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

Four Salmon River Basin Spring/Summer Chinook Salmon Hatchery Programs in the Upper Salmon River Basin

NMFS Consultation Number: WCR-2017-7042

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

Program Operators: Idaho Department of Fish and Game (IDFG)
Shoshone-Bannock Tribes (SBT)
Idaho Power Company (IPC)

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	Yes	Yes

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

Issued By: Kevin C. Duffy
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Date: 12/26/2017

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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. NMFS is consulting on its review, pursuant to 50 CFR 223.203, of a series of hatchery programs in the Upper Salmon River basin in Idaho. The underlying activities that drive these Proposed Actions are the operation and maintenance of four hatchery programs that rear and release Snake River spring/summer Chinook salmon in the Salmon River subbasin. The programs include associated hatchery monitoring and evaluation activities throughout the Salmon River subbasin. The hatchery programs are operated by Federal, state, tribal agencies, or Idaho Power Company as described in Table 1. Each program is described in detail in a Hatchery and Genetic Management Plan (HGMP) submitted to the NMFS for review.

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

Program	Final HGMP Receipt[1]	Primary Program Operator[2]	Funding Agency	Program Type and Purpose	ESA Pathway
Yankee Fork Spring Chinook Salmon	Nov. 30, 2017	SBT	BPA[3, 4,] and LSRCP[3, 5]	Integrated Recovery	4(d) Limit 5
Panther Creek Summer Chinook Salmon	Nov. 30, 2017	SBT	TBD[5]	Integrated Recovery	4(d) Limit 5
Upper Salmon River Spring Chinook Salmon (Sawtooth Hatchery)	Nov. 30, 2017	IDFG	LSRCP[4]	Segregated Harvest *and* Integrated Recovery	4(d) Limit 5
Pahsimeroi Summer Chinook Salmon	Nov. 30, 2017	IDFG and IPC	IPC	Segregated Harvest *and* Integrated Recovery	4(d) Limit 5

[1] Most recent HGMP receipt. Many HGMPs have been previously submitted and updated.

[2] Primary operators are listed, but all programs are coordinated between Idaho, the Tribes, and Federal agencies collectively. Operators are: Idaho Fish and Game (IDFG), Shoshone-Bannock Tribes (SBT), Idaho Power Company (IPC).

[3] The BPA and LSRCP will fund the construction of the Yankee Fork weir and BPA will fund the ongoing operation of the weir for Chinook broodstock collection. The LSRCP provides some funding for the Yankee Fork weir, primarily in support of their use of the weir for steelhead broodstock collection, however, some overlap with Yankee Fork facilities may occur in the future.

[4] The United States Fish and Wildlife Service (USFWS) is the funding agency through the Lower Snake River Compensation Plan (LSRCP)

[5] Funding may vary over time and depending on program phase between funding agencies and operator agreement.

1.1. Background

The National Marine Fisheries Service (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, USFS, and BPA.

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

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available through NMFS' Public Consultation Tracking System. A complete record of this consultation is on file at the NMFS West Coast Region's Sustainable Fisheries Division (SFD) 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 Federally-funded hatchery programs ordered by Congress was underway at about the same time that the 2000 Federal Columbia River Power System (FCRPS) opinion was issued by NMFS (NMFS 2000a). The Northwest Power and Conservation Council (Council) was asked to develop a set of coordinated policies to guide the future use of artificial propagation, and RPA 169 of the FCRPS opinion called for the completion of NMFS-approved hatchery operating plans (i.e., HGMPs) by the end of 2003. The RPA required the Action Agencies to facilitate this process, first by assisting in the development of HGMPs, and then by helping to implement identified hatchery reforms. Also at this time, a new *U.S. v. Oregon* Columbia River Fisheries Management Plan (CRFMP), which included goals for hatchery management, was under negotiation and new information and science on the status and recovery goals for salmon and steelhead was emerging from Technical Recovery Teams (TRTs). Work on HGMPs under the FCRPS opinion was undertaken in cooperation with the Council's Artificial Production Review and Evaluation process, with CRFMP negotiations, and with ESA recovery planning (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 2007a) determined that operation of the programs would not jeopardize salmon and steelhead protected under the ESA.

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

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

On April 28, 2010 (Walton 2010), NMFS issued a letter to "co-managers, hatchery operators, and hatchery funding agencies" that described how NMFS "has been working with co-managers throughout the Northwest on the development and submittal of fishery and hatchery plans in compliance with the Federal 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 four spring/summer Chinook salmon hatchery programs, and the construction of two permanent weirs is based the applications (HGMPs and supporting documents) submitted to NMFS by the operators and funding agencies. Informal reviews of draft HGMPs occurred between 2002 and 2017, and programs were modified or updated during those times. Program changes occurred as regional hatchery reviews took place, and when operators believed that program changes could improve overall survival, or the effectiveness of the program at returning or managing adults. Some changes were also related to agreements reached through forums such as *U.S. v. Oregon*, which legally upholds the Columbia River Treaty Tribes' reserved fishing rights and tribal entitlement to a fair share of fish runs and remains under the Federal court's continuing jurisdiction.

In response to recovery plan targets and natural-population goals, the operators have modified the programs in recent years. In general, changes were made to adult management and the size of the conservation components of the Sawtooth and Pahsimeroi programs. Some minor changes were also made to adult management targets in the Yankee Fork and Panther Creek.

The operators submitted final HGMPs for formal consultation in the spring of 2017. Once submitted, NMFS reviewed the HGMPs for sufficiency, and issued letters indicating that HGMPs were sufficient for consultation (Purcell 2017a; 2017b). This consultation evaluates the effects of the hatchery programs on all ESU and DPSs of salmon and steelhead in the Columbia River Basin under the ESA, and their designated critical habitat. It also evaluates the effects of the programs on Essential Fish Habitat (EFH) under the Magnuson-Stevens Fishery and Conservation Management Act.

1.3. Proposed Federal Action

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

The objective of this opinion is to determine the likely effects on ESA-listed salmon and steelhead and their designated critical habitat resulting from NMFS' approval of the construction of collection and holding facilities on Yankee Fork and Panther Creek, as well as the continued operation of the four spring/summer Chinook salmon hatchery programs in the upper Salmon River basin. This opinion will determine if the construction of facilities on Yankee Fork and Panther Creek as well as the ongoing actions proposed in each of the four HGMPs comply with the provisions of Section 7(a)(2) of the ESA. Under section 4(d), final determinations do not expire unless specifically defined to do so, but are subject to reinitiation if changes to the action, species status, or if new information indicates that the effects of the action on listed species have changed. Ongoing monitoring and reporting on each of the programs will inform the operators and NMFS of the program effectiveness as well as effects on listed species to determine if/when reinitiation may be needed.

The four Proposed Actions we are considering in this opinion include:

- The Proposed Action for the Bonneville Power Administration (BPA) is the funding of the construction and operation of the Crystal Springs Fish Hatchery, the construction and operation of collection and holding facilities on Yankee Fork and Panther Creek, as well as the ongoing operation, maintenance, and monitoring and evaluation of the Yankee Fork and Panther Creek Spring/summer Chinook Salmon hatchery programs.[1]
- The Proposed Action for the U.S. Fish and Wildlife Service (USFWS) is the funding of the operation, maintenance, and monitoring and evaluation of the Sawtooth Spring/summer Chinook salmon hatchery program through the Lower Snake River Compensation Plan (LSRCP). LSRCP is also partially funding the construction of the Yankee Fork weir, operation of the Yankee Fork Chinook program, and will use the weir for the collection of steelhead broodstock[1]. The LSRCP was approved by the Water Resources Development Act of 1976 (Public Law 94-587, Section 102, 94th Congress).
- The Proposed Action for NMFS is making a determination on the HGMPs for all four programs under the ESA section 4(d) limit 5. NMFS' HGMP determination will allow operation of hatchery related activities for these programs. Note that the Idaho Power

[1] Though a permanent weir is proposed on Panther Creek, a temporary weir may be used if a permanent weir is not feasible. Though other parties are contributing to the funding for the Yankee Fork (e.g., USFWS) and Panther Creek facilities, BPA is the primary funding agency and other funding sources do not alter the action being proposed.

Company funds operation, maintenance, and monitoring and evaluation of the Pahsimeroi Summer Chinook salmon hatchery program (Table 1).

- The Proposed Action for the U.S. Forest Service (USFS) is the issuance of a Special Use Permit for the construction, operation, and maintenance of the Yankee Fork and Panther Creek weirs, and associated facilities, on USFS land located within the Salmon-Challis National Forest.

Under the Proposed Action, NMFS would make a determination that the four submitted HGMPs meet the requirements of section 4(d) of ESA, and determine if the operation of the programs is likely to jeopardize the continued existence of each of the species affected by action in this Section 7 consultation. The effects of these funding actions are fully subsumed in the effects of the proposed programs.

1.3.1. Proposed Construction Activities

As part of the SBT Spring/summer Chinook salmon programs in Yankee Fork and Panther Creek, a hatchery facility (Crystal Springs Fish Hatchery) may be constructed; however, the details of funding and construction feasibility are still uncertain. Temporary seasonal weirs may be used for program management prior to construction. There is also the possibility that temporary weirs may be used indefinitely if funding is not available or if construction is not feasible. Though temporary weirs are typically more difficult to operate, the program and adult management (spawner escapement and broodstock composition) goals remain the same regardless of the weir type used.

Because the Crystal Springs Fish Hatchery is outside of the range of anadromous salmon and steelhead, the construction and operation actives taking place at the Crystal Springs Fish Hatchery are expected to have no effect on listed salmon or steelhead. Though it is part of the larger suite of activities undertaken by the BPA, the Crystal Springs Fish Hatchery component does not occur within the range of listed anadromous salmonids, and therefore has been excluded from further consideration. However, the construction of collection and holding facilities on Yankee Fork and Panther Creek, as well as their ongoing operation and maintenance, will occur in anadromous waters. A detailed description of construction activities is included in the DEIS prepared by the BPA, and briefly summarized here (BPA et al. 2017). At each location, a permanent adult collection weir and adult holding ponds will be constructed for broodstock collecting and holding. All instream structures proposed for construction will be reviewed by NMFS to meet adult management objectives and for compliance with fish passage criteria (NMFS 2011b). Due to the natural hydraulics of the Yankee Fork, funding constraints, and construction-related habitat considerations, final weir design may not meet all of NMFS's passage criteria. Where criteria cannot be met, alternative designs and operational modifications will be coordinated with NMFS's passage review team (as part of the engineering approval process) to minimize adverse effects to listed and resident fish. As a result of this review, it is expected that the weir will safely capture fish and allow for upstream and downstream movements with minimal adverse effects. Until construction is complete, or if a permanent weir is not feasible, temporary weirs will be used to collect adults at Yankee Fork and Panther Creek. Until permanent adult holding constructed at either location, then adult holding may occur at Sawtooth or Pahsimeroi.

1.3.1.1. Yankee Fork Bridge Weir

A new bridge weir that would span the Yankee Fork is proposed to be located a short distance downstream of the existing temporary weir site in order to locate the ladder entrance at a more defined stream bottom near the left bank of Yankee Fork. This weir would allow water to flow through, but would limit fish passage and direct fish toward the fish ladder. On the left bank looking downstream (eastern bank), the embankment for Yankee Fork Road is approximately 2 feet above the 100-year floodplain. On the right bank (western bank), lower lying ground could result in flood events occasionally bypassing around the right bank bridge weir abutment. In the event of a high-flow event resulting in the Yankee Fork overtopping its bank, Tribal operators may need to deploy a temporary picket weir to extend the weir on the right bank to seal off fish passage[2]. Prior to construction, the weir design will be reviewed by NMFS to meet adult management objectives and ensure compliance with fish passage criteria (NMFS 2011b). Due to the natural hydraulics of the Yankee Fork, funding constraints, and construction-related habitat considerations, final weir design may not meet all of NMFS's passage criteria. Where criteria cannot be met, alternative designs and operational modifications will be coordinated with NMFS's passage review team (as part of the engineering approval process) to minimize adverse effects to listed and resident fish. As a result of this review, it is expected that the weir will safely capture fish and allow for upstream and downstream movements with minimal adverse effects.

The bridge weir would be supported by concrete abutments extending down to a foundation on each side of the stream channel. The weir sill would utilize U-shaped pre-cast concrete sections excavated approximately 7 feet into the stream bottom. The U-sections would be backfilled with cobbles and gravel and would then receive a topping slab (a flat segment of concrete) to create the sill. Gates to control stream flow elevations would be mounted onto the concrete weir sill at the stream bed elevation up to the walkway. The bridge portion of the weir would be steel construction, spanning the width of the Yankee Fork. Rotating picket panels would attach to the upstream edge of the bridge and drop into place to seal against the concrete sill. Chain link fences and gates would be used to prevent public access to the bridge structure. Signage would be provided to indicate a portage around the right abutment for water craft floating the river.

[2] Deployment of this temporary picket weir would be limited to high flow events (when the Yankee Fork overtops its bank) during the early June Chinook salmon trapping season. It is anticipated that this would be an extremely rare occurrence and is included in the design in the event of an unusual water year.

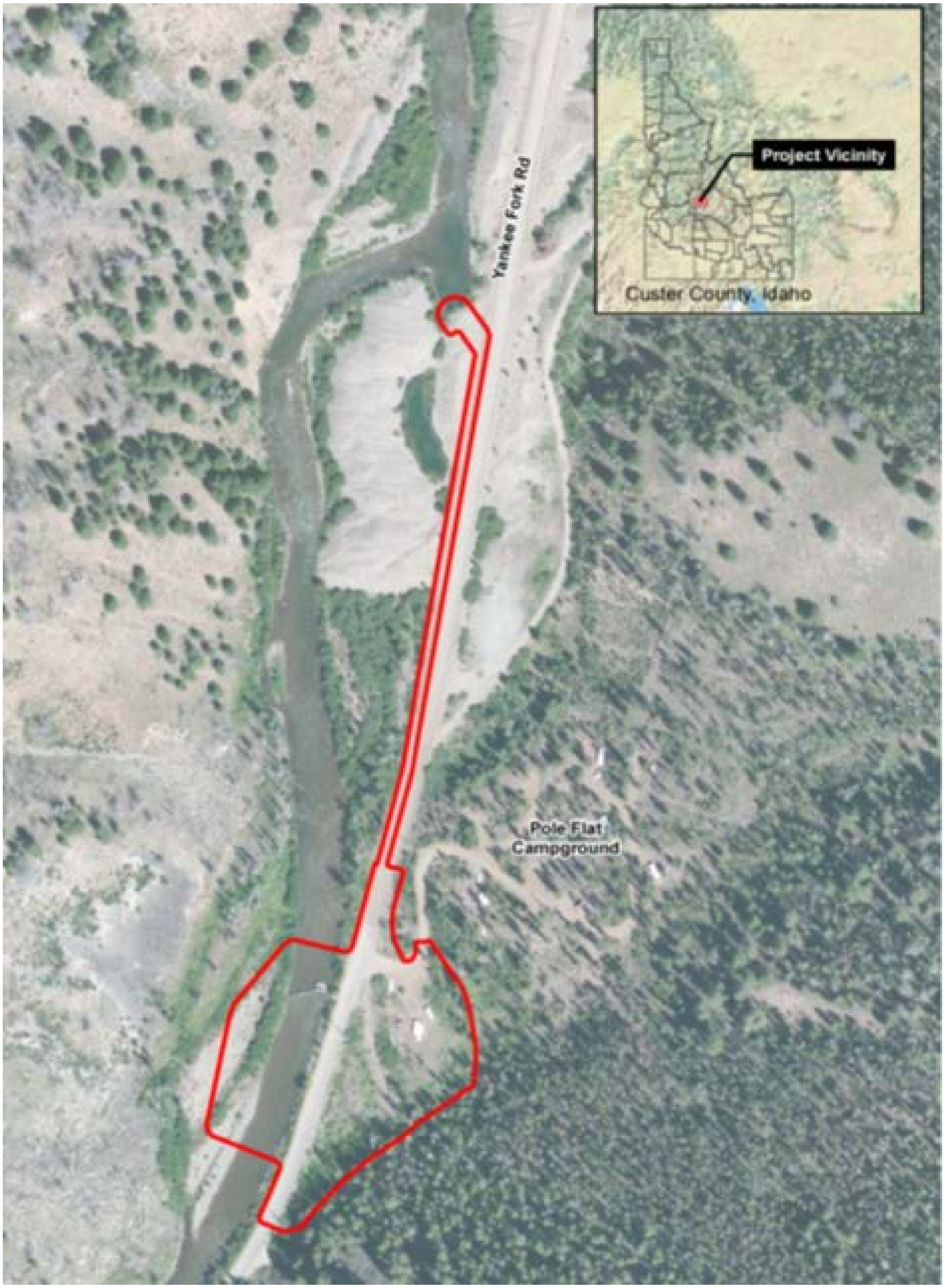

Figure 1 Proposed Site for the Yankee Fork Weir Facility (BPA et al. 2017).

Figure 2 Yankee Fork Fish Acclimation Ponds (steam flow from north to south)(BPA et al. 2017). Any of the ponds visible east of the stream may be used or direct stream release.

Jib Crane

A permanent jib crane would be installed adjacent to the bridge weir and used to remove debris from the weir, to possibly lift fish for transfer to transport trucks, or from a live box to the holding pools if the fish ladder is not effective at attracting fish during certain times (e.g., during low flow).

Fish Ladder

A fish ladder is a structure on or around a natural or artificial barrier that helps fish to naturally migrate upstream or downstream of the artificial barrier. A half-Ice Harbor fish ladder design[3] would be used because of the relatively constant flow of water that would be available. This type of ladder uses both openings and weirs to draw fish into the ladder. The 2-foot-by-3-foot ladder entrance would be built into a precast concrete weir abutment, just downstream of the weir picket panels. A vertical bar gate would control access into the fish ladder. A canal gate would also be installed to control water flow and completely isolate the ladder from the river for maintenance purposes. On average, the ladder pools would be 12 feet long and 5 feet wide with a water depth of 5 feet. The Yankee Fork ladder would consist of 5 pools terminating at the finger weir into the pre-sort holding pond for the collected adult salmon. The ladder would function within the range

[3] This design consists of one weir barring upstream migration, a fish ladder to move adults into the fish trap, a pre-sort holding pool (the terminus of the fish trap), two adult holding ponds (one on either side of the pre-sort pool), and a return pipe upstream of the weir for any natural-origin fish to return directly to the river.

of high and low water elevations of 6,139.0 and 6,135.0 feet above mean sea level, respectively. During high flows, the ladder pools would be backwatered by the river but would not affect the function of the ladder. Prior to construction, the ladder design will be reviewed by NMFS to ensure compliance with fish passage criteria (NMFS 2011b). Due to the natural hydraulics of the Yankee Fork, funding constraints, and construction-related habitat considerations, final weir design may not meet all of NMFS's passage criteria. Where criteria cannot be met, alternative designs and operational modifications will be coordinated with NMFS's passage review team (as part of the engineering approval process) to minimize adverse effects to listed and resident fish. As a result of this review, it is expected that the weir will safely capture fish and allow for upstream and downstream movements with minimal adverse effects.

Adult Holding Ponds

Holding ponds for the collected adult salmon would be constructed adjacent to the weir on the east bank of the Yankee Fork. The ponds would be made of reinforced concrete walls and slabs. Fish migrating up the ladder would pass over a finger weir that would separate fish between the fish ladder and the pre-sort holding pond, preventing the fish from returning to the ladder. The pre-sort pond would be 6 feet wide and would be dedicated to holding adult fish prior to sorting. After sorting, fish would be placed in one of the two post-sort holding ponds. Pass-through gates would be provided in the pre-sort pool walls to minimize the amount of lifting required to move fish for the pre-sort to post-sort pools.

Water Intake

A gravity flow intake of 10 cfs for the collection facility water supply would be located approximately 1,100 feet upstream of the weir facility. The proposed intake screen would be a self-cleaning cone screen installed in a pre-cast concrete structure built into the stream bank in order to protect the screen from vandalism and to provide maintenance access. The intake screen would meet criteria for juvenile fish protection (NMFS 2011b). The intake site would be on a large eddy, isolated from the stream thalweg (line of lowest elevation within a stream). Angled wing walls would provide for sweeping velocity across the screen face during high water when juvenile fish are most likely to be migrating downstream. A 24-inch diameter supply pipeline would route from the intake screen to the facility along the west side of Yankee Fork Road. The pipeline would discharge into the holding tank diffusers. The water would pass through the holding pools and ultimately collect into the fish ladder. The water would discharge back to Yankee Fork through the ladder entrance. Maintenance of the water intake structure would require occasional in-stream work necessary to clear gravel and/or debris.

Egg Collection and Preparation Structures

Adjacent to the three adult fish holding ponds, a three-sided structure would be built for collecting, fertilizing, and disinfecting eggs from the adult fish and a fully enclosed metal-sided one-story structure would be built for temporary egg storage prior to transport.

Chemical Storage Building

A 10x20 foot chemical storage building would be installed adjacent to the fish holding ponds (just to the north) to hold formalin, which is used as a disinfectant. Formalin would be pumped from barrels in the chemical storage shed underground to the water supply in the post-sort holding ponds.

RV pad
Two 30x10 foot RV pad areas would be graded and graveled for temporary staff housing during the adult trapping season.

Hopper Structure
A fish hopper is a holding box and piping structure that aids in the transfer of fish from one holding pond to another. The hopper would measure approximately 6 feet by 6 feet.

Collection Facilities
At the Yankee Fork adult collection facilities, sorting and processing activities would primarily take place in the spawning area. The egg preparation building would be utilized to store the eggs after spawning, along with egg transportation equipment. Both facilities would be located adjacent to the upstream end of the pre-sort and post-sort holding ponds.

Yankee Fork Road Alignment
About 425 feet of the existing paved road would be removed and a new 675-foot section of road would be constructed to the east and curved to circumvent the weir site. According to the Tribes' discussions with Custer County Commissioners, the road realignment and construction would likely require additional evaluation for their approval (pers. comm. Stone 2016a). The road would consist of the same look and materials as the existing road section and would include landscaping berms and signage to increase the safety of the road features and minimize visual effects. It would provide three new access points to the lands adjacent to the road; one would access the facility, one would access a new public parking area for visitors to the facility, and one would provide a new entrance to Pole Flat Campground, adjacent to the site. Once the new section of road was completed, the traffic would be rerouted to the new section, and the old road section would be converted to use for the Yankee Fork weir facility (most of the road would be removed; some portions would remain for facility use). The speed limit for the new, curved section of road would be set at 20 miles per hour.

Natural side channels serve as acclimation ponds to hold juvenile fish before release after they are trucked in from the hatchery. Therefore, construction of acclimation facilities is not needed at Yankee Fork. Though they may be held in the ponds with block nets until they are ready for volitional release. Water flows naturally through the ponds, and fish are likely to rear, acclimate, and volitionally migrate from the ponds once nets are removed.

Construction BMPs would be implemented to minimize the potential for storm water runoff to surface waters (see Section 3.5, *Groundwater and Surface Water Quality and Quantity*). The realignment would be designed to provide a safe work environment by routing through-traffic around the trapping facility and the holding ponds. The design would meet state highway standards, and would meet appropriate code requirements for horizontal and vertical curves, sight distances, and roadway design. Additional Construction Mitigation Measures are described in the BPAs DEIS Table 2-9.

Construction Activities

All facilities would be constructed during the work window for in-water work during a single season (likely in late summer or early fall), and during the dry season of June through October for the upland work. Road grading and re-alignment would occur in close coordination with Custer County and the USFS to avoid any unnecessary complications with visitors to the Yankee Fork or local residents. In total, the proposed construction period would not exceed four months, depending on weather conditions, including mobilization and road realignment.

Materials staging and stockpile locations are not yet determined, but would be sited within the project work area, either on developed surfaces (e.g., parking areas) or in areas to be disturbed for facilities construction.

The construction would entail re-routing the main Yankee Fork Salmon River channel during fall base flows via a temporary channel for approximately two weeks. The temporary channel would be used to allow for sufficient de-watering to occur at the construction location using a sand or soil bag coffer dam and temporary pump system to clear the site and allow for anchors to be placed for the pre-cast concrete sill and abutments. A fish rescue and relocation plan approved by NMFS, the Shoshone-Bannock Tribes, the Idaho Department of Fish and Game (IDFG), and USFS would be implemented during dewatering to protect aquatic species. Upon abandonment of the temporary channel, all native plants would be returned to the disturbed area if viable, or replanted to maintain the character of the disturbed area.

Construction BMPs include sediment and silt fencing downstream of the construction area and daily turbidity monitoring throughout the placement of in-stream structures.

1.3.1.2.Panther Creek Bridge Weir

A bridge weir is proposed for Panther Creek. It would be similar to the Yankee Fork weir, except that the span would be shorter, approximately 38 feet in length. Pre-cast sill, abutments, and fish ladder elements would be incorporated. The weir would consist of a pedestrian bridge spanning the stream, supported by pre-cast concrete abutments on each bank. Top-hinged rotating picket panels would be fastened to the upstream side of the bridge deck. The panels would sit on a pre-cast concrete sill to seal off uncontrolled fish passage.

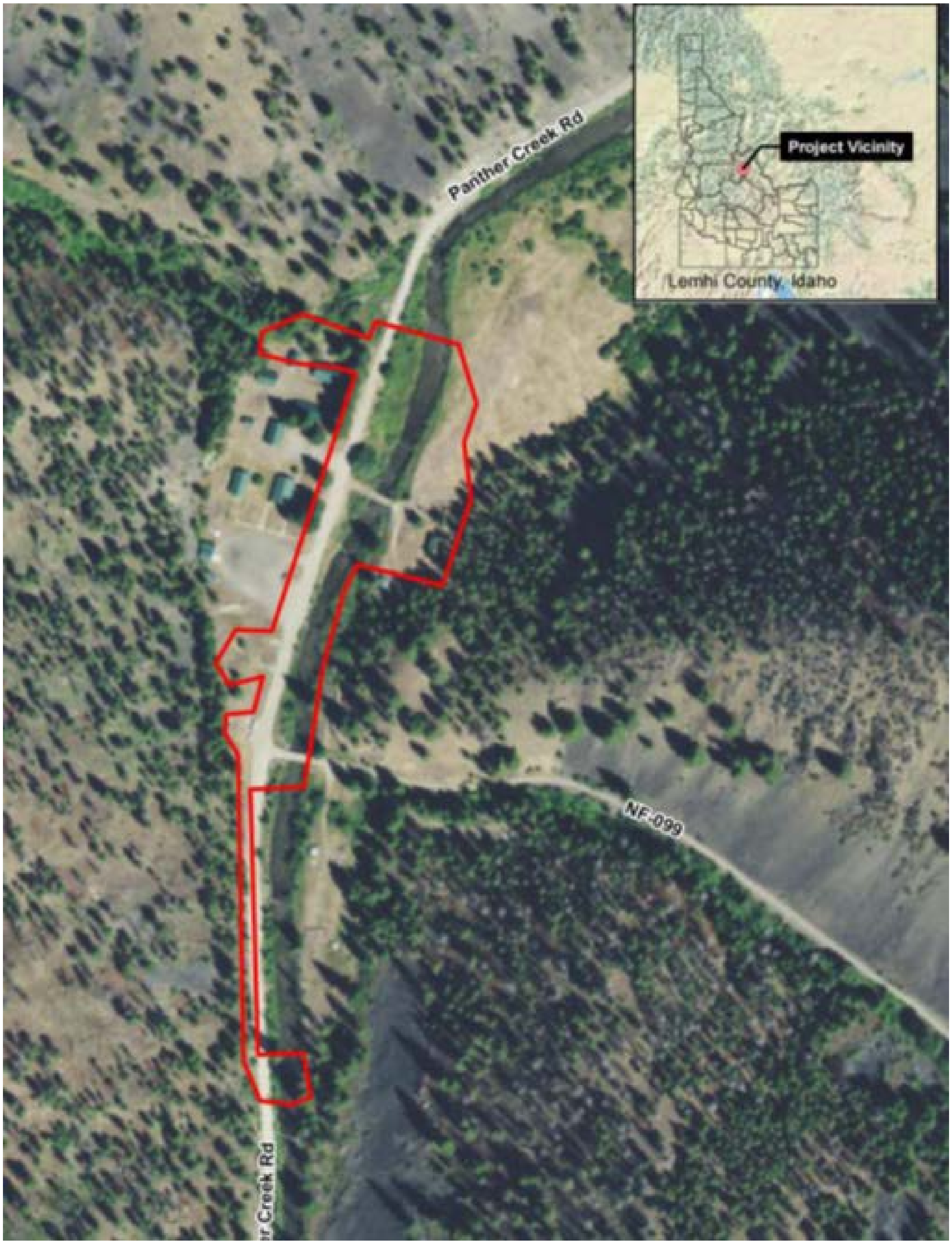

Figure 3: Proposed Site for the Panther Creek Weir Facility (stream flows south to north)(BPA et al. 2017).

Jib Crane
A jib crane is an option included at the Panther Creek weir facility. The jib crane would be adjacent to the bridge weir. It would be used for debris management and possibly for lifting fish for transfer to transport trucks or from a live box to the holding pools if the fish ladder is not effective at attracting fish at critical collection times (i.e., during low flow).

Fish Ladder
The ladder would be the same design as the Yankee Fork weir facility. The entrance and exit include the same design components as discussed above. The 4 ladder pools are 8 feet long and travel the required distance and elevation to the pre-sort holding pool. The Panther Creek ladder is also designed for 10 cfs flows over a range of creek elevations from 5,226 to 5,229 feet above mean sea level. The design of these pools and height of ladder allows fish to pass at different life stages. The ladder would be supported by a reinforced concrete slab extending from the east abutment sloping up to the adult holding tanks. Prior to construction, the ladder design will be reviewed by NMFS to meet adult management objectives and ensure compliance with fish passage criteria (NMFS 2011a). Due to the natural hydraulics of the Yankee Fork, funding constraints, and construction-related habitat considerations, final weir design may not meet all of NMFS's passage criteria. Where criteria cannot be met, alternative designs and operational modifications will be coordinated with NMFS's passage review team (as part of the engineering approval process) to minimize adverse effects to listed and resident fish. As a result of this review, it is expected that the weir will safely capture fish and allow for upstream and downstream movements with minimal adverse effects.

Water Intake
A gravity flow water intake on Panther Creek would supply water for the facility. The intake will be screened, and water would flow though the facility and discharge back to the creek approximately 1,250 feet downstream through the fish ladder. Additional water will be supplied by an intake on Dummy Creek, to provide a colder water source for the adult holding pond.

Adult Holding Ponds
A finger weir would separate fish between the fish ladder and the pre-sort holding pond. The presort pond would be 6 feet wide and dedicated to holding fish prior to sorting. After sorting, fish would be placed in one of the two 10-foot-wide post-sort holding ponds. Pass-through gates would be provided in the pre-sort pool walls to minimize the amount of lifting required to move fish from the pre-sort to post-sort pools. The ponds would be 32 feet long and designed with a 5-foot water depth. The concrete bottom of the pond would be at a similar elevation as the fish ladder, and would hold approximately 4.5 feet of water.

Acclimation Ponds
Modular portable raceways or circular acclimation ponds will hold juvenile fish before release after they are trucked in from the hatchery. The Panther Creek facility is designed to hold up to 135,000 fish at 10 fish per pound. Water supply flows would be approximately 3 cfs at Panther Creek. Batches of fish would be acclimated and released every 1-2 weeks until stocking goals are met. The water intake design will be reviewed and approved by NMFS passage engineers.

Spawning and Egg Preparation Structure

The spawning structure would be three-sided and the egg preparation structure would be a fully enclosed steel structure. During high water events, primarily during peak spring run-off periods, the fish ladder would be partially submerged, and the holding ponds would need to be pumped down to allow manual crowding and sorting of the fish. A pump station with two low head/high flow pumps would be located at the downstream end of the holding ponds. The utility water pump would also be located at this pump station. Fish sorting data collection (size, weight, sex, tissue samples) and spawning activities would primarily take place in the spawning area. The egg preparation building would be utilized to fertilize, disinfect, and store the eggs along with egg transportation containers and equipment. Both facilities would be located adjacent to the upstream end of the holding ponds. Both areas would have electrical outlets, radiant heaters, and hydrants supplying river water for wash down and cleaning. The spawning area would have a fish return pipe to transport native fish back to the river upstream of the weir.

Chemical Storage Building

A 10x20-foot chemical storage building would be installed adjacent to the fish holding ponds (just to the north) to hold formalin, a disinfectant. The formalin would be pumped from barrels in the chemical storage shed underground to the water supply in the post-sort holding ponds.

More specific construction mitigation measures are described in detail in the Crystal Springs DEIS for both Yankee Fork and Panther Creek construction activities (BPA et al. 2017), and are part of the proposed action considered.

1.3.2. Hatchery Program purpose and type

The proposed **Yankee Fork** spring/summer Chinook salmon program would enhance harvest opportunities and is also expected to boost the natural-origin population for conservation. The Yankee Fork spring/summer Chinook salmon program is currently funded by the LSRCP (adult outplants and juvenile releases), and may continue for some time, but the updated program will be funded by BPA under the Pacific Northwest Power Planning and Conservation Act of 1980, 16 U.S.C. §§ 839 et seq. (Northwest Power Act). The program includes infrastructure improvements in Yankee Fork to capture, hold, and spawn returning adults, as well as the ongoing operation of the supplementation program. Crystal Springs Fish Hatchery is being constructed with funding from the BPA to rear juveniles for release in Yankee Fork.

