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

Six Lower Snake River Spring/Summer Chinook Salmon Hatchery Programs

NMFS Consultation Number: WCR-2013-21

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

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 basin steelhead (*O. mykiss*) | Threatened | Yes | No | No |
| Snake River fall Chinook salmon (*O. tshawytscha*) | Threatened | No* | No | No |
| Snake River sockeye salmon (*O. nerka*) | Endangered | No | No | No |

*The overlapping LAA on Snake River Fall Chinook salmon from monitoring activities were covered in the Biological Opinion for the ESA section 10 permits for the Snake River Fall Chinook salmon hatchery programs (NMFS Consultation # 2011/03947 and 2011/03948)

| 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:

for William W. Stelle, Jr.
Regional Administrator

Date: June 24, 2016

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## TABLE OF CONTENTS

**Table of Tables**

## Table of Figures

## 1. INTRODUCTION

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

The underlying activities that drive the Proposed Actions are the operation and maintenance of six hatchery programs rearing and releasing Snake River spring/summer Chinook salmon in the Snake River basin – specifically, the Catherine Creek, Upper Grande Ronde River, Lookingglass Creek, Lostine River, Imnaha River, and Tucannon River Hatchery programs.

There are three action agencies:

- The Proposed Action for the National Marine Fisheries Service (NMFS) is the issuance of six Endangered Species Act (ESA) section 10(a)(1)(A) permits for the enhanced propagation and survival of Snake River spring/summer Chinook salmon by those programs.
- The Proposed Action for the Bonneville Power Administration (BPA) is the funding under the Pacific Northwest Power Planning and Conservation Act of 1980, 16 U.S.C. §§ 839 et seq. (Northwest Power Act) of the operation and maintenance of the Upper Grande Ronde River Adult Trap and Juvenile Acclimation Facilities, Catherine Creek Adult Trap and Juvenile Acclimation Facilities, the Lostine River Adult Trap and Juvenile Acclimation Facilities, and spawning and rearing activities at Lookingglass Fish Hatchery. BPA also funds a safety net program for the Upper Grande Ronde population and various monitoring and evaluation (M&E) programs within the Grande Ronde River Basin.
- The Proposed Action for the U.S. Fish and Wildlife Service (USFWS) is the funding of the operation and maintenance, and monitoring and evaluation of those programs through the Lower Snake River Compensation Plan (LSRCP), which is approved by the Water Resources Development Act of 1976, (Public Law 94-587, Section 102, 94$^{th}$ Congress).

The hatchery programs are operated by state and/or tribal agencies as described below. Each program is described in detail in a Hatchery and Genetic Management Plan (HGMP), which was submitted to (NMFS) for review. All programs are designed to supplement natural-origin populations of Snake River spring/summer Chinook salmon listed under the ESA. Snake River basin steelhead, sockeye salmon, and fall Chinook salmon may be present within the action area, and are potentially affected by the hatchery programs.

The type and purpose of each of the hatchery programs is described in Section 1.6 and Section 1.7 of each (HGMP). All programs are founded from, and integrated[1] with, the natural population (except for the Lookingglass Creek spring/summer Chinook salmon program initiated with an adjacent local stock to re-establish a population that was extirpated), and are intended to: establish, supplement, or support local natural populations; mitigate under the LSCRP for fish losses caused by the construction and operation of the four Lower Snake dams; and provide harvest benefits. Additional funding comes from BPA in fulfilling their Northwest Power Act

[1]These terms are defined in Section 2.4.1. Integrated hatchery programs are reproductively connected with the natural population, are included in an ESU, and contain genetic resources that represent the ecological and genetic diversity of the ESU.

responsibilities to protect, mitigate and enhance anadromous salmon affected by the Federal Columbia River Power System dams.

Table 1. Programs included in the Proposed Action.

| Program | HGMP Receipt | Program Operator(s)* | Funding Agency(s) |
|---|---|---|---|
| Catherine Creek spring/summer Chinook salmon | May 2, 2011 | ODFW and CTUIR | USFWS** and BPA |
| Upper Grande Ronde River spring/summer Chinook salmon | July 15, 2011 | CTUIR and ODFW | USFWS** and BPA |
| Imnaha River spring/summer Chinook salmon | May 2, 2011 | ODFW | USFWS** |
| Lookingglass Creek spring Chinook salmon | January 23, 2012 | ODFW and CTUIR | USFWS** and BPA |
| Lostine spring/summer Chinook salmon | May 27, 2011 | NPT and ODFW | USFWS** and BPA |
| Tucannon River Endemic Spring Chinook salmon | August 8, 2011 | WDFW | USFWS** |

*Primary operators are listed, but all programs are coordinated between States, Tribes, and Federal agencies collectively. Operators are Oregon Department of Fish and Wildlife (ODFW), Confederated Tribes of the Umatilla Indian Reservation (CTUIR), Nez Perce Tribe (NPT), and the Washington Department of Fish and Wildlife (WDFW).

**The USFWS is the funding agency through the Lower Snake River Compensation Plan (LSRCP); the Bonneville Power Administration (BPA).

