number of returning hatchery and natural-origin adults
            - The number and species of listed fish encountered at each adult collection location, and the number that die
            - The contribution of fish from these programs into ESA-listed populations (i.e., Salmon Basin) based on CWT recoveries/PIT tag detections
            - Post-release out-of-basin migration timing (median travel time and residual rates) of juvenile hatchery-origin fish to Lower Granite Dam
            - Mean length, coefficient of variation, number, and age of natural-origin juveniles

- Number and species of listed juveniles and adults encountered and the number that die during RM&E activities

2.10. Conservation Recommendations

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

1. Estimate the number of natural-origin spring/summer Chinook salmon juveniles outmigrating from the Clearwater Subbasin as a proportion of the total (Salmon and Clearwater Subbasins) number of outmigrating natural-origin spring/summer Chinook salmon to Lower Granite Dam, to allow NMFS to partition the Chinook salmon estimates in the PCDRisk model for ecological effects.

2.11. Re-initiation of Consultation

This concludes formal consultation on the approval and implementation of five hatchery programs rearing and releasing spring/summer Chinook and coho salmon in the Clearwater River Basin.

As 50 CFR 402.16 states, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) The amount or extent of incidental taking 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 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 2014b) contained in the fishery management plans developed by the PFMC and approved by the Secretary of Commerce.

3.1. Essential Fish Habitat Affected by the Project

The Proposed Action is the implementation of four spring/summer Chinook salmon and one coho salmon hatchery programs, as described in Section 1.3. The Action Area (Figure 1) of the Proposed Action includes habitat described as EFH for Chinook and coho salmon (PFMC 2014a) within the Snake River Basin. Because EFH has not been described for steelhead, the analysis is restricted to the effects of the Proposed Action on EFH for Chinook and coho salmon.

As described by (PFMC 2014a), 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). Additionally, hatchery operations may have effects on complex channels and floodplain habitat used by natural-origin Chinook and coho salmon (primarily addressing HAPC 1).

3.2. Adverse Effects on Essential Fish Habitat

The Proposed Action would have 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, impending 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 virtually undetectable, and impacts would not occur.

The PFMC (2003) recognized concerns regarding the “genetic and ecological interactions of hatchery and wild fish… [which have] been identified as risk factors for wild populations.” The biological opinion describes in considerable detail the impacts hatchery programs might have on natural populations of Chinook salmon (Appendix A to the opinion); the effects on coho salmon are typically much smaller, due to the species-specific nature of many of the interactions and relatively small overlap in habitat usage by the two species. Ecological effects of juvenile and adult hatchery-origin fish on natural-origin fish are discussed in Sections 2.5.2.2 and 2.5.2.3. Hatchery fish returning to the Clearwater River Basin are expected to largely spawn and rear near the hatchery and not compete for space with Chinook or coho salmon. Predation by adult hatchery spring/summer Chinook and coho salmon on juvenile natural-origin Chinook or coho salmon is unlikely due to timing differences and because adult salmon typically stop feeding by the time they reach spawning areas (Groot and Margolis 1991). Predation and competition by juvenile hatchery-origin spring/summer Chinook and coho salmon on juvenile natural-origin Chinook or coho salmon is expected to have no adverse effects because these fish outmigrate relatively quickly and at sizes (majority smolt-ready) that limit these types of interactions.

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

3.3. Essential Fish Habitat Conservation Recommendations

Because NMFS has determined that the Proposed Action would not adversely affect EFH for Pacific salmon, NMFS has not identified any EFH conservation recommendations.

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. Because NMFS has determined that the Proposed Action would not adversely affect EFH for Pacific salmon, there is no statutory response requirement.

3.5. Supplemental Consultation

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

4. Data Quality Act Documentation and Pre-Dissemination Review

Section 515 of the Treasury and General Government Appropriations Act of 2001 (Public Law 106-554) (“Data Quality Act”) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these

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

4.1. Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. NMFS has determined, through this ESA section 7 consultation that operation of the five spring/summer Chinook salmon hatchery programs in the Clearwater River Basin 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), the USFWS (funding and operating entity), the USFWS LSRCP Office (funding entity), BPA (funding entity), CRITFC (funding entity), the IDFG (operating entity), and the NPT (operating entity). The scientific community, resource managers, and stakeholders benefit from the consultation through the anticipated increase in returns of spring/summer Chinook and coho salmon to the Clearwater River Basin for conservation and harvest, and through the collection of data indicating the potential effects of the operation on the viability of natural populations of Snake River spring/summer Chinook, fall Chinook, and sockeye salmon, and Snake River steelhead. This information will improve scientific understanding of hatchery-origin Chinook and coho salmon 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 32. Generally speaking, effects range from beneficial to negative when programs use local fish[11] for hatchery broodstock, and from negligible to negative when programs do not use local fish for broodstock[12]. 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) construction, operation, and maintenance of hatchery facilities that exist because of the hatchery program, and
(6) fisheries that exist because of the hatchery program, including terminal fisheries intended to reduce the escapement of hatchery-origin fish to spawning grounds.