The proposed **Panther Creek** spring/summer Chinook salmon program would enhance harvest opportunities and create a localized natural-origin population for conservation. Construction funding for the Panther Creek weir has not yet been identified. Operation and maintenance of the Panther Creek weir would be funded by BPA under the Pacific Northwest Power Planning and Conservation Act of 1980, 16 U.S.C. §§ 839 et seq. (Northwest Power Act). The program includes infrastructure improvements in Panther Creek to capture, hold, and spawn returning adults, as well as the ongoing operation of the supplementation program. Crystal Springs Fish Hatchery is being constructed with funding from the BPA to rear juveniles for release in Panther Creek.

The proposed **Upper Salmon (Sawtooth)** spring/summer Chinook salmon hatchery program is intended to mitigate for anadromous fish loss caused by the construction and operation of the four Lower Snake River dams and provide harvest opportunity. Hatchery operations and monitoring activities are funded by the Lower Snake River Compensation Plan, and includes an integrated component to supplement natural origin spawning in the Salmon River Upper Mainstem population above Redfish Lake Creek.

The proposed **Pahsimeroi** summer Chinook salmon program was designed to provide harvest to meet mitigation objectives associated with losses of anadromous fish associated with the construction and operation of the Hells Canyon Complex dams on the Snake River. The 1980 Hells Canyon Settlement Agreement calls for the program to trap sufficient numbers of adult summer Chinook salmon to permit the production of one million smolts annually. The program also includes an integrated conservation component to supplement natural-origin populations in the Pahsimeroi River. These hatchery operations and monitoring activities are funded by the Idaho Power Company.

1.3.3. Species and population (or stock) under propagation and ESA status

All populations used in these four programs are part of the **Snake River Spring/Summer Chinook ESU,** which is classified as ***threatened*** under the Endangered Species Act (ESA) (79 FR 20802; April 14, 2014). All four programs use ESA-listed broodstock and release fish within the populations they intend to supplement. Though each program operates within a separate population, they are all part of the Upper Salmon River major population group.

The **Yankee Fork** spring/summer Chinook salmon program has a goal of collecting all broodstock from Yankee Fork and releasing smolts in the Yankee Fork of the Salmon River. The program was initiated using adults and releases from the Sawtooth Hatchery (within MPG). Currently broodstock from the Sawtooth Hatchery are used if/when sufficient broodstock cannot be collected at the Yankee Fork weir. As returns increase, broodstock will be localized by collecting most or all of the broodstock in the Yankee Fork. Hatchery-origin spring/summer Chinook salmon for the Yankee Fork program are listed as threatened under the ESA (79 FR 20802; April 14, 2014).

The **Panther Creek** summer Chinook salmon program has a long term goal of collecting broodstock and releasing smolts in Panther Creek. During the initial reintroduction phase, the program is outplanting eyed-eggs provided by the Pahsimeroi Fish Hatchery (within MPG), with the intention of developing a localized broodstock to meet the long term harvest goals. The intention is these fish will return to Panther Creek as localized hatchery adults and will be collected at Panther Creek once a functional weir is installed. Hatchery-origin Chinook salmon for the Panther Creek program are listed as threatened under the ESA (79 FR 20802; April 14, 2014).

The **Pahsimeroi** summer Chinook salmon program collects broodstock and releases smolts in the Pahsimeroi River. Pahsimeroi Fish Hatchery also provides up to 800,000 eyed eggs for Panther Creek program. The Pahsimeroi program was initiated using adults from the Pahsimeroi River. The hatchery-origin summer Chinook salmon for the Pahsimeroi program was listed as threatened under the ESA (79 FR 20802; April 14, 2014).

The **Upper Salmon River (Sawtooth)** spring/summer Chinook salmon program collects broodstock and releases smolts in the Upper Mainstem Population. The program was initiated using local adults collected at a temporary weir at the location of the Sawtooth FH. The hatchery-origin spring/summer Chinook salmon for the Sawtooth program was listed as threatened under the ESA (79 FR 20802; April 14, 2014).

1.3.4. Proposed hatchery broodstock collection details and adult management

Broodstock collections for each of the programs is summarized below. All programs use local ESA-listed stocks that are within MPG, and the Pahsimeroi and Sawtooth broodstocks are also within population. Both Yankee Fork and Panther Creek broodstocks originated from within-MPG ESA-listed hatchery broodstock (Sawtooth and Pahsimeroi respectively), will be used to supplement fish that are returning naturally to those systems. Each of the four programs will operate a weir within their respective systems to collect broodstock, monitor population trends, and manage adult returns according to guidelines described in each of the HGMPs. The existing weirs (Sawtooth and Pahsimeroi) are typically capable of operating efficiently throughout the entire return timing, and therefore capture on average >98% of the returning spawners. During high flow years, a few fish may escape above the Sawtooth weir site prior to weir installation, but the weir is still able to capture most of the run. On rare occasions, IDFG may also collect brood using seines below Sawtooth weir if fish are not ascending the ladder where they can be collected in the trap. The proposed Yankee Fork and Panther Creek weirs are designed to capture a large proportion of the run while minimizing passage concerns.

Table 2. Broodstock collection details and Interior Columbia Basin Technical Recovery Team (ICTRT) targets. NOR = Natural-origin returns; HOR = hatchery-origin returns.

Program	Broodstock collection for Snake River spring/summer Chinook salmon ESU					
	Component and Purpose	**Population and ICTRT viability target**	**Number and origin**	**Location(s) and method**	**Approximate timing**	**PNI or pHOS targets and pNOB**
Sawtooth[1]	*Segregated harvest*	Upper Salmon Mainstem, Highly Viable	1,018 (509 pairs) HORs (segregated and opportunistic integrated)	Sawtooth Weir, could include the use of seines below the weir	Mid-June through mid-September	pHOS = 0 pNOB = 0[2]
	Integrated conservation	Upper Salmon Mainstem, Highly Viable	80 (40pairs) HORs and NORs	Sawtooth Weir, could include the use of seines below the weir	Mid-June through mid-September	PNI > 0.5 to PNI > 0.67 depending on NORs (sliding scale)[3] pNOB = up to 100%
Pahsimeroi	*Segregated harvest*	Pahsimeroi, Viable	704 (352 pairs) HORs to produce 935,000 smolts; Up to 600 (300 pairs) HORs for Panther Creek	Pahsimeroi weir	Mid-June through September	pHOS = 0 pNOB = 0
	Integrated conservation	Pahsimeroi, Viable	42 (21 pairs) HORs and NORs	Pahsimeroi weir	Mid-June through September	PNI > 0.5 depending on NORs (sliding scale)[4] pNOB = up to 1
Yankee Fork	*Integrated recovery*	Yankee Fork, Maintained	358 (179 pairs) HORs and NORs on a sliding scale[1]	Yankee Fork weir (or backfill with Sawtooth)	Likely mid-June through September	PNI > 0.5 depending on NORs (sliding scale)[5] pNOB = Sliding Scale
Panther Creek	*Integrated recovery*	Panther Creek, No target (extirpated)	288 (144 pairs) HORs and NORs	Panther Creek weir (or backfill with Pahsimeroi)	Likely mid-June through September	PNI > 0.5 depending on NORs (sliding scale)[5] pNOB = Sliding Scale
	Segregated recovery (from Pahsimeroi)		Up to 800,000 eyed eggs (from Pahsimeroi)	See Pahsimeroi Segregated Harvest	See Pahsimeroi Segregated Harvest	See Pahsimeroi Segregated Harvest

[1] Though currently operated as two components, the intention is to transition to a fully integrated harvest program when sufficient NOR returns allow 100% of the smolts released to be integrated.

[2] Refer to Table 3 regarding sliding scale broodstock collection

[3] Refer to Table 4 regarding sliding scale broodstock collection

[4] Refer to Table 5 regarding sliding scale broodstock collection

[5] Refer to Table 6 regarding sliding scale broodstock collection

For the two spring/summer Chinook segregated harvest program components (**Pahsimeroi and Sawtooth**), only hatchery-origin returns are used for broodstock. In general, segregated hatchery –origin adults are not intended to spawn naturally. However, at both locations a minimum of 300 adults will be released upstream to spawn naturally. If there are insufficient natural-origin and integrated hatchery-origin adults to meet this minimum, segregated adults may be released upstream of the weirs. At Pahsimeroi, broodstock for the segregated program is primarily from segregated adults. Integrated adults are not programmed for the segregated program but may be used if integrated returns are in excess of numbers needed for natural spawning or integrated broodstock. At Sawtooth, integrated adults will be included in the segregated broodstock as part of the stepping-stone integration, which phases integration based on availability of natural-origin adults. All hatchery-origin spring/summer Chinook salmon from the segregated harvest programs are adipose-clipped, so that fish may be easily distinguished in fisheries and escapement. Hatchery-origin fish in excess of broodstock and escapement needs may be recycled through fisheries, outplanted for natural production, distributed to tribes for subsistence or ceremonial use, or given to food banks, or used as nutrient enhancement in local watersheds, based on co-manager priority.

For the two spring/summer Chinook integrated conservation program components (**Pahsimeroi and Sawtooth**), the numbers of integrated hatchery-origin and natural-origin adults that are either retained for broodstock or released to spawn naturally are based on sliding scales (**Table 3** and **Table 5**). The abundance of natural-origin returns (NORs) will determine the proportion of natural-origin fish retained for broodstock (pNOB) and the number of hatchery-origin adults released to spawn naturally above the weir (pHOS) in both programs. In general, higher natural-origin returns will result in a higher pNOB and a lower pHOS (overall higher PNI). If the natural origin return in a given year is forecasted be less than 50 adults, managers will consult with NOAA Fisheries and other operators to determine adult management or reinitiate consultation. Integrated smolts are marked or tagged differentially from the segregated smolts to allow identification of both groups when they return as adults.

The **Sawtooth** program has two program components (segregated and integrated) with a *genetic linkage* between them. A percentage of returning fish from the integrated component will be used as broodstock in the segregated component. This type of genetic linkage is what the HSRG calls a “stepping stone” system (HSRG 2014). Initial analysis by NMFS of programs connected this way shows that programs so linked pose considerably less risk of hatchery-influenced selection than unlinked programs (Busack 2015).

Adults returning from the integrated component will be: (1) used as broodstock for the next generation of integrated smolts, (2) released upstream of the weir to supplement natural spawning, and/or (3) used as broodstock in the segregated component of the program. Over time, the program may become fully integrated, without the need for separate program components.

Table 3. Sliding scale broodstock and weir management for the Sawtooth program: NORs = Natural-origin return; pNOB = proportion natural-origin broodstock; pHOS = proportion of hatchery-origin spawners.

NOR to Weir		**NORs Released Above Weir**[1]		**Number of NORs Held for Brood**		**Max % of Natural-Origin Returns Retained for Brood**	**Max pHOS upstream of weir**
Low	**High**	**Low**	**High**	**Low**	**High**		
50	249	30	149	20	100	40.0%	NA
250	499	150	368	100	131	40.0%	0.75
500	699	369	568	131	131	40.0%	0.45
700	999	569	868	131	131	40.0%	0.45
1,000	1,299	790	1,089	210	210	40.0%	0.35
1,300	1,599	881	1,180	419	419	40.0%	0.35
1,600	2,000	866	1266	734	734	50.0%	0.35

[1] A minimum of 300 adults will be released upstream to spawn naturally. If there are insufficient natural-origin and integrated hatchery-origin adults to meet this minimum, segregated adults may be released upstream of the weir.

There are four abundance-based production levels associated with increasing the size of the integrated component at Sawtooth Fish Hatchery (Table 4). As the number of smolts produced for the integrated component increases, the number of segregated smolts produced will decrease an equivalent amount so that the total production at Sawtooth Fish Hatchery remains that same.

Table 4. Sliding scale for the Sawtooth Hatchery program based on natural origin abundance at the Sawtooth weir used to determine the size of the integrated smolt program.

Projected NOR Return to Weir (Jacks Excluded)	**Size of Integrated Smolt Program**	**Targeted pNOB**	**Min % of Segregated Brood composed of integrated Adults**	**Max % of Segregated Brood composed of integrated Adults**	**Mark/Tag for Integrated Smolts**	**Mark/Tag for Segregated Smolts**
<1,000	250,000	100%	20%	30%	100% CWT, no Ad-clip	100% Ad, 120k Ad-CWT
1,000 - 1,299	500,000	80%	20%	50%	100% Ad-CWT	100% Ad, no CWT
1300 - 1599	1,000,000	80%	20%	60%	100% Ad, 500k Ad-CWT	100% Ad, no CWT
>1,600	1,700,000-2,000,000	70%	NA	NA	100% Ad, 120k Ad-CWT	N/A

For the **Pahsimeroi** program, the integrated and segregated components of the program are usually isolated from each other. However, if returns of integrated adults are in excess of integrated broodstock and escapement needs, some may be included in the segregated component of the program. Returning adults from the integrated component are prioritized to be: 1) used as broodstock for the next generation of integrated smolts, or 2) released upstream of the weir to supplement natural spawning as described in the sliding scale (Table 5).

Table 5. Sliding scale broodstock and weir management for the integrated program component of the Pahsimeroi program: NORs = Natural-origin return; pNOB = proportion natural-origin broodstock; pHOS = proportion of hatchery-origin spawners.

Escapement of NORs to Pahsimeroi Weir	**Number of NORs Released Above Weir**	**Number of NOR Broodstock**	**Max. % of NORs Held for Broodstock**	**Min. pNOB**	**Max. % pHOS Above Weir**
50-124	35-87	15-37	30	0.35	NA
125-249	88-208	38-41	30	0.90	0.70
250-499	209-458	41	30	1.00	0.30
500-999	459-958	41	20	1.00	0.25
>1000	>958	41	20	1.00	0.25

The **Yankee Fork** program was developed to achieve a conservation objective, a harvest objective, and a cultural objective. The conservation objective is to contribute to recovery of Snake River spring/summer Chinook ESU by restoring a population of Chinook salmon in Yankee Fork. The harvest objective is to achieve a harvest of 1,000 Chinook from Yankee Fork. The cultural objective is to ensure that Shoshone-Bannock peoples can harvest salmon in Yankee Fork by their traditional hunting methods as well as contemporary methods. A three-phase program is proposed to meet these objectives, integral to which is construction of the Crystal Springs Fish Hatchery to provide needed production capacity.

In the first phase, colonization, surplus adults (up to 1,500) and up to 400,000 smolts from Sawtooth Fish Hatchery will be released annually. These fish will be allowed to spawn naturally thereby localizing the Sawtooth stock to Yankee Fork. In Phase 2, local adaptation, adults from phase 1 efforts will be collected as broodstock for rearing at the Crystal Springs Fish Hatchery to produce 600,000 smolts. If natural productivity rates reach sufficient levels, phase 3, an integrated harvest program, may be implemented if established triggers are net.

The Yankee Fork program was initiated with adult outplants and smolt releases from the Sawtooth Fish Hatchery (which are within MPG). These fish will be the primary source for broodstock collection during this initial stages of Crystal Springs Fish Hatchery. Once Crystal Springs Fish Hatchery is operation and 600,000 smolts are annually released and adult are returning from these efforts, the program will use a sliding scale to integrate naturally produced fish with hatchery fish produced from Crystal Springs Fish Hatchery. However, if natural adult returns to Yankee Fork are too low to meet broodstock needs, the Tribes may continue to outplant surplus adults from Sawtooth Fish Hatchery to bolster natural production. If broodstock cannot be met with natural and hatchery adults returning to Yankee Fork, the Tribes may source broodstock from Sawtooth Fish Hatchery, pending availability.

Adult broodstock for Crystal Springs Fish Hatchery will be prioritized as follows:

1. NOR x NOR
2. NOR x weir-collected HOR
3. weir-collected HOR x weir collected HOR
4. weir-collected HOR x Sawtooth HOR

Yankee Fork has a minimum natural escapement objective of 500 adult spawners (see Master Plan, SBT (2011)). If the adult escapement cannot be met with natural adult returns, weir collected HOR will be released upstream to make up any shortfall. If the shortfall cannot be made with weir collected HOR, we may outplant Sawtooth HOR adults if available. If NOR adult returns appear to limit the program from meeting natural escapement and broodstock objectives, the SBT and IDFG may release Sawtooth HOR adults into Yankee Fork. However, adult outplant numbers will be dependent on meeting desired pHOS scale and availability of adults at Sawtooth.

A sliding scale has been developed (Table 6) to integrate this program with the fish that are returning to the basin naturally or from adult and smolt outplants (phase 1 efforts). The initial goal of the program is to achieve and maintain a minimum of 0.5 PNI, though a higher PNI of 0.67 is the long-term aspiration of the program if supplementation boosts natural-origin abundance enough to fully integrate with the sliding scale.

The **Panther Creek** program was developed to achieve a conservation objective, a harvest objective, and a cultural objective. The conservation objective is to contribute to recovery of Snake River spring/summer Chinook ESU by restoring a population of Chinook salmon in Panther Creek. The harvest objective is to achieve a harvest of 800 Chinook from Panther Creek. The cultural objective is to ensure that Shoshone-Bannock peoples can harvest salmon in Panther Creek by their traditional hunting methods as well as contemporary methods. A three-phase program is proposed to meet these objectives, integral to which is construction of the Crystal Springs Fish Hatchery to provide needed production capacity.

In the first phase, colonization, surplus eggs (up to 800,000) from Pahsimeroi Fish Hatchery will be outplanted in eggboxes annually. These juveniles will rear in Panther Creek and be allowed to spawn naturally thereby localizing the Pahsimeroi stock to Panther Creek. In Phase 2, local adaptation, adults from phase 1 efforts will be collected as broodstock for rearing at the Crystal Springs Fish Hatchery to produce 400,000 smolts. If natural productivity rates reach sufficient levels, phase 3, an integrated harvest program, may be implemented if established triggers are net.

Since 2014, eggs supplied by Pahsimeroi Fish Hatchery have been outplanted to Panther Creek (segregated brood). The target is to release up to 800,000 eggs, but actual release numbers vary with egg availability. In recent years, releases have varied from ~400,000 to 700,000 eggs. The eggbox component is expected to continue for 5-8 years (up to 2022); however, effectiveness monitoring, informed by parentage-based tagging (PBT), will determine if the eggbox component will continue or be modified during that time. Some factors that will be considered for changes to egg box releases will include whether the Panther Creek component of Crystal

Springs Fish Hatchery is operating at capacity and how effective the eggboxes are at returning adults. Locations of egg boxes will vary from year-to-year, in an effort to monitor survival by location and box type, dispersal of juveniles from eggboxes, and rearing preferences.

A sliding scale has been developed (Table 6) to integrate this program with the fish that are returning to the basin naturally or from adult produced by eggboxes (phase 1 efforts). The goal of the program is to achieve and maintain a minimum of 0.5 PNI, though a higher PNI of 0.67 is the long-term aspiration for the population; a minimum of 25% of returning NORs will be incorporated into broodstock.

Panther Creek also has a minimum escapement objective of 500 adult spawners. If the adult escapement cannot be met with natural or eggbox adult returns, weir collected HOR will be released upstream to make up any shortfall. If NOR adult returns appear to limit the program from meeting natural escapement and broodstock objectives, the SBT may continue to outplant hatchery eyed-eggs in eggboxes from broodstock acquired at Panther Creek, or Pahsimeroi Fish Hatchery if production is limited in Panther Creek.

Adult broodstock for Crystal Springs Fish Hatchery will be prioritized as follows:

1. NOR x NOR
2. NOR x weir-collected HOR
3. weir-collected HOR x weir-collected HOR
4. weir-collected HOR x Pahsimeroi HOR

Table 6. Yankee Fork and Panther Creek broodstock management program using a minimum of 25 percent of NORs arriving at the weir for broodstock. Note that this is not a sliding scale in the usual sense but rather a demonstration of outcomes for various return levels (SBT 2017a).

						HOR Run Size at Weir								
						500			1,000			1,500		
Natural Origin Returns (NOR)	Max Proportion of Natural Run Collected	NORs Brood Stock	HORs Brood Stock	Total Brood Stock	pNOB	Total NOR+HOR Escapement	pHOS	PNI	Total NOR+HOR Escapement	pHOS	PNI	Total NOR+HOR Escapement	pHOS	PNI
100	35%	35	323	358	10%	242	73%	0.12	742	91%	0.10	1,242	95%	0.09
200	25%	50	308	358	14%	342	56%	0.20	842	82%	0.15	1,342	89%	0.14
300	25%	75	283	358	21%	442	49%	0.30	942	76%	0.22	1,442	84%	0.20
400	25%	100	258	358	28%	542	45%	0.38	1,042	71%	0.28	1,542	81%	0.26
500	25%	125	233	358	35%	642	42%	0.46	1,142	67%	0.34	1,642	77%	0.31
600	25%	150	208	358	42%	742	39%	0.52	1,242	64%	0.40	1,742	74%	0.36
700	25%	175	183	358	49%	842	38%	0.56	1,342	61%	0.45	1,842	71%	0.41
750	25%	188	171	358	52%	892	37%	0.59	1,392	60%	0.47	1,892	70%	0.43

1.3.5. Proposed hatchery egg incubation and juvenile rearing, acclimation, and release

The **Sawtooth** program spawns and incubates eggs at the hatchery facilities. The facility is designed for the full cycle of production to occur on site. The smolts produced at Sawtooth Fish

Hatchery are released from raceways into the Upper Salmon River. Dam boards are removed to lower raceway elevations, and allow fish to move through the outfall into the river.

The **Pahsimeroi** Hatchery consists of two separate facilities that work together to produce summer Chinook salmon for the program. The lower facility collects, holds, and spawns adults, while the upper facility incubates eggs, and rears fish to smolt size. The smolts produced at Pahsimeroi Fish Hatchery are volitionally released from two ponds into the Pahsimeroi River. Dam boards are removed to lower water elevations, and allow fish to move through the outfall into the river.

The **Yankee Fork** and **Panther Creek** programs will be operated similarly. Adults are collected, held, and spawned at small facilities at their respective streams. Eggs from each program are then transferred to Crystal Springs Fish Hatchery for egg incubation and juvenile rearing. After rearing, smolts are transported back to their respective streams for release. The Yankee Fork will release smolts into existing streamside ponds where they will be acclimated and released or direct stream released. The ponds are directly connected to the Yankee Fork, and no water source is needed. The ponds have been modified to simulate natural side channel stream habitat. Panther Creek is expected to have an acclimation site that will allow smolts to rear and migrate volitionally. Intake screens will be reviewed and approved by NMFS passage engineers.

Please refer to Table 7 and Table 8 for additional information regarding annual release groups, marking, egg incubation and rearing, rearing location, acclimation, and release time for the four programs.

Table 7. Summary of Annual release groups (number and life stage), marking, egg incubation and rearing locations, acclimation, and release times at full production.

Program	Annual release groups (number and life stage)	Marking[4]	Egg incubation/Rearing Location	Acclimation	Release Time
Sawtooth Segregated	1.85 Million Smolt[1]	100% Ad-clip, representative CWT (see Table 8)	Sawtooth	On-site	Late March-mid-April
Sawtooth Integrated	150,000 Smolts[2]	100% CWT (see Table 8)	Sawtooth	On-site	Late March-mid-April
Pahsimeroi Integrated	65,000 Smolts	100% CWT, no Ad-clip	Pahsimeroi	On-site	Late March-mid-April
Pahsimeroi Segregated	935,000 Smolt	100% Ad-clip, representative CWT	Pahsimeroi	On-site	Late March-mid-April
Yankee Fork	600,000 Smolt	Ad-clip and CWT TBD	Crystal Springs	Yankee Fork acclimation ponds	Late March -April
	Up to 1,500 Adults[3] for natural spawning	TBD	N/A	N/A	June - September
Panther Creek	400,000 Smolt	Ad-clip and CWT TBD	Crystal Springs	Acclimated Release, Panther Creek Satellite Facility	Late March - April
	800,000 Eggs	Parental-based Tagging[4]	Pahsimeroi then Panther Creek eggbox	Panther Creek Egg Box	October - November

[1]This includes Yankee Fork production (300K)

[2] Integrated program may be increased, concomitant with decreases in segregated program (total production remains 2M)

[3] Numbers will depend on the number of adults available that are not needed for production for the Sawtooth program, as well as the pHOS scale for adult management.

[4] All release groups are part of a parental-based tagging (PBT) strategy and will and include some level of PIT tagging to represent the groups.

Table 8. Mark/tag for smolts released from the Sawtooth program by component.

Size of Integrated Smolt Program	Mark/Tag for Integrated Smolts[1]	Mark/Tag for Segregated Smolts
150,000	100% CWT, no Ad-clip	100% Ad, 120k Ad-CWT
250,000	100% CWT, no Ad-clip	100% Ad, 120k Ad-CWT
500,000	100% Ad-CWT	100% Ad, no CWT
1,000,000	100% Ad, 500k Ad-CWT	100% Ad, no CWT
1,700,000 -2,000,000	100% Ad, 120k Ad-CWT	N/A

[1] All release groups are part of a parental-based tagging (PBT) strategy and will and include some level of PIT tagging to represent the groups

Fish health staff monitor the fish throughout their rearing cycle for signs of disease for all programs. Fish are checked and any mortalities and moribund fish are removed daily. A subset of live fish are taken monthly for routine health exams. Fish are also tested prior to transfer to acclimation sites. Recommendations for treating specific disease agents comes from the Idaho Department of Fish and Game Fish Health Laboratory in Eagle, ID. Prior to release, the Eagle Fish Health Laboratory conducts a final pre-release fish health inspection.

1.3.6. Disposition of program fish in excess of program needs

Generally, Chinook salmon are not collected in surplus of need for program production. However, if the number of hatchery origin fish trapped exceeds broodstock requirements disposition will occur as described in Table 9. Adipose-fin clipped hatchery-origin fish in excess of broodstock needs for are intended for harvest purposes. Adipose-clipped fish are easily distinguished by their mark for harvests and escapement monitoring. Disposition of surplus hatchery spring Chinook salmon without adipose-fin clips (identified with CWT) varies based on adult return numbers and management objectives. In general, options for surplus adults include transport for recycling back through the local fisheries, distribution to tribal entities for subsistence or ceremonial use or charitable organizations human consumption. In some cases, carcasses may also be provided for research or educational purposes or frozen for rendering at a later date. If no other uses are available, they may be given to rendering plants or landfills for disposal.

Similarly, operators attempt to keep releases at the levels identified as program goals. This often includes collecting enough eggs to release the intended number of smolts with some buffer for normal rearing mortality. To ensure goals are met for each program, hatchery managers have agreed to target the release number as specified in the Proposed Action. However, because of the variability in within-hatchery survival in any given year caused by; low adult holding survival, unexpected drops in trapping success, low egg fecundity in spawned females, poor juvenile survival, fish pathogen impacts, diminished water quality, human error, power outages, etc., some flexibility sought in the HGMP. Therefore the proposed action includes juvenile release targets that include a cushion, not to exceed an additional 10 percent of each program’s release target, by the hatchery annually, which must be approved by the managers as part of the AOP process. In these cases, the disposition of Chinook salmon in surplus of program release targets will occur as described in Table 9.

Table 9. Proposed disposition protocols for spring/summer Chinook salmon in excess of hatchery broodstock needs.

Program(s)	Lifestage	Disposition
Sawtooth Integrated	Adults	• Released for natural spawning in the Upper Salmon River • Recycled back through the local fishery • Supplement natural production in the Yankee Fork • given to tribes for subsistence and ceremonial use • foodbank distribution • research/educational purposes • nutrient enhancement in local watersheds • given to rendering plants or landfills for disposal
	Juveniles	• marked consistent with segregated smolts and released[2] • Released as eggs/sub-yearling
Sawtooth Segregated	Adults	• transported to mainstem Salmon to be recycled back through the local fishery • given to tribes for subsistence and ceremonial use • foodbank distribution • research/educational purposes • nutrient enhancement in local watersheds • given to rendering plants or landfills for disposal • Supplement natural production in the Yankee Fork
	Juveniles	• Used to supplement Yankee Fork releases as eggs • Culled
Pahsimeroi Integrated	Adults	• Used as brood for Segregated component • Used to produce eyed eggs for Panther Creek program
	Juveniles	• marked consistent with Segregated smolts • Released as eggs/sub-yearlings
Pahsimeroi Segregated	Adults	• transported back to mainstem Salmon to be recycled back through the local fishery • given to tribes for subsistence and ceremonial use • foodbank distribution charitable organizations • Used to produce eyed eggs for Panther Creek program research/educational purposes • nutrient enhancement in local watershed • given to rendering plants or landfills for disposal
	Juveniles	• Released as eggs/sub-yearlings in Panther Creek • Culled
Yankee Fork	Adults	• Released for volitional spawning • Recycled back through the fishery • Provided to the tribes for ceremonial subsistence use • Released for nutrient enhancement in local watershed

Program(s)	Lifestage	Disposition
	Juveniles	• Culled • Released as eggs in Yankee Fork
Panther Creek	Adults	• Released for volitional spawning • Recycled back through the fishery • Provided to the tribes for ceremonial subsistence use • Released for nutrient enhancement in local watershed
	Juveniles	• Culled • Released as eggs in Panther Creek

1.3.7. RM&E activities for each program

PIT tag arrays are used in Panther Creek, Yankee Fork, North Fork Salmon, Lemhi, East Fork Salmon River and Valley Creek as well as in the hatchery ladder at Sawtooth Fish Hatchery. PIT tag arrays passively monitor migration of previously tagged adults. Though juvenile fish may be detected, these PIT tag arrays are not a reliable way to monitor juveniles consistently.

There will be ongoing monitoring of natural spawning and juvenile production of populations throughout the Upper Salmon MPG. For Sawtooth and Pahsimeroi, natural populations are monitored with juvenile screw traps and spawning ground surveys, but are not directly related to the hatchery program. This natural population monitoring is covered under separate permits for IDFG programs in the Upper Salmon MPG.

Screw traps in the Yankee Fork and Panther Creek are included as part of the hatchery program to monitor hatchery effectiveness and relative reproductive success, and are included as part of the hatchery action. The screw trap in Yankee Fork has been in operation, though was previously covered in a research section 10 permit. The monitoring will include methods to capture, handle, tag, and tissue sample both natural- and hatchery-origin fish. More detailed descriptions are provided in the Yankee Fork and Panther Creek HGMPs, but briefly summarized below.

Monitoring of production of juveniles from naturally spawning fish is conducted using rotary screw traps to capture out-migrating juveniles. Fish will be captured, handled, anesthetized, and fin clips may be taken. In addition, some natural-origin juveniles will be PIT tagged. All fish will be allowed to recover, and will be released by the trap location. The information will be used to determine juvenile migration timing, rearing preferences, dispersal, and parental lineage (based on PBT). Trap locations and operation timing is included below. Hatchery-origin fish are tagged in known numbers at the hatchery.

Table 10. Juvenile rotary screw trap location and operations.

Program	Trap Type	Trap Location	Operations	Activity
Panther Creek	Rotary Screw Trap	5.6 Rkm from mouth	March – November	Trap, anesthetize, sample, tag, release.
Yankee Fork	Rotary Screw Trap	5.3 Rkm[1] from mouth	March – November	Trap, anesthetize, sample, tag, release.

[1]This is the proposed location, but could change slightly if this location is not feasible.

Adults

In general, most adults will be captured at weirs during broodstock collection activities. Fish not retained for broodstock may be handled, tissue sampled, tagged/marked, and released consistent with plans. Tissue samples will be used for genetic analysis including parental based tagging (PBT) to track parental lineage of all fish sampled and provide the data needed to quantify adult production derived from hatchery releases. The operators will:

- Monitor adult collection, numbers, origin, length, age, marks/tags, return timing at weirs/traps/hatchery facilities
    - Take genetic samples for genetic analysis
    - Continue maintenance and regular updating of genetic profiles for hatchery- and natural-origin spring/summer Chinook populations in Upper Salmon River, Pahsimeroi River, Yankee Fork, and Panther Creek
- Monitor proportion of hatchery- and natural-origin fish in natural production areas and collect basic life history information for management planning

Juveniles

As described above, though all four programs use screw trap to monitor juvenile abundance and migration, only Yankee Fork and Panther Creek screw traps are part of the proposed action, and linked to the hatchery The screw traps in the Upper Salmon River and Pahsimeroi are primarily intended to monitor natural-populations, and are covered under separate research permits.

The Yankee Fork and Panther Creek programs incorporate the operation of a rotary screw trap in the basin to capture out-migrating juveniles. Rotary screw traps will be used collect genetic samples and tag fish to estimate the abundance, emigration timing, and age composition of naturally produced spring/summer Chinook salmon migrants. Tissue samples will be collected and used for pedigree analysis to determine parentage of migrants. Locations of each screw trap are provided above. In addition, some juveniles may be captured by use of backpack electroshock equipment, block nets, and dip nets throughout each basin. Fish will be captured, handled, anesthetized, and fin clips may be taken, some fish will be marked with PIT tags. All fish will be allowed to recover, and will be released at or near the location that they were trapped. The information will be used to determine juvenile migration timing, rearing preferences, dispersal, and parental lineage (based on PBT).

Please refer to Table 11 for information regarding specific adult and juvenile RM&E activities for each of the four programs.

Table 11. Specific adult and juvenile RM&E activities for each of the four programs.