## 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, and the BPA and the USFWS.

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

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

## 1.2. Consultation History

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

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

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

The increase in ESA listings during the mid to late 1990s triggered a period of investigation, planning, and reporting across multiple jurisdictions and this served to complicate, at least from a resources and scheduling standpoint, hatchery consultations. A review of Federal funded hatchery programs ordered by Congress was underway at about the same time that the 2000 Federal Columbia River Power System (FCRPS) opinion was issued by NMFS (NMFS 2000). The Northwest Power and Conservation Council (Council) was asked to develop a set of coordinated policies to guide the future use of artificial propagation, and RPA 169 of the FCRPS opinion called for the completion of NMFS-approved hatchery operating plans (i.e., HGMPs) by the end of 2003. The RPA required the Action Agencies to facilitate this process, first by assisting in the development of HGMPs, and then by helping to implement identified hatchery reforms (NMFS 2001). Also at this time, a new *U.S. v. Oregon* Columbia River Fisheries Management Plan (CRFMP), which included goals for hatchery management, was under negotiation and new information and science on the status and recovery goals for salmon and steelhead was emerging from Technical Recovery Teams (TRTs). Work on HGMPs under the FCRPS opinion was undertaken in cooperation with the Council's Artificial Production Review and Evaluation process, with CRFMP negotiations, and with ESA recovery planning (Foster 2004; Jones 2002). HGMPs were submitted to NMFS under RPA 169; however, many were incomplete and, therefore, were not found to be sufficient[2] for ESA consultation.

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

On May 5, 2008, NMFS published a Supplemental Comprehensive Analysis (SCA) (NMFS 2008e) and an opinion and RPAs for the FCRPS to avoid jeopardizing ESA-listed salmon and steelhead in the Columbia Basin (NMFS 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 7consultation, 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 2008).

[2] "Sufficient" means that an HGMP meets the criteria listed at 50 CFR 223.203(b)(5)(i), which include (1) the purpose of the hatchery program is described in meaningful and measureable terms, (2) available scientific and commercial information and data are included, (3) the Proposed Action, including any research, monitoring, and evaluation, is clearly described both spatially and temporally, (4) application materials provide an analysis of effects on ESA-listed species, and (5) preliminary review suggests that the program has addressed criteria for issuance of ESA authorization such that public review of the application materials would be meaningful.

NMFS also “promised to share key considerations in analyzing HGMPs” and provided those materials to interested parties in February 2009 (Jones 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 six Chinook salmon hatchery programs is based on a series of documents submitted to NMFS by the co-managers and the funding agencies. The co-managers have shared several drafts of the HGMPs since 2002. Minor program changes occurred as run sizes increased, regional hatchery reviews took place, and agreements were reached through forums such as *U.S. v. Oregon*. Multiple informal reviews of draft HGMPs occurred, and in the spring and summer 2011, co-managers submitted final HGMPs for formal consultation (Table 1).

Once submitted, NMFS reviewed the HGMPs for sufficiency, and issued letters indicating that the HGMPs were sufficient for consultation (Jones Jr. 2011a; Jones Jr. 2011b; Jones Jr. 2011c; Jones Jr. 2011d; Jones Jr. 2011e; Jones Jr. 2012). Two HGMPs (Imnaha and Tucannon) required additional changes to their adult management protocols. During formal ESA consultation, NMFS received additional information and analyses for the Imnaha and Tucannon programs that revised adult management protocols. Modifications to the Proposed Actions under consideration required that consultation be delayed until the adult management protocols were finalized. Because NMFS batched these programs based on both geography and relatedness, all six programs were placed on hold pending project updates.

Revisions to the adult management protocol for the Tucannon HGMP were provided on January 30, 2013, and several times through 2014 and into 2015 for informal review. In October 2014, the co-managers agreed to a protocol that reduced the number of adults needed for broodstock based on female fecundity. In February 2015, the co-managers indicated that the revised protocol would be implemented in most years, but the original protocol submitted in January 2013 would be used during years when adult returns were low. The WDFW also added adult tagging at the Tucannon weir to determine adult movement patterns, and identify where adults are delayed or drawn away from the spawning grounds.

The Imnaha HGMP identifies problems with the weir that have made it difficult or impossible for co-managers to meet adult management goals in most years (ODFW 2011b). The current weir cannot be installed during high flows because of employee safety and infrastructure limitations. As a result, early arriving adults cannot be collected for broodstock or adult management goals. The HGMP for the Imnaha program includes a commitment to correct the weir issues within three years, or develop alternatives that ensure the adult management goal is met in the interim.

There was also a discussion over the proper interpretation of management above the weir. The discussion considered whether (1) management of the total proportion of hatchery origin spawners (pHOS) above the weir (accounting for fish passage prior to weir installation), or (2) a simplified method of proportional passage of only the adults that are handled at the weir (disregarding fish that may escape the weir and trap) was intended. In December 2013, all parties agreed that the intent was managing for total above-weir pHOS (Farman 2013).

Based on information in the Imnaha HGMP and monitoring data available during consultation, NMFS expressed concern that the program goals have not been met in recent years. In response, the co-managers indicated that the available data may have inconsistencies, and offered to provide a retrospective analysis of program performance. In May 2014, NMFS agreed to hold the consultation, and wait for new information on program performance. NMFS also indicated that a change in program implementation would be needed to proceed with the consultation if program targets have been routinely missed.

In March 2015, the co-managers submitted an addendum to the HGMP with program performance data (ODFW and NPT 2015). The addendum confirmed that adult management goals were not met between 2007 and 2013. The addendum highlighted the difficulties in forecasting and weir inefficiency as primary factors in missing program targets. The addendum also relied primarily on the construction of the new weir that would allow managers to capture and handle a larger proportion of the run. NMFS was concerned that no change in management was proposed; many of the forecasting difficulties remained unchanged, and the efficiency of the future weir was unknown.