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

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

The effects of hatchery fish on ESU/DPS status will depend on which of the four VSP criteria are currently limiting the ESU/DPS and how the hatchery program affects each of the criteria (NMFS 2005c). The category of effect assigned to a factor is based on an analysis of each factor weighed against each affected population's current risk level for abundance, productivity, spatial

[11] 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).
[12] Exceptions include restoring extirpated populations and gene banks.

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

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

1.1. 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.

1.2. 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).

1.2.1. **Genetic effects**

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

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

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

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

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

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

The proportion of hatchery fish (pHOS)[13] 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

[13] 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.

reduced survival of their progeny (Leider et al. 1990; Reisenbichler and McIntyre 1977; Williamson et al. 2010).

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

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

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

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

Critical information for analysis of hatchery-induced selection includes the number, location, and timing of naturally spawning hatchery fish, the estimated level of gene flow between hatchery-origin and natural-origin fish, the origin of the hatchery stock (the more distant the origin compared to the affected natural population, the greater the threat), the level and intensity of hatchery selection and the number of years the operation has been run in this way. Efforts to control and evaluate the risk of hatchery-influenced selection are currently largely focused on gene flow between natural-origin and hatchery-origin fish[14]. 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 8).

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)[15]. PNI is, in theory, a reflection of the relative strength of selection in the hatchery and natural environments; a PNI value greater than 0.5 indicates dominance of natural selective forces. The HSRG guidelines vary according to type of program and conservation importance of the population. When the underlying natural population is of high conservation importance, the guidelines are a pHOS of no greater than 5 percent for isolated programs. For integrated programs, the guidelines are a pHOS no greater than 30 percent and PNI of at least 67 percent for integrated programs (HSRG 2009). Higher levels of hatchery influence are acceptable, however, when a population is at high risk or very high risk of extinction due to low abundance and the hatchery program is being used to conserve the population and reduce extinction risk in the short-term. (HSRG 2004) offered additional guidance regarding isolated programs, stating that risk increases dramatically as the level of divergence increases, especially if the hatchery stock has been selected directly or indirectly for characteristics that differ from the natural population. The HSRG recently produced an update report (HSRG 2014) that stated that the guidelines for isolated programs may not provide as much protection from fitness loss as the corresponding guidelines for integrated programs.

[14] 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.

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

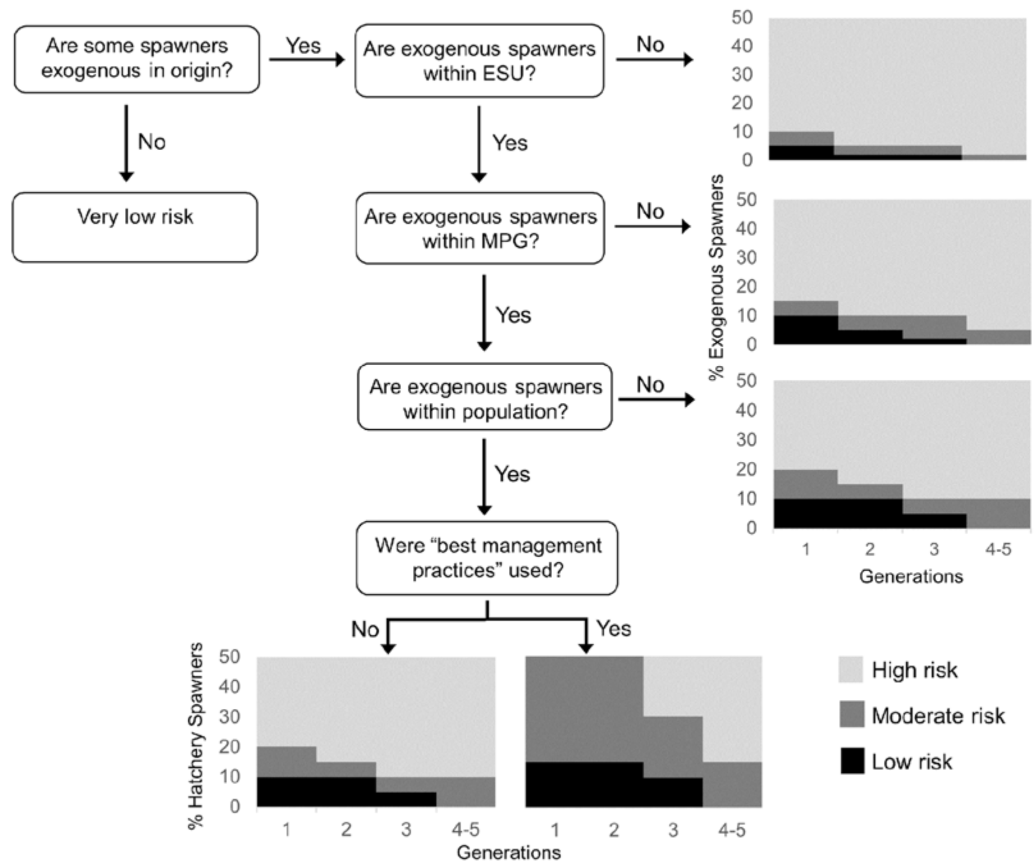

Figure 8. ICTRT (2007b) risk criteria associated with spawner composition for viability assessment of exogenous spawners on maintaining natural patterns of gene flow. Exogenous fish are considered to be all fish hatchery origin, and non-normative strays of natural origin.