Program	Spring/summer Chinook salmon ESU		
	Adult Monitoring	**Juvenile Monitoring**	**ESA coverage**
All	Systematic tissue sample of adipose clipped adults at Lower Granite Dam to provide escapement estimates		NMFS Letter of Determination under 2014 FCRPS Supplemental Opinion and Permit # TE-82106B-0 under Section 10(a)(1)(A) for Bull trout
Yankee Fork	Yankee Fork weir and fish trap operation: data collection to include date, sex, length, marks, and tags; applying marks and collecting tissue samples	Monitoring of survival metrics for all life stages in the hatchery from spawning to release. CWT and/or PBT 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. PIT tagging representative groups of hatchery juveniles to estimate migration timing, outmigration survival rate, and adult returns. Adult PIT detections in the mainstem Columbia River and Lower Snake River dams are used to inform in-season fisheries management.	This Opinion for Spring Chinook Salmon
	Multiple-pass spawning surveys, pre-spawning mortality, and carcass surveys, genetic monitoring	Operate rotary screw trap(s) in lower Yankee Fork; estimate juvenile production, estimate survival to Lower Granite Dam, and monitor migration timing; most fish counted/released or anesthetized, measured, weighed, and released; some receive PIT before release	This Opinion for Spring Chinook Salmon
Panther Creek	Pahsimeroi weir and fish trap operation; data collection to include date, sex, length, marks, and tags; applying marks and collecting tissue samples	Monitoring of survival metrics for all life stages in the hatchery from spawning to release. CWT and/or PBT 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. PIT tagging representative groups of hatchery juveniles to estimate migration timing, outmigration survival rate, and adult returns. Adult PIT detections in the mainstem Columbia River and Lower Snake River dams are	This Opinion for Summer Chinook Salmon

Program	Spring/summer Chinook salmon ESU		
	Adult Monitoring	Juvenile Monitoring	ESA coverage
		used to inform in-season fisheries management.	
	Multiple-pass spawning surveys, pre-spawning mortality, and carcass surveys, genetic monitoring	Operate rotary screw trap in Panther Creek; estimate juvenile production, estimate survival to Lower Granite Dam, and monitor migration timing; most fish counted/released or anesthetized, measured, weighed, and released; some receive PIT before release	This Opinion for Summer Chinook Salmon
Sawtooth (Natural, integrated and segregated)	Sawtooth Fish Hatchery weir and fish trap operation: data collection to include date, sex, length, marks, and tags; applying marks and collecting tissue samples	Monitoring of survival metrics for all life stages in the hatchery from spawning to release. CWT and/or PBT 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. PIT tagging representative groups of hatchery juveniles to estimate migration timing, outmigration survival rate, and adult returns. Adult PIT detections in the mainstem Columbia River and Lower Snake River dams are used to inform in-season fisheries management.	This Opinion for Spring Chinook Salmon
	Multiple-pass spawning surveys, pre-spawning mortality, and carcass surveys, genetic monitoring	Operate rotary screw trap near Sawtooth weir; estimate juvenile production, estimate survival to Lower Granite Dam, and monitor migration timing; most fish counted/released or anesthetized, measured, weighed, and released; some receive PIT before release	Research: 4(d) Authorization 20863
Pahsimeroi (Natural, integrated and segregated)	Pahsimeroi weir and fish trap operation; data collection to include date, sex, length, marks, and tags; applying marks and collecting tissue samples	Monitoring of survival metrics for all life stages in the hatchery from spawning to release. CWT and/or PBT 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. PIT tagging representative groups of hatchery juveniles to estimate migration timing, outmigration survival rate, and adult returns. Adult PIT detections in the mainstem Columbia River and Lower Snake River dams are used to inform in-season fisheries management.	This Opinion for Summer Chinook Salmon

Program	Spring/summer Chinook salmon ESU		
	Adult Monitoring	Juvenile Monitoring	ESA coverage
	Multiple-pass spawning surveys, pre-spawning mortality, and carcass surveys, genetic monitoring	Operate rotary screw trap near Pahsimeroi weir; estimate juvenile production, estimate survival to Lower Granite Dam, and monitor migration timing; most fish counted/released or anesthetized, measured, weighed, and released; some receive PIT before release	Research: 4(d) Authorization 20863

*This is the future proposed location of an 8-foot diameter screw trap that should be in operation by 2019. In the interim, a 5-foot diameter screw trap is currently operated 5.0 kilometers from the mouth of Yankee Fork.

Spawning surveys will occur annually to track population abundance and trends. Surveys will take place on most natural spawning areas affected by supplementation programs, and any fish identified as hatchery-origin will be sampled in efforts to identify their origin.

Live adults may be observed, but not handled during surveys. Carcasses found during surveys are sampled for marks, or tags and for age, sex, and size information. Most carcasses will be sampled for tissue scanned for tags (e.g., CWT, PIT), and dorsal fin ray taken for aging before being returned to the water to remain as a nutrient source. Annual estimates of spawners by age are used to monitor inter-annual spawner recruitment relationships.

Ongoing monitoring efforts and data sharing will continue throughout Idaho to track population trends and relationships between programs throughout the Snake River basin. These efforts are not specifically part of any of the individual programs under consideration, but help the operators determine basin-wide interactions and inform program effectiveness and impacts. In general, operators will:

- Analyze marked fish recovery data collected by others from the Columbia and Snake River mainstem and tributary fisheries to determine harvest numbers and rate
- Monitor harvest numbers and rates throughout Idaho, as well as in the Upper Salmon River, Pahsimeroi River, Yankee Fork, and Panther Creek
- Monitor adult escapement of PIT tagged adults (including straying) using current or future PIT tag arrays installed throughout anadromous waters in Idaho
- Estimate smolt-to-adult survival and in-season run forecasts using any program specific tagging detections at mainstem Dams on the Columbia and Snake Rivers and to the tributaries

At facilities, the operators will:

- Monitor discharge water quality/withdrawals and report annually on compliance with related permits and criteria (i.e., screening and fish passage criteria)
- Monitor health and condition of adult and juvenile spring/summer Chinook salmon associated with hatchery production during hatchery residence

1.3.8. Proposed operation and maintenance of hatchery facilities

Several routine (and semi-routine) maintenance activities occur in or near water that could impact fish in the area including: sediment/gravel removal/relocation from intake and/or outfall structures, pond cleaning, pump maintenance, debris removal from intake and outfall structures, and maintenance and stabilization of existing bank protection.

Both the Sawtooth and Pahsimeroi intakes (both upper and lower) have ongoing problems with sediment deposition by the intake, which can limit or jeopardize the availability of water if not removed routinely. Sediment has been removed by heavy equipment during the in-water-work-window in most years to keep the intake free. At Pahsimeroi, the canals, which are behind the screens, are also dredged occasionally to maintain flow. Work is typically done with a large excavator. The Pahsimeroi intake channel was redesigned in 2008, though it has experienced ongoing problems with sediment build up and maintenance. It has required annual instream gravel removal to maintain flow to the hatchery. In April 2017, the design of a fish ladder and sluice gate associated with the diversion structure and surface water intake was approved and constructed. The newly designed fish ladder and associated sluice gate, may reduce the amount of material that builds up in front of the intake, but is not expected to eliminate the problem.

All in-water maintenance activities described in the HGMPs and summarized above are considered “routine” (occurring on an annual basis) or “semi-routine” (occurring with regularity, but not necessarily on an annual basis) for the purposes of this action. All activities will occur within existing structures or the footprint of areas that have already been impacted. When maintenance activities occur within water, they will comply with the following guidance:

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

For additional information regarding facility water sources for each program, please refer to Table 12.

Table 12. Facility details for those facilities that divert water for hatchery operations. N/A = not applicable.

Program and facility	Surface Water (cfs)	Ground Water (cfs)	Water Diversion Distance (km)	Surface water source	Discharge Location	Meet NMFS Screening Criteria; Year?	NPDES Permit?	Water Rights Permit
Sawtooth (both components)	43cfs	11.6cfs	1.48	Salmon River	Salmon River	LSRCP currently evaluating #	Yes; IDG131010	71-10934; 71-10937; 71-02088; 71-07079
Pahsimeroi Upper (rearing)	20cfs	13.53cfs	0.23	Pahsimeroi River	Pahsimeroi River	Yes; compliant rotating drum screen	Yes, IDG131007	7302168; 7307051, 7311961
Pahsimeroi Lower (adult holding)	40cfs	0.21cfs	0.4	Pahsimeroi River	Pahsimeroi River	Yes, compliant rotating drum screen	NA (adult holding only)	7307006, 7307055, 734041
Yankee Fork Adult[4]	10cfs	None	0.38	Yankee Fork	Yankee Fork	Yes[1]	Yes	TBD
Yankee Fork Juvenile[1, 2]	N/A[2]	None	N/A	N/A[2]	N/A[2]	N/A[2]	Yes	N/A
Panther Creek Adul[4]t	11 cfs	None	0.38	Panther Creek (10 cfs) Dummy Creek (1 cfs)	Panther Creek	Yes[1]	Yes	TBD
Panther Creek Juvenile[1]	3 cfs		0.30	Panther Creek		Yes[1]	Yes	TBD
Crystal Springs[3]	N/A	23cfs	N/A[2]			N/A – no fish access	Yes	

[1]Yankee Fork and Panther Creek intakes are being designed to meet current criteria
[2]Yankee Fork acclimation takes place in side channel ponds that already exist, and do not require
[3]Crystal Springs only uses groundwater, and does not use surface water in anadromy.
[4]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 for LSRCP facilities are completed, the LSRCP and facility managers/operators 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.

1.4. Interrelated and Interdependent Actions

Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration (50 CFR 402.02). NMFS has not identified any interdependent or interrelated activities associated with the proposed action.

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

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

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

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. Section 7(a)(2) of the ESA requires Federal agencies to consult with the U.S. Fish and Wildlife Service (USFWS), NMFS, or both, to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or adversely modify or destroy their designated critical habitat. Section 7(b)(3) requires that at the conclusion of consultation, NMFS provide an opinion stating how the agencies' actions will affect listed species or their critical habitat. If incidental take is expected, Section 7(b)(4) requires NMFS to provide an ITS that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

The Mitchell Act Biological Opinion (NMFS 2017b) and the Northeast Oregon Biological Opinion (NMFS 2016b) that were recently completed by NMFS have largely contributed to the status descriptions (Section 2.2), the description of the environmental baseline (Section 2.4), the description of the factors that are considered when analyzing hatchery effects (Section 2.5.1), as well as background information used to analyze the hatchery effects (Section 2.5.2) in this Biological Opinion. These descriptions have either been taken directly from the Mitchell Act Biological Opinion and Northeast Oregon Biological Opinion documents and incorporated by reference or have been modified to suit this Biological Opinion.

2.1. Analytical Approach

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 current, revised 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 PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

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

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 physical and biological features (also called "primary constituent elements" or PCEs). Status of the species and critical habitat are discussed in Section 2.2.

Description of the environmental baseline

The environmental baseline includes the past and present impacts of Federal, state, or private actions and other human activities *in the action area* on ESA-listed species. It includes the anticipated impacts of proposed Federal projects that have already undergone formal or early section 7 consultation and the impacts of state or private actions that are contemporaneous with the consultation in process. The environmental baseline is discussed in Section 2.4 of this opinion.

Cumulative effects

Cumulative effects, as defined in NMFS' implementing regulations (50 CFR 402.02), are the effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area. Future Federal actions that are unrelated to the Proposed Action are not considered because they require separate Section 7 consultation. Cumulative effects are considered in Section 2.6 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 2.5.2) 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, and these are combined with the overall status of the strata/MGP to determine the effects on the ESA-listed species (ESU/DPS), which will be used to formulate the agency's opinion as to whether the hatchery action is likely to: (1) result in appreciable reductions in the likelihood of both survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution; or (2) reduce the value of designated or proposed critical habitat.

Jeopardy and adverse modification

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

Reasonable and prudent alternative(s) to the Proposed Action

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

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

This Opinion examines the status of each ESA listed species that would be affected by the Proposed Action as described in Table 13[4]. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02. The Opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the current function of the essential physical and biological features that help to form that conservation value.

Table 13. Federal Register notices for the final rules that list species, designate critical habitat, or apply protective regulations to a listed species considered in this consultation.

Species	Listing Status	Critical Habitat	Protective Regulations
Chinook salmon *(Oncorhynchus tshawytscha)*			
Snake River spring/summer-run	Threatened, 79 FR[5] 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

[4] ESA-listed bull trout (*Salvelinus confluentus*) are administered by the FWS and the effects of the proposed hatchery programs on bull trout are currently covered under a separate FWS section 7 consultation (FWS ref #___). Take associated with hatchery monitoring and evaluation activities is covered under USFWS ___

[5] Citations to "FR" are citations to the Federal Register.

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

"Species" Definition: The ESA of 1973, as amended, 16 U.S.C. 1531 *et seq.* defines "species" to include any "distinct population segment (DPS) of any species of vertebrate fish or wildlife which interbreeds when mature." To identify DPSs of salmon species, NMFS follows the "Policy on Applying the Definition of Species under the ESA to Pacific Salmon" (56 FR 58612, November 20, 1991). Under this policy, a group of Pacific salmon is considered a distinct population, and hence a "species" under the ESA if it represents an 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 USFWS-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 13 each constitute an ESU (a salmon DPS) of the taxonomic species *Oncorhynchus tshawytscha*; Snake River Sockeye salmon constitute an ESU of the taxonomic species *Oncorhynchus nerka;* and the steelhead constitutes a DPS of the taxonomic species *Oncorhynchus mykiss*.

2.2.1. Status of Listed Species

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

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

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

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

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

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

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

On June 3, 1992, NMFS listed the Snake River Spring/summer-run Chinook Salmon ESU as a threatened species (57 FR 23458). More recently, the threatened status was reaffirmed on June 28, 2005 (70 FR 37160) and on April 14, 2014 (79 FR 20802) (Table 13). Critical habitat was originally designated on December 28, 1993 (58 FR 68543) but updated most recently on October 25, 1999 (65 FR 57399) (Table 13).

The Snake River Spring/summer-run Chinook Salmon ESU includes all naturally spawned populations of spring/summer-run Chinook salmon in the mainstem Snake River and the Tucannon River, Grande Ronde River, Imnaha River, and Salmon River subbasins, as well as 11 artificial propagation programs (Jones Jr. 2015; NWFSC 2015). However, inside the geographic range of the ESU, there are a total of 19 hatchery spring/summer-run Chinook salmon programs currently operational (Jones Jr. 2015). Table 14 lists the natural and hatchery populations included (or excluded) in the ESU.

Table 14. Snake River Spring/Summer-Run Chinook Salmon ESU description and MPGs (Jones Jr. 2015; NWFSC 2015).

ESU Description	
Threatened	Listed under ESA in 1992; updated in 2014 (see Table 13)
5 major population groups	28 historical populations (4 extirpated)
Major Population Group	***Populations***
Lower Snake River	Tucannon River
Grande Ronde/Imnaha River	Wenaha, Lostine/Wallowa, Minam, Catherine Creek, Upper Grande Ronde, Imnaha
South Fork Salmon River	Secesh, East Fork/Johnson Creek, South Fork Salmon River Mainstem, Little Salmon River
Middle Fork	Bear Valley, Marsh Creek, Sulphur Creek, Loon Creek, Camas Creek, Big Creek, Chamberlain Creek, Lower Middle Fork (MF) Salmon, Upper MF Salmon
Upper Salmon	Lower Salmon Mainstem, Lemhi River, Pahsimeroi River, Upper Salmon Mainstem, East Fork Salmon, Valley Creek, Yankee Fork, North Fork Salmon
Artificial production	
Hatchery programs included in ESU (11)	Tucannon River Spr/Sum, Lostine River Spr/Sum, Catherine Creek Spr/Sum, Looking glass Hatchery Reintroduction Spr/Sum, Upper Grande Ronde Spr/Sum, Imnaha River Spr/Sum, Big Sheep Creek-Adult Spr/Sum out-planting from Imnaha program, McCall Hatchery summer, Johnson Creek Artificial Propagation Enhancement summer, Pahsimeroi Hatchery summer, Sawtooth Hatchery spring.

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

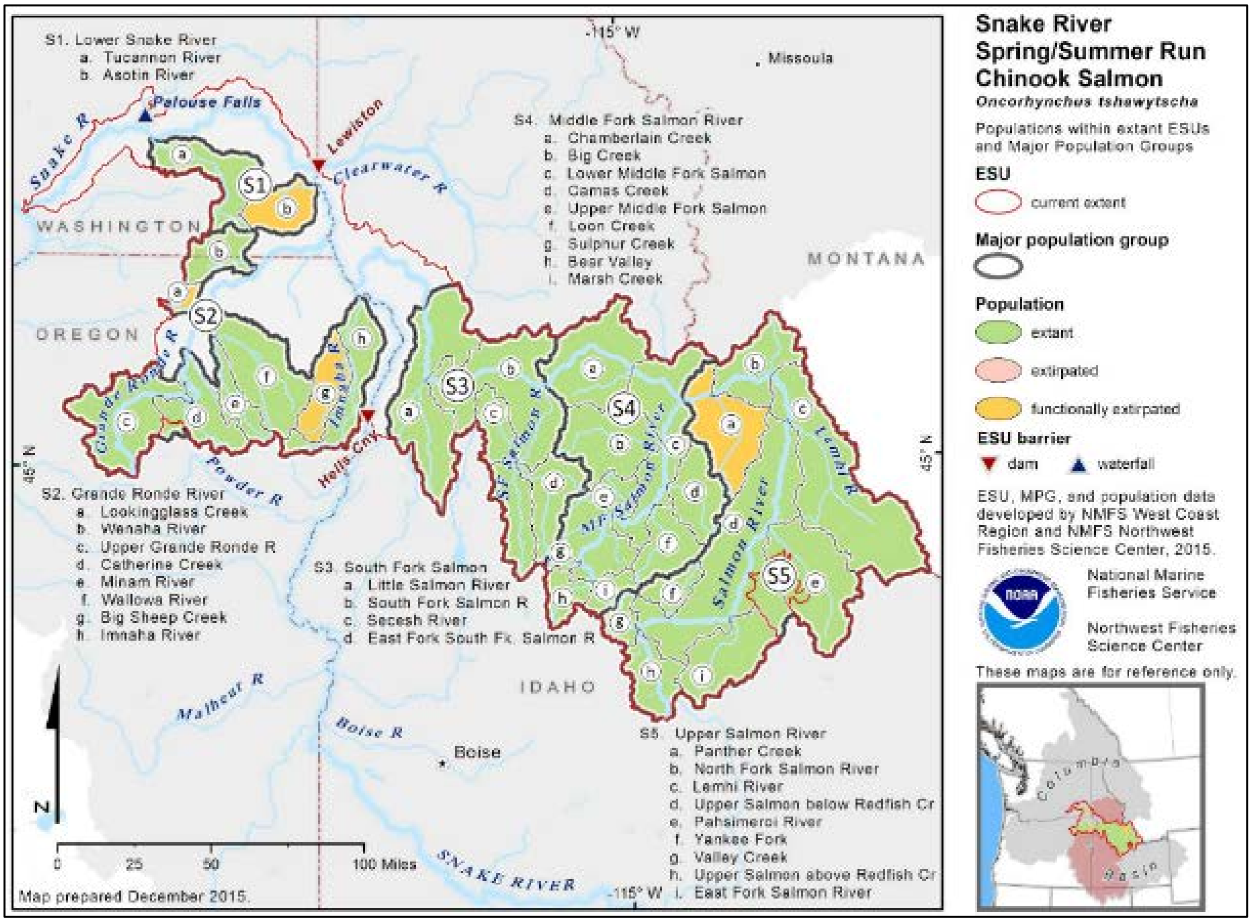

Figure 4. Snake River Spring/Summer-Run Chinook Salmon ESU spawning and rearing areas, illustrating natural populations and MPGs (NWFSC 2015).

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

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

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

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

Abundance, Productivity, Spatial Structure, and Diversity

Status of the species is determined based on Viable Salmonid Population (VSP) criteria including abundance, productivity, spatial structure, and diversity of its constituent natural populations (McElhany et al. 2000). NMFS has initiated recovery planning for the Snake River drainage, organized around a subset of management unit plans corresponding to state boundaries. The recovery plans will incorporate VSP criteria recommended by the Interior Columbia Technical Recovery Team (ICTRT). The ICTRT recovery criteria are hierarchical in nature, with ESU/DPS level criteria being based on the status of natural-origin Chinook salmon assessed at the population level. The population level assessments are based on a set of metrics designed to evaluate risk across the four VSP elements. The ICTRT approach calls for comparing estimates of current natural-origin abundance and productivity against predefined viability curves (NWFSC 2015). Achieving recovery (i.e., delisting the species) of each ESU is the longer-term goal of the recovery plan. Table 15 shows the most recent metrics for the Snake River Spring/summer-run Chinook Salmon ESU. A more detailed description of the populations that are the focus of this consultation follows.

Table 15. Measures of viability and overall viability rating for Snake River spring/summer-run Chinook salmon populations[1] (NWFSC 2015).

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

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

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

The Upper Salmon River MPG included nine historical populations one of which, Panther Creek, is considered functionally extirpated. Much of the upper Salmon River basin is managed for public use, with some of the basin protected in wilderness or roadless areas. High watershed and aquatic integrity is found in the East Fork Salmon and Middle Salmon–Chamberlain watersheds (NPCC 2004). Habitats tend to be more modified or degraded in the major watersheds that have broad valleys and easier access for humans and development, such as the lower Salmon, Pahsimeroi, and Lemhi watersheds. Private lands tend to be concentrated along the valley bottoms—i.e., near the river. The small towns in the subbasin are located along the river (Stanley, Challis, Salmon), with rural populations scattered in the surrounding areas.(NWFSC 2015)

One of the largest impacts on salmonid habitat in the upper Salmon River comes from the effects of irrigation diversions and evapotranspiration of crops (Ecovista 2004). Consumptive water use in the upper Salmon River basin reduces streamflow in individual tributaries and cumulatively in the Salmon River. Reductions during juvenile spring migration and during summer and fall adult migrations reduce the amount and function of available habitat, leading to reduced survival (Morrow and Arthaud 2009; Arthaud and Morrow 2013). Smallmouth bass thrive in the lower Salmon River mainstem extending upstream to Salmon, Idaho. Introduced smallmouth bass, brook trout, hatchery steelhead, and hatchery rainbow trout compete with and prey upon emigrating juveniles (Peterson et al. 2012).

Table 16. Risk levels and viability ratings for Snake River spring/summer-run Chinook salmon Upper Salmon River MPG, populations, and key elements (abundance/productivity “A/P”, diversity, and spatial structure/diversity “SS/D”) used to determine current overall viability risk for Snake River spring/summer-run Chinook salmon (NWFSC 2015). [1]

MPG	Population	A/P	Diversity	SS/D	Overall Viability Risk
Upper Salmon River	Salmon River Upper Main	High	Low	Low	High Risk
	Pahsimeroi	High	High	High	High Risk
	Yankee Fork	High	High	High	High Risk
	Panther Creek (ext)	N/A[2]	N/A[2]	N/A[2]	Extirpated

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

Limiting Factors

Understanding the limiting factors and threats that affect the Snake River Spring/summer-run Chinook Salmon ESU provides important information and perspective regarding the status of a species. One of the necessary steps in recovery and consideration for delisting is to ensure that the underlying limiting factors and threats have been addressed. The abundance of spring/summer-run Chinook salmon had already began to decline by the 1950s, and it continued declining through the 1970s. In 1995, only 1,797 spring/summer-run Chinook salmon total adults (both hatchery and natural combined) returned to the Snake River (NMFS 2012b).

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

NMFS (2012b) determined the range-wide status of critical habitat by examining the condition of its PBF (also called PCEs, in some designations) that were identified when critical habitat was designated. These features are essential to the conservation of the listed species because they support one or more of the species' life stages (e.g., sites with conditions that support spawning, rearing, migration, and foraging). PCEs for Snake River spring/summer-run Chinook salmon are shown in Table 17.

Table 17. PCEs identified for Snake River spring/summer-run Chinook salmon (NMFS 2012b).

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

Habitat Component	Primary Constituent Elements (PCEs)
Adult migration corridors	1) substrate 2) water quality 3) water quantity 4) water temperature 5) water velocity 6) cover/shelter 7) riparian vegetation 8) space 9) safe passage

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

2.2.1.2. Life History and Status of Snake River Steelhead

On August 18, 1997, NMFS listed the Snake River Basin Steelhead DPS as a threatened species (62 FR 43937). The threatened status was reaffirmed in 2006 and most recently on April 14, 2014 (79 FR 20802) (Table 13). Critical habitat for the DPS was designated on September 2, 2005 (70 FR 52769) (Table 13).

The Snake River Basin Steelhead DPS includes all naturally spawned anadromous *O. mykiss* originating below natural and manmade impassable barriers in streams in the Snake River Basin of southeast Washington, northeast Oregon, and Idaho (NWFSC 2015). The Snake River Basin Steelhead DPS comprises twenty-four historical populations within six MGPs comprise the Snake River Basin Steelhead DPS. Inside the geographic range of the DPS, 19 hatchery steelhead programs are currently operational. Nine of these artificial programs are included in the DPS (Table 18). This DPS consists of A-run steelhead, which are primarily returning to spawning areas beginning in the summer and the B-run steelhead, which exhibit a larger body size and begin their migration in the fall (NMFS 2011a). Figure 5 shows a map of the current DPS and the MPGs within the DPS.

Table 18. Snake River Basin Steelhead DPS description and MPGs (NMFS 2012b; Jones Jr. 2015; NWFSC 2015).

DPS Description	
Threatened	Listed under ESA as threatened in 1997; updated in 2014 (see Table 13)
6 major population groups	27 historical populations (3 extirpated)
Major Population Group	***Populations***
Grande Ronde	Joseph Creek, Upper Mainstem, Lower Mainstem, Wallowa River
Imnaha River	Imnaha River
Clearwater	Lower Mainstem River, North Fork Clearwater, Lolo Creek, Lochsa River, Selway River, South Fork Clearwater

DPS Description	
Salmon River	Little Salmon/Rapid, Chamberlain Creek, Secesh River, South Fork Salmon, Panther Creek, Lower MF, Upper MF, North Fork, Lemhi River, Pahsimeroi River, East Fork Salmon, Upper Mainstem
Lower Snake	Tucannon River, Asotin Creek
Hells Canyon Tributaries	n/a – area excluded from listing due to lack of available habitat
Artificial production	
Hatchery programs included in DPS (7)	Tucannon River summer, Little Sheep Creek/Imnaha River Hatchery summer, EF Salmon River A, Dworshak NFH B, Lolo Creek B, Clearwater Hatchery B, SF Clearwater (localized) B

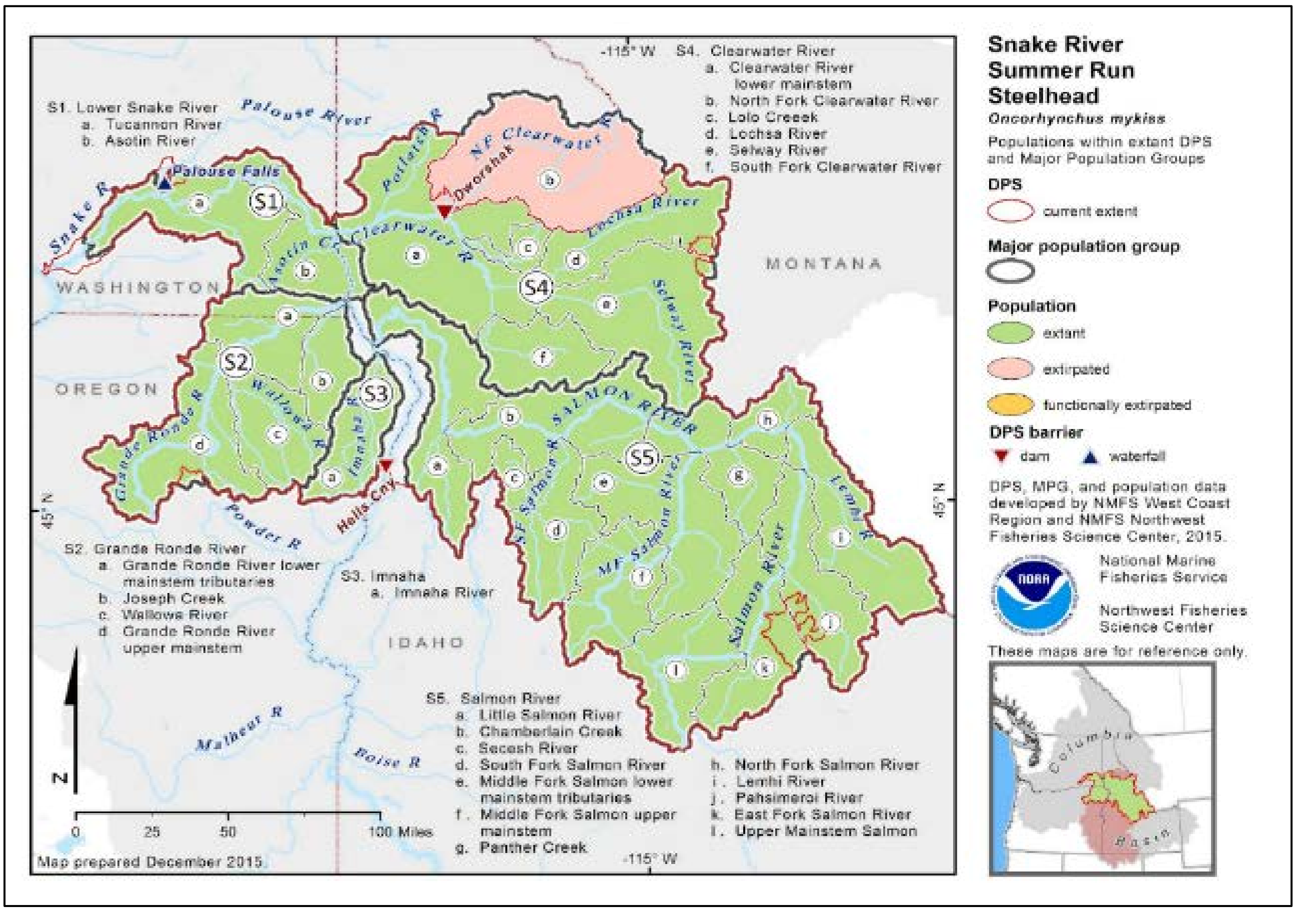

Figure 5. Snake River Basin Steelhead DPS spawning and rearing areas, illustrating natural populations and MPGs (NWFSC 2015).

O. mykiss exhibit perhaps the most complex suite of life-history traits of any species of Pacific salmonid. They can be anadromous or freshwater resident, and under some circumstances, yield offspring of the opposite form. Steelhead are the anadromous form. A non-anadromous form of *O. mykiss* (redband trout) co-occurs with the anadromous form in this DPS, and juvenile life stages of the two forms can be very difficult to differentiate. Steelhead can spend up to 7 years in fresh water prior to smoltification, and then spend up to 3 years in salt water prior to first spawning. This species can also spawn more than once (iteroparous), whereas all other species of *Oncorhynchus*, except *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).

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

Abundance, Productivity, Spatial Structure, and Diversity

Status of the species is determined based on the abundance, productivity, spatial structure, and diversity of its constituent natural populations. Best available information indicates that the species, in this case the Snake River Basin Steelhead DPS, ranges from moderate to high risk and remains at threatened status. The most recent status update (NWFSC 2015) used new data (i.e., data from 2009 to 2014) to inform the analysis on this DPS. Additionally, IDFG has continued to refine sampling methods for various survey types, which has also led to more accurate data available for use. However, a great deal of uncertainty remains regarding the relative proportion of hatchery-origin fish in natural spawning areas near major hatchery release sites. Because of this, it is difficult to estimate changes in the DPS viability (NWFSC 2015).

Limiting Factors

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

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

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

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

On June 3, 1992, NMFS listed the Snake River Fall-run Chinook Salmon ESU as a threatened species (57 FR 23458). More recently, the threatened status was reaffirmed on June 28, 2005 (70 FR 37160) and on April 14, 2014 (79 FR 20802) (Table 13). Critical habitat was designated on December 28, 1993 (58 FR 68543) (Table 13).

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

Table 19. Snake River Fall-Run Chinook Salmon ESU description and MPGs (Jones Jr. 2015; NWFSC 2015).

ESU Description	
Threatened	Listed under ESA in 1992; updated in 2014 (see Table 13)
1 major population groups	2 historical populations (1 extirpated)
Major Population Group	***Population***
Snake River	Lower Mainstem Fall-Run
Artificial production	
Hatchery programs included in ESU (4)	Lyons Ferry NFH fall, Acclimation Ponds Program fall, Nez Perce Tribal Hatchery fall, Idaho Power fall.

Two historical populations (1 extirpated) within one MPG comprise the Snake River fall-run Chinook Salmon ESU. The extant natural population spawns and rears in the mainstem Snake River and its tributaries below Hells Canyon Dam. Figure 6 shows a map of the ESU area. The decline of this ESU was due to heavy fishing pressure beginning in the 1890s and loss of habitat with the construction of Swan Falls Dam in 1901 and the Hells Canyon Complex from 1958 to 1967, which extirpated one of the historical populations. Hatcheries mitigating for losses caused by the dams have played a major role in the production of Snake River fall-run Chinook salmon since the 1980s (NMFS 2012b). Since the species were originally listed in 1992, fishery impacts have been reduced in both ocean and river fisheries. Total exploitation rate has been relatively stable in the range of 40% to 50% since the mid-1990s (NWFSC 2015).