In response, NMFS developed a simplified approach to adjust passage at the weir based on historical run timing. The co-managers disapproved of the approach, and suggested that the new weir would allow them to manage pHOS effectively. Because the co-managers made the explicit commitment to meet the adult management goals, and with the new weir, weir efficiency should improve, NMFS decided to proceed with the consultation without any changes in management.

On April 30, 2013, a new proposal was submitted with preliminary designs to upgrade the Imnaha weir. Once designs were complete enough for review, NMFS visited the site on September 10, 2013. A final design was submitted on January 30, 2015, for review. NMFS issued a letter on March 16, 2015 (Busack 2015), concurring with the USFWS determination that the weir was consistent with an existing consultation, and construction was scheduled to proceed in the fall of 2015. Though not all passage criteria could be met (because of site limitations), NMFS' environmental services branch granted a waiver (within the Busack 2015 letter) to proceed with weir construction. New weir construction began in October 2015 and the weir is expected to be operational by the time broodstock are collected for the 2016 season.

This consultation evaluates the effects of the six hatchery programs on Snake River spring/summer Chinook salmon and Snake River steelhead listed under the ESA, and their designated critical habitat. It also evaluates the effect of the programs on Essential Fish Habitat 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. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration. NMFS has not identified any interdependent or interrelated activities associated with the proposed action (see section 1.5, below). For EFH consultation, "Federal action" means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a Federal Agency (50 CFR 600.910). The Proposed Action is the issuance of six section 10(a)(1)(A) permits for the operation of six hatchery programs that produce ESA-listed Snake River spring/summer Chinook salmon by NMFS, and the funding of the programs by the BPA, either directly or through the USFWS LSRCP.

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

The objective of this opinion is to determine the likely effects on ESA-listed Snake River spring/summer Chinook salmon and steelhead resulting from NMFS' issuance of these permits. This opinion will determine if the actions proposed by the operators comply with the provisions of section 10(a)(1)(A) of the ESA. Specifically, the hatchery programs must operate "for scientific purposes or to enhance the propagation or survival of the affected species." NMFS considers enhancing the propagation or survival of the affected species to mean improving the viability status of the species (McElhany et al. 2000) and/or reducing the species extinction risk.

This opinion will also determine if the incidental take resulting from the proposed hatchery programs is likely to jeopardize the continued existence of or result in the destruction or adverse modification of designated critical habitats for the Snake River Spring/summer Chinook Salmon ESU or Snake River Steelhead DPS. The Snake River Fall Chinook Salmon ESU and the Snake River Sockeye Salmon ESU are not likely to be adversely affected by the proposed action because they have minimal temporal and spatial overlap with spring/summer Chinook (Section 2.11).

The duration of the Proposed Action is 11 years. The permits would remain valid beyond the *U.S. v. Oregon* Management Agreement expiration date of December 31, 2017. This would allow managers to continue operations during the renewal of that agreement, and any program modifications as a result of that process can be considered during permit renewal.

More information on the management of each program follows in the description below.