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

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

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

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

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

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

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

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

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

Additional perspective on pHOS that is independent of HSRG modelling is provided by a simple analysis of the expected proportions of mating types. Figure 9 shows the expected proportion of mating types in a mixed population of natural-origin (N) and hatchery-origin (H) fish as a function of the census pHOS, assuming that N and H adults mate randomly[16]. For example, at a census pHOS level of 10 percent, 81 percent of the matings will be NxN, 18 percent will be NxH, and 1 percent will be HxH. This diagram can also be interpreted as probability of parentage of naturally produced progeny, assuming random mating and equal reproductive success of all mating types. Under this interpretation, progeny produced by a parental group with a pHOS level of 10 percent will have an 81 percent chance of having two natural-origin parents, etc.

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

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

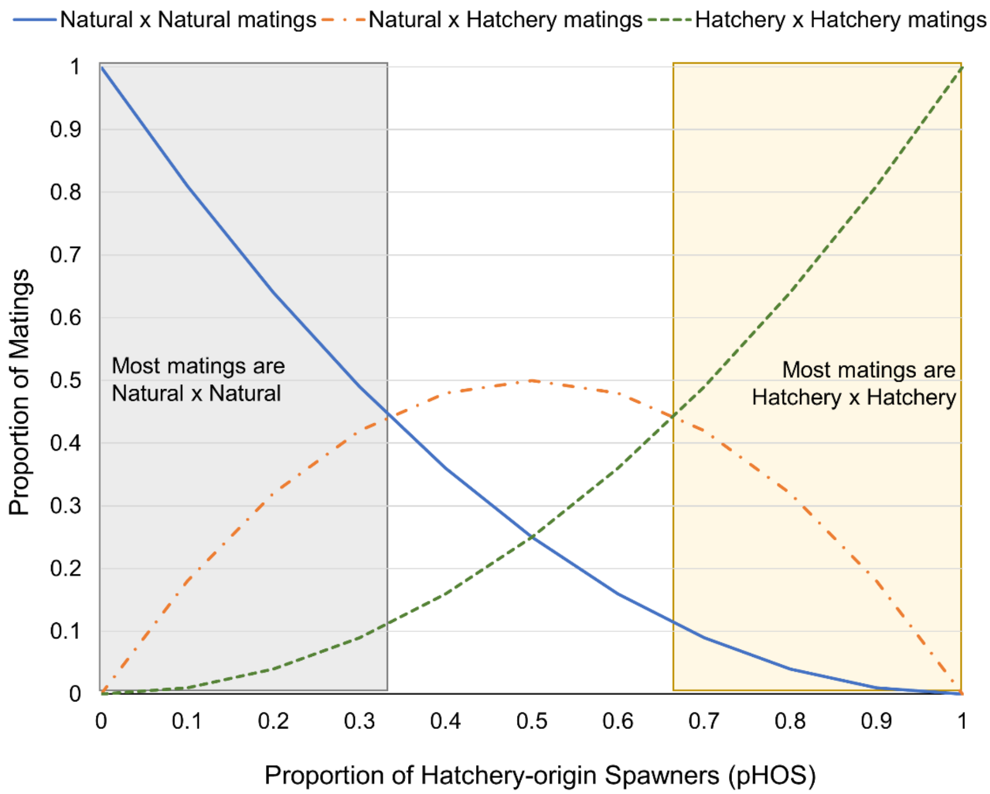

Figure 9. Relative proportions of types of matings as a function of proportion of hatchery-origin fish on the spawning grounds (pHOS).

1.2.2. **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).

1.2.3. 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.

1.3. 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.

1.3.1. 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 2012b). In an assessment of the potential ecological impacts of hatchery fish production on naturally produced salmonids, the Species Interaction Work Group (Rensel et al. 1984) concluded that naturally produced coho and Chinook salmon and steelhead are all potentially at “high risk” due to competition (both interspecific and intraspecific) from hatchery fish of any of these three species. In contrast, the risk to naturally produced pink, chum, and sockeye salmon due to competition from hatchery salmon and steelhead was judged to be low.

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

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

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

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

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

Critical to analyzing competition risk is information on the quality and quantity of spawning and rearing habitat in the action area,[17] 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.

1.3.2. **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

[17] "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.

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.

1.3.3. **Disease**

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

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

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

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

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

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

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

1.3.4. **Acclimation**

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

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

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

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

1.4. 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)

1.4.1. **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.

1.4.2. **Capturing/handling**

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

1.4.3. **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.

1.5. 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.

1.6. 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 when fisheries 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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