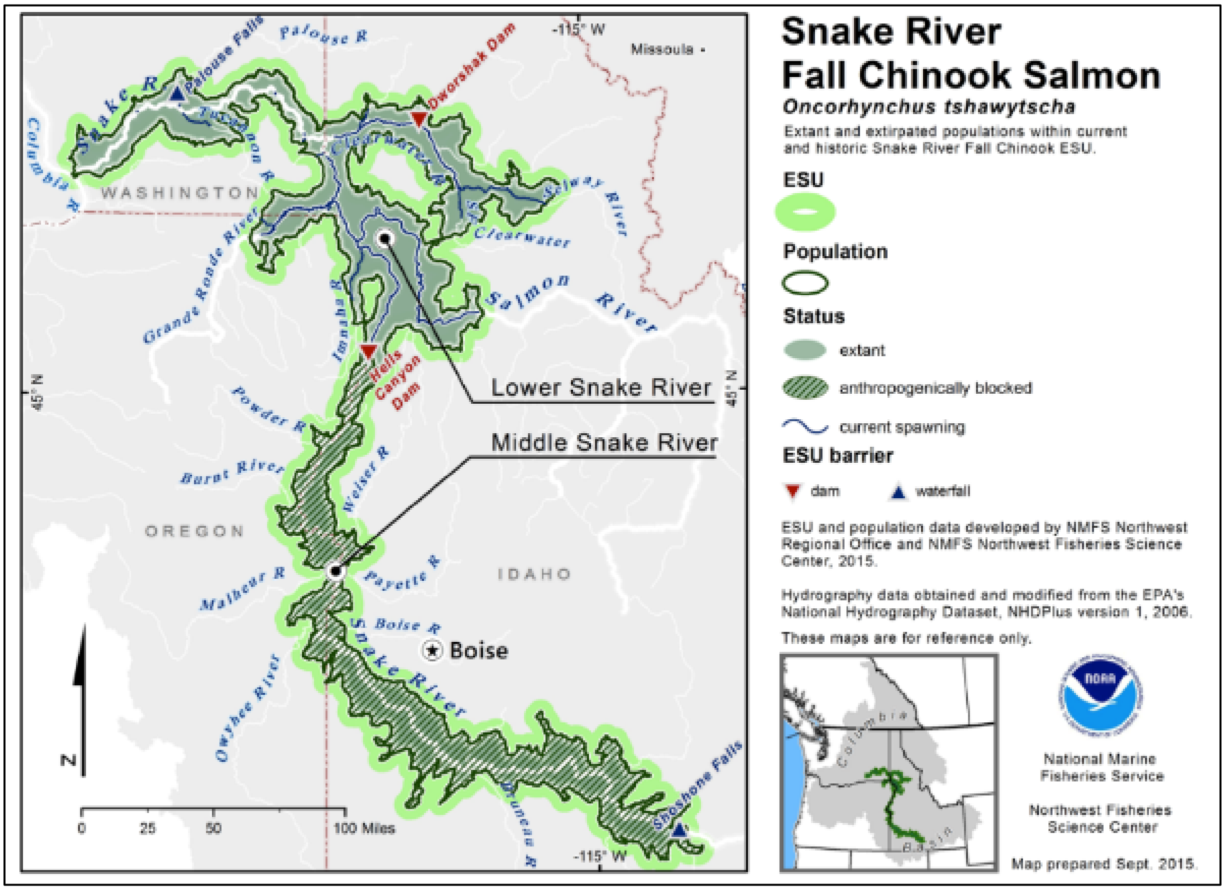

Figure 6. Map of the Snake River Fall-Run Chinook Salmon ESU's spawning and rearing areas, illustrating populations and MPGs (NWFSC 2015).

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

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

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

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

Abundance, Productivity, Spatial Structure, and Diversity

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

The recently released 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 a scenario could be possible if major spawning areas supporting the bulk of natural returns are operating consistent with long-term diversity objectives in the proposed plan. Under this single population scenario, the requirements for a sufficient combination of natural abundance and productivity could be based on a combination of total population natural abundance and relatively high production from one or more major spawning areas with relatively low hatchery contributions to spawning—i.e., low hatchery influence for at least one major natural spawning production area.

Limiting Factors

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

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

Overall, the status of Snake River fall-run Chinook salmon has clearly improved compared to the time of listing and since the time of prior status reviews. The single extant population in the ESU is currently meeting the criteria for a rating of viable developed by the ICTRT, but the ESU as a whole is not meeting the recovery goals described in the draft recovery plan for the species, which require the single population to be "highly viable with high certainty" and/or will require reintroduction of a viable population above the Hells Canyon Dam complex (NWFSC 2015).

2.2.1.4. Life History and Status of Snake River Sockeye Salmon

On April 5, 1991, NMFS listed the Snake River Sockeye Salmon ESU as an endangered species (56 FR 14055) under the Endangered Species Act (ESA). This listing was affirmed in 2005 (70 FR 37160), and again on April 14, 2014 (79 FR 20802) (Table 13). Critical habitat was designated on December 28, 1993 (58 FR 68543) and reaffirmed on September 2, 2005 (Table 13).

The ESU includes naturally spawned anadromous and residual sockeye salmon originating from the Snake River Basin in Idaho, as well as artificially propagated sockeye salmon from the Redfish Lake captive propagation program (Jones Jr. 2015) (Table 20).

Table 20. Snake River Sockeye Salmon ESU description and MPG (Jones Jr. 2015; NMFS 2015a).

ESU Description	
Threatened	Listed under ESA in 1991; updated in 2014 (see Table 13)
1 major population group	5 historical populations (4 extirpated)
Major Population Group	***Population***
Sawtooth Valley Sockeye	Redfish Lake
Artificial production	
Hatchery programs included in ESU (1)	Redfish Lake Captive Broodstock

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

Lake sockeye salmon population have been outplanted to Pettit and Alturas Lakes within the Sawtooth Valley for recolonization purposes (NMFS 2011a).

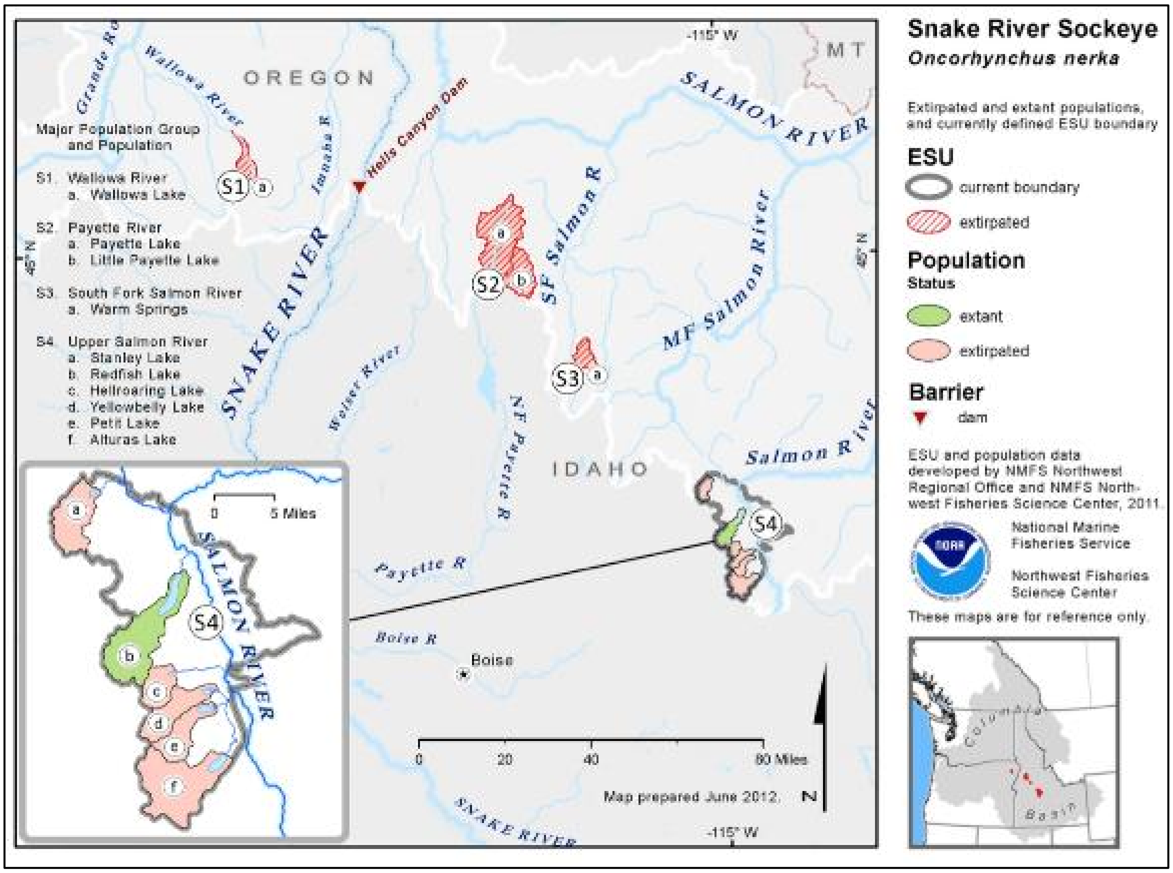

Figure 7. Map of the Snake River Sockeye Salmon ESU's spawning and rearing areas, illustrating populations and MPGs (NWFSC 2015).

While there are very few sockeye salmon currently following an anadromous life cycle in the Snake River, the small remnant run of the historical population migrates 900 miles downstream from the Sawtooth Valley through the Salmon, Snake, and Columbia Rivers to the ocean (Figure 7). After one to three years in the ocean, they return to the Sawtooth Valley as adults, passing once again through these mainstem rivers and through eight major Federal dams, four on the Columbia River and four on the lower Snake River. Anadromous sockeye salmon returning to Redfish Lake in Idaho's Sawtooth Valley travel a greater distance from the sea, 900 miles, to a higher elevation (6,500 feet.) than any other sockeye salmon population. They are the southernmost population of sockeye salmon in the world (NMFS 2015a).

Abundance, Productivity, Spatial Structure, and Diversity

Although the endangered Snake River Sockeye Salmon ESU has a long way to go before it meets 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.

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 historical range (NMFS 2015a; NWFSC 2015).

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

Limiting Factors

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

2.2.2. Range-wide Status of Critical Habitat

NMFS determines the range-wide status of critical habitat by examining the condition of its PBFs that were identified when critical habitat was designated. These features are essential to the conservation of the listed species because they support one or more of the species' life stages. An example of some PBFs are listed below. These are often similar among listed salmon and steelhead; specific differences can be found in the critical habitat designation for each species (Table 13).

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

(2) Freshwater rearing sites with: (i) Water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; (ii) Water

quality and forage supporting juvenile development; and (iii) Natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks;

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

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

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

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

The status of critical habitat is based primarily on a watershed-level analysis of conservation value that focused on the presence of ESA-listed species and physical features that are essential to the species' conservation. NMFS organized information at the 5th field hydrologic unit code (HUC) watershed scale because it corresponds to the spatial distribution and site fidelity scales of salmon and steelhead populations (McElhany et al. 2000). The analysis for the 2005 designations of salmon and steelhead species was completed by Critical Habitat Analytical Review Teams (CHARTs) that focused on large geographical areas corresponding approximately to recovery domains (NMFS 2005b). Each watershed was ranked using a conservation value attributed to the quantity of stream habitat with physical and biological features (PBFs; also known as primary and constituent elements (PCEs), the present condition of those PBFs, the likelihood of achieving PBF potential (either naturally or through active restoration), support for rare or important genetic or life history characteristics, support for abundant populations, and support for spawning and rearing populations. In some cases, our understanding of these interim conservation values has been further refined by the work of technical recovery teams and other recovery planning efforts that have better explained the habitat attributes, ecological interactions, and population characteristics important to each species.

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

The following are the major factors limiting the conservation value of critical habitat for Snake River steelhead:

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

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

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

Critical habitat has been designated in the Interior Columbia (IC) recovery domain, which includes the Snake River Basin, for the Snake River spring/summer-run Chinook Salmon ESU, Snake River fall-run Chinook Salmon ESU, Snake River Sockeye Salmon ESU, and Snake River Basin Steelhead DPS (Table 13). In the Snake River Basin, some watersheds with PCEs for steelhead (Upper Middle Salmon, Upper Salmon/Pahsimeroi, MF Salmon, Little Salmon, Selway, and Lochsa Rivers) are in good-to-excellent condition with no potential for improvement. Additionally, several Lower Snake River watersheds in the Hells Canyon area, straddling Oregon and Idaho, are in good-to-excellent condition with no potential for improvement (NMFS 2016c).

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

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

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

2.3. Action Area

The "action area" means all areas to be affected directly or indirectly by the Proposed Action and not merely the immediate area involved in the action (50 CFR 402.02). The action area resulting from this analysis includes the entire Upper Salmon River Basin downstream to its confluence with the Snake River, and the Snake River downstream to Ice Harbor Dam. Included in this area are the Yankee Fork, Pahsimeroi River, and Panther Creek. The extent to which we believe the effects of the Proposed Action can be detected is from the area downstream of the release sites to Ice Harbor Dam. We did not extend the action area beyond Ice Harbor Dam to the estuary/plume because the action area as defined represents the area in which effects of the action can be meaningfully detected. The Mitchell Act Biological Opinion (NMFS 2017b) considered the effects of hatchery fish in the estuary and ocean, and found that subyearling Chinook salmon and coho salmon are the most likely hatchery fish to have effects in these areas due to their long residence times and relatively high predation rates, respectively. Almost all releases are yearling Chinook salmon and eyed-eggs in the Action Area. This suggests that the likelihood of detecting effects from the releases of hatchery steelhead on natural-origin fish below Ice Harbor Dam have already been examined to the best of our ability.

The effects of the Proposed Action on Southern Resident Killer Whales (SRKW) was considered, but we ultimately determined not to include them in the Action Area because the total number of releases is not large enough to have an effect on Southern Resident Killer Whales. While the primary food source of SRKW is Chinook salmon, the total adult equivalents of all of the proposed hatchery program releases is only 35,200 adult Chinook salmon (based on the average SAR return value of 0.8 to LGD). The Pacific Fisheries Management Council provides ocean abundance estimates for Chinook salmon that originate from the U.S. systems (PFMC 2016). Between 2008 and 2016, escapement forecasts for Columbia River Chinook salmon stocks ranged from approximately 741,000 to 1,960,800 fish; Puget Sound stocks ranged from 150,600 to 269,800 fish; Washington coast stocks ranged from 65,500 to 115,900 fish, and Oregon and California coast stocks ranged from 142,200 to 1,651,800 fish. The average total Chinook salmon abundance from these sources was approximately 2,035,778 fish. Therefore, 35,200 adult Chinook salmon would be a small portion (or approximately 1.7%) of the total estimated ocean escapement that may be available to SRKW. Therefore, we did not find these proposed releases, which continue to support the escapement totals and do not cause take that would measurably reduce the SRKW prey base, to be a large enough proportion of the run to constitute extending the Action Area to include SRKW geographic ranges.

Within this reach and included in the Action Area are major tributaries where the Proposed Action is likely to have an observable effect. Major tributaries to the Salmon River include Yankee Fork, Pahsimeroi River, lower Lemhi River, and lower Middle Fork Salmon River. Besides these tributary reaches, the analyses will focus on the mainstem Salmon and Snake Rivers 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 might stray.

2.4. Environmental Baseline

In the Environmental Baseline section, NMFS describes what is affecting ESA-listed species and designated critical habitat in the action area before including any effects resulting from the Proposed Action. The “environmental baseline” includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area and the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation (50 CFR 402.02). The effects of future actions over which the Federal agency has discretionary involvement or control will be analyzed as “effects of the action.”

2.4.1. Habitat in the Columbia River Basin

Salmon and steelhead habitat in the Columbia River Basin is greatly affected by hydropower development. Much material in this Section has, therefore, been taken from or based on Chapter 5 of the FCRPS 2008 Opinion’s SCA (NMFS 2008e), with specific applications to and any changes from the current proposed action detailed below. In addition, the tributary Section has been augmented by material from various recovery plans developed within the basin. This information was originally organized and referenced in the Mitchell Act Biological Opinion (NMFS 2017b), and has since been modified for this Biological Opinion and will be incorporated by reference.

The Columbia River stretches from the Canadian province of British Columbia, through the U.S. state of Washington, forming much of the border between Washington and Oregon before emptying into the Pacific Ocean. The river is 1,243 miles long, and its drainage basin is 258,000 square miles. Grand Coulee and Chief Joseph Dams completely block anadromous fish passage on the upper mainstem Columbia River.

Migratory habitat quality in this area has been impacted by the development and operation of privately owned dams in the Upper Columbia River Basin. Hydroelectric development has modified natural flow regimes, resulting in higher water temperatures, changes in fish community structure leading to increased rates of piscivory and avian predation on juvenile salmonids, and delayed migration time for both adult and juvenile salmonids. Physical features of dams such as turbines also kill migrating fish. In-river survival is inversely related to the number of hydropower projects encountered by emigrating juveniles.

Habitat quality in tributary streams in the Upper Columbia River Basin varies from excellent in wilderness and roadless areas to poor in areas subject to heavy agricultural and urban development (McIntosh et al. 1994; Wissmar et al. 1994) (Overton et al. 1997);. Lack of summer stream flows, impaired water quality, and reduction of habitat complexity are common problems for critical habitat in developed areas. Critical habitat throughout the Interior Columbia River basin has been degraded by several management activities, including agriculture, alteration of stream morphology (i.e., channel modifications and diking), riparian vegetation disturbance, wetland draining and conversion, livestock grazing, dredging, road construction and maintenance, timber harvest, mining, and urbanization (Lee et al. 1997). Changes in habitat quantity, availability, and diversity, and flow, temperature, sediment load and channel instability are common symptoms of ecosystem decline in areas of critical habitat. Large-scale habitat assessments in the Interior Columbia basin indicate that in watersheds managed for natural resources extraction, the number of large pools has decreased from 20 to 87 percent (McIntosh et al. 1994).

2.4.1.1. Idaho Snake River Basin Tributary Habitat

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

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

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

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

Many streams occupied by salmon and steelhead are listed on the State of Idaho’s Clean Water Act section 303(d) list for impaired water quality, such as impairment for elevated water temperature (IDEQ 2014). High summer stream temperatures may currently restrict salmonid use of some historically suitable habitat areas, particularly rearing and migration habitat. Removal of riparian vegetation, alteration of natural stream morphology, and withdrawal of water all contribute to elevated stream temperatures. Water quality in spawning, rearing, and migration habitat has also been impaired by high levels of sedimentation, and by other pollutants such as heavy metal contamination from mine waste (e.g., IDEQ (2001); (IDEQ 2003). Contaminants, such as insecticides and herbicides from agricultural runoff are common in some areas of critical habitat (NMFS 2016c). They can negatively impact critical habitat and the organisms associated with these areas.

While harmful land-use practices continue in some areas, many land management activities, including forestry practices, now have fewer impacts on salmonid habitat due to raised awareness and less invasive techniques. For example, timber harvest on public land has declined drastically since the 1980s and current harvest techniques (e.g., the use of mechanical harvesters and forwarders) and silvicultural prescriptions (i.e., thinning and cleaning) require little, if any, road construction and produce much less sediment.

2.4.1.2. Recent Habitat Restoration Activities

Since the 1990s when salmonid populations began to be listed under the Endangered Species Act, organizations have coordinated, developed, and implemented various habitat restoration activities in the subbasins within the Snake River Basin. The focus of these projects has been to reduce the effects of ecological concerns (limiting factors) that impact the environment, which may influence VSP metrics of salmonids (Section 2.5.1). Intensive habitat restoration has been underway since the state of Washington's Salmon Recovery Act of 1998 in the Snake River region.

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

2.4.1.3. Habitat and Hydropower

A discussion of the baseline condition of habitat and hydropower throughout the Columbia River Basin occurs in our Biological Opinion on the Mitchell Act Hatchery programs (NMFS 2017b). The baseline includes all Federally-authorized hydropower projects, including projects with licenses issued by the Federal Energy Regulatory Commission, the Federal Columbia River Power System, and other developments that have undergone ESA §7 consultation. Here we summarize some of the key impacts on salmon and steelhead habitat in the Snake River Basin.

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

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

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

While harmful land-use practices continue in some areas, many land management activities, including forestry practices, now have fewer impacts on salmonid habitat due to raised awareness and less invasive techniques. For example, timber harvest on public land has declined drastically since the 1980s and current harvest techniques (e.g., the use of mechanical harvesters and forwarders) and silvicultural prescriptions (i.e., thinning and cleaning) require little, if any, road construction and produce much less sediment.

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 over the next 40 years:

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

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

Climate change is also predicted to cause a variety of impacts on Pacific salmon as well as their ecosystems (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 effects (e.g., increasing temperature) affect salmon at all life stages in all habitats, while others are habitat specific (e.g., stream flow variation in freshwater). The complex life cycles of anadromous fishes including salmon rely on productive freshwater, estuarine, and marine habitats for growth and survival, making them particularly vulnerable to environmental variation (Morrison et al. 2016). Ultimately, the effect of climate change on salmon and steelhead across the Pacific Northwest will be determined by the specific nature, level, and rate of change and the synergy between interconnected terrestrial/freshwater, estuarine, nearshore and ocean environments. The primary effects of climate change on Pacific Northwest salmon and steelhead are:

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

How climate change will affect each stock or population of salmon also varies widely depending on the level or extent of change and the rate of change and the unique life history characteristics of different natural populations (Crozier et al. 2008b). Dittmer (2013) suggests that juveniles may outmigrate earlier with less tributary water. Returning adults may be challenged by lower and warmer summer flows. In addition, the warmer water temperatures in the summer months may persist for longer and more frequently reach and exceed thermal tolerance thresholds for salmon and steelhead (Mantua et al. 2009). Larger winter streamflows may increase redd scouring for those adults that do reach spawning areas and successfully spawn. Climate change may also have long-term effects that include accelerated embryo development, premature emergence of fry, and increased competition among species (ISAB 2007). The uncertainty associated with these potential outcomes of climate change do provide some justification for hatchery programs as reservoirs for some salmon stocks. For more detail on climate change effects please see (NMFS 2017b).

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).

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

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

2.4.3. Artificial Propagation

A more comprehensive discussion of hatchery programs in the Snake River Basin can be found in our opinion on Mitchell Act funded programs (NMFS 2017b). In summary, because most programs are ongoing, the effects of each are reflected in the most recent status of the species (NWFSC 2015), and was summarized in Section 2.2.1 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 can also be used to help improve viability by supplementing natural population abundance and expanding spatial distribution. However, the long-term benefits and risks of hatchery supplementation remain untested (Christie et al. 2014). Therefore, fixing the factors limiting viability is essential for long-term viability.

Below is a brief history of hatchery production in each of the four populations being supplemented by the four programs. All are currently ongoing, and were initiated under the LSRCP, Hells Canyon Settlement Agreement or the BPAs Fish and Wildlife Program to mitigate for the construction and operation of the four lower Snake River dams, the Hells Canyon

Complex, and the Federal Columbia River Power System on salmon and steelhead in the Snake River basin. These programs have helped maintain populations that have been depressed.

2.4.3.1. Sawtooth History

A spring Chinook salmon brood stock development program began in 1981 with trapping and spawning of adult spring at a temporary weir at the Sawtooth site. Because East Fork Salmon River and Rapid River hatchery broodstocks were released between 1977 and 1979, the Upper Salmon River broodstock collection would have included influence from Rapid River origin fish returning to the weir. Juvenile rearing took place at McCall Hatchery, and yearling smolt release into the Upper Salmon River began in March 1983 (Hutchinson 1985; Partridge 1985).

The Sawtooth Hatchery was constructed in 1984-85 and was designed to rear 2.4 million smolts, though this target has never been reached. The Sawtooth program was initially designed as a harvest program, but has evolved to also include a supplementation objective. Since listing in 1992, the program has been managed to achieve two objectives; to supplement the upper Salmon River natural population above the hatchery and to provide fishing opportunities by producing smolts from known hatchery-by-hatchery crosses. The supplementation component has remained fully integrated with the natural population by incorporating natural fish into the broodstock and release of hatchery-origin adults for natural spawning. The segregated component (primarily for harvest mitigation) is composed of known hatchery fish whose linage predates the listing and has not incorporated natural fish. This later group of hatchery fish has used only marked hatchery fish for broodstock (NMFS 2004).

2.4.3.1.1. Yankee Fork History

The Yankee Fork has had various levels of hatchery influence since 1966 (SBT 2017b). In early years, predominantly Rapid River broodstock were used for releases in the Yankee Fork between 1966 and 1989 (Kiefer et al. 1992) but Sawtooth broodstock were also used. More recently, both Sawtooth and Pahsimeroi adults have been used to supplement the Yankee Fork, and long-term plans are to capture broodstock from Yankee Fork for the program. The spring/summer Chinook salmon in the hatchery program are included in the ESA listing (70 FR 37160). The current program is intended to increase abundance primarily to support tribal treaty harvest.

The IDFG initiated a captive rearing program for the Yankee Fork population in 1995 by collecting brood year 1994 parr and rearing them to sexual maturity in captivity. The program was isolated (using weirs) to the West Fork Yankee Fork. A captive population was sourced from the natural population each year through 2003. A small number of sexually mature adults from the captive-cultured groups have been released into the population to spawn naturally each year between 1998 and 2009. The captive rearing program has been terminated, and the last remaining adults were released in 2009.

2.4.3.1.2. Pahsimeroi History

A hatchery program has existed in the Pahsimeroi basin for over 40 years, and was developed as mitigation for losses attributable to construction of the Hells Canyon Dam complex. Broodstock was started by collecting wild adults at the Pahsimeroi weir, and for most of the life of the program some natural-origin returns have been incorporated into the broodstock, and some hatchery-origin fish have been allowed to spawn naturally (integrated program). However, in addition to using natural returns of summer Chinook to the Pahsimeroi River, other stocks were used to meet production goals for several years after initiating the smolt program. In each of the years between 1981 and 1984, Hayden Creek Hatchery (Lemhi River) spring Chinook eggs were used, and spring Chinook from the Rapid River and Sawtooth hatcheries were also used for broodstock to meet production goals in 1982 (HSRG 2009b; IDFG 2017b). Ratios of other stocks to Pahsimeroi stock varied, but generally outnumbered Pahsimeroi stock by several multiples (up to 32 times as many fish released) in the early years of using other stocks. That trend reversed when McCall stock was used in 1987 and 1988, when Pahsimeroi hatchery broodstock were released in approximately four times the number of the McCall stock (IDFG 2017b).

In 1987, the hatchery Chinook program was converted back to solely summer Chinook production, and summer Chinook salmon from McCall Hatchery (South Fork Salmon River stock) were used to meet production goals for 1986 and 1987 during the transition.(Kiefer et al. 1992; IDFG 2017b). Since 1989, broodstock have been taken exclusively from returns to the Pahsimeroi Fish Hatchery (HSRG 2009b; IDFG 2017b).

Though some marks were used, no mass marking occurred until the 1991 brood year releases, and because the two were indistinguishable until marked returns occurred in 1994, unknown proportions of hatchery and natural fish were released upstream to spawn. As a result, the current broodstock is a mixture of hatchery (spring and summer life history) and naturally produced (summer life history) fish (Kiefer et al. 1992). Since 1991, releases have been marked for mark-select fisheries and managing proportions of returning adults in the brood and upstream of the weir.

2.4.3.2.Panther Creek History

The Panther Creek Chinook population was extirpated by the 1970s primarily due to mining activities (HSRG 2009a; 2009b), and is one of five populations in the Upper Salmon MPG which do not currently have ongoing artificial production. Rapid River stock fingerlings were released into Panther Creek in 1977 and 1986 (Kiefer et al. 1992), however reintroduction efforts were abandoned soon after. Mine clean- up efforts have improved water quality, and Panther Creek and habitat conditions are currently good enough to support bull trout and steelhead (HSRG 2009b). Some Chinook of unknown origin have begun to use Panther Creek in recent years, and Panther Creek may be supporting a small population. Reintroduction efforts are currently being discussed.

All programs are currently consistent with the 2008-2017 *U.S. v Oregon* Management Agreement. Any proposed changes to these programs at the current environmental baseline artificial production levels must first be approved by the *U.S. v Oregon* Production Advisory Committee (PAC) before the new Management Agreement is signed.

2.4.4. Harvest

The five hatchery programs primarily contribute to spring/summer Chinook salmon fisheries in the mainstem Snake and Columbia Rivers and terminal areas. The current 2008-2017 management agreement defines mainstem Columbia River harvest rates on a sliding scale. This abundance based sliding scale harvest rate (5.5% to 17%) in the mainstem is based on natural-origin spring/summer Chinook salmon returning to the Snake River basin. Terminal harvest rates are also managed on an abundance based sliding scale based on NORs. Few spring/summer Chinook salmon from the Upper Salmon River are thought to be harvested in ocean fisheries.

The following outlines the various fisheries that occur in the Action Area that may affect listed species. Fisheries are covered under separate Fishery Management and Evaluation Plans and Tribal Resource Management Plans.

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

Table 21. Number of ESA-listed natural-origin spring/summer Chinook salmon encountered and incidentally killed (catch-and-release mortality is estimated at 10 percent of those caught) in fisheries from 2011-2016.

Fishery Manager	Average Incidental Mortality take Authorized	Average Encounter	Average Incidental Mortality	Average natural-origin estimated escapement above LGR	% Average natural-origin incidental mortality above LGR
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 2017a; 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 impacted by the fisheries because IDFG tracks sockeye migration, and attempts to close the fishery as sockeye begin arrive in the fishing areas. Additionally, sockeye salmon typically do not strike at lures used by recreational anglers fishing for spring/summer Chinook salmon.

Steelhead

Steelhead fisheries above Lower Granite Dam 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 Lower Granite Dam, and migrates into Idaho in the spring of the following year. Similar to spring/summer Chinook salmon fisheries, the non-tribal fisheries selectively target hatchery fish with a clipped adipose fin. Tribal fisheries target both hatchery and natural-origin fish regardless of external marking, meaning there is no incidental take of the target species for their fisheries. Table 21 below shows that an average of ~ 4.1 % of the Snake River steelhead DPS is killed annually in fisheries. This may be an overestimate of the percentage impact because the Lower Granite Dam natural-origin return estimate does not include those fish that return to tributaries in the Snake below Lower Granite Dam (i.e., Tucannon River).

Table 22. Number of ESA-listed natural-origin steelhead encountered and killed in fisheries from 2011-2016.

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

Sources: (Petrosky 2012; Petrosky 2013; IDFG 2014; Petrosky 2014; IDFG 2016; Hurst 2017; IDFG 2017a; 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.

Table 23 Number of ESA-listed natural-origin fall Chinook salmon encountered and incidentally killed (catch-and-release mortality is estimated at 5 percent of those caught) in steelhead fisheries from 2011-2016.

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

Sources: (Petrosky 2012; Petrosky 2013; IDFG 2014; Petrosky 2014; IDFG 2016; Hurst 2017; IDFG 2017a; 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.

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, so all take of the target species, regardless of origin, is considered direct take. Table 24 below shows that an average of ~ 4.5% of natural-origin adults of the Snake River Fall Chinook Salmon ESU is killed in fisheries.

Table 24. 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 LGR	% Average natural-origin mortality above LGR
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; 2017a; 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, IDFG believes that an average of 0.5 percent of the sockeye salmon population in Redfish Lake were incidentally harvested in this fishery. Because kokanee and sockeye salmon are phenotypically indistinguishable, 29 percent of the unclipped fish caught are assumed to be sockeye salmon since they represent 29 percent of the *O. nerka* population (IDFG 2014; 2016; 2017a**)**.

2.4.5. Existing Permits For Research, Monitoring, and Evaluation and Artificial Propagation in the Basin

There are a variety of section 10 permits and 4(d) authorizations currently in place to allow the operators to assess natural-origin juvenile abundance, productivity and migration timing through the use of screw traps and electrofishing and to conduct spawning ground/redd surveys for estimating escapement to individual populations. These include the 4(d) “IDFG Salmon Basin VSP monitoring for spring/summer Chinook and steelhead” project (APPS #20863), the 4(d) “IDFG Region 2 Fish Management” project (APPS #20868), and Section 10 permit numbers 1341-5R, 19391, 1339-4R, 1334-6R, 1127-4R, 16298-3R, and 1454.

In addition, there is separate ESA section 10 coverage for sockeye salmon and steelhead captured and handled at the Sawtooth, Pahsimeroi, Yankee Fork, and East Fork Salmon weirs, indicating that these activities are also included in the baseline. The expected take from each of the RM&E activities was previously analyzed by NMFS in the Biological Opinions associated with these 4(d) authorizations and Section 10 permits (NMFS 2013; 2017c). None of these analyses resulted in jeopardy, and the overall effects from RM&E activities have both beneficial and negative effects.

2.4.6. Other

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

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

2.5. Effects of the Action

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. Under the ESA, "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 2004; 2005c; Jones Jr. 2006; NFMS 2008; NMFS 2011c). 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 2.6).

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 (Section 5).