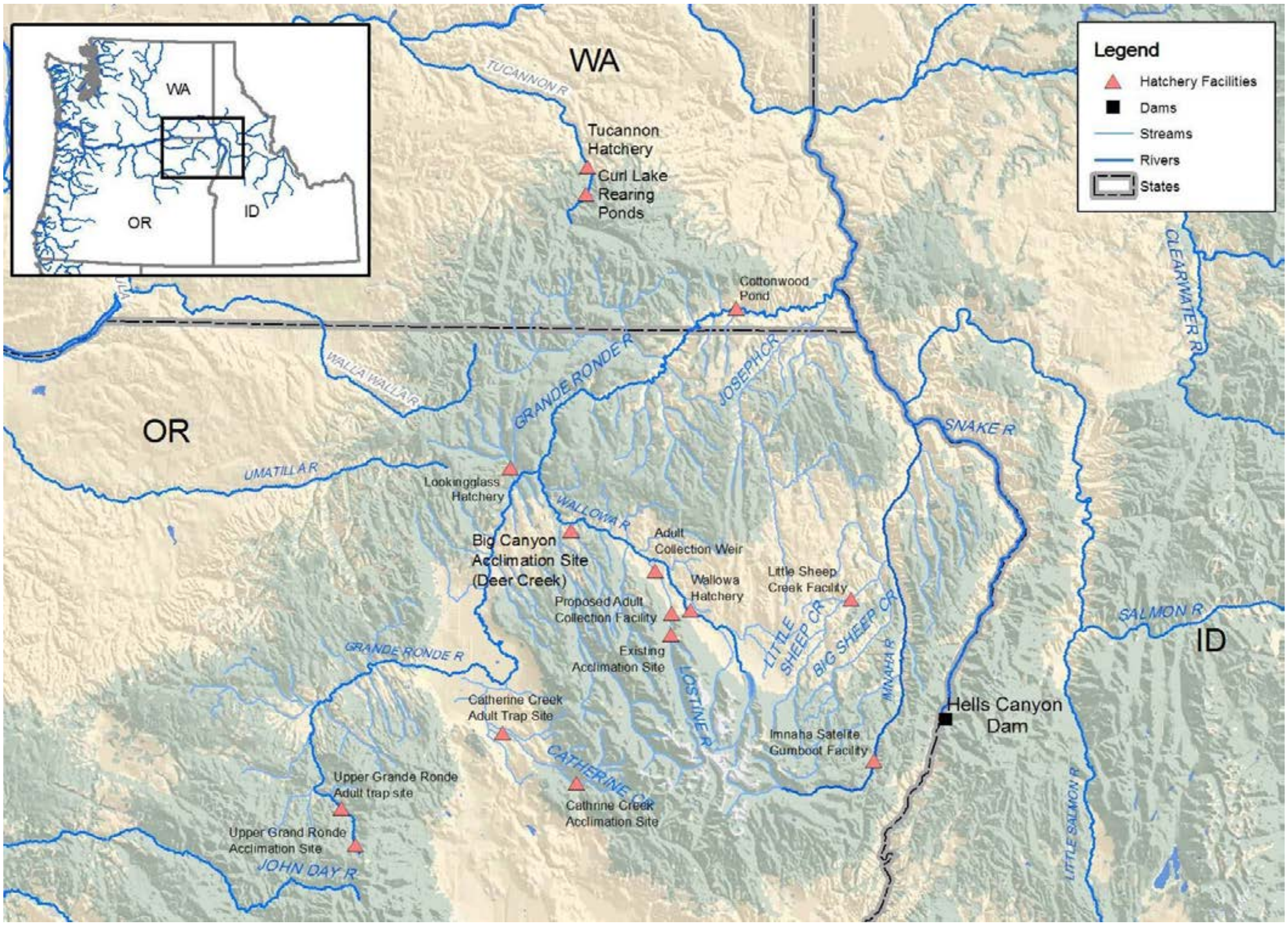

Figure 1. Location of facilities used by the six Chinook salmon hatchery programs.

### 1.3.1. Proposed hatchery broodstock collection and mating

All six programs intend to trap and handle 100 percent of both natural- and hatchery-origin spring/summer Chinook salmon returning to the basin. Broodstock will be collected throughout the entire return to ensure a representative sample. Disposition of adults (passage, collection, or transport) would be decided based on the pass: keep schedule and sliding scales in Tables 3-8.

Table 2. Broodstock collection plans for six hatchery programs in N.E. Oregon & S.E. Washington.

| Program | Broodstock origin | Broodstock Collection Location | Broodstock Collection Method | Broodstock Collection Number | Collection Duration | pHOS/pNOB |
|---|---|---|---|---|---|---|
| Lookingglass | Catherine Creek (hatchery-origin) | Primary- Lookingglass Creek Secondary- Catherine Creek | Removable weir directs fish into hatchery trap and ladder | 170 | May 1- Sept. 15 | Pass/keep schedule: see Table 3 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Catherine Creek | Catherine Creek (natural-origin) | Catherine Creek | Permanent weir directs fish into ladder and trap | 100 | May 1-Aug. 15 | Sliding scale: see Table 4 |
| Grande Ronde | Grande Ronde River (natural-origin) | Grande Ronde River | Removable weir and trap | 178 | Apr. 1-Aug. 15 | Sliding scale: see Table 5 |
| Imnaha | | Imnaha River | Removable weir directs fish into hatchery ladder and trap | 342 | May 1-Sep. 21 | Sliding scale: see Table 6 |
| Lostine | Lostine River (natural-origin) | Lostine River | Permanent weir and trap | 142 | Apr. 15-Sep. 31 | Sliding scale: see Table 7 |
| Tucannon | Tucannon River (natural-origin) | Tucannon River | Removable weir panels directs fish into hatchery ladder and trap | 170 | May 1-Sep. 30 | Sliding scale: see Table 8 |

All six programs target a 1:1 female to male ratio. Mating is conducted using matrix-spawning protocols where each fish may be crossed with multiple fish of the opposite sex. For most programs, size selective mating is proposed for both large and small male returns. Large males (over 80 cm) would be prioritized for use to fertilize 30 percent of the broodstock, while small males (under 60 cm) would be limited to fertilizing no more than 10 percent of the available eggs. Additionally, small males may be combined to fertilize a single female's eggs.

All spawned females are tested for Bacterial Kidney Disease, and a subset are also sampled for viral pathogens. Groups that test positive may be destroyed if they pose a risk to other fish in the hatchery (IHOT 1995; Pacific Northwest Fish Health Protection Committee (PNFHPC) 1989).

The Grande Ronde spring/summer Chinook salmon program is currently operated as a conventional program in which adults returning to the basin are collected for broodstock. A second program,  a safety-net captive broodstock production program for the Upper Grande Ronde River, was phased out in 2015, but could be reinitiated in the future by rearing 300 eggs annually from the conventional and rearing them to  maturity in captivity. Captive rearing maximizes smolt-to-adult survival, and provides a genetic reserve for both the wild and hatchery populations in extremely low return years. The eggs represent all families spawned in the conventional program to provide as much genetic variability as possible. All safety-net program broodstock would be marked with an adipose fin clip.

Table 3. Pass/keep management plan for Lookingglass Chinook salmon hatchery program (ODFW 2012). All criteria are based on total escapement (hatchery and natural).

| Escapement Level | % Total Escapement Passed Above | % Total Escapement to be Kept for Brood |
|---|---|---|
| 150 | 67 | 33 |
| 200 | 60 | 40 |
| 250 | 55 | 45 |
| 300 | 50 | 50 |
| >300 | Adjustments would be made based on broodstock needs. If broodstock need has been met, the remainder of the fish would be released upstream | |

Table 4. Sliding scale for Catherine Creek Chinook salmon hatchery program (ODFW 2011a).

| Estimated Total Adult Escapement[1] | Ratio Hatchery to Natural Adults | Maximum % Natural-origin Adults Retained for Broodstock | % Hatchery-origin Adults Retained for Broodstock | % Hatchery-origin Adults Released Above Weir (pHOS) | Minimum % Natural-origin Broodstock (pNOB) |
|---|---|---|---|---|---|
| <250 | Any | 40 | 40 | Up to 100[2] | Not Restricted[2] |
| 251-500 | Any | 20 | 20 | ≤70 | ≥20 |
| >500 | Any | ≤20 | Not Restricted[2] | ≤50 | ≥30 |

[1]Pre-season estimate of hatchery and natural-origin Chinook salmon escapement to Catherine Creek.
[2]Percentage determined by co-manager agreement depending on availability of natural-origin fish.

Table 5. Sliding scale for the Upper Grande Ronde Chinook salmon hatchery program (Confederated Tribes of the Umatilla Indian Reservation (CTUIR) 2011).

| Estimated Total Adult Escapement to the Grande Ronde River | Ratio Hatchery to Natural adults | Maximum % Natural-origin Adults Retained for Broodstock | % Conventional Hatchery-origin Adults Retained for Broodstock[2] | % Hatchery-origin Adults Released Above Weir (pHOS) | Minimum % Natural-origin Broodstock (pNOB) |
|---|---|---|---|---|---|
| Any | Any | 50 | ≤ 100 | ≤ 100 | Any |

[2]All returning adults from the captive brood program are released to spawn naturally.

Table 6. Sliding scale for the Imnaha River Chinook salmon hatchery program (ODFW 2011b; ODFW and NPT 2015).

| Estimated Natural-origin Adults to river mouth as a proportion of ICTRT minimum abundance threshold (MAT)[1] | Number Natural-origin Adults to River Mouth | Expected Number Natural-origin Adults Handled at Weir[2] | Maximum % Natural-origin Adults for Broodstock | Number Natural-origin Adults Retained for Broodstock | Maximum % Hatchery-origin Adults Allowed Above Weir (pHOS) | Target % Natural-origin Adults in Broodstock (pNOB) |
|---|---|---|---|---|---|---|
| < 0.05 x Critical | < 15 | < 8 | 0 | 0 | NA | NA |
| 0.05 - 0.5 x Critical | 15 - 149 | 8 - 74 | 50 | 4 – 37 | NA | NA |
| 0.5 x Critical - Critical | 150 -299 | 75 -149 | 40 | 30 – 60 | 70 | 20 |
| Critical - 0.5 x MAT | 300 - 499 | 150 -249 | 40 | 60 – 100 | 60 | 25 |
| 0.5 x MAT - MAT | 500 - 999 | 250 - 499 | 30/**40**[3] | 75 – 150 | 50 | 30 |

| | | | | | | |
|---|---|---|---|---|---|---|
| MAT - 1.5 x MAT | 1000 - 1499 | 500 - 749 | 30/**40**[3] | 150 - 225 | 40 | 40 |
| 1.5 x MAT - 2 x MAT | 1500 - 1999 | 750 - 999 | 25 | 188 - 250 | 25 | 50 |
| > 2 x MAT | > 2000 | > 1000 | 25 | > 250 | < 10 | 100 |

[1]Interior Columbia Technical Recovery Team (ICTRT 2007); Critical = 300; MAT = 1000. This column explains the source of the numbers in the adjacent column.
[2]The expected number of natural-origin adults handled at the weir is 50% of the Natural-origin escapement.
[3]Percentage **bolded** would be implemented in the third year after two consecutive years of preseason projections and escapements at that level or higher.

Table 7. Sliding scale for Lostine River Chinook salmon hatchery program (Nez Perce Tribe 2011).

| Estimated Natural-origin Adults to River Mouth as a Proportion of ICTRT minimum abundance threshold[1] | Number Natural-origin Adults to River Mouth | Maximum % Natural-origin Adults for Broodstock | Number Natural-origin Adults Retained for Broodstock | Maximum % Hatchery-origin Adults Released Above Weir (pHOS) | Target % Natural-origin Adults in Broodstock (pNOB) |
|---|---|---|---|---|---|
| < 0.05 x Critical | < 8 | 0 | 0 | NA | NA |
| 0.05 - 0.5 x Critical | 8 - 74 | 50 | 4 - 37 | NA | NA |
| 0.5 x Critical - Critical | 75 -149 | 40 | 30 - 60 | 70 | 20 |
| Critical - 0.5 x Viable | 150 -249 | 40 | 60 - 100 | 60 | 20 |
| 0.5 x Viable - Viable | 250 - 499 | 30 | 75 - 150 | 50 | 30 |
| Viable - 1.5 x Viable | 500 - 749 | 30 | 150 - 225 | 40 | 40 |
| 1.5 x Viable - 2 x Viable | 750 - 999 | 25 | 188 - 250 | 25 | 50 |
| > 2 x Viable | > 1000 | 25 | > 250 | < 10 | 100 |

[1]Because the Lostine River contributes about 50% of the total production for the Wallowa/Lostine Population, the co-managers manage the program based on a viable number of 500 adults, which is 50% of ICTRT recommended minimum abundance threshold of 1,000 for the entire Wallowa/Lostine population. Critical = 300. This column explains the source of the numbers in the adjacent column.

For the Tucannon program, the co-managers agreed to allow all hatchery-origin fish to spawn naturally regardless of return numbers. The exception would be hatchery-origin jacks that would be removed to limit the proportion of hatchery-origin jacks in the natural-spawning population. Thus, a pHOS standard has not been set for this program and the sliding scale is only applied to broodstock collection (Table 8). However, the program would attempt to meet a goal of 0.67 proportionate natural influence (PNI) when natural-origin returns are high enough to support 100 percent natural-origin broodstock and natural-origin escapement exceeds hatchery-origin escapement in the wild.