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 hatchery broodstock

This risk factor is not applicable to Snake River Fall Chinook salmon due to the proposed action, because broodstock collection occurs in areas where fall Chinook salmon do not occur. However, during targeted spring/summer Chinook salmon broodstock collection (direct take), the proposed action may incidentally encounter listed steelhead or sockeye salmon at some of the weirs. Incidental effects to fall Chinook salmon, steelhead, and sockeye salmon during broodstock collection activities are considered under Factor 2, below

Guided by sliding scales (Section 1.3), all four programs intend to remove natural-origin fish for broodstock. The removal of natural-origin broodstock is limited by abundance-based sliding scales to reduce risk to the naturally spawning population, which are explained and analyzed in detail below (Section 2.5.2.2.1)

The Sawtooth and Pahsimeroi hatchery programs are proposing to use up to 100% natural-origin broodstock in their integrated components, meaning they can collect up to 819 and 41 NORs, respectively. The segregated components of the Sawtooth and Pahsimeroi programs are not currently using natural-origin brood, and are not planning to in the foreseeable future. The Sawtooth hatchery program is proposing to collect no more than 52% of the natural-origin return to the population. In addition, no more than 30% of the natural-origin returns are proposed to be collected for the Pahsimeroi hatchery program.

The Yankee Fork and Panther Creek hatchery programs are proposing to use up to 52% natural-origin broodstock in their integrated programs and collect up to 188 NORs for each of the programs. Both of these programs propose to collect no more than 35% of natural-origin returns to the populations.

The removal of natural-origin broodstock from the Upper Salmon River upper mainstem population and the Pahsimeroi River population is managed on a sliding scale to minimize impacts on population abundances (Table 4). Returns to these two populations do not meet minimum abundance thresholds outlined in the Proposed ESA Recovery Plan for Snake River Spring/Summer Chinook Salmon and Steelhead (NMFS 2016d); however, they do not show a decreasing trend in recent years. In addition, the fish that are removed for broodstock are used to propagate the next generation of salmon, and though they are removed from the natural environment, their contribution to increased abundance to future generations remains a beneficial effect. Therefore, removal of natural-origin fish for broodstock is considered to have a negligible negative impact on the abundances of these two populations, which is eventually offset by increases in future abundance. Natural-origin returns to Yankee Fork are low, and so a sliding-scale management scheme has been proposed to limit the removal of natural-origin fish (Table 6). There are no genetic concerns with removing natural-origin fish from the Yankee Fork population since the program operation still allows for PNI targets, as outlined in the sliding scale (Table 6). Since the Panther Creek population is considered extirpated, there are no current concerns with removing natural fish from the population.

In summary, the removal of broodstock for the Sawtooth, Pahsimeroi, Yankee Fork, and proposed Panther Creek hatchery programs at the proposed levels does not pose a risk to the abundance of these populations.

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

The proposed hatchery programs pose both genetic and ecological risks, and, although there is some benefit to the species from the integrated programs designed to supplement the natural populations, the net effect on spring/summer Chinook salmon is negative, as discussed below.

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

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

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 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.

For each program, NMFS considers three major areas of genetic effects: within-population diversity, outbreeding effects, and hatchery-influenced selection. The within-population diversity area covers such topics as effective size and mating protocols. It is usually not a concern with integrated programs like the ones in these programs. Though the effects may be viewed as risks, in depressed populations these effects can be offset by reducing extinction risks. For segregated programs (Sawtooth and Pahsimeroi segregated) diversity is usually not a concern, because the purpose of segregated programs is not for maintaining genetic diversity, and have little or no interaction with the wild population. Therefore, we see a very low likelihood of effects on within-population diversity resulting from the Proposed Action.

Assessment of the other two categories occurs simultaneously using the pHOS/PNI metrics. For segregated programs, including the two components in the Proposed Action, genetic effects are assessed by considering how many fish from each program may spawn naturally. Because supplementation of the natural population is not an objective for this type of program, the number/proportion of hatchery-origin spawners should ideally be zero. However, this is not a realistic goal. As explained in the appendix, the Hatchery Scientific Review Group (HSRG) has developed guidelines for allowable pHOS levels in populations, scaled by the population's conservation importance, recommending a maximum of 5% in "primary" populations, 10% for "contributing" populations, and at a level required to maintain "sustaining" populations (e.g., HSRG 2014). Listed salmonid populations in the Snake are classified by recovery expectation (ICTRT 2007a) rather than by the HSRG classification scheme, but "viable" and "highly viable" equate to "primary", and "maintain" equates to "contributing" and "sustaining."

2.5.2.2.1.1. Straying

Here, and elsewhere in Idaho, strays are detected by PIT tag arrays, CWT recoveries, or by use of PBT (parentage-based tagging). PIT tag detectors are dispersed throughout the Salmon River Basin, and PIT tagged fish are identified as they pass through these detectors. CWT recoveries are typically made during fisheries, on spawning grounds, and at hatchery traps. PBT uses genotyping of hatchery broodstock to identify individual fish to parents. Tissue samples are collected, typically from hatchery broodstock and during spawning surveys. With this information, parentage assignments are used to identify the origin and brood year of their progeny. Program strays can be identified with this method after genetic samples have been analyzed. In our straying analyses, CWT and PBT were used to detect fish and calculate population level pHOS values. PBT is used widely among hatchery programs in the Snake River Basin. All returning adult program fish used in hatchery broodstock within the Snake River Basin receive a clip for PBT analysis.

NMFS has analyzed recent stray rates from these programs. Data for our analyses were detected from CWT recoveries and PBT analysis by IDFG and SBT in fisheries (e.g., creel census), on spawning grounds, and at hatchery traps from 2011 to 2015, unless otherwise specified. We analyzed strays from each of the hatchery programs in the Proposed Action into other populations. We also accounted for hatchery-origin strays from other programs into the populations within our Action Area. All of these detections are converted to population level pHOS values in Table 29.

Strays from Pahsimeroi hatchery program that contribute to populations within the Salmon River basin have been identified (Table 25). We did not use PIT tag information in this analysis. The CWT data available was expanded for the entire population, and was taken from spawning ground surveys that are carried out throughout the basin. Carcass recoveries from spawning surveys are also likely to represent fish that remained and/or spawned in the area rather than those that just passed by a PIT tag array. This information is used to determine what percentage of each population is composed of strays from hatchery programs. According to CWT and PBT data from IDFG, a five-year mean of 0.8 fish from the Pahsimeroi hatchery program strayed into the Upper Salmon River area during spawning surveys.

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

Years	Fish detected by CWT[1]	Fish detected by PBT[1, 2]	Recovery location	Release location
2011	0	0	N/A	Pahsimeroi
2012	0	0	N/A	
2013	0	0	N/A	
2014	1	0	Upper Salmon River[3]	
2015	3	0	Upper Salmon River[3]	
Mean[4]	0.8	0	Upper Salmon River[3]	

[1]Expanded value (for tagging rate) in parentheses.
[2]PBT stands for parental based tagging and has been sampled and analyzed since 2013 (brood year 2009). All fish returning to the hatchery trap are PBT sampled.
[3]Detected during spawning ground survey.
[4]Means calculated using expanded values, if applicable, per recovery and release location.

No strays from any hatchery programs were detected at the Pahsimeroi fish trap; therefore, we can infer that, according to this analysis, a very small (possibly zero) percent of strays from these hatchery programs ended up in the Pahsimeroi River population. The 7% pHOS (Table 29) level in the Pahsimeroi basin is thus likely made up from fish from the Pahsimeroi hatchery program.

Straying from the Sawtooth hatchery program into other populations of conservation concern needs to be considered. (Table 25 and Table 26) present data on strays from the Sawtooth hatchery program that contribute to populations within the Salmon River basin and program strays from any hatchery program that utilizes CWT or PBT data detected in the Upper Salmon River, upper mainstem population region.

Table 26. Spring/summer Chinook salmon from the Sawtooth hatchery program detected in the Salmon River. (Cassinelli et al. 2012) (Cassinelli et al. 2013) (Sullivan et al. 2015; Sullivan et al. 2016)

Years	Number CWT recovered[1]	Number PBT detections[1]	Recovery location	Release location
2011	1 (12)	0	Upper Salmon River[3]	Sawtooth
2012	0	0	N/A	
2013	0	0	N/A	
2014	0	0	N/A	
2015	0	0	N/A	
Mean[4]	2.4	0	Upper Salmon River[3]	

[1] Expanded value (for tagging rate) in parentheses
[2] PBT stands for "parental-based tagging" and has been sampled and analyzed since 2013 (brood year 2009). All fish returning to the hatchery trap are PBT sampled.
[3] Detected during spawning ground survey.
[4] Averages calculated using expanded values, if applicable, per recovery and release location.

Table 27. Spring/summer Chinook salmon from all hatchery programs recovered at the Sawtooth Fish Trap (Cassinelli et al. 2012) (Cassinelli et al. 2013) (Sullivan et al. 2015; Sullivan et al. 2016).

Years	Number CWT recovered[1]	Number PBT detections[2]	Recovery location	Release location
2011	379 (391)	0	Sawtooth Fish Trap	Yankee Fork
2012	273 (282)	0		Yankee Fork
2013	45	0		Yankee Fork
2014	1 4	0 0		Rapid River Yankee Fork
2015	3	0		Yankee Fork
Mean[3]	145 0.2	0		Yankee Fork Rapid River

[1] Expanded value (for tagging rate) in parentheses.
[2] PBT stands for "parental-based tagging" and has been sampled and analyzed since 2013 (brood year 2009). All fish returning to the hatchery trap are PBT sampled.
[3] Averages calculated using expanded values, if applicable, per recovery and release location.

A five-year mean of 2.4 adult fish (CWT) from the Sawtooth hatchery program was detected in the Upper Salmon River during spawning surveys (Table 25). Furthermore, a five-year average of 145 fish from the Yankee Fork hatchery program and 0.2 fish from the Rapid River hatchery program were detected at the Sawtooth Fish Trap (Table 26). According to the data in Table 28, it appears that straying from the Yankee Fork hatchery program has showed a decreasing trend over the last five years. The overall five-year average remains high; however, the last two years of data (2014 and 2015) shows fewer than five strays from the program each year. This may be a result of not recovering all CWTs at hatchery rack due to transition to using PBT and a lack of releases in Yankee Fork for brood year 2011 (returning in 2014-2015). Improvements in habitat and acclimation release sites, and lengthening acclimation time should help limit straying.

For the Yankee Fork hatchery program, IDFG and SBT have identified strays from the program that contribute to populations within the Salmon River basin (Table 28). Moreover, they have identified strays from any hatchery program that utilizes CWT or PBT data that were detected in Yankee Fork population area (Table 28). Since spawning ground surveys are carried out throughout the basin, a large proportion of the carcasses are recovered. Carcass recoveries from spawning surveys are also likely to represent fish that remained and/or spawned in the area rather than just passed by a PIT tag array. Of note is the fact that the Panther Creek hatchery program is not yet operating. ; Though we cannot predict how many strays from this proposed hatchery program will contribute to straying in the Salmon River Basin in the future, using localized broodstock and acclimating fish prior to release is likely to keep straying low. After the program has been operational for at least five years, and ongoing monitoring continues, we will have a better understanding of these potential effects.

Table 28. Spring/summer Chinook salmon from the Yankee Fork hatchery program detected in the Salmon River. (Cassinelli et al. 2012) (Cassinelli et al. 2013) (Sullivan et al. 2015; Sullivan et al. 2016).

Years	Number CWT recovered[1]	Number PBT detections[1,2]	Recovery location	Release location
2011	379 (391) 13 1	0 0 0	Sawtooth Fish Trap Upper Salmon River[3] Valley Creek[3]	Yankee Fork
2012	273 (282) 22 (23)	0 0	Sawtooth Fish Trap Upper Salmon River[3]	
2013	45 16 (17)	0 0	Sawtooth Fish Trap Upper Salmon River[3]	
2014	4	0	Sawtooth Fish Trap	
2015	3	0	Sawtooth Fish Trap	
Mean[4]	145 21.2 0.2	0 0 0	Sawtooth Fish Trap Upper Salmon River[3] Valley Creek[3]	

[1]Expanded value (for tagging and sampling rate) in parentheses.
[2]PBT stands for parental based tagging and has been sampled and analyzed since 2013 (brood year 2009). All fish returning to the hatchery trap are PBT sampled.
[3]Detected during spawning ground survey.
[4]Averages calculated using expanded values, if applicable, per recovery and release location.

As previously mentioned, a five-year mean of 145 fish (CWT) was detected at the Sawtooth Fish trap from the Yankee Fork hatchery program (Table 28). In addition, a five-year mean of 21.2 fish (CWT) was detected in the Upper Salmon River during spawning surveys. Similar to the Yankee Fork hatchery program strays into the Sawtooth Fish Trap, strays to this area demonstrate a decreasing trend over the five years for which data were analyzed (Table 27), though some reduction was expected as there was no Yankee Fork release in 2011. Recoveries of

Yankee Fork releases at Sawtooth may continue in the short term because the broodstock and rearing for the programs is the same. Decreases in Yankee Fork releases returning to Sawtooth Hatchery would be expected over time as the Yankee Fork hatchery program localizes broodstock to the Yankee Fork, and ongoing improvements to acclimation release sites. In addition to these strays, a five-year mean of 0.2 fish (CWT) were detected in Valley Creek (Table 28). The only year where a stray was found in Valley Creek was in 2011 (Table 28), which, once again, can be explained by the program using acclimated releases in later years.

Table 29 summarizes the data from Table 25 through Table 28 as pHOS values for populations where fish from any of Proposed Action programs could contribute to, or where other hatchery fish may contribute to populations within the action area of this analysis. These hatchery program contributions to the total pHOS are also calculated as a percentage. The role for a given population in terms of viability (NMFS 2016a) was also listed in this table to show how hatchery program strays may be contributing to the likelihood of achieving viability status.

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

Population	Role in Viability Scenario (NMFS 2016)	Population level pHOS (2010-2014)	pHOS attributable to strays to populations from the proposed hatchery programs[1]
Pahsimeroi River	Viable or Highly Viable	0.07	0%
Upper Salmon River Upper mainstem, above Redfish Lake	Viable or Highly Viable	0.30	15.9% strays from the Yankee Fork hatchery program[2]. Strays from the other programs were calculated to be negligible in this analysis.
Panther Creek	*Extirpated*	*unknown*	*unknown*
Yankee Fork	Maintained	0.61	*unknown*

[1]Percentages based on five year mean expanded number of strays divided by five year mean total hatchery-origin fish and natural-origin spawning grounds

[2] This is based on years before acclimation improvement occurred. The strays from Yankee Fork are showing a decreasing trend, and this is expected to continue to remain low.

These straying effects and population level pHOS values (Table 29) do not constitute a serious threat to the Snake River Spring/summer Chinook Salmon ESU and are considered negligible. There were no strays recorded into the Pahsimeroi Fish Trap, therefore the contribution of strays to the Pahsimeroi River population is likely at or close to 0%. The Yankee Fork hatchery program contributed 15.9% of all spawning fish to the Upper Salmon River Upper mainstem population, which constitutes over half of the entire pHOS calculated over the last five years. However, it is important to keep in mind that at this point the Yankee Fork population may be indistinguishable genetically from the Upper Salmon population due to use of Sawtooth releases to support the Yankee Fork supplementation. Also, as mentioned before, the strays from this program are showing a decreasing trend over five years, and incidence of Yankee Fork strays is expected to continue to decrease as the population grows and becomes less reliant on the Sawtooth program. Once releases to the Yankee Fork switch from Sawtooth rearing to another facility additional reductions in straying to the Upper Salmon River are expected because they won't be reared in a facility close to the release site. Using the most recent two years of data, the contribution of strays to the total number of spawners on the spawning grounds in the Upper Salmon River, Upper mainstem population is only 0.4% (0.004). This recent value is what we expect future stray values to reflect, which is well below the 0.05 level. The level of strays from other hatchery programs into the Yankee Fork Population is currently unknown, though the proximity to Sawtooth and known low stray levels there suggest that straying would also be low into Yankee Fork. Additional efforts to better understand strays into the Yankee Fork population will occur as the program institutes annual weir use and spawning surveys. At the present time, the Panther Creek population level pHOS and stray values are unknown. We expect to be able to begin evaluating the future impacts of the proposed Panther Creek hatchery program at least five years after the program begins. In summary, all strays from the proposed hatchery programs are limited to populations within the Upper Salmon River MPG, and the levels of strays contributing to pHOS do not pose a serious threat to diversity of populations in the action area.

2.5.2.2.1.2. Hatchery-influenced selection effects

In addition to gene flow effects from straying, hatchery-influenced selection may result from hatchery-origin fish spawning on natural-origin spawning grounds. NMFS generally evaluates PNI and pHOS values to determine the overall hatchery-influenced selection effects.

Gene Flow Assessment for Panther Creek

At this time, the Panther Creek population is considered "extirpated" under the Upper Salmon River MPG (NMFS 2016a), and though reestablishing a natural-origin population through supplementation is not critical for recovery of the species, it may reduce risk to the ESU if the population becomes self-sustaining and could aid in overall recovery efforts. The Panther Creek hatchery program is also not currently operating. Therefore, although the future PNI and pHOS values occurring from the proposed Panther Creek hatchery program remain uncertain, the viability status of the population makes meeting pHOS or PNI standards a minor concern for the time being. However, there is a commitment for this future hatchery program to adhere to PNI values in the sliding scale management objectives (Table 6). In addition, efforts have been made to understand the genetic origin of the Panther Creek population (Smith et al. 2011; Smith et al. 2012), which will influence future management objectives. The proposed Panther Creek hatchery program will utilize an eggbox component that obtains eggs from segregated Pahsimeroi hatchery program fish. Because of this and the fact that it may take a few years to obtain substantial NORs, the pHOS may be as high as 0.73 to 0.95, and the PNI values could be as low as 0.09 to 0.12. There are many unknowns regarding the genetic effects with this proposed program at this time. Regardless, because this program is supplementing an "extirpated" population, we consider that any genetic effects would be outweighed by the benefits to population abundance.

Table 30. Modeled sliding scale broodstock and proportionate natural influence (PNI) management plan for the Panther Creek and Yankee Fork spring and summer Chinook populations. A minimum of 25 percent of NORs arriving at the weirs will be used in the broodstock (SBT 2017a).

NORs	Max % NORs collected	# NOR in brood	# HOR in brood	Total # brood	pNOB %	500 HOR[1] at weir			1,000 HOR at weir			1,500 HOR at weir		
						NOR and HOR escapement	pHOS	PNI	NOR and HOR escapement	pHOS	PNI	NOR and HOR escapement	pHOS	PNI
100	35	35	323	358	10	242	0.73	0.12	742	0.91	0.10	1,242	0.95	0.09
200	25	50	308	358	14	342	0.56	0.20	842	0.82	0.15	1,342	0.89	0.14
300	25	75	283	358	21	442	0.49	0.30	942	0.76	0.22	1,442	0.84	0.20
400	25	100	258	358	28	542	0.45	0.38	1,042	0.71	0.28	1,542	0.81	0.26
500	25	125	233	358	35	642	0.42	0.46	1,142	0.67	0.34	1,642	0.77	0.31
600	25	150	208	358	42	742	0.39	0.52	1,242	0.64	0.40	1,742	0.74	0.36
700	25	175	183	358	49	842	0.38	0.56	1,342	0.61	0.45	1,842	0.71	0.41
750+	25	188	171	358	52	892	0.37	0.59	1,392	0.60	0.47	1,892	0.70	0.43

[1]500 HORs may be an overestimate for the scenarios where 200,000 smolts and 600,000 smolts are released for the Yankee Fork hatchery program (based on a three year mean SAR value of 0.017% from release years 2008-2010). SAR values will continue to be monitored into the future to better understand population level survival (Denny 2017b).

Gene Flow Assessment for Yankee Fork

The Yankee Fork spring Chinook salmon population plays a "Maintain" role in (NMFS 2016a) viability scenarios. We have calculated PNI over the last five years (Table 30). Future estimates of PNI for the Yankee Fork population can be inferred from the Sliding Scale in Table 6. Based on a three-year (2008-2010) mean Yankee Fork hatchery program SAR value of 0.017%, the 200,000 releases should return around 34 total HORs and the proposed 600,000 releases should total 102 HORs. These totals represent HORs to the entire Yankee Fork population, which is a small proportion of the target abundance in the basin. At this level, these returning HORs would help sustain brood collection and provide some additional adults for supplementation, but would not be expected to limit available spawning areas for natural-origin returns. The column representing the 500 HORs returns at the weir would therefore be conservative estimates of the minimum and maximum program releases. Based on a five-year mean of 213.6 natural-origin fish and 35.4 hatchery-origin fish in the population, five-year mean PNI and pHOS values for the Yankee Fork were calculated to be 0.49 and 0.14, respectively (Table 31). In contrast, the proposed 600,000 smolt releases should have a future PNI value of 0.30 and a pHOS of 0.32 (Table 31). The current pHOS, pNOB, and PNI levels are not very meaningful, considering the natural-origin returns have been very low into this population and IDFG and SBT released hatchery adults to increase the numbers of spawners in the population. As natural-origin returns begin to increase, we would expect PNI and pHOS values to increase in a pattern outlined in the sliding scale (Table 30). Moreover, the SBT has outplanted fish in the past and proposes to outplant fish into the future. However, these outplants have been included in the calculations of five-year mean PNI and pHOS and will be included in the sliding scale to contribute to total PNI and pHOS values.

Table 31. Proportionate Natural Influence (PNI) and pHOS values for the Yankee Fork program with the current 200,000 release levels. This hatchery program is proposing an increase to 600,000 smolts released in the future. PNI was calculated based on the equation: $= \frac{pNOB}{pHOS+pNOB}$.

Year	Hatchery-origin adult fish population estimate[1]	Natural-origin adult fish population estimate[1]	pNOB	pHOS	PNI
2012	61	279	0.14[3]	0.18	0.44
2013	63	361	0.21[3]	0.17	0.55
2014	30	213	0.14[3]	0.14	0.50
2015	15	94	0.10[3]	0.16	0.38
2016	8	121	0.10[3]	0.07	0.59
Five-year mean	**35.4**	**213.6**	**0.14[3]**	**0.14**	**0.49**
Future with 600,000 smolt released	**102[2]**	**213.6**	**0.14[3]**	**0.32**	**0.30**

[1]Above and below weir estimates have been combined.
[2] Based on a three year mean SAR value of 0.017% from release years 2008-2010
[3]Values from sliding scale (Table 6).

Gene Flow Assessment for the Pahsimeroi River Summer Chinook Salmon Population

The potential negative genetic effects from this program are considered along with the demographic benefit of increasing abundance. To perform our analysis, we will use tools that consider the best available information for the target population to determine the likely PNI of the population based on the applicants' proposed proportion of natural-origin broodstock (pNOB) and proportion of hatchery-origin spawners (pHOS) in natural spawning areas. A PNI of > 0.5 indicates that natural selection outweighs hatchery-influenced selection. Because the current recovery scenario (NMFS 2016d) for the Salmon River spring/summer Chinook Salmon MPG calls for viability of the Pahsimeroi River population, we believe a PNI of > 0.5 puts this population on a trajectory to achieve viability.

Our analysis divided the Pahsimeroi population into three population components; naturally-spawning, integrated hatchery, and segregated hatchery. Even though there is a weir used to collect adults, it is relatively close to the mouth of the River and is assumed to encounter the vast majority of the population (~98%). Thus, there was no reason to split the naturally spawning population into two components (above and below the weir) for our analysis.

Best available data suggests that the Pahsimeroi River population is likely to obtain a PNI of > 0.5. For example, data from 2014-2016 indicates that PNI ranged from 0.44-0.62 (**Table 32**) based on the multi-population component model analysis tool developed by Busack (2015), and an integrated component SAR of 0.0024. We also factored in a pHOS attributed to the segregated component of 0.03 to the program, despite the data indicating this value was zero for 2014-2016. This accounts to some degree for a weir efficiency at the Pahsimeroi River weir of 90 percent on average from 2008-2012 (NMFS and IDFG 2017a) , which means that a small number of segregated fish could bypass the weir.

In applying the sliding scale to the natural-origin returns from 2014-2016, the PNI would range from 0.51-0.56. This anticipated increase in PNI is attributable to halting the use of segregated hatchery-origin fish for broodstock in the integrated component, obtaining a pNOB of 1, and limiting pHOS (**Table 32**). The minimum abundance threshold for the population is 1,000 natural-origin spawners (ICTRT 2007b), and the sliding scale ensures that a PNI of > 0.5 is targeted when this level is observed. NMFS believes a PNI of > 0.5 is a reasonable target for population viability, but that a PNI of < 0.5 is acceptable when natural-origin abundance is low (fewer than 250 fish), to ensure enough fish are available to spawn regardless of fish origin. We did obtain data based on parentage-based tagging (PBT) to validate the results of the mark-only estimates (ref. spreadsheet). Although we found that with the PBT approach PNI estimates would be lower (0.32-0.37), this was largely a result of missed detections of CWT at Pahsimeroi hatchery. This has since been corrected and we anticipate in future years that the PBT and mark-only estimates will be more similar.

Table 32. Proportionate Natural Influence (PNI) for the Pahsimeroi River Summer Chinook Salmon Natural-Origin Population.

Return Year	NOR	Naturally Spawning Component[1]			Integrated Hatchery Component[2]			Segregated Hatchery Component[3]		PNI
		pHOSi	pHOSs	pNOS	pNOB	pHOBi	pHOBs	pHOBi	pHOBs	
Current conditions (mark only)										
2014	594	0.15	0.02	0.83	0.77	0	0.23	0	1	0.44
2015	430	0.17	0.02	0.81	0.58	0.35	0.07	0	1	0.48
2016	370	0.15	0.02	0.83	1.00	0	0	0	1	0.62
Sliding Scale										
Step 1	50-124	0.56-0.77	0.02	0.2-0.42	0.35	0.65	0	0	1	0.29-0.34
Step 2	125-249	0.68	0.02	0.3	0.9	0.1	0	0	1	0.44
Step 3	250-499	0.43	0.02	0.55	1	0	0	0	1	0.51
Step 4	500-999	0.23	0.02	0.75	1	0	0	0	1	0.56
Step 5	< 1000	0.23	0.02	0.75	1	0	0	0	1	0.56

Sources: (NMFS and IDFG 2017a)

[1] NOR = natural-origin returns; pNOS = proportion of natural-origin spawners; pHOSi = proportion of integrated hatchery-origin spawners; pHOSs = proportion of segregated hatchery-origin spawners;

[2] pNOB = proportion natural-origin broodstock; pHOBi = proportion of integrated hatchery-origin broodstock;

[3] pHOBs = proportion of segregated hatchery-origin broodstock.

Gene Flow Assessment for the Upper Salmon River Mainstem Spring Chinook Salmon Population (Sawtooth)

Similar to the Pahsimeroi River population, the potential negative genetic effects from the Sawtooth program are considered along with the demographic benefit of increasing abundance for the Upper Salmon River Mainstem population. To perform our analysis, we will use tools that consider the best available information for the target population to determine the likely PNI of the population based on the applicants' proposed proportion of natural-origin broodstock (pNOB) and proportion of hatchery-origin spawners (pHOS) in natural spawning areas. A PNI of > 0.5 indicates that natural selection outweighs hatchery-influenced selection. Because the current recovery scenario (NMFS 2016d) for the Salmon River spring/summer Chinook Salmon MPG calls for high viability of the Upper Salmon River Mainstem population, we believe a more aggressive PNI than that considered for the Pahsimeroi River population puts this population on a trajectory to achieve high viability. NMFS believes a PNI of ≥ 0.67 is a reasonable metric for a highly viable population when natural-origin returns exceed the MAT of 1,000. However, when returns are below MAT, PNI targets may be relaxed to ensure enough fish are available to spawn regardless of fish origin.

Our analysis divided the Upper Salmon River mainstem population into four population components, naturally-spawning below the weir, naturally-spawning above the weir, integrated hatchery, and segregated hatchery. We factored in a pHOS attributed to the segregated component of 0.02 to the program for the naturally-spawning component above the weir, despite the data indicating this value was zero for 2014-2016. This accounts to some degree for a weir efficiency at the Sawtooth weir of 90 percent on average from 2008-2012 (NMFS and IDFG 2017b)   which means that a small number of segregated fish could bypass the weir. The Sawtooth weir efficiency varies slightly when it cannot be installed in extreme flows, but has historically been installed so that it captures the entire run and is typically greater than 90 percent annually.

Best available data suggests that with application of the sliding scale, the Upper Salmon River Mainstem population is likely to see an improvement in PNI. For example, data from 2014-2016 indicates that PNI ranged from 0.12-0.35 (Table 33) based on the multi-population component analysis tool developed by Busack (2015), and an SAR for the integrated component of 0.0022. In applying the sliding scale to the natural-origin returns above the weir and data below the weir from 2014-2016, the PNI would range from 0.45-0.62, assuming the lowest pNOB within the sliding scale range for that step (0.76-1.0). This anticipated increase in PNI is attributable to using integrated component fish in the segregated component broodstock, targeting a high pNOB and increasing the size of the integrated component as natural-origin returns increase, and limiting pHOS above the weir (Table 33).

Analysis of the steps in the sliding scale proposed by the applicants suggests that PNI should continue to improve into the future as long as natural-origin returns increase. The “below weir” data used in the sliding scale was modified from an average value of 2014-2016 to account for the changing proportions of the integrated and segregated program components as the natural-origin returns increase. To do this, we used the total average pHOS from 2014-2016 of 0.57 and the estimated numbers of integrated HOS (41) and segregated HOS (180) below the weir and increased/decreased the numbers by the proportion change in each program component for each step on the scale (Table 34). For each step on the scale we assumed the minimum proportion of segregated component broodstock comprised of integrated fish (0.2), and the maximum pHOS values proposed above the weir. Given the current SAR of 0.0022, some maximum pHOS values above the weir are not likely to be met, thus PNI values at these steps (steps 3-5) are likely to increase if SAR improves. However, when natural-origin returns are over 1,000 fish and the integrated component increases in size, our analysis anticipates there will be enough fish returning from the integrated component to fulfill the minimum segregated brood need (first) and reach the maximum pHOS above the weir (second), with some remaining. Thus, any extra fish could be used to meet the maximum proportion of the segregated broodstock comprised of integrated fish. This maximum is 50 percent when at step 6 and 60 percent for step 7 on the scale. PNI values would then be 0.66 for step 6 and 0.67 for step 7.

Based on the above analysis, and that 90 percent of the intrinsic potential spawning and rearing habitat in the population is above the weir and subject to pHOS control, NMFS believes that the sliding scale proposed for the Sawtooth spring/summer Chinook salmon program would allow the hatchery program to operate in a manner that not only minimizes adverse genetic effects on the Upper salmon mainstem population, but may actually improve abundance and productivity of the natural-origin population. With continued monitoring of the proportions of natural, segregated and integrated spawners above and below the weir, smolt-to-adult survival rates, and tracking of broodstock composition, we believe it is feasible for operators to manage within the limits of the sliding and to not reduce, and perhaps contribute to the likelihood of recovery for the Upper salmon mainstem population.

Table 33. Proportionate Natural Influence (PNI) for the Upper Salmon River Mainstem Population; NOR = natural-origin returns; pNOS = proportion of natural-origin spawners; pHOSi = proportion of integrated hatchery-origin spawners; pHOSs = proportion of segregated hatchery-origin spawners; pNOB = proportion natural-origin broodstock; pHOBi = proportion of integrated hatchery-origin broodstock; pHOBs = proportion of segregated hatchery-origin broodstock.

Return Year	NOR	Size of Integrated Component	Below Weir*			Above Weir			Integrated Component		Segregated Component		PNI
			pHOSi	pHOSs	pNOS	pHOSi	pHOSs	pNOS	pNOB	pHOBi	pHOBi	pHOBs	
Current conditions													
2014	632	150,000	0.10	0.30	0.60	0.36	0.00	0.64	0.50	0.50	0.00	1.00	0.35
2015	288	150,000	0.10	0.59	0.30	0.39	0.27	0.34	0.61	0.39	0.00	1.00	0.12
2016	327	150,000	0.12	0.49	0.39	0.61	0.10	0.29	0.60	0.40	0.00	1.00	0.18
With sliding scale application													
2014	632	250,000	0.10	0.30	0.60	0.43	0.02	0.55	1.00	0.00	0.20	0.80	0.62
2015	288	250,000	0.11	0.59	0.30	0.73	0.02	0.25	0.76	0.24	0.20	0.80	0.45
2016	327	250,000	0.12	0.49	0.39	0.73	0.02	0.25	0.76	0.24	0.20	0.80	0.45
Sliding scale													
Step 1	0-49	Discuss with NMFS prior to implementation											
Step 2	50-249	250,000	0.14	0.43	0.43	0.90	0.02	0.08	0.23	0.77	0.20	0.80	0.19[1]
Step 3	250-499	250,000	0.14	0.43	0.43	0.73	0.02	0.25	0.76	0.24	0.20	0.80	0.46[1]
Step 4	500-699	250,000	0.14	0.43	0.43	0.43	0.02	0.55	1.00	0.00	0.20	0.80	0.60
Step 5	700-999	250,000	0.14	0.43	0.43	0.43	0.02	0.55	1.00	0.00	0.20	0.80	0.60
Step 6	1000-1299	500,000	0.22	0.35	0.43	0.33	0.02	0.65	0.80	0.20	0.20	0.80	0.62
Step 7	1300-1599	1,000,000	0.35	0.22	0.43	0.33	0.02	0.65	0.80	0.20	0.20	0.80	0.64
Step 8	1600+	1,700,000-2,000,000	0.57	0.00	0.43	0.33	0.02	0.65	0.70	0.30	0.00	0.00	0.67

[1]Calculated assuming the lowest pNOB for that step.

Table 34. Change in proportion of integrated and segregated program components and alterations to the proportion of hatchery-origin spawners (pHOS) below the Sawtooth Weir for each program component: pNOS = proportion of natural-origin spawners; pHOSi = proportion of integrated hatchery-origin spawners; pHOSs = proportion of segregated hatchery-origin spawners.