Table 8. Sliding scale for Tucannon River Chinook salmon hatchery program (WDFW 2011; WDFW 2013).

| Estimated Total Natural-origin Adults at the Trap | Number of Natural-origin Adults Retained for Broodstock |
|---|---|
| 50-149 | 50 |
| 150-199 | 75 |
| 200-299 | 85 |
| 300-349 | 100 |
| 350-399 | 110 |
| 400-449 | 130 |
| 450-499 | 150 |
| > 500 | 170 |

### 1.3.2. Proposed hatchery juvenile releases

The Proposed Action includes juvenile rearing at Lookingglass Fish Hatchery for all of the programs except for the Tucannon. Juveniles for the Tucannon program are reared at Tucannon and Lyons Ferry Hatcheries. Fish are incubated and reared in the hatchery for about a year before being transferred to acclimation sites. Smolts that have not left acclimation sites volitionally after two to eight weeks of acclimation will be forced out by mid-April (Table 9).

Fish health staff monitor the fish throughout their rearing cycle for signs of disease. Mortalities are checked daily and live grab samples are taken monthly. Fish are also tested prior to transfer to acclimation sites and before release. Sampling, testing, and treatment/control procedures are outlined in multiple documents (IHOT 1995; NWIFC and WDFW 2006; Pacific Northwest Fish Health Protection Committee (PNFHPC) 1989). To reduce disease risks further, Lookingglass Hatchery has installed an ultraviolet light system to kill pathogens in the water prior to its use in the hatchery. In addition, the hatchery is transitioning to the use of moist air incubators, which will likely decrease the prevalence of fungus on incubating eggs.

Table 9. Proposed annual release protocols for each program. Operators may rear up to ten percent over their target to offset the risk of loss. CWT = coded-wire tag; PIT = passive integrated transponder tag.

| Program | Life Stage, Size and Number | Marking | Acclimation Site; Duration | Volitional Release? | Release Location | Release Time |
|---|---|---|---|---|---|---|
| Lookingglass | 250,000 Yearlings, 22-27g | 100% ad clip; ≥ 25% CWT | Lookingglass Hatchery; Entire rearing cycle | Yes up to mid-April | Lookingglass Hatchery | Mid-March to mid-April |
| Catherine Creek | 150,000 Yearlings, 18-23g | 100% ad clip; ≥ 40% CWT ~ 21,000 PIT | Catherine Creek Acclimation Site; ≤ 6 weeks | Yes up to mid-April | Catherine Creek Acclimation Site | Mid-March to mid-April |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 21,000, eyed-eggs[2] | None | Buried in stream gravel | Not applicable | Indian Creek | October |
| Grande Ronde | 250,000 Yearlings, 22-27g | 100% CWT[1] ~21,000 PIT | Grande Ronde Acclimation Site; ≤ 8 weeks | Yes up to mid-April | Grande Ronde Acclimation Site | Mid-March to mid-April |
| | 35,000 eyed-eggs[2] | None | Buried in stream gravel | Not applicable | Meadow and Sheep Creeks | October |
| Imnaha | 490,000 Yearlings, 18-23g | 100% ad clip[1]; ~50% CWT ~21,000 PIT | Imnaha River Satellite Facility; ≤ 6 weeks | Yes up to mid-April | Imnaha River Satellite Facility | Mid-March to mid-April |
| | 95,000 eyed-eggs[2] | None | Buried in stream gravel | Not applicable | Lick Creek | October |
| Lostine | 250,000 Yearlings, 22g | 100% ad clip; 100% CWT ~7000 PIT | Lostine River Acclimation Site; ≤ 6 weeks | Yes up to mid-April | Lostine River Acclimation Site | Mid-March to mid-April |
| | 48,016 eyed-eggs or fry[2] | None | Buried in stream gravel | Not applicable | Bear Creek, Upper Wallowa River, Upper Lostine River, and/or Hurricane Creek. | October |
| Tucannon | 225,000 Yearlings, 30g | 0% ad clip; 100% CWT ≤ 25000 PIT | Curl Lake Acclimation Site; 3-7 weeks | Yes up to mid-April | Curl Lake Acclimation Site | Mid-March to mid-April |
| | 55,125 eyed-eggs or fry[2] | None | Buried in stream gravel | Not applicable | Tucannon River | October |

[1]Fish would be adipose fin clipped according to the production tables and Attachment C of the *U.S. v. Oregon* Agreement.
[2]This is the maximum number of eggs or fry; occurs intermittently depending on the availability of eggs in excess of program needs.

### 1.3.3. Proposed adult management

Hatchery fish that are removed can be used for hatchery broodstock, harvest, human consumption (e.g., food banks), outplanting and in-stream nutrient enhancement.

For all six programs, pNOB and pHOS can be controlled to some extent by using the adult management scale designed for each program. The Lookingglass Creek (Table 3) and upper Grande Ronde River (Table 5) programs do little to control hatchery contribution because of very low current natural-origin abundance, but would revisit more restrictive scales as abundance increases, as described in the HGMPs. The Catherine Creek (Table 4), Imnaha (Table 6), and Lostine (Table 7) programs use sliding scales sensitive to population abundance, an approach consistent with HSRG recommendations (HSRG 2009). The programs allow some hatchery-origin fish to spawn in the wild at all abundance levels, but reduce proportions as natural-origin abundance increases. Outplanting of adults is in addition to the pHOS determined by the sliding scales. This strategy attempts to balance the risk of extinction (low natural-origin abundance) with the risk of hatchery influence.