Integrated component	Hatchery-origin spawners (integrated)	Proportion increase to next step	Segregated	Hatchery-origin spawners (segregated)	Proportion decrease to next step	pHOS total	Proportion of total pHOS integrated	pHOSi	pHOSs
150,000	**41**[1]	0.40	1,550,000	**180**[1]	0.065	0.57	0.19	0.11	0.46
250,000	57	0.5	1,450,000	168	0.173	0.57	0.25	0.14	0.43
500,000	86	0.5	1,200,000	139	0.42	0.57	0.38	0.22	0.35
1,000,000	129	up to 0.5	700,000	81	1	0.57	0.62	0.35	0.22
all	194		0	0		0.57	1.00	0.57	0.00

[1] Value from average of 2014-2016 data.

2.5.2.2.2. Ecological effects

Adult nutrient contribution

The marine origin of these nutrients is important, as freshwater streams in the Pacific Northwest are oligotrophic (low in available nutrients); the importation of marine-derived nutrients by adult salmon returning from the ocean to freshwater is key in providing nutrients for freshwater aquatic communities (Naiman et al. 2002). The return of hatchery fish is known to contribute nutrients to the action area**. Table 35** shows that adult hatchery fish produced by the Proposed Action, if all estimated returning fish spawn naturally, would contribute an estimated 310 kg of phosphorous to the action area annually. With the use of mark selective fisheries and fish collected for broodstock, the true contribution is likely less than this value, perhaps ~50 percent less or 155 kg. Regardless, hatchery-origin fish increase phosphorous concentrations, which likely compensates for some marine-derived nutrients lost from declining numbers of natural-origin fish.

Table 35. Total phosphorous imported by adult returns from the proposed hatchery programs based on the equation (Imports= hatchery adults*mass*phosphorous concentration) in Scheuerell et al. (2005).

<table>
<tr><th>Program</th><th>Program Component</th><th>Release number</th><th>SAR (years of data)</th><th>Estimated number of hatchery-origin adults[2]</th><th>Adult mass (kg)</th><th>Phosphorous concentration (kg/adult)</th><th>Phosphorous imported (kg/year)</th></tr>
<tr><td rowspan="2">Pahsimeroi</td><td>Integrated</td><td>65,000</td><td>0.0024 (2010-2011)</td><td>156</td><td rowspan="8">5.5</td><td rowspan="8">0.0038</td><td>3.3</td></tr>
<tr><td>Segregated</td><td>935,000</td><td>0.0036 (2005-2011)</td><td>3,366</td><td>70.3</td></tr>
<tr><td rowspan="2">Sawtooth</td><td>Integrated</td><td>150,000</td><td>0.0039 (2-010-2011)</td><td>585</td><td>12.2</td></tr>
<tr><td>Segregated</td><td>1,850,000</td><td>0.0032 (2005-2011)</td><td>5,920</td><td>123.7</td></tr>
<tr><td rowspan="2">Yankee Fork</td><td>Smolt releases</td><td>600,000</td><td>0.28 (20xx)</td><td>1,680</td><td>35.1</td></tr>
<tr><td>Adult releases</td><td>1,500</td><td>Not applicable</td><td>1,500</td><td>31.4</td></tr>
<tr><td rowspan="2">Panther Creek</td><td>Smolt releases</td><td>400,000</td><td rowspan="2">0.0036[1]</td><td>1,440</td><td>30.1</td></tr>
<tr><td>Egg releases</td><td>800,000</td><td>202</td><td>4.2</td></tr>
</table>

Sources: Yankee Fork HGMP, Brian leth SAR e-mail.

[1]We used the Pahsimeroi segregated program value as a proxy as this is the stock that is intended for initial use.

[2]Calculated by multiplying the release number by the smolt to adult survival rate (SAR) values. For the eggbox program component in Panther Creek we multiplied the number of eggs by the egg-to-smolt survival rate (0.07; Bradford 1995), and then multiplied this by the SAR.

Spawning site competition and redd superimposition

According to the program HGMPs, run and spawn timing between hatchery-origin and natural-origin Snake River spring/summer Chinook is very similar. Therefore, it is possible that 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; however, pHOS management limits this potential. Though all four programs have components that produce hatchery-origin fish that are intended to spawn with natural-origin fish to supplement the natural-origin population, the operators manage hatchery escapement in relation to natural-origin abundance to reduce hatchery-origin spawners on natural-origin spawning grounds. The abundance-based management ensures that hatchery influence is reduced when abundance may make habitat more limited (which is a precondition for spawning site competition and redd superimposition). For the segregated components of the Sawtooth and Pahsimeroi programs, efforts are made to reduce hatchery-origin spawners on natural-origin spawning grounds, and pHOS calculations and are in line with recommendations made by the HSRG (HSRG 2009b).

There is unlikely to be spawning site competition or redd superimposition with hatchery-origin spring/summer Chinook salmon and the other three listed species (Table 36). This is because their spawn timings largely do not overlap; therefore, there is limited opportunity for these potential ecological interactions to occur. Therefore, the releases from the four programs are not expected to create opportunities for spawning site competition and redd superimposition between hatchery-origin fish and the other listed salmonids in the basin. Additionally, the ongoing PBT analyses will indicate if there is any spawning overlap between fall and spring/summer Chinook, though none has been detected thus far and it is not expected to occur in the future.

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

<table>
<tr><th colspan="2">Species</th><th>Run timing</th><th>Spawning</th></tr>
<tr><td colspan="2">spring/summer Chinook salmon</td><td>March to mid-August</td><td>late July to September</td></tr>
<tr><td colspan="2">steelhead</td><td>September to November</td><td>April to May</td></tr>
<tr><td colspan="2">fall Chinook salmon</td><td>late-August to November</td><td>late-September to October</td></tr>
<tr><td rowspan="3">sockeye salmon</td><td>resident life form I</td><td>NA</td><td>late-fall</td></tr>
<tr><td>resident life form II: kokanee</td><td>NA</td><td>late-summer to early-fall</td></tr>
<tr><td>anadromous</td><td>mid-summer</td><td>late-fall</td></tr>
</table>

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

The overall ecological effects from adult hatchery-origin fish on listed steelhead, fall Chinook, and sockeye are likely to be negligible because the lack of overlap between the spring Chinook hatchery programs and the other three listed species. The effects of nutrient contribution in the form of marine-derived nutrients will be slightly positive, but does not constitute a measurable change to VSP criteria. In addition, the effects of spawning site competition and redd superimposition between hatchery- and natural-origin spring/summer Chinook salmon will be negligible because pHOS management will limit the proportion of hatchery-origin spawners that will be competing for spawning sites. Because the programs limit the competition with natural-origin spawners through adult management, the limited overlap in spawning between natural- and hatchery-origin spring/summer Chinook salmon reduce the extent of effects to VSP criteria.

Disease

Over the last three years, a few pathogens endemic to the Snake Basin have been detected in adult spring/summer Chinook salmon intended for broodstock, but none of these detections have resulted in a disease outbreak (**Table 37**). Although IHNV and *Renibacterium salmoninarum* have no known treatments, fish health protocols are designed to prevent and control outbreaks with these pathogens. For example, to prevent outbreaks and reduce amplification in natural environments, hatchery staff may decide to cull individuals with high infection loads (Pacific Northwest Fish Health Protection Committee (PNFHPC) 1989; IHOT 1995; ODFW 2003; NWIFC and WDFW 2006). These control measures have proven effective in controlling pathogens as demonstrated by the lack of outbreaks in the broodstocks. Thus, NMFS believes the risk of transmitting pathogens to listed salmon and steelhead or amplifying pathogen levels in the natural environment by hatchery-origin adults is negligible.

Table 37. Pathogen detections in adults that are part of the proposed action; IHNV = infectious hematopoietic necrosis virus.

Facility	**Pathogen Detected**		
	2014	2015	2016
Sawtooth Hatchery	*Saprolegnia sp; Renibacterium salmoninarum*	*Saprolegnia sp; R. salmoninarum*	*Saprolegnia sp; R. salmoninarum*
Pahsimeroi Hatchery	IHNV	None	None

Sources: (Munson 2017a; 2017b)

2.5.2.2.3. Adult collection

The operation of weirs and traps can effect migrating salmonids in three general ways: injury and mortality as a result of handling, delay in migration, and changes in spatial distribution of adults.

The operation of weirs and traps for broodstock collection would result in the capture and handling of both natural- and hatchery-origin spring/summer Chinook salmon (Table 38). Based on an SAR for Yankee Fork of 0.24 percent, up to 1120 hatchery-origin spring/summer Chinook salmon adults are anticipated to return. Using the same SAR value for Panther Creek, up to 1440 hatchery-origin spring/summer Chinook salmon adults are anticipated to return. These values helped inform our estimates of proposed handling for hatchery-origin adults at the Panther Creek and Yankee Fork weirs. With the use of these two hatchery programs we also anticipate the number of natural-origin steelhead encountered at these weirs to increase over time (Table 38). Samples for parental-based tagging and relative reproductive success analyses may be taken from all spring/summer Chinook salmon regardless of origin at the time of collection.

There are no encounters with fall Chinook salmon at these locations because timing of the fall Chinook salmon run does not overlap with the spring/summer Chinook salmon run. Encounters with sockeye salmon during the operation of these weirs and traps for steelhead broodstock collection is a rare occurrence. There is separate ESA section 10 coverage for sockeye salmon captured and handled at the Sawtooth and Pahsimeroi weirs, as discussed above in the baseline section 2.4. The applicants estimate that up to 10 hatchery and 10 natural sockeye salmon adults may be encountered at the Panther Creek and Yankee Fork Weirs. When encountered, adults are held in live wells and given to IDFG personnel for returning to more suitable sockeye salmon habitat. Of these 10, up to 2 of each may die incidentally due to handling. Steelhead incidental take at all of the weirs used for spring/summer Chinook salmon broodstock collection for these programs is covered in the Opinion and associated 4(d) determinations for the steelhead program and would be considered part of the targeted steelhead collection (NMFS 2017c) . The Panther Creek program is expected to handle about 100 natural-origin steelhead with no incidental mortality once the weir is constructed and becomes operational.

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 throughout the trapping season. In addition, the spatial distribution of juvenile and adult listed species is not expected to be affected by weir operation in these areas because the weirs are designed to allow juvenile passage and natural-origin adults are passed upstream when not required for broodstock.

Table 38. Number of ESA-listed spring/summer Chinook salmon handled by origin. Mortalities from handling, if any, are shown in parentheses and exclude those used as broodstock.

Facility	Origin	Average Handling	Actual Handling; range (mortalities)	Proposed Handling (1% mortality)
Pahsimeroi Hatchery Weir	Natural	271	95-619 (6)	1,000 (10)
	Hatchery	2,567	364-8,899 (39)	9,000 (90)
Sawtooth Hatchery Weir	Natural	493	186-863 (3)	1,000 (10)
	Hatchery	1,976	451-5,228 (36)	8,500 (85)
Yankee Fork Weir	Natural	137	90-213 (1)	1,000 (10)
	Hatchery	15	7-26 (0)	3,600 (36)
Panther Creek Weir	Natural	Not available		1,000 (10)
	Hatchery	Not available		2,400 (24)

Sources: Sawtooth HGMP (IDFG 2017c) Table 16; Pahsimeroi HGMP (IDFG 2017b) table 14, APPS database for permit 1127-4R.

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

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

2.5.2.3.1. Hatchery release competition and predation effects

We used the PCD Risk 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. The remaining parameters and their values considered in the model are shown in Table 39 and-Table 41.

For our model runs, we assumed a 100 percent population overlap between hatchery steelhead and all natural-origin species present. We acknowledge that a 100 percent population overlap in microhabitats is likely an overestimation, but without more information the risk of up to 100% overlap, however small, compels us to make conservative assumptions. Our model also does not assess effects on age-0 steelhead because steelhead spawn from March to June with a peak from April to May in the action area (Busby et al. 1996). Thus, it is unlikely that any age-0 steelhead would have emerged in time to interact with the hatchery steelhead smolts as they migrate downstream. A lack of spatial overlap with age-0 sockeye salmon rearing in Redfish, Petit and Alturas Lakes, provide the basis for our decision to also not include this age-class in our model. In addition, we did not analyze the effects of hatchery steelhead on age-1 steelhead below Lower Granite Dam because these fish are not yet smolted and migrating downstream. Including them in our analyses all the way to Lower Granite Dam likely overestimates the effects, because this steelhead age class is unlikely to move out of tributary rearing areas until the following year.

In contrast to how we have used the model in other areas (e.g., Upper Columbia River), we included consideration of the proportion of fish being barged downstream in this model. We used barging proportions from 2008 and 2015 (Table 41) 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 juvenile hatchery Chinook salmon (all races) that made it down to Lower Granite Dam in-river, summed them, 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 41).

Table 39. Parameters in the PCDrisk model that are the same across all programs. All values from HETT (2014) unless otherwise noted.

Parameter	Value
Habitat complexity	0.1
Population overlap	1.0
Habitat segregation	0.3 for Chinook salmon (all races), 0.6 for all other species
Dominance mode	3
Hatchery fish size	145-171 mm
Piscivory	0.002 on Chinook salmon (all races) only
Maximum encounters per day	3
Predator:prey length ratio for predation	0.25[1]
Average temperature across release sites	4.7°C from release to Lower Granite Dam, 10.5 from Lower Granite Dam to Ice Harbor Dam

[1]Daly et al. (2014)
[2]DART accessed on July 28, 2017.

Table 40. 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 (all races)	0	55 (10)
	1	91 (11)
Steelhead	1	71 (10)
	2	128 (30)
Sockeye Salmon	1	86 (7)
	2	128 (8)

Sources: (HETT 2014; Leth 2017c; Rabe 2017).

Table 41. Hatchery fish parameter values for the PCDrisk model; LGR =Lower Granite Dam; ICH = Ice Harbor Dam.

Program	Release Site	Release #	Survival to LG Dam	Residence/Travel Time to LG Dam (median days)[1]	Proportion Barged in 2008	Proportion Barged in 2015	Survival from ICH to LG Dams	Travel Time from LG to ICH Dams (median days)
Sawtooth	Sawtooth Hatchery	2,000,000	0.57	31	0.59	0.06	0.77	7
Pahsimeroi	Pahsimeroi Hatchery	1,000,000	0.64	22	0.54	0.19		
Yankee Fork	Yankee Fork (RM 3.7)	600,000	0.43	25	0.59	0.06		
Panther Creek	Panther Creek (RM 23)	400,000	0.43	12	0.54	0.19		
Panther Creek (egg boxes)	Panther Creek (RM 37)[1]	56,000	0.43	13	0.54	0.19		

Sources: Fish Passage Center(FPC), accessed July 31, 2017; Leth (2017c); (McCann 2017); (NMFS 2017d)

[1] Released as eggs, but assume 7 percent egg-to-smolt survival based on Bradford (1995).

Based on the data above, our model results show that hatchery Chinook salmon (all races) are likely to have the largest effect on natural-origin Chinook salmon (all races), followed by steelhead, and sockeye salmon (NMFS 2017d). The maximum numbers of fish lost are also shown in Table 42 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: 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. We used this value in the model along with the actual proportions of each age-class (87 percent age-1, and 13 percent age-2) available (Kozfkay 2017).

Using the number of each species that pass over Lower Granite Dam, which is 30,607 for natural-origin Chinook salmon (all races, Table 21 in Harvest baseline section), 25,991 for steelhead (Table 21in Harvest baseline section), and 1,115 for both hatchery and natural sockeye salmon (DART, 10-year average from 2007-2016 accessed August 2, 2017). These would equate to a maximum potential loss of ~ 0.8, 0.7, and 0.5 percent of the potential adult return for Chinook salmon (all races), steelhead, and sockeye salmon, respectively, from competition and predation during the juvenile life stage (NMFS 2017d). In addition, these negative effects are spread out over the various populations that comprise the Snake River ESUs/DPSs, and also include the unlisted spring/summer Chinook salmon (all races) originating from the Clearwater Subbasin.

Table 42. Maximum numbers of natural-origin juvenile salmon and steelhead lost to competition (C) with and predation (P) on hatchery-origin Chinook salmon (all races) released from the Proposed Action.

Program	**Chinook** (all races)		**Steelhead**		**Sockeye**	
	P	**C**[1]	**P**	**C**[1]	**P**	**C**[1]
From Release to Lower Granite Dam						
Sawtooth	2200	36210	0	12755	0	322
Pahsimeroi	1000	13610	0	5379	0	237
Yankee Fork	1540	7680	0	3409	0	277
Panther Creek	490	2550	0	1107	0	134
Panther Creek (egg boxes)	0	380	0	142	0	111
From Lower Granite Dam to Ice Harbor						
Aggregate-large barged proportion	1030	15515	0	2069	0	137
Aggregate-small barged proportion	438	7391	0	4312	0	137
Total Juveniles Lost	73489-82205		24861-27104		1218	
Average SAR[2]	0.003		0.007		0.005	

Program	Chinook (all races)		Steelhead		Sockeye	
	P	**C**[1]	**P**	**C**[1]	**P**	**C**[1]
Adult Equivalents	220-247		174-190		6	
Maximum Potential Loss (%)	0.8		0.7		0.5	

[1] Competition as used here is the number of natural-origin fish lost to competitive interactions assuming that all competitive interactions that result in body weight loss are applied to each fish until death occurs (i.e., when a fish loses 50% of its body weight). This is not reality, but does provide a maximum mortality estimate using these parameter values.

[2] Smolt-to-adult survival rate for all races of Chinook Salmon (Table 35), Steelhead (Farman 2017; Leth 2017b; NMFS 2017c) and sockeye salmon (IDFG 2012). Of note is that SARs for the segregated programs are adjusted to account for harvest; because they are calculated based on what arrives at the weir after harvest.

Similar to the use of models for biological systems elsewhere, this model cannot possibly account for all the variables that could influence competition and predation of hatchery juveniles on natural juveniles. For example, the model assumes that if a hatchery fish is piscivorous and stomach capacity allows the fish to consume prey, 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.

2.5.2.3.2. Disease

The risk of pathogen transmission to natural-origin salmon and steelhead or amplifying pathogen levels in the natural environment is negligible for these spring/summer Chinook salmon programs. This is because, first, all the pathogens detected over the last three years are endemic to the Snake Basin. Second, only one outbreak has occurred at either facility in the last three years (Table 43). Third, all three pathogens have treatment options available. However, treatment for *Renibacterium salmoninarum*, which causes Bacterial Kidney Disease (BKD) is less effective than for the other two pathogens because it is an intracellular bacterium, but options for controlling outbreaks such as culling of fish with *R. salmoninarum* infections also exist.

Table 43. Pathogen detections in hatchery spring/summer Chinook salmon juveniles that are part of the proposed action

Facility	Pathogen Detected		
	2014	**2015**	**2016**
Sawtooth Hatchery	*Renibacterium salmoninarum; Icthyophthirius multifilius; Flavobacterium columnare*	*F. branchiophilum; I. multifilius*	None
Pahsimeroi Hatchery	*R. salmoninarum; I. multifilius*	*I. multifilius; R. salmoninarum**	*R. salmoninarum; I. multifilius*

Sources:
* This infection resulted in an outbreak from November 2015 to release and was treated with erthyromycin medicated feed.

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

NMFS analyses the incidental effects of the proposed research, monitoring, and evaluation (RM&E) on listed species. This factor can also affect the productivity VSP parameter (Section 2.5.1) of the natural population.

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

Although there is a great deal of 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). Although the analyses in that Opinion resulted in a jeopardy conclusion, the RM&E associated with the Opinion is largely part of the Reasonable and Prudent Alternatives for the jeopardy analysis, and was not the factor contributing to the jeopardy conclusion.

As discussed in the baseline section 2.4.5 above, there are also a variety of section 10 permits and 4(d) authorizations currently in place to allow the operators to assess natural-origin juvenile abundance, productivity and migration timing through the use of screw traps and electrofishing and to conduct spawning ground/redd surveys for estimating escapement to individual populations. These include the 4(d) "IDFG Salmon Basin VSP monitoring for spring/summer Chinook and steelhead" project (APPS #20863), the 4(d) "IDFG Region 2 Fish Management" project (APPS #20868), and Section 10 permit numbers 1341-5R, 19391, 1339-4R, 1334-6R, 1127-4R, 16298-3R, and 1454. The expected take from each of the RM&E activities was previously analyzed by NMFS in the Biological Opinions associated with these 4(d) authorizations and Section 10 permits. None of these analyses resulted in jeopardy, and the overall effects from RM&E activities have both beneficial and negative effects.

The proposed RM&E directly related to fish culture uses well-established (e.g., (Galbreath et al. 2008a) methods and protocols. Listed fish are cultured in all four programs. The average green egg-to smolt survival rates are listed in Table 44. These rates are anticipated prior to egg takes, and generally pose little to no risk to the population because these survival rates greatly exceed survival expectations of egg-to-smolt survival in the wild (e.g., egg-to-smolt survival was 7 percent for Chinook salmon (Bradford 1995).

Table 44. Average egg survival for Upper Salmon River Chinook salmon programs as described in HGMPs submitted by action agencies.

Program	Average Egg Survival (green egg to smolt)	Comments
Pahsimeroi	88.8%	2008-2012
Sawtooth	94.3%	2008-2012
Yankee Fork	>80%	This is a target survival for Crystal Springs
Panther Creek	>80%	This is a target survival for Crystal Springs

Some of the handling and mortality associated with screw trap operation and electrofishing in Panther Creek and Yankee Fork was previously covered by Section 10 permits, but is included here as part of the proposed action. The proposed action supersedes the previous permits 1127-4R for some activities in Yankee Fork, and 19391 for activities in Panther Creek. The effects of the Yankee Fork and Panther Creek screw traps are detailed in Table 45. The effects of electrofishing in Yankee Fork and Panther Creek are detailed in Table 46. Although no hatchery fish have been encountered at either screw trap location, with the implementation of hatchery programs in both the Yankee Fork and Panther Creek, it is likely that encounters with hatchery-origin spring/summer Chinook salmon juveniles (mostly adipose-clipped, and thus exempt from take prohibitions) will occur. In addition, a few spring/summer Chinook salmon adults (10 hatchery, 5 natural) may be encountered at each screw trap during operation annually, resulting in mortality of up to 2 fish of each origin. Thus, the number of adult equivalents potentially handled and incidentally killed by these activities combined is 140 and 10, respectively.

Table 45. Number of juvenile spring/summer Chinook salmon handled/tagged and that incidentally die due to handling/tagging and trap operation during juvenile rotary screw trapping.

Trap Site	**Fish origin**	**Average; min and max of Actual handling/tagging (mortality)**	**Proposed handling/tagging (mortality)**	**Adult Equivalents**
Yankee Fork	Natural	3680; 1414-6010 (61; 17-143)	21,000 (210)	84 (1)
	Hatchery	0 (0)	2,500 (25)	10 (1)
Panther Creek	Natural	None available	21,000 (210)	84 (1)
	Hatchery	None available	2,500 (25)	10 (1)

Source: Apps database

Table 46. Number of juvenile spring/summer Chinook salmon handled/tagged and that incidentally die from handling/tagging during electrofishing.

Electrofishing Site	**Fish origin**	**Actual handling/tagging (mortality)**	**Proposed handling/tagging (mortality)**	**Adult Equivalents**
Yankee Fork	Natural	1987; 1201-2828 (192; 36-486)	5000 (500)	20 (2)
	Hatchery	0 (0)	10 (1)	0 (0)
Panther Creek	Natural	None available	5000 (500)	20 (2)
	Hatchery	None available	10 (1)	0 (0)

Source: Apps database

There is likely to be no effect of the activities on fall Chinook salmon because they are separated spatially and temporally from these activities, and have not been encountered previously during electrofishing in these areas. Although encounters with sockeye salmon during screw trapping and electrofishing are likely to be low it is possible due to the presence of juvenile sockeye salmon in the Upper salmon River Basin. Based on discussions with the SBT NMFS assumes that the applicants could handle up to 30 natural and 50 hatchery sockeye salmon juveniles with an incidental mortality of up to 2 fish of each origin (Denny 2017a). When encountered, sockeye salmon juveniles will be released downstream of the weir. Effects on steelhead during these activities were analyzed and covered in NMFS (NMFS 2017c). That analysis did not result in a determination of jeopardy.

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

Construction Activities Related to Yankee Fork and Panther Creek Weirs

Infrastructure already exists for managing the Pahsimeroi and Sawtooth programs, and no new construction will occur for those programs; however, the Yankee Fork and Panther Creek programs do not have permanent on site facilities for collection and holding of broodstock. The construction of facilities on Yankee Fork and Panther Creek will result in impacts as described below.

Several project-related activities are likely to cause adverse effects on listed salmonids, including (1) handling and relocation of salmon and steelhead from the work area, (2) dewatering the construction sites, (3) short- and long-term habitat disruption through the generation of suspended sediments, (4) replacement of stream substrate with a concrete sill and placement of rock to protect abutments and intakes (benthic habitat loss and disturbance), (5) sediment input from upland construction disturbance, and (7) potential migration delays at the weir. These impacts will occur at both construction sites (Yankee Fork and Panther Creek). Best management practices for in-water work will be implemented at both construction sites; however, juvenile spring/summer Chinook salmon and steelhead rearing within and downstream of the construction area may be harmed or killed by impacts of construction and handling.

Handling and relocation of salmon and steelhead from the work area

Juvenile spring/summer Chinook salmon and steelhead are expected to be captured, handled, harassed, and injured while salvaging the dewatered areas at the reconstructed weir. It is reasonable to expect some captured fish will die, either during capture or after capture. All fish that are trapped and removed from the work area will experience stress and potentially be injured or killed if proper procedures are not followed. Any physical handling or psychological disturbance is known to be stressful to fish (Sharpe et al. 1998). The primary contributing factors to stress and death from handling are excessive doses of anesthetic, differences in water temperatures (between the river and wherever the fish are held), dissolved oxygen conditions, the amount of time that fish are held out of the water, and physical trauma. Stress on salmonids increases rapidly from handling if the water temperature exceeds 18ºC or dissolved oxygen is below saturation. Fish that are 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 or recovery tanks if not emptied regularly. High levels of stress can both immediately debilitate individuals and over a longer period, increase their vulnerability to physical and biological challenges (Sharpe et al. 1998).

The relatively few studies that have been conducted on juvenile salmonids indicate that spinal injury rates are substantially lower than they are for large fish. Smaller fish intercept a smaller head-to-tail electrical potential than larger fish (Sharber and Carothers 1988) and may therefore be subject to lower injury rates (e.g., (Hollender and Carline 1994; Dalbey et al. 1996). McMichael and Pearsons (1998) found a 5.1% injury rate for juvenile MCR steelhead captured by electrofishing in the Yakima River subbasin. The incidence and severity of electrofishing damage is partly related to the type of equipment used and the waveform produced (Sharber and Carothers 1988; McMichael 1993; Dalbey et al. 1996; Dwyer and White 1997). Continuous direct current (DC) or low-frequency (30 Hz) pulsed DC have been recommended for electrofishing (Dalbey et al. 1996; Snyder 2003) because lower spinal injury rates, particularly in salmonids, occur with these waveforms (McMichael 1993; Sharber et al. 1994; Dalbey et al. 1996). Only a few recent studies have examined the long-term effects of electrofishing on salmonid survival and growth (Dalbey et al. 1996; Ainslie et al. 1998). These studies indicate that although some of the fish suffer spinal injury, few die as a result. However, severely injured fish grow at slower rates and sometimes show no growth at all (Dalbey et al. 1996).

To analyze the extent of fish injury or death for juvenile spring/summer Chinook salmon and steelhead within the isolated work area, we relied on the following data, estimates, and assumptions: (1) Adult fish will not be handled or removed, (2) estimates of juvenile fish in the action area were based on estimates from SBT biologists from the area (Evans et al. 2016b; Evans et al. 2017a); (3) relocation will be done by biologists trained to use electrofishing equipment and will follow NMFS's electrofishing guidelines (NMFS 2000b) and (4) as discussed in Section 1.1 above, the only anadromous salmonids presumed to be in the action area during the proposed work window will be spring/summer Chinook salmon and steelhead.

The effects electrofishing may have on the species in this opinion would be limited to the direct and indirect effects of exposure to an electric field, capture by netting, holding captured fish in aerated tanks, and the effects of handling associated with transferring the fish back to the river.

Dewatering the construction sites and heavy equipment use

Equipment work in and near the water creates the potential for surface water chemical contamination via a fuel or fluid leak. Petroleum-based contaminants such as fuel, oil, and some hydraulic fluids, contain poly-cyclic aromatic hydrocarbons, which can cause chronic sublethal effects on aquatic organisms (Neff 1985) Ethylene glycol (the primary ingredient in antifreeze) has been shown to result in sublethal effects on rainbow trout at concentrations of 20,400 milligrams per liter (Staples et al. 2001) Best management practices to limit use of machinery in-water, using alternative fluids and lubricants safer for the environment, and out-of-floodplain vehicle staging will minimize or avoid any chemical contamination from equipment use.
Fish that are not captured by the relocation methods will remain in the isolated area, and would likely be harmed or killed within the work area as a result of dewatering, crushing, burial, lack of suitable flow, or acute levels of suspended sediments. NMFS anticipates that the number of spring/summer Chinook salmon and steelhead remaining in the work areas post-relocation will be small because the multi-pass electrofishing to salvage fish prior to dewatering is expected to capture most of the fish. Therefore, few or no fish will be killed by dewatering.

Short- and long-term habitat disruption through the generation of suspended sediments

Grading and excavation activities will disturb instream substrate as well as upland soils during construction of the weirs, intakes, access roads, and facilities. In-water excavation of gravel at the project site will cause an immediate elevation in turbidity in the stream. Re-watering the isolated work areas will also create a sediment pulse as flow returns to the disturbed area. Additionally, upland ground disturbance may cause delayed sediment pulses that will be occur during rain events, and may continue until soil has stabilized or revegetated. This instream construction and ground disturbance will increase the short-term erosion potential and so increase the amount of suspended sediment in both Yankee Fork and Panther Creek. In both locations, the substrate is predominantly gravels and cobbles, so turbidity and suspended sediment increases are likely to settle within a short distance downstream of the disturbance.

We expect juvenile spring/summer Chinook salmon and steelhead to be present downstream during the construction disturbance where waters may be turbid, and so juveniles would be disrupted from normal behavior patterns by short-term exposures to suspended sediments. If pulses are severe, or fish are unable to escape high levels of turbidity, it is possible that a portion may be killed or injured.

Exposure duration is a critical determinant of the occurrence and magnitude of turbidity-caused physical or behavioral effects (Newcombe and MacDonald 1991; Newcombe and Jensen 1996) Changes in normal behaviors to avoid turbid waters may be one of the most important effects of suspended sediments. Salmonids have been observed moving laterally and downstream to avoid turbid plumes (Lloyd 1987; Servizi and Martens 1991). Suspended sediment and resultant turbidity is known to disrupt feeding rates and success, reduce growth rates, impair homing, and cause abandonment of cover. At moderate levels, turbidity has the potential to adversely affect primary and secondary productivity, and, at high levels, has the potential to injure and kill adult and juvenile fish (Newcombe and Jensen 1996). Turbidity might also interfere with feeding (Spence et al. 1996). Other behavioral effects on fish, such as gill flaring and feeding changes, have been observed in response to pulses of suspended sediment (Berg and Northcote 1985).

Localized increases of turbidity during in-water work will likely displace fish in the project area and disrupt normal behavior. However, a potentially positive reported effect of turbidity is that it provides refuge and cover from predation (Gregory and Levings 1998). Juvenile salmonids are also known to avoid turbid conditions created by suspended sediment and seek out clearer water (Newcombe and Jensen 1996).

Moderate or high levels of turbidity increases from in-water work would be limited to one season of work during the instream construction associated with building the proposed weirs, associated coffer dams, construction of on-site facilities. The precise distribution and abundance of fish within and downstream of the construction area at the time of the action are not a simple function of the quantity, quality, or availability of predictable habitat resources within that area. So, the distribution and abundance of fish is not a precise measurement, but most fish downstream will experience some increase in turbidity.

The impact of the exposure will range from no behavioral change to potential death, with the majority for fish experiencing only short-term minor impacts. In highly turbid waters, affected fish are unlikely to be observed or recovered if they are killed. Therefore, the number of fish injured or killed by suspended sediment and turbidity can almost never be accurately measured. Further, there is no way to use the information derived above on fish presence to determine the distribution of those fish within the action area at the time of the expected water quality changes. The largest pulses will occur during excavation and construction events (hours or single days).

Regardless, NMFS expects low mortality and limited behavioral change from turbidity plumes. Because exposure to high sediment inputs will be sporadic pulses rather than chronic acute levels, and the downstream area where suspended sediment will occur is open water, we expect any exposure to be brief because fish will be able avoid the most severe plumes when possible, or endure the levels for a brief time with limited long-term impact

Replacement of stream substrate with a concrete sill and placement of rock to protect abutments and intakes

The installation of the weir, concrete abutments, and armoring will permanently alter a section of the stream bed, eliminating the rock substrate in that cross section of the stream. Both weirs are being constructed in previously impacted areas with little or no vegetation present, and not in ideal spawning areas because of stream morphology. Therefore, the footprint of each weir is not expected to reduce habitat used extensively by either juvenile or adult spring/summer Chinook salmon or steelhead. Fish will not experience direct mortality, and benthic habitat loss is unlikely to result in any measurable change to growth or survival in the area.

Chronic sediment input from upland construction disturbance

As a result of ground disturbance and clearing in the upland areas, there may be lower level sediment pulses from rainstorms from exposed areas with some runoff from areas with limited vegetation. This may occur until replacement vegetation establishes or loose sediment supply is exhausted (months to a few years). The sediment and erosion control plan (Proposed Action) will limit or eliminate inputs of sediment at levels that would impact instream water quality. Except in the case of extreme downpours, these pulses should be minor in both scale and duration, and fish are expected to experience little or no change in behavior or mortality. Therefore NMFS believes there is a low probability of any direct mortality from turbidity associated with proposed activities. The turbidity should be infrequent, localized, and fish are likely to either avoid the larger pulses or endure the effects until they clear. Behavior avoidance is unlikely to affect fish in the long-term or result in measurable injury or death.

Potential migration delays at the weir

By definition, a weir is an obstruction over which water flows (NMFS 2011b), and are typically installed, as is the case for this proposed action, for the purpose of enumerating or physically managing passage of adult spawners. If not designed properly, any in-stream structure may act as a barrier or deterrent for passage for different life stages of anadromous salmonids. Even if a structure is designed properly, it must be operated within the tolerances and flows in which it was designed to handle in order to pass fish safely and remain effective.

The current designs for the two structures do not comply with existing passage criteria (NMFS 2011b). NMFS fish passage engineers are currently working with applicants and construction engineers to improve designs, to minimize impacts on listed salmonids. Temporary weirs being operated for program management will also require a review by NMFS passage engineers. The design modifications (to temporary and permanent structures) will focus on limiting injury through false attraction flows, physical injury, or weir rejection (the tendency of fish to avoid approaching instream structures). Where criteria cannot be met, alternative designs and monitoring (as part of the engineering approval process) will be required to limit adverse impact. As a result of this review, weirs at both Panther Creek and Yankee Fork are expected to safely capture fish through modifications to structures and/or operations.

The proposed trapping protocols require fish to be sampled, collected, or passed within a short period of time (typically <24 hours). Regardless of final design, the downstream passage of juveniles is expected to be unimpeded through the pickets. Because these weirs (permanent or temporary) will go through a passage criteria review, any approved final design will address passage/delay concerns in a manner that minimizes impacts to adults migrating to spawning grounds or juveniles emigrating out of the system.

Ongoing Operations

Hatchery intake dredging and rock protection

Dredging Hatchery maintenance activities could also displace juvenile fish. Specifically, through noise and instream activity as well as exposing fish to brief pulses in sediment may alter the routine movement of juvenile fish. These activities may result in short term displacement (within the normal range of fish behaviors in response to noise or a periodic habitat disturbance), but it is unlikely that long-term displacement will occur. The Proposed Action includes best management practices that limit the type, timing, and magnitude of allowable instream activities. These practices would likely limit potential short-term effects. Based on past implementation of dredging at the Pahsimeroi Hatchery, no effects have been observed (Abbott 2014).

For the Sawtooth and Pahsimeroi facilities, no construction is included as part of the Proposed Action, and will not have impacts related to construction. Once the Yankee Fork and Panther Creek facilities are constructed, they will be operated as described in the proposed action (section). Each of the four facilities (Sawtooth, Pahsimeroi, Yankee Fork, and Panther Creek) will include water withdrawal and discharge activities that will be guided by the best management practices as described in the Proposed Action (Section 1.3). Best management practices address water withdrawal practices, screening criteria, facility upgrades, maintenance activities, and NPDES permit information for each hatchery facility.

These best management practices will limit effects on listed salmonids and their associated critical habitat. Ongoing operation of the facilities for these will have a small negative effect on listed salmon and steelhead.

The Proposed Action for the Yankee Fork and Panther Creek facilities include new water withdrawals; however, the withdrawal amounts are proportionally small, and will comply with NMFS screening criteria.

The water flow rate through the Yankee Fork facility would be approximately 10 cubic feet per second (cfs). When using monthly averages, the maximum percent of flow divergence is highest (13.7%) in September. Daily mean flows have been as low as 48 cfs in September, which would result in use of up to 21% of the streamflow for facility operations in severe years. Earlier in the summer, when flows are higher, the flow reduction would generally be less than 5% of streamflow. The distance between the intake and the discharge through the fish ladder (area of impact) is approximately 1,260 feet. There may be some reduction in edge habitat in the affected area, but fish in the area will still be able to either use the remaining habitat or migrate up or downstream.

The Panther Creek weir facility would require water for the acclimation ponds (3 cfs), used in April and May, and for the adult holding facilities (10 cfs), used from June to October. During April and May, Panther Creek mean monthly discharges would indicate that the diversion would reduce flows in the affected reach of Panther Creek by up to 2%. Between June and October, the diversion rate could be up to 29.4% in October. The distance between the intake and the discharge through the fish ladder would be approximately 700 feet, so it is over this distance that the reduced flows would occur.

Table 47. Mean Monthly Discharge Diverted for Adult Holding of Chinook Salmon at Yankee Fork and Adult Holding and Smolt Acclimation at Panther Creek Weir Facilities (2012–2014) (USGS 2012).

	Month						
	April	May	June	July	August	September	October
Yankee Fork							
Mean Monthly Discharge (cfs)		934	596	196	88	73	90
Percent Diversion		1.1%	1.7%	5.1%	11.4%	13.7%	11.7%
Panther Creek							
Mean Monthly Discharge (cfs)	131	381	197	75	45	37	34
Percent Diversion	2.3%	0.8%	6.6%	13.3%	22.2%	27.0%	29.4%

Note: Collection of spring/summer Chinook salmon typically concludes at the end of August, or when adults are not found in the weirs for seven consecutive days. Diversions would continue at the facilities, as held adults are ready for spawning.
cfs = cubic feet per second

The Sawtooth and Pahsimeroi facilities will not include any changes in water withdrawals from current operations; therefore, current effects are assumed into the future. The Sawtooth facility diverts up to 43 cfs from the Upper Salmon River. The lowest flows occur in the late fall and winter, with the record low at 230 cfs (January1930), but the lowest average monthly mean is 405 cfs (February). In the worst years, the Sawtooth facility may withdraw up to 18.7% of the flow, but would average 10.6% in average low conditions, and less at all other times (USGS 2012).

The Pahsimeroi facility diverts 60 cfs from the Pahsimeroi River. The lowest flows in the Pahsimeroi River occur in the spring and summer when irrigation withdrawals in the basin are high, with the record low at 111.3 cfs (May 1992), but the lowest average monthly mean is 151 cfs (August) (USGS 2012). In the lowest flows in the last 10 years, the 60 cfs the Pahsimeroi facility would use would represent up to 53.9% of the flow, and would average 39.7% in average low conditions. Typically, the facility will use about 26% of the flow based on the annual average (228.7 cfs). There will likely be some reduction in habitat complexity in the affected area, but will not be completely disconnected from flow, and fish in the area will still be able to either use the remaining habitat or migrate up or downstream.

Table 48. Water use summary for Sawtooth and Pahsimeroi Hatcheries (Leth 2017a)

	Surface Water (cfs)					Meet NMFS screening criteria (specify year)?
	Source and water right	**Average and maximum use**	**Diversion Distance (Feet) (See below)**	**Discharge Location**	**Months utilized**	
Sawtooth Fish Hatchery	Salmon River / 71-02088 and 71-07079	27 avg, 43 max	4,860	Salmon River	1/1 to 12/31	*see below
Pahsimeroi Fish Hatchery (lower)	Pahsimeroi River / 7307006 and 7307055	31.4 avg, 40 max and 6.2 avg, 40 max	1,320	Pahsimeroi River	3/1 to 11/30 and 12/1 to 2/29	Yes (2004)
Pahsimeroi Fish Hatchery (upper)	Pahsimeroi River / 7302168 and 7307051	9.3 avg 10 max	750	Pahsimeroi River	1/1 to 12/31	Yes (2004)

*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 screening/passage criteria (NMFS 2011b). When final assessments are completed, the LSRCP and facility managers/operators 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.

Table 49 Mean Monthly Discharge and Water Use Proportions for Sawtooth and Pahsimeroi Hatcheries (USGS 2012)

	Month											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**June**	**July**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Salmon River												
Mean Monthly Discharge (cfs)	425.26	449.34	596.68	1576.6	2777.6	2281	972.92	498.04	454.58	559.76	548.98	492
Percent Diversion Max	10.11%	9.57%	7.21%	2.73%	1.55%	1.89%	4.42%	8.63%	9.46%	7.68%	7.83%	8.74%
Percent Diversion Average	6.35%	6.01%	4.53%	1.71%	0.97%	1.18%	2.78%	5.42%	5.94%	4.82%	4.92%	5.49%
Pahsimeroi												
Mean Monthly Discharge (cfs)	277.9	294.26	295.68	262.52	174.56	199.08	197.7	162.54	185.44	275.94	301.18	283.4
Percent Diversion Max	21.59%	20.39%	20.29%	22.86%	34.37%	30.14%	30.35%	36.91%	32.36%	21.74%	19.92%	21.17%
Percent Diversion Average	5.58%	5.27%	13.76%	15.50%	23.32%	20.44%	20.59%	25.04%	21.95%	14.75%	13.51%	5.47%
Note: cfs = cubic feet per second												

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

There are two aspects of fisheries that are potentially relevant to NMFS' analysis of hatchery program effects:

- Fisheries that exist because of the proposed action (i.e., the fishery is an interrelated and interdependent action to the hatchery) and listed species are inadvertently and incidentally taken in those fisheries. These fisheries would have negative effects on the abundance and diversity VSP parameters of the affected populations (Section 2.5.1).
- Fisheries that are used as a tool to prevent the hatchery fish associated with the proposed action, including hatchery-origin fish included in an ESA-listed ESU or steelhead DPS from spawning naturally. The effects of these fisheries can range from positive to negative.

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

For a detailed description of listed encounters during and the effects of fisheries that exist because of hatchery programs, refer to Section 2.4.4. Based on these detailed descriptions, the effects from fisheries on natural-origin spring/summer Chinook salmon are negative, and negligible for fall Chinook salmon, steelhead, and sockeye salmon.

2.5.3. Effects of the Action on Critical Habitat

This consultation analyzed the Proposed Action for its effects on designated critical habitat and are described below by location and activity type. Of the six PCEs, minor, short term impacts may affect freshwater spawning, freshwater rearing, and freshwater migration corridors.

Construction in Yankee Fork and Panther Creek

As described above, the proposed action will have mostly short-term, negative effects on water quality (which dissipates quickly), forage (which re-establishes in 6 months to a year), and passage (which will be very temporary). These effects will primarily affect freshwater rearing sites, with negligible impact on freshwater spawning or migration corridors.

For freshwater rearing, the action will have mostly short-term, negative effects on water quality and minor long term effects on substrate for the permanent footprint of the weir and rock placement around the abutments. The most discernible functional change to freshwater rearing sites will be the constrained dewatered area, where fish will be temporarily excluded. This impact will be limited to a short window of time (up to 2 weeks) during a single construction season.

Ongoing operation of water intakes and outfalls

The ongoing operation of all four facilities will have minor impacts on water quality and quantity.

For the Sawtooth and Yankee Fork Facilities, these impacts will be negligible because maximum water withdrawals will be 15 percent or less, and will not measurably change freshwater rearing, freshwater spawning, or migration corridors.

The Pahsimeroi and Panther Creek facilities withdraw more water proportionally from the Pahsimeroi River (25 percent max) and Panther Creek (30 percent max); however, the effects on Critical Habitat will still be small for the following reasons:

Freshwater rearing – Though some shallow water habitat may be lost because of withdrawals, the impact will occur in a small section of stream between the intake and outfall. Most habitat within the reach will still be available and usable for rearing.

Freshwater spawning – Though some shallow water habitat may be lost because of withdrawals, the impact will occur in a small section of stream between the intake and outfall. Most spawning habitat within the reach will still be available and usable for spawning. .

Freshwater Migration corridors – Water withdrawals will have little or no impact on migration because contiguous streamflow will be maintained at all times.

All hatchery facilities have current NPDES permits, and effluent would be monitored to ensure compliance with permit requirements. All chemicals used for sanitation and for treatment of diseases would be diluted to manufacturer's instructions prior to release into the main water body.

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

Ongoing operation of all four weirs

The ongoing operation of all four weir facilities will have minor impacts on adult migration, minor impacts on spawning habitat, and little or no impact on juvenile rearing.

Habitat free of obstruction is an essential element of freshwater migration that the weir operation will directly affect. For adults not collected for broodstock, the project will result in a temporary barrier to migration as a result of trapping prior to release above the weir. The seasonal physical barrier to adult upstream migration will delay adults for a few hours (up to a day) as they are captured, handled, and sampled prior to release. Migration of juvenile salmonids and other fish will not be impeded, as they can pass between the pickets of the weir. The delay will not occur when the weir is not in operation.

Spawning habitat is eliminated within the footprint of each of the four weirs. This loss of spawning habitat is minor in scale. For management purposes, the weirs have been placed in location where most of the spawning is upstream, and not disrupted.

The beneficial effects on critical habitat, specifically freshwater spawning and rearing habitat, are from the conveyance of marine-derived nutrients from the carcasses of hatchery spawners and from conditioning of spawning gravel by hatchery spawners (Montgomery et al. 1996; Cederholm et al. 1999). Salmon carcasses provide a direct food source for juvenile salmonids and other fish, aquatic invertebrates, and terrestrial animals, and their decomposition supplies nutrients that may increase primary and secondary production. These marine-derived nutrients can increase the growth and survival of the ESA-listed species by increasing forage species (i.e., aquatic and terrestrial insects), aquatic vegetation, and riparian vegetation to name a few.

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.

Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline *vs.* cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the environmental baseline (Section 2.4).

For the purpose of this analysis, the Action Area is that part of the Snake River Basin described in the Section 2.3. To the extent ongoing activities have occurred in the past and are currently occurring, their effects are included in the environmental baseline (whether they are Federal, state, tribal, or private). To the extent those same activities are reasonably certain to occur in the future (and are tribal, state, or private), their future effects are included in the cumulative effects analysis. This is the case even if the ongoing, tribal, state, or private activities may become the subject of section 10(a)(1)(B) incidental take permits in the future. The effects of such activities are treated as cumulative effects unless and until an opinion has been issued.

State, tribal, and local governments have developed plans and initiatives to benefit listed species and these plans must be implemented and sustained in a comprehensive manner for NMFS to consider them "reasonably foreseeable" in its analysis of cumulative effects. The Federally approved draft Recovery Plan for Snake River Spring/Summer Chinook Salmon (NMFS 2016d) is such a plan and it describes, in detail, the on-going and proposed Federal, state, tribal, and local government actions that are targeted to reduce known threats to ESA-listed salmon and steelhead in the Snake River Basin. NMFS released this document for public comment on

October 27, 2016 through February 9, 2017. It is acknowledged, however, that such future state, tribal, and local government actions will likely be in the form of legislation, administrative rules, or policy initiatives, and land use and other types of permits and that government actions are subject to political, legislative and fiscal uncertainties. A full discussion of cumulative effects can also be found in the FCRPS Biological Opinion (NMFS 2008c) and the Mitchell Act Biological Opinion (NMFS 2017a), many of which are relevant to this Action Area. It should be noted that the actions in the FCRPS Biological Opinion – the operation of the Columbia River Federal Hydropower system – and the Mitchell Act biological opinion – the funding of Columbia River hatchery programs – are included in the baseline for this opinion.

The cumulative impacts from these programs contribute to the total impacts from hatcheries in the entire Columbia River Basin, which is noted in the Mitchell Act Biological Opinion (NMFS 2017a). It is likely that the type and extent of salmon and steelhead hatchery programs and the numbers of fish released in the Columbia River Basin will change over time. Although adverse effects will continue, these changes are likely to reduce effects such as competition and predation on natural-origin salmon and steelhead compared to current levels, especially for those species that are listed under the ESA. This is because all salmon and steelhead hatchery programs funded and operated by non-Federal agencies and tribes in the Columbia River Basin have to undergo review under the ESA to ensure that listed species are not jeopardized and that “take” under the ESA from salmon and steelhead hatchery programs is minimized or avoided. Although adverse effects on natural-origin salmon and steelhead will likely not be completely eliminated, effects would be expected to decrease from current levels over time to the extent that hatchery programs are reviewed and approved by NMFS under the ESA. Where needed, reductions in effects on listed salmon and steelhead are likely to occur through changes in:

- Hatchery monitoring information and best available science
- Times and locations of fish releases to reduce risks of competition and predation
- Management of overlap in hatchery- and natural-origin spawners to meet gene flow objectives
- Decreased use of isolated hatchery programs
- Increased use of integrated hatchery programs for conservation purposes
- Incorporation of new research results and improved best management practices for hatchery operations
- Creation of wild fish only areas
- Changes in the species propagated and released into streams and rivers and in hatchery production levels
- Termination of programs
- Increased use of marking of hatchery-origin fish
- More accurate estimates of natural-origin salmon and steelhead abundance for abundance-based fishery management approaches

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 effects. However, the continued restoration of habitat, should alleviate some of this potential pressure for cold water refugia as well as suitable rearing and spawning habitat.

It is also possible the changing flow patterns due to climate change may change the suitable operation periods of water intakes and weirs for the programs. In the short-term, these changes are expected to be small, and infrastructure is likely able to sustain continued operations as described without exacerbating 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 Basin steelhead DPS, or the Snake River Fall and Spring/Summer Chinook Salmon and Sockeye Salmon ESUs.

2.7. Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the benefits and risks posed to ESA-listed species and critical habitat as a result of implementing the Proposed Action. In this section, NMFS add the effects of the Proposed Action (Section 2.5) to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6) to formulate the agency’s opinion as to whether the Proposed Action is likely to: (1) result in appreciable reductions in the likelihood of both survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated or proposed critical habitat for the conservation of the species. This assessment is made in full consideration of the status of the species and critical habitat and the status and role of the affected populations in recovery (Section 2.2).

In assessing the overall risk of the Proposed Action on each species, NMFS considers the benefits and risks of each factor discussed in Section 2.5, above, in combination, considering their potential additive effects with each other and with other actions in the area (environmental baseline and cumulative effects). This combination serves to translate the positive and negative effects posed by the Proposed Action into a determination as to whether the Proposed Action as a whole would appreciably reduce the likelihood of survival and recovery of the ESA-listed species and their designated critical habitat.

2.7.1. Listed Species

2.7.2. Snake River Spring/Summer Chinook Salmon ESU

Best available information indicates that the Snake River Spring/Summer Chinook Salmon ESU is at high risk and remains threatened (NWFSC 2015). That status is the result of threats to all viability parameters, particularly abundance and productivity. The NWFSC determined that there are 27 extant and four extirpated populations within this ESU. All of these extant populations except one (Chamberlain Creek in the Middle Fork MPG) were designated at a high overall risk (NWFSC 2015). Moreover, the Biological Review Team (BRT) identified the most serious risk to the ESU was low natural productivity and the decline in abundance relative to historical returns (NWFSC 2015).

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

Effects of the proposed action include effects that occur immediately (handling, monitoring, construction, and operation of facilities), as well as those that will occur over time (genetic and ecological). Effects of facility operation are generally small and localized. The effects of construction will be localized and limited in duration. Salvage efforts at the construction site will also limit mortality to a few individuals, and population impacts will be low. Broodstock collection and RM&E requires ongoing annual handling of a portion of the population (juvenile and adult), though handling mortality is low. The broodstock collection is an essential component of the action, and information gained from conducting RM&E is essential for understanding the effects of the hatchery program on natural-origin spring/summer Chinook salmon populations.

The ongoing effects of the Proposed Action on this ESU are genetic and ecological in nature. This is a factor in the abundance (ecological), productivity (ecological), and diversity (genetic) parameters. NMFS will monitor whether decreased productivity, diversity, or abundance of natural-origin fish may necessitate more aggressive adult management, and/or reconsideration of hatchery program size in the future to limit impacts on these VSP parameters in these ESUs (Appendix).

The ecological and genetic effects on the adult life stage are affected by the proportion of hatchery-origin fish spawning naturally, but will be limited based on sliding scale and pHOS management. For these four programs, this is managed through removal of adults at adult trapping locations and in the area. In years that hatchery-origin returns are high, mark-select fisheries (which are a separate action) that target hatchery-origin returns may result in the harvest of hatchery-origin adults in excess of broodstock needs. Though not an essential part of managing adults above the weir, removal of adults through fisheries may reduce the number of adults handled and aid in pHOS management. All four programs manage proportional hatchery influence by adhering to natural-origin abundance-based sliding scales to limit hatchery influence progressively as each population increases in abundance (Section 1.3).

As explained in the appendix, the Hatchery Scientific Review Group (HSRG) has developed guidelines for allowable pHOS levels in populations, scaled by the population's conservation importance, recommending a maximum of 5% in "primary" populations, 10% for "contributing" populations, and at a level required to maintain "sustaining" populations (e.g., HSRG 2014).

Listed salmonid populations in the Snake are classified by potential recovery expectation (ICTRT 2007a) rather than by the HSRG classification scheme, but "viable" and "highly viable" equate to "primary", and "maintain" equates to "contributing" and "sustaining." The Upper Salmon River MPG within the Snake River Spring/summer Chinook Salmon ESU has eight extant populations and one functionally extirpated (Panther Creek) population. The recovery aspirations for the populations in which these programs are operated are listed in Table 50 below

Table 50. Recovery aspirations for Salmon River Spring/summer Chinook populations.

Population	Recovery Aspiration*	Recovery Strategy	
Upper Salmon River	Highly Viable	Manage for natural production; Monitor for strays	
Pahsimeroi River	Viable	Manage for no hatchery influence on spawning grounds above weir. Develop gene flow standards through HGMP process	
Yankee Fork	Maintained	Develop local broodstock; Develop gene flow standards through HGMP process	
Panther Creek	None	No recovery targets set; because the population was extirpated	

*These are suggested recovery targets, though other scenarios may be suitable for recovery

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

In general, NMFS believes a PNI of 0.5 is adequate for maintaining the population's genetic structure and productivity because the natural-origin influence is not dominated by hatchery influence. However, a PNI less than 0.5 may be acceptable when natural-origin abundance is low (i.e. < 250 fish), to ensure enough fish are available to spawn regardless of fish origin. For viable" and "highly viable" populations, the guidelines are a pHOS no greater than 30 percent and PNI of at least 67 percent for integrated programs.

2.7.2.1.1. Upper Salmon River

The Upper Salmon River population is targeted for high viability, and is directly affected by the Upper Salmon River program. The operators have adopted a sliding scale that has a future expected PNI values that is expected to be over 0.67, before the population reaches the minimum abundance threshold. The weir on the Upper Salmon River is highly efficient (>90%). The weir controls spawning access to over 90% of the intrinsic potential spawning habitat in the Upper Salmon River population which allows program operators to manage the spawning composition upstream of the weir. This commitment to achieve PNI and pHOS values in the sliding scale is an improvement in diversity from previous operations. Because the sliding scale depends on natural-origin returns, at low abundance, the PNI will be between 0.5 and 0.67 in most years (based on the values designated by the operators). Only fish from the integrated program are intended to spawn above the weir. In all but the most extreme low abundance years, the genetic influence will be predominantly influenced by natural-origin fish either through direct spawning or through controlled integration of the hatchery broodstock. Taken together, these actions are expected to contribute to an increase in all four VSP criteria (abundance, productivity, spatial structure, and diversity) for this population in the long-term and therefore support overall trajectory toward recovery and decrease risk of extinction.

2.7.2.1.2. Pahsimeroi River

The Pahsimeroi River population is targeted for viability, and is directly affected by the Pahsimeroi River program. The operators have adopted a sliding scale that has a future expected PNI values that is expected to be over 0.67, before the population reaches the minimum abundance threshold. This commitment to achieve PNI and pHOS values in the sliding scale is an improvement in diversity from previous operations. The majority of above weir spawning will be natural-origin returns. We expect the future PNI values in most years to exceed 0.67. Because the sliding scale depends on natural-origin returns, at low abundance, the PNI will be between 0.5 and 0.67 (based on the values designated by the operators). Only fish from the integrated program are intended to spawn above the weir. In all but the most extreme low abundance years, the genetic influence will be predominantly influenced by natural origin fish either through direct spawning, or controlled integration of the hatchery broodstock. Taken together, these actions are expected to contribute to an increase in all four VSP criteria (abundance, productivity, spatial structure, and diversity) for this population in the long-term, and therefore support overall trajectory toward recovery and decrease risk of extinction

2.7.2.1.3. Yankee Fork

The Yankee Fork population is targeted for to be maintained, and is directly affected by the Yankee Fork program. The operators have adopted a sliding scale that has a future expected PNI values that is expected to be over 0.5, which will maintain natural influence within the population. In addition, the operators have agreed to target a PNI over 0.67 after the population reaches the minimum abundance threshold. This commitment to achieve PNI and pHOS values in the sliding scale is an improvement in diversity from previous operations. In all but the most extreme low abundance years, the genetic influence will be predominantly influenced by natural origin fish either through direct spawning, or controlled integration of the hatchery broodstock. Taken together, these actions are expected to contribute to an increase in all four VSP criteria (abundance, productivity, spatial structure, and diversity) for this population in the long-term, and therefore support overall trajectory toward recovery and decrease risk of extinction.

2.7.2.1.4. Panther Creek

The Panther Creek population was functionally extirpated, and, therefore, does not have a recovery target for viability. Even though it is not mandatory, the operators have adopted a sliding scale that has future expected PNI values that is expected to be over 0.5, which will maintain natural influence within the population. In addition, the operators have agreed to target a PNI over 0.67 after the population reaches the minimum abundance threshold. This commitment to achieve PNI and pHOS values in the sliding scale is an improvement in diversity from previous operations. In all but the most extreme low abundance years, the genetic influence will be predominantly influenced by natural origin fish either through direct spawning, or controlled integration of the hatchery broodstock. Taken together, these actions are expected to contribute to an increase in abundance and productivity for this population in the long-term.

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

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

After taking into account the status of each population, the current viability status of the 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

2.7.3. Snake River Steelhead, Fall Chinook, and Sockeye Salmon DPS and ESUs

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

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

Added to the Species' Status, Environmental Baseline, and effects of the Proposed Action are the effects of future state, private, or tribal activities, not involving Federal activities, within the Action Area. The recovery plans for each ESU/DPS 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.

Snake River Fall Chinook Salmon

There will be little or no impact on SR Fall Chinook during broodstock collection or RM&E because of the differences in spatial and temporal overlap with spring/summer Chinook salmon spawning or rearing. Therefore, the effects of the Proposed Action on SR Fall Chinook Salmon is limited to ecological effects because of the overlap in outmigration timing. The ecological effects on juvenile natural-origin fall Chinook salmon from the hatchery programs were included in Section 2.7.2. Our analysis showed that the impacts of these programs on fall Chinook salmon were around 2 percent; however, these values are likely to be overestimates based on many of the assumptions in the model analyses. The small percentage loss within this ESU at this life stage is unlikely to affect the productivity of these natural-origin fish in the Snake River Basin.

After taking into account the status of each population, the current viability status of the 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.

Snake River Basin Steelhead

The effects of our Proposed Action on Snake River Basin Steelhead will occur incidental to collection of spring/summer Chinook salmon for broodstock and during RM&E activities. In addition ecological effects will occur because of the overlap in outmigration timing. These effects may result in changes to the abundance and productivity of natural-origin fish; however, NMFS believes they impacts are small.

Effects of broodstock collection targeting spring/summer Chinook salmon are small because of the differences in spatial and temporal overlap between spring/summer Chinook salmon and steelhead mean that the overlap is only during a short window at the early part of the run. Because they are not a target species, they are released unharmed. Direct monitoring and collection would only occur as part of another program (authorized separately). Thus, there is very little incidental effect on Snake River Basin Steelhead, and it is unlikely that these activities would lead to a decrease in the abundance, productivity, spatial structure, or diversity of the DPS.

The ecological effects on juvenile natural-origin steelhead from the hatchery programs were included in Section 2.7.2. Our analysis showed that the impacts of these programs on steelhead were around 2.2 percent; however, these values are likely to be overestimates based on many of the assumptions in the model analyses. The small percentage loss within this DPS at this life stage is unlikely to affect the productivity of these natural-origin fish in the Snake River Basin.

After taking into account the status of each population, the current viability status of the species, the Environmental Baseline, and other pertinent cumulative effects, including any anticipated Federal, state, or private projects, NMFS concludes that the effects of the Proposed Action will not appreciably reduce the likelihood of survival and recovery of this ESA-listed DPS in the wild.

Snake River Sockeye Salmon

The effects of our Proposed Action on Snake River Sockeye will occur incidental to collection of spring/summer Chinook salmon for broodstock and during RM&E activities. In addition, ecological effects will occur because of the overlap in outmigration timing. These effects may result in changes to the abundance and productivity of natural-origin fish; however, NMFS believes they impacts are small.

Effects of broodstock collection targeting spring/summer Chinook salmon are small because of the differences in spatial and temporal overlap between spring/summer Chinook salmon and sockeye mean that the overlap is only during a short window at the early part of the run. Because they are not a target species, they are released unharmed. Direct monitoring and collection would only occur as part of another program (authorized separately). Thus, there is very little incidental effect on Snake River Basin Steelhead, and it is unlikely that these activities would lead to a decrease in the abundance, productivity, spatial structure, or diversity of the ESU.

The ecological effects on juvenile natural-origin steelhead from the hatchery programs were included in Section 2.7.2. Our analysis showed that the impacts of these programs on sockeye were around 1.6 percent; however, these values are likely to be overestimates based on many of the assumptions in the model analyses. The small percentage loss within this ESU at this life stage is unlikely to affect the productivity of these natural-origin fish in the Snake River Basin.

After taking into account the status of each population, the current viability status of the 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.

2.7.4. Critical Habitat

The weir construction impacts on rearing and migration are small, localized, and short in duration. The hatchery water diversion and the discharge pose a negligible effect on designated critical habitat in the Action Area (Section 2.5.3). Existing hatchery facilities have not contributed to altered channel morphology and stability, reduced and degraded floodplain connectivity, excessive sediment input, or the loss of habitat diversity. The operation of the weirs and other hatchery facilities may impact migration PBFs due to delay at these structures and possible rejection. However, the number of natural-origin adults delayed for all species is expected to be small and the delay would be for only a short period because of weir design and fish handling protocols. Thus, the impact on the spawning, rearing, and migration PBFs will be small in scale, and will not appreciably diminish the capability of the critical habitat to satisfy the essential requirements of the species.

2.8. Conclusion

After reviewing the current status of the listed species, the environmental baseline within the Action Area, the effects of the Proposed Action, including effects of the Proposed Action that are likely to persist following expiration of the Proposed Action, and cumulative effects, it is NMFS' biological opinion that the Proposed Action is not likely to jeopardize the continued existence of the Snake River Spring/Summer Chinook Salmon ESU, the Snake River Fall-run Chinook Salmon ESU, the Snake River Sockeye Salmon ESU, or the 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 regulations 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). 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 of Extent of Take

In the biological opinion, NMFS determined that incidental take is reasonably certain to occur as follows:

The primary form of take of ESA-listed spring/summer Chinook salmon is direct take, to be authorized under the Proposed Action's 4(d) determinations for the Upper Salmon, Pahsimeroi, Yankee Fork, and Panther Creek programs (Factor 1 and Factor 4). However, NMFS also expects incidental take of ESA-listed salmonids will occur as a result of the Proposed Action for the following factors.

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

- Incidental take related to construction, operation, and maintenance of facilities

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

There is take for this factor due to three forms of harm: genetic effects, ecological effects and adult handling/tagging and incidental mortality at adult collection facilities. Specifically, take occurs for genetic effects through a reduction in genetic diversity, outbreeding depression, and hatchery-influenced selection. Additionally, take occurs through ecological effects of hatchery adults on the spawning grounds such as competition for spawning sites and redd superimposition.

Take due to genetic effects and ecological effects pathways cannot be directly measured because it is not possible to observe gene flow or interbreeding between hatchery and wild fish in a reliable way, or to quantify spawning site competition or redd superimposition. For these two take pathways, NMFS will therefore rely on a single common set of surrogate take indicators: the number of hatchery-origin spring/summer Chinook on the spawning grounds (pHOS) upstream of the weir:

The pHOS surrogate has a rational connection to the take of the listed species because it is a direct measure of the extent that both hatchery- and natural-origin fish occur simultaneously on the spawning grounds, and represents the number of hatchery-origin fish that may contribute to the population. This value can also be used in calculations to approximation of the true proportionate natural influence (PNI).

The take associated with genetic effects will be considered to have been exceeded when the proportion of hatchery-origin spawner (pHOS) limits upstream of the weir in Table 3, Table 5, and Table 6 above have been exceeded. The pHOS can be monitored in-season by tracking adult returns using weir counts, PIT tag detections, and spawning estimates.

Straying from these hatchery programs is very low, so there is no need to assign incidental take to these programs from straying.

Encounters with sockeye salmon during the operation of these weirs and traps for broodstock collection occurs at low levels annually. There is separate ESA section 10 coverage for sockeye salmon captured and handled at the Sawtooth and Pahsimeroi weirs. The applicants estimate that up to 10 hatchery and 10 natural sockeye salmon adults may be encountered at the Panther Creek and Yankee Fork Weirs. Of these 10, up to 2 of each may die incidentally due to handling.