Three of the six programs propose to outplant adults that are surplus to program needs for harvest (Lookingglass Creek), to utilize fish removed for adult management according to co-manager policy (Big Sheep and Lick Creeks), and to supplement natural production (Indian Creek). Fish from the Catherine Creek program are outplanted throughout the run. Fish from the Imnaha program are outplanted primarily in August. Fish from the Wallowa/Lostine program are outplanted after July 20th through September.

Table 10. Program Goals, average returns, and adult outplanting locations (Feldhaus 2013).

<table>
<tr><th>Program</th><th>LCSRCP Goal</th><th>Program Goal</th><th>Average Program Returns from 2003-2012 (Range)</th><th>Outplanting Location/Number</th></tr>
<tr><td>Lookingglass</td><td rowspan="4">5720</td><td>1000</td><td>409 (45-1273)</td><td>None</td></tr>
<tr><td>Catherine Creek</td><td>970</td><td>323 (113-1169)</td><td>Indian Creek/50 pairs<br>Lookingglass Creek/variable</td></tr>
<tr><td>Grande Ronde</td><td>1625</td><td>609 (18-2272)</td><td>None</td></tr>
<tr><td>Lostine</td><td>1625</td><td>1687 (270-3996)</td><td>Bear and Hurricane Creeks/variable<br>Wallowa River/variable</td></tr>
<tr><td>Imnaha</td><td>3210</td><td>3210</td><td>1345 (545-2245)</td><td>Big Sheep and Lick Creeks/300</td></tr>
<tr><td>Tucannon</td><td>2400</td><td>1152</td><td>452 (133-1112)</td><td>None</td></tr>
</table>

Because of some recent problems with survival of adults passed above the weir on the Tucannon River, the applicants propose taking some proportion of the fish (both hatchery- and natural-origin) that would have been passed above the weir for holding in the hatchery. Fish may be held up to four months before being released 2-15 miles upstream of the hatchery after August 15th to spawn naturally. Fish will be released in the morning to take advantage of cooler water temperatures and will be released in small groups of 15 pairs or less.

All six programs propose to limit known strays above the weir to five percent or less of the total number of fish passed.

### 1.3.4. Proposed research, monitoring, and evaluation

**Adults**

- Annual spawning surveys to measure abundance, distribution and population trends in Lookingglass and Catherine Creeks, and the Imnaha, Minam, Wenaha, Grande Ronde, Lostine, and Tucannon Rivers
- Program performance in relation to program goals
- Impact on the natural-origin population

- Adults handled at the weir may be measured, have genetic samples taken, or be tagged to monitor survival and movement after weir handling. Weirs are operated until up to October 1 to sample and enumerate steelhead for natural population status and trends
- Carcass surveys are conducted in Big Sheep, Lick, Bear, and Hurricane Creeks, and the Wallowa River to assess spawning of outplanted fish

**Juveniles**

- Spring/summer Chinook salmon emigrating from the Imnaha River would be captured and tagged for monitoring program performance
- Snake River basin steelhead would also be captured, and tagged during monitoring activities to assess natural-population metrics
- Fish would be captured using screw traps, beach seines, cast nets, dip nets, and electroshocking equipment throughout the basin
- Screw traps are operated every spring to monitor total juvenile outmigration (Table 1), and would continue.
- To evaluate post-release migration of hatchery juveniles, passive integrated transponder (PIT) tags would be used to tag fish as funding allows.
- Fish captured by any trapping method would be anesthetized, measured, and may have fin clips or scales removed, or PIT tags inserted prior to release.
- Redd surveys are conducted in Indian, Big Sheep, Lick, Bear, and Hurricane Creeks, and the Wallowa River to assess production of outplanted fish.

All traps are downstream of acclimation sites to monitor and compare performance of hatchery- and natural-origin outmigrants. Specific numbers of ESA-listed fish handled would vary annually, and are quantified in section 10(a)(1)(A) enhanced propagation permits 18024, 18030, 18033, 18034, 18035, and 18036. Any encounters with ESA-listed fish associated with operation of screw traps for research and monitoring associated with hatchery programs covered elsewhere are included in this opinion.

Table 11. Smolt trap locations.

| Program | Trap Location | Operator |
|---|---|---|
| Catherine Creek | Catherine Creek RM 20 | ODFW |
| Upper Grande Ronde River | Spool Cart Trap–Grande Ronde River RM 185<br>Elgin Trap–Grande Ronde River RM 99 | ODFW |
| Imnaha | Imnaha River RM 4.3 | NPT |
| Lookingglass | Lookingglass Creek RM 2.5<br>Minam River RM 0.2 | CTUIR<br>ODFW |
| Lostine | Lostine River RM 1.9 | NPT |
| Tucannon | Tucannon River RM 1.9 | WDFW |

### 1.3.5. Proposed operation, maintenance, and construction of hatchery facilities

All programs return water to the diverted creek or river (minus any leakage and evaporation) along with any groundwater discharge. Water at all facilities is withdrawn in accordance with state-issued water rights. All facilities that rear over 20,000 pounds of fish operate under

National Pollutant Discharge Elimination System (NPDES) through a general permit (Permit number 300J) issued by the Oregon Department of Environmental Quality.

Minor armoring would be maintained at the intake diversions, fish ladders, effluent outfall, and the abutments of the concrete sill for the Imnaha program and the abutments of the permanent weirs in Catherine Creek and the Lostine River.