Table 51 Incidental mortality of SR Sockeye salmon resulting from adult trapping for broodstock collection activities (e.g., adult traps). Broodstock collection is considered direct take

Program	Species and origin	Lifestage	Maximum incidental handling number (adults)	Maximum incidental mortality (adults)
Yankee Fork	SR Sockeye salmon; natural- and hatchery origin	Adult	20	2
Panther Creek	SR Sockeye salmon; natural- and hatchery origin	Adult	20	2

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

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

For outmigrants, NMFS applies a take surrogate 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 in "viable" and "maintain" populations above Lower Granite will be the take that occurs when the five-year median travel time[6] for emigrating juvenile hatchery-origin spring/summer Chinook salmon is more than five days longer than the median travel time value (which equates to 50% of the fish) identified in Table 41 for each program for 3 of the next 5 years. NMFS will begin calculating each five-year running medians beginning in 2018 with data from 2018 to 2022. Beginning in 2018, the annual travel time will be used, and averaged in each successive year, until a five-year running average is established. This is a reasonable, reliable, and measurable surrogate for incidental take because if travel rate is five days more than previous estimates, it is a sign that fish are not migrating as quickly as expected, and therefore the expected take from interactions has likely been exceeded as a result of greater overlap between hatchery and natural-origin fish. This threshold will be monitored using emigration estimates from PIT tags, screw traps, or other juvenile monitoring techniques developed by the operators and approved by NMFS.

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

For take associated with residualism (non-migrants), the take surrogate is the percentage of spring/summer Chinook salmon from the pending release that are either precociously maturing or precociously mature prior to release (based on visual observation). This surrogate has a rational connection to the amount of take expected from residualism because precocious spring/summer Chinook salmon may remain in the system after release from the hatchery, leading to take from competition and predation as well as genetic effects from residual fish spawning naturally. NMFS considers, for the purpose of this take surrogate, that no more than five percent of program fish should be visibly precociously mature, using a running five-year average beginning with the 2018 release. Furthermore, no more than five percent of program fish should be precociously mature in any one year. The take surrogate can be reliably measured and monitored through assessment of precocious maturation rates prior to release. This assessment relies on visual observation at pre-release sampling with a reasonable sample size determined by hatchery staff.

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

Take associated with research, monitoring, and evaluation is summarized in Table 51.

Table 52. Incidental capture and mortality of all SR Steelhead resulting from RM&E activities (e.g., screw traps). Capture, handling, and sampling is considered direct take.

Program	Species and origin	Maximum number of juveniles captures with incidental mortality in parenthesis	Maximum number of juveniles marked with incidental mortality in parenthesis	Total. Adult Equivalents
Yankee Fork	SR Basin Steelhead, Natural-Origin	10,500 (53)	5,500 (55)	64 (1)
	SR Basin Steelhead, Hatchery-Origin	2,500 (13)	0	10 (0)
Panther Creek	SR Basin Steelhead, Natural-Origin	10,500 (53)	5,500 (55)	64 (1)

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

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

Construction impacts

Based on the probability that, during the construction phase of the proposed action, some numbers of spring/summer Chinook salmon and steelhead will be in the action area, take of fish from both species is reasonably certain to occur. Take, during the construction phase of the proposed action, is expected to occur in three different forms: (1) capture of individual fish during worksite isolation and fish relocation, (2) death of fish that remain in the work area after worksite isolation, and (3) harm from exposure to increased suspended sediment in the action area.

Yankee Fork

Based on electrofishing surveys done at multiple sites by the SBT in Yankee Fork, the number of juvenile spring/summer Chinook salmon captured within one reach (approximately 300 feet section of stream approximately 15 feet wide) may be as high as 26 spring/summer Chinook salmon juveniles (Evans et al. 2016a). Because electrofishing an open channel may not be 100 percent efficient at collecting all juveniles present, NMFS expects it is possible that more fish may be present in the work area; however, NMFS does not believe that more than 52 juvenile spring/summer Chinook salmon are likely to be captured during isolation of the construction area. All fish affected would be captured, handled, and released, and up to ten percent (6 individuals) may die. In addition, it is possible, though unlikely, that fish that avoid capture may die in the isolated work area. NMFS estimates that fewer than 10 juvenile spring/summer Chinook salmon will remain in the work area after salvage efforts, all of which may die. Thus, the extent of expected take will be the number of juveniles (52) captured and relocated from the isolated work area, and those that may be killed (16), and will serve as a clear and observable threshold for reinitiating consultation.

In addition, some juvenile steelhead may be present that will be captured and released. According to the same electrofishing surveys, juvenile steelhead abundance is much lower than the spring/summer Chinook salmon abundance, and only 5 total individuals were captured across several sites (Evans et al. 2017b). Therefore, NMFS expects that no more than 5 juvenile steelhead are likely to be taken annually as a result of construction, including up to ten percent (1 individual) mortality. In addition, it is possible that up to two steelhead that avoid capture may be encountered and die annually in the isolated work area. These are observable thresholds for monitoring take.

Some take of juvenile spring/summer Chinook salmon and steelhead could occur as a result of the elevated turbidity during construction. This may not be reliably observed, and NMFS will therefore rely on a take surrogate consisting of the extent of the area impacted by elevated turbidity. This surrogate has a causal link to the take because the amount of habitat affected by turbidity correlates directly to the number of individuals impacted by it. We expect that the point where suspended sediment is will drop back to background levels will be no more than 300 feet downstream on the active work area. This will include the entire width of stream channel downstream from the active work area. This surrogate can be reliably monitored and measured by visual observations of turbidity downstream of the construction site.

Panther Creek

Based on electrofishing surveys done at multiple sites by the SBT in Panther Creek, juvenile spring/summer Chinook salmon within one reach (approximately 15 feet by 300 feet section) may be as high as 19 spring/summer Chinook salmon juveniles (Evans et al. 2016b). Because electrofishing an open channel may not be 100 percent efficient at collecting all juveniles present, NMFS expects it is possible that more fish may be present in the work area; however NMFS does not believe that more than 38 juvenile spring/summer Chinook salmon are likely to be captured during isolation construction area. All of these will be captured, handled, and released, and up to ten percent (4 individuals) may die. In addition, it is possible, though unlikely, that fish that avoid capture may die in the isolated work area. NMFS estimates that fewer than 10 juvenile spring/summer Chinook salmon will remain in the work area after salvage efforts, all of which may die. Thus, the extent of expected take will be the number of juveniles (38) captured and relocated from the isolated work area, and those that may be killed (14), Thus, the extent of expected take includes the number of juveniles captured and relocated from the isolated work area (38 handled, 4 of which may die), and the number estimated to remain in the work area after salvage (10, all of which may die). This total (38 handled, 14 mortalities) is observable for monitoring purposes.

In addition, some juvenile steelhead may be present that will be captured and released. During the same electrofishing surveys, juvenile steelhead abundance within one reach (approximately 15 feet by 300 feet section) may be as high as 58 steelhead juveniles (Evans et al. 2016b). Because electrofishing an open channel may not be 100 percent efficient at collecting all juveniles present, NMFS expects it is possible that more fish may be present in the work area; however does not believe that more than 116 juvenile spring/summer Chinook salmon are likely to be captured during isolation construction area. All of these will be captured, handled, and released, and up to ten percent (12 individuals) may die. In addition, it is possible, though unlikely, that fish that avoid capture may die in the isolated work area. NMFS expects that fewer than 20 juvenile steelhead will remain in the work area after salvage efforts, all of which may die. Thus, the extent of expected take will be the number of juveniles (116) captured and relocated from the isolated work area, and those that may be killed (32), and will serve as a clear and observable threshold for reinitiating consultation. Because electrofishing allows for a count of the number of affected individuals, this estimate of take can be reliably monitored.

Some juvenile spring/summer Chinook salmon and steelhead will also be impacted by the elevated turbidity during construction. As described above (Section 2.5.2.5), we expect that the point where suspended sediment will drop back to background levels will be no more than 300 feet downstream on the active work area. Therefore, we will base the amount of take on the extent of habitat modified during construction, and take will be limited to that represented by the linear extent of habitat influenced by suspended sediment (no more than 300 feet downstream from the construction site). This surrogate can be reliably monitored and measured by visual observations of turbidity downstream of the construction site.

Operation impacts

During the annual operation and maintenance of intake and outfall structures, some numbers of spring/summer Chinook salmon and steelhead will be in the action area. Take of fish from both species is reasonably certain to occur in two different forms: (1) death of fish in the work area during maintenance; and (2) harm from exposure to increased suspended sediment in the action area. Because work will be conducted during in-water work windows, when fish are presence will be low, NMFS anticipates that fewer than 5 juvenile spring/summer Chinook salmon and 5 juvenile steelhead will be injured or killed during each maintenance activity.

Some juvenile spring/summer Chinook salmon and steelhead will also be impacted by the elevated turbidity during construction. As described above (Section 2.5.2.5), we expect that the point where suspended sediment will drop back to background levels will be no more than 300 feet downstream on the active work area. Therefore, we will base the amount of take on the extent of habitat modified during construction, and take will be limited to the linear extent of habitat influenced by suspended sediment (no more than 300 feet downstream from the construction site). This surrogate can be reliably monitored and measured by visual observations of turbidity downstream of the construction site.

Intake Screens and water withdrawal
All intakes are either screened to NMFS criteria, or will be evaluated for compliance. As a result, entrainment or impingement on screens is unlikely, and NMFS does not believe any take will occur from operation of existing screens at intakes.

Withdrawal of water may reduce the available habitat through reduction in stream depth or wetted width, which is related to the proportion of water withdrawn. Some individuals may be impacted by the proportional reduction in habitat, though most will avoid “harm” because withdrawals are small, and reductions in habitat will be too small to be perceived, or if it is perceptible, they may freely move to better habitat. Though we may be able to estimate the total number of juvenile fish that may present in the area between the intake and outfall, not all fish will perceive habitat loss. Furthermore, the specific number of individuals “harmed” from proportionally small water withdrawals cannot be accurately predicted, observed, or measured. Therefore, we will use a take surrogate consisting of the proportion of streamflow removed, which is related to the habitat modified during withdrawal. The extent of affected habitat is the linear distances of affected area, which is described along with the extent of time the impacts will last in Table 54. It is appropriate to quantify the extent of take based on the maximum proportion of water withdrawn from each stream because it reflects the extent of habitat modified in these circumstances.

Table 53. Extent of take (linear distance) for water withdrawals

Program and facility	Surface Water Use (cfs)	Water Diversion Distance	Surface water source	Use time	Maximum Proportional Withdrawal
Sawtooth (both components)	43cfs	1,480 m (4,855 feet)	Salmon River	Year Round	11%
Pahsimeroi Upper (rearing)	20cfs	230 m (755 feet)	Pahsimeroi River	Year Round	37%
Pahsimeroi Lower (adult holding)	40cfs	400 m (1,312 feet)	Pahsimeroi River	Year Round	
Yankee Fork Adult	10cfs	380 m (1,247 feet)	Yankee Fork	April - October	14%
Panther Creek Adult	11 cfs	380 m (1,247 feet)	Panther Creek (10 cfs), Dummy Creek (1 cfs)	April - October	30%

Panther Creek Juvenile	3 cfs	300 m (984 feet)	Panther Creek	April – October	

2.9.2. Effect of the Take

In Section 2.6, NMFS determined that the level of anticipated take, coupled with other effects of the Proposed Action, is not likely to jeopardize the continued existence of the Snake River Spring/summer Chinook Salmon ESU, Snake River Fall Chinook Salmon ESU, Snake River Sockeye Salmon ESU, and Snake River Basin Steelhead DPS or result in the destruction or adverse modification of their designated critical habitat.

2.9.3. 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, USFS, and the USFWS (i.e., LSRCP) shall ensure that:

1. BPA shall ensure that SBT's activities are consistent with the BPA-funded portion of the Proposed Action (Yankee Fork and Panther Creek).
2. The USFS shall ensure that Special Use Permits are consistent with the Yankee Fork and Panther Creek portions of the Proposed Action.
3. USFWS through LSRCP shall ensure that IDFG and SBT (current Yankee Fork program) activities are consistent with the LSRCP-funded portion of the Proposed Action (Sawtooth)
4. NMFS shall ensure that IDFG's activities are consistent with the IPC-funded portion of the Proposed Action
5. NMFS shall ensure that all applicants implement the hatchery programs and operate the hatchery facilities, including monitoring, as described in the Proposed Action (Section 1.3) and in the submitted HGMPs. The applicants provide reports to SFD annually for all hatchery programs, and associated RM&E.Terms and Conditions

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.

1. BPA shall take the following measures:
    a. Review and approve the SBT's activities as described in the contracts between BPA and SBT for the programs and activities in Yankee Fork and Panther Creek to ensure they are consistent with the BPA-funded portion of the Proposed Action.
    b. Provide advance notice to NMFS of any change in hatchery program operation (including early releases) that potentially increases the amount or extent of take, or results in an effect of take not previously considered
    c. Ensure there is an evaluation of weirs (either temporary or permanent) in conjunction with NMFS' engineer staff for compliance with NMFS' most recent screening criteria (NMFS 2011b) within one year of Opinion signature. If any structure is out of compliance, the applicants will develop a plan to bring the structure into compliance with current passage and screening criteria, or work with NMFS staff to improve operations design if needed to minimize or avoid take. If any modifications are needed, the plan will include a schedule for securing funding and an implementation timeline.
    d. Continue to work collaboratively with operators and other funders on weir/adult management in Yankee Fork and Panther Creek to ensure that the majority of the Chinook salmon run can be managed to program goals
    e. Ensure that applicants include in their annual report (outlined in 5.b. below) weir operation information including
        a. Weir efficiency
            i. Days of operation planned vs implemented
            ii. Proportion of run encountered
            iii. Any operational issues or breaks in weir fishing
    f. Observations of weir rejection, delay, or injury (based on recommendations from NMFS passage engineers)
    g. The number and origin (hatchery and natural) of each listed species handled and incidental mortality resulting from construction activities.

2. USFS shall take the following measures:
    a. Ensure that Special Use Permits issued for construction and/or operation of all facilities on USFS land are consistent with descriptions in the Proposed Action

3. USFWS through LSRCP shall take the following measures:
    a. Review IDFG's activities as described in the Annual Operating Procedures for the Sawtooth Hatchery program to ensure they are consistent with the LSRCP-funded portion of the Proposed Action
    b. Provide advance notice to NMFS of any change in hatchery program operation (including early releases) that potentially increases the amount or extent of take, or results in an effect of take not previously considered
    c. Ensure there is an evaluation of intake screens at Sawtooth hatchery in conjunction with NMFS' engineer staff for compliance with NMFS' most recent screening criteria (NMFS 2011b) within one year of Opinion signature, If any

structure is out of compliance, the applicants will develop a plan to bring the structure into compliance with current passage and screening criteria, or work with NMFS staff to improve operations design if needed to minimize or avoid take. If any modifications are needed, the plan will include a schedule for securing funding and an implementation timeline.

   d. Monitor passage between the weir and the hatchery water intake, to ensure fish are not delayed, and able to pass above the intake.

4. NMFS shall take the following measures:
   a. Review IDFG's activities as described in the Annual Operating Procedures for the Pahsimeroi Hatchery program to ensure they are consistent with the IPC-funded portion of the Proposed Action.
   b. Continue to work collaboratively with operators and other funders on weir/adult management in Yankee Fork and Panther Creek to ensure that the majority of the Chinook salmon run can be managed to program goals
   c. Ensure that the applicants provide advance notice of any change in hatchery program operation (including early releases) that potentially increases the amount or extent of take, or results in an effect of take not previously considered
   d. Ensure there is an evaluation of the adult weir and intake screens at Pahsimeroi in conjunction with NMFS' engineer staff for compliance with NMFS' most recent screening criteria (NMFS 2011b) within one year of Opinion signature. If either structure is out of compliance, the applicants will develop a plan to bring the structure into compliance with current passage and screening criteria, or work with NMFS staff to improve operations design if needed to minimize or avoid take. If any modifications are needed, the plan will include a schedule for securing funding and an implementation timeline.

5. NMFS shall ensure that:
   a. Applicants provide notice if monitoring reveals an increase in the amount or extent of take, or discovers an effect of the Proposed Action not considered in this opinion
   b. Applicants notify SFD within 48 hours after knowledge of exceeding any authorized take. Additionally, the applicants shall submit a written notification within two weeks of the event detailing why the authorized take was exceeded, and proposed changes to avoid exceeding take in future operations.
   c. Reports for all four programs, along with other required notifications, are submitted by applicants electronically to NMFS, West Coast Region, Sustainable Fisheries Division, APIF by March 31st of the year following release (e.g., brood year 2015, release year 2016, report due March 2017)
   d. Annual reports to SFD for hatchery programs should include:
      b. The number and origin (hatchery and natural) of each listed species handled and incidental mortality across all activities
      c. Hatchery Environment Monitoring Reporting
         i. Number and composition of broodstock, and dates of collection

ii. Numbers, pounds, dates, locations, size (and coefficient of variation), and tag/mark information of released fish
iii. Survival rates of all life stages (i.e., egg-to-smolt; smolt-to-adult)
iv. Disease occurrence at hatcheries
v. Precocious maturation rates prior to release
vi. Any problems that may have arisen during hatchery activities
vii. Any unforeseen effects on listed fish

d. Natural Environment Monitoring Reporting

i. The number of returning hatchery and natural-origin adults
ii. The number and species of listed fish encountered at each adult collection location, and the number that die
iii. Distribution of hatchery- and listed natural-origin spawners
iv. The contribution of fish from these programs into ESA-listed populations, as determined through standard infrastructure or sampling protocols
v. Post-release out-of-basin migration timing of juvenile hatchery-origin fish through Snake River and Columbia River dams.
vi. Mean length, coefficient of variation, number, and age of natural-origin juveniles

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

All reports, along with other required notifications, should be submitted by applicants electronically to NMFS, West Coast Region, Sustainable Fisheries Division, APIF Program. The current point of contact for document submission is Brett Farman brett.farman@noaa.gov, 503-231-6222).

2.10. Conservation Recommendations

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

1. For the Yankee Fork and Panther Creek weirs, NMFS recommends that the BPA and/or LSRCP ensure that infrastructure on both Yankee Fork and Panther Creek maintain efficiency managing pHOS and broodstock collection for the programs, and can be installed and operated in a way that is safe for staff.

2. For the Pahsimeroi program, NMFS recommends that the IDFG continue to pursue options to use integrated returns (similar to Sawtooth) in the segregated program component to continue increasing PNI over time.

2.11. Reinitiation of Consultation

This concludes formal consultation on the authorization, funding, and operation of four Salmon River basin spring/summer Chinook salmon hatchery programs in the upper Salmon River Basin of Idaho.

As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the agency action is subsequently modified in a manner that causes an effect on the listed species or critical habitat that was not considered in this opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

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

If the amount or extent of take considered in this opinion is exceeded, NMFS may reinitiate consultation. SFD will consult with the operators to determine specific actions and measures that can be implemented to address the take or implement further analysis of the impacts on listed species.

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 2014) contained in the fishery management plans developed by the Pacific Fishery Management Council (PFMC) and approved by the Secretary of Commerce.

3.1. Essential Fish Habitat Affected by the Project

The Proposed Action is described in Section 1.3, above, with underlying effects accruing from the implementation of four spring/summer Chinook salmon hatchery programs in the upper Salmon River basin of Idaho. The Action Area (Section) of the Proposed Action includes habitat described as EFH for Chinook salmon (PFMC 2014a; 2014b) 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 salmon.

As described by (PFMC 2014b), the freshwater EFH for Chinook 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. HAPCs 1, 2, and 3 are potentially affected by the Proposed Action.

3.2. Adverse Effects on Essential Fish Habitat

The Proposed Action has small effects on Chinook salmon EFH. These effects would result from operation and existence of associated structures—weirs, water withdrawal, water withdrawal structures, effluent, and maintenance and construction—and genetic and ecological interactions of the hatchery-reared fish with natural fish in the natural environment.

As described in Section 2.6.2.5, water withdrawal for hatchery operations can adversely affect salmon by reducing streamflow, impeding migration, or reducing other stream-dwelling organisms that could serve as prey for juvenile salmonids. Water withdrawals can also kill or injure juvenile salmonids through impingement upon inadequately designed intake screens or by entrainment of juvenile fish into the water diversion structures. The proposed hatchery programs include designs to minimize each of these effects. In general, water withdrawals are small enough in scale that changes in flow would be undetectable, and impacts would not occur. Additionally, the action includes minor modifications to channel habitat by construction and operation of weirs for adult management and short-term impairment of water quality. Impacts on water quality will be short-lived, and will not alter the function or usability of habitat once turbidity subsides. Changes to stream substrate from weir construction are minor, and do not occur in areas where spawning substrate is limited.

The PFMC (2003) recognized concerns regarding the "genetic and ecological interactions of hatchery and wild fish… [which have] been identified as risk factors for wild populations." The biological opinion describes in considerable detail the impacts hatchery programs might have on natural populations of Chinook salmon (Section 2.6.2.2; Appendix A). Ecological effects of juvenile and adult hatchery-origin fish on natural-origin fish are discussed in Sections 2.6.2.2 and 2.6.2.3. Hatchery fish returning to the Lower Salmon River Subbasin are expected to largely spawn and rear near the hatchery, and not enter areas that are identified as EFH for other species outside of the Upper Salmon River. Some spring/summer Chinook salmon from the programs could stray into other rivers but because straying is low from these programs, it is assume that these few strays would not exceed the carrying capacities of natural production areas, or that would result in increased incidence of disease or predators. Predation by adult hatchery spring/summer Chinook salmon on juvenile natural-origin Chinook salmon has been analyzed in Section 2.6.2.2, with the result that impacts are small (around 2 percent).

NMFS has determined that the Proposed Action is likely to adversely affect EFH for Pacific salmon, specifically through operation and existence of associated structures—weirs, water withdrawal, water withdrawal structures, effluent, and maintenance and construction—and genetic and ecological interactions of the hatchery-reared fish with natural fish in the natural environment, affecting complex channels and floodplain habitat; thermal refugia, and spawning habitat.

3.3. Essential Fish Habitat Conservation Recommendations

For each of the potential adverse effects by the Proposed Action on EFH for Chinook salmon, NMFS believes that the Proposed Action, as described in the HGMPs and the ITS (Section 2.10), includes the best approaches to avoid or minimize those adverse effects. NMFS believes that the Reasonable and Prudent Measures and Terms and Conditions included in the ITS sufficiently address potential EFH effects. Specifically, implementing construction BMPs, monitoring and addressing passage concerns at existing facilities, and reporting program compliance will avoid or minimize adverse effects to Critical Habitat. Thus, NMFS has no additional conservation recommendations for Chinook salmon EFH.

3.4. Statutory Response Requirement

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

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

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

3.5. Supplemental Consultation

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

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

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

4.1. Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users are NMFS, BPA, LSRCP, USFS, BIA, and the program operators and their co-operators. Other interested users could include the scientific community, resource managers, and stakeholders, who could benefit from the consultation through the anticipated increase in returns of salmonids, and through the collection of data indicating the potential effects of the operation on the viability of natural populations of ESA-listed salmon and steelhead in the Upper Columbia River Basin. This information will improve scientific understanding of hatchery salmon and steelhead effects that can be applied broadly within the Pacific Northwest area for managing benefits and risks associated with hatchery operations. This opinion will be posted on the Public Consultation Tracking System website (*https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts*). 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 and 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 53. Generally speaking, effects range from beneficial to negative when programs use local fish[7] for hatchery broodstock, and from negligible to negative when programs do not use local fish for broodstock[8]. Hatchery programs can benefit population viability, but only if they use genetic resources that represent the ecological and genetic diversity of the target or affected natural population(s). When hatchery programs use genetic resources that do not represent the ecological and genetic diversity of the target or affected natural population(s), NMFS is particularly interested in how effective the program will be at isolating hatchery fish and at avoiding co-occurrence and effects that potentially disadvantage fish from natural populations. NMFS applies available scientific information, identifies the types of circumstances and conditions that are unique to individual hatchery programs, then refines the range in effects for a specific hatchery program. Analysis of a Proposed Action for its effects on ESA-listed species and on designated critical habitat depends on six factors. These factors are:

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

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

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

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

[7] 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).
[8] Exceptions include restoring extirpated populations and gene banks.

steelhead DPS recovery, the target viability for the affected natural population(s), and the environmental baseline including the factors currently limiting population viability.

Table 54. 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 2004).	**Negligible to negative effect** Productivity is dependent on differences between hatchery fish and the local natural population (i.e., the more distant the origin of the hatchery fish, the greater the threat), the duration and strength of selection in the hatchery, and the level of isolation achieved by the hatchery program (i.e., the greater the isolation, the closer to a negligible effect).
Diversity	**Positive to negative effect** Hatcheries can temporarily support natural populations that might otherwise be extirpated or suffer severe bottlenecks and have the potential to increase the effective size of small natural populations. On the other hand, broodstock collection that homogenizes population structure is a threat to population diversity.	**Negligible to negative effect** Diversity is dependent on the differences between hatchery fish and the local natural population (i.e., the more distant the origin of the hatchery fish, the greater the threat) and the level of isolation achieved by the hatchery program (i.e., the greater the isolation, the closer to a negligible effect).
Abundance	**Positive to negative effect** Hatchery-origin fish can positively affect the status of an ESU by contributing to the abundance of the natural populations in the ESU (70 FR 37204, June 28, 2005, at 37215). Increased abundance can also increase density dependent effects.	**Negligible to negative effect** Abundance is dependent on the level of isolation achieved by the hatchery program (i.e., the greater the isolation, the closer to a negligible effect), handling, RM&E, and facility operation, maintenance and construction effects.
Spatial Structure	**Positive to negative effect** Hatcheries can accelerate re-colonization and increase population spatial structure, but only in conjunction with remediation of the factor(s) that limited spatial structure in the first place. "Any benefits to spatial structure over the long term depend on the degree to which the hatchery stock(s) add to (rather than replace) natural populations" (70 FR 37204, June 28, 2005 at 37213).	**Negligible to negative effect** Spatial structure is dependent on facility operation, maintenance, and construction effects and the level of isolation achieved by the hatchery program (i.e., the greater the isolation, the closer to a negligible effect).

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

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

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

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

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

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

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

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

5.3. Genetic effects

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

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

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

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; 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 (Grant 1997; Quinn 1997; Jonsson et al. 2003; Goodman 2005), 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)[9] 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 (Saisa et al. 2003; Blankenship et al. 2007). 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

[9] 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 (Reisenbichler and McIntyre 1977; Leider et al. 1990; 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 (Lynch and O'Hely 2001; Ford 2002), 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; Theriault et al. 2011; Ford et al. 2012; Hess et al. 2012). 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[10]. 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)[11]. 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 2009b). 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.

[10] 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.

[11] 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 of 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 2009b), 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 2009b) 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[12]. 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.

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

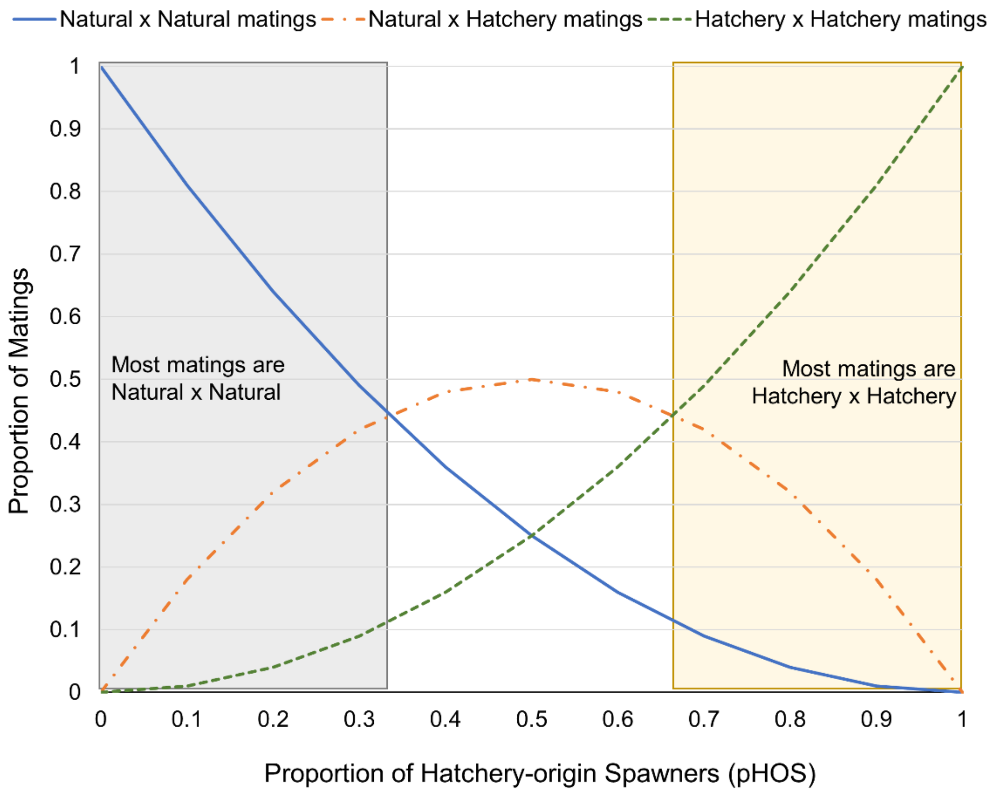

Figure 9. Relative proportions of types of matings as a function of proportion of hatchery-origin fish on the spawning grounds (pHOS).

5.4. 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 (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 superimpose or destroy the eggs and embryos of ESA-listed species when there is spatial overlap between hatchery and natural spawners. Redd superimposition has been shown to be a cause of egg loss in pink salmon and other species (e.g., Fukushima et al. 1998).

5.5. Adult Collection Facilities

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

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

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

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

5.7. 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, and take up residency before naturally produced fry emerge from redds, and residualize. Hatchery fish might alter natural-origin salmon behavioral patterns and habitat use, making natural-origin fish more susceptible to predators (Hillman and Mullan 1989; Steward and Bjornn 1990). Hatchery-origin fish may also alter natural-origin salmonid migratory responses or movement patterns, leading to a decrease in foraging success by the natural-origin fish (Hillman and Mullan 1989; Steward and Bjornn 1990). Actual impacts on natural-origin fish would thus depend on the degree of dietary overlap, food availability, size-related differences in prey selection, foraging tactics, and differences in microhabitat use (Steward and Bjornn 1990).

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

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

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

A proportion of the smolts released from a hatchery may not migrate to the ocean but rather reside for a period of time in the vicinity of the release point. These non-migratory fish (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 (Steward and Bjornn 1990; California HSRG 2012)
- 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,[13] including the distribution of spawning and rearing habitat by quality and best estimates for spawning and rearing habitat capacity. Additional important information includes the abundance, distribution, and timing for naturally spawning hatchery fish and natural-origin fish; the timing of emergence; the distribution and estimated abundance for progeny from both hatchery and natural-origin natural spawners; the abundance, size, distribution, and timing for juvenile hatchery fish in the action area; and the size of hatchery fish relative to co-occurring natural-origin fish.

5.8. 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

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

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

- Releasing all hatchery fish as actively migrating smolts through volitional release practices so that the fish migrate quickly seaward, limiting the duration of interaction with any co-occurring natural-origin fish downstream of the release site.
- Ensuring that a high proportion of the population have physiologically achieved full smolt status. Juvenile salmon tend to migrate seaward rapidly when fully smolted,

limiting the duration of interaction between hatchery fish and naturally produced fish present within, and downstream of, release areas.
- Releasing hatchery smolts in lower river areas near river mouths and below upstream areas used for stream-rearing young-of-the-year naturally produced salmon fry, thereby reducing the likelihood for interaction between the hatchery and naturally produced fish.
- Operating hatchery programs and releases to minimize the potential for residualism.

5.9. 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 (Steward and Bjornn 1990; Naish et al. 2008). 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; ODFW 2003; 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 non-reportable, pathogen spread and amplification are minimized through regular monitoring (typically monthly) removing mortalities, and disinfecting all eggs. Vaccines may provide additional protection from certain pathogens when available (e.g., *Vibrio anguillarum*). If a pathogen is determined to be the cause of fish mortality, treatments (e.g., antibiotics) will be used to limit further pathogen transmission and amplification. Some pathogens, such as *infectious hematopoietic necrosis virus* (IHNV), have no known treatment. Thus, if an epizootic occurs for those pathogens, the only way to control pathogen amplification is to cull infected individuals or terminate all susceptible fish. In addition, current hatchery operations often rear hatchery fish on a timeline that mimics their natural life history, which limits the presence of fish susceptible to pathogen infection and prevents hatchery fish from becoming a pathogen reservoir when no natural fish hosts are present.

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

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

5.10. 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 (Quinn 1997; Dunnigan 1999; 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 (Hoar 1976; Beckman et al. 2000). 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 (Fulton and Pearson 1981; Quinn 1997; Hard and Heard 1999; Bentzen et al. 2001; Kostow 2009; 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., (Kenaston et al. 2001; Clarke et al. 2011).

Increasing the likelihood that 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 encouraging the hatchery fish to home to a particular location, those fish can be removed (e.g., through fisheries, use of a weir) or they can be isolated from primary spawning areas. Factors that can affect the success of homing include:

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

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

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

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

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

5.12. Observing/Harassing

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

5.13. Capturing/handling

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

5.14. 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 (Reimchen and Temple 2003; Buckland-Nicks et al. 2011).

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 and Park 1984; Prentice et al. 1987; 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 can be either acute (occurring during or soon after tagging) or 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; 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. 2008b).

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

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

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

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

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

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

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

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