**Routine Maintenance**

All six programs perform annual routine maintenance of hatchery facilities and structures. Much of the maintenance would include grounds maintenance, building maintenance, and non-pump mechanical maintenance. Several routine maintenance activities occur in or near water that could impact fish in the area including: sediment/gravel removal/relocation from intake and/or outfall structures, pond cleaning, pump maintenance, debris removal from intake and outfall structures, and maintenance and stabilization of existing bank protection. All in-water maintenance activities considered “routine” for the purposes of this action will occur within existing structures or the footprint of areas that have already been impacted. When maintenance activities occur within water, they will comply with the following guidance:

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

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

| Facilities | Program(s) | Surface Water (cfs) | Ground Water (cfs) | Water Diversion Distance (km) | Surface water source | Instream Structures | Meet NMFS Screening Criteria? | NPDES Permit? |
|---|---|---|---|---|---|---|---|---|

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Lookingglass Hatchery | Lookingglass, Catherine Creek, Grande Ronde, Imnaha, Lostine | 50 | 5 | 0.45 | Lookingglass Creek | 4: intake, discharge outfall, ladder, weir | No-not sweeping velocity | Yes |
| Catherine Creek Acclimation Site | Catherine Creek | 5 | 0 | 0.15 | Catherine Creek | 2: water intake, outfall | Yes | NA |
| Up. Grande Ronde Acclimation Site | Grande Ronde | 5 | 0 | 0.15 | Grande Ronde River | 2: water intake, outfall | Yes | NA |
| Imnaha River Satellite Facility | Imnaha | 15 | 0 | 0.15 | Imnaha River | 3: water intake, concrete sill, fish ladder | No-not yet evaluated | NA |
| Lostine River Acclimation Site | Lostine | 5.7 | 0 | 0.1 | Lostine River | 2: water intake, outfall | Yes | NA |
| Lostine River Hatchery[1] | Lostine | 18 | 3.2 | 0.85 | Lostine River | 3: water intake, discharge outfall, weir | Yes | Yes |
| Tucannon Fish Hatchery | Tucannon | 8.83 | 1.76 | 1.3 | Tucannon River | 3: water intake, discharge outfall, fish ladder | Yes | Yes |
| Curl Lake Acclimation Ponds | Tucannon | 6 | 0 | 0.15 | Tucannon River | 3: water intake, discharge outfall, fish ladder | Yes | Yes |

[1]Not yet constructed

**Water Intake**

The Lookingglass Creek water intake diversion structure is a complete barrier to upstream migration for both adult and juvenile fish. The structure resulted in the extirpation of the Lookingglass Creek population of spring/summer Chinook salmon above the intake. The current reintroduction effort (this program) includes manual handling and placement of adult fish above the structure. Downstream passage is not blocked, although fish must pass over the top of the structure on their way downstream.

The current water intake at the Imnaha River diversion needs to be evaluated for compliance with NOAA screening criteria. Additionally, it is not designed to meet the flow needs of the facility, and will need to be upgraded. Designs for a new intake structure are complete, though construction has not begun. The use of this new structure will be will be evaluated in a separate consultation and will need to be consistent with NOAA screening criteria.

**Weirs**

All six programs included in the proposed action use weirs; two of those programs use permanent weirs. The weir on Catherine Creek has a fish ladder that provides passage for both adult and juvenile fish. The full channel hydraulic weir on the Lostine River is a seasonal passage barrier (both upstream and downstream) in the main channel when it is in use. The weir is permanently fixed in the stream, but can be raised or lowered pneumatically when needed. During operation, adult passage above the weir occurs through manual handling and release of fish in the fish trap. Juvenile fish would be able to pass through the pickets of the weir. A small proportion may experience delayed migration. If constructed, the Lostine River hatchery would have a swim trap that is capable of collecting fish that volunteer into the facility. This alternate trap would only be used if a weir failure does not allow for collection of adults at the weir.

The remaining four programs use removable weirs. The weir on Lookinglass Creek is a seasonal passage barrier and directs fish to move upstream through the ladder and trap. The adult weir on the upper Grande Ronde River is a seasonal passage barrier that spans the main channel, and includes a trap box. The pickets in the weir are designed to pass juveniles, but block adult passage. The weir is now removed to allow free passage when temperatures exceed 20°C to reduce impacts associated with weir delay or injury (Carmichael et al. 2011d) and this practice will continue under the Proposed Action. The Tucannon weir panels are installed on a permanent sheet pile dam early enough in most years to capture all fish that reach the trap site. The weir on the Imnaha River is installed annually on a permanent concrete sill. However, the current weir's effectiveness is limited because it cannot be installed safely early in the run due to high flows, and is ineffective during high flows.

The weir traps for all six programs are operated seasonally. Weir traps for three of the programs (the Upper Grande Ronde, Catherine Creek, and Imnaha programs) may delay fish for up to 72 hours when in operation. Weir traps for the remaining three programs may delay fish up to 24 hours. The proposal to hold fish for longer than 24 hours includes a density trigger. Fish must be passed either within 72 hours or when fish numbers are greater than 10 (10 percent trap capacity) for Catherine Creek, 3 (10 percent capacity) for the Grande Ronde, or 100 (75 percent trap capacity) for Imnaha. The Imnaha trap is in a particularly remote location, making it difficult for personnel to access the trap daily.

A modified weir on the Imnaha River has been proposed that would allow for collection throughout the run and improve safety. The new weir will be constructed in the same footprint as the existing weir, and is designed to collect adults across the entire run. A separate consultation covered weir construction (NMFS 2004a). In the interim, adult collections will be limited by weir installation date. The adult weir on the Imnaha River will be a seasonal passage barrier (both upstream and downstream) in the main channel when installed. During operation, fish passage above the weir for adults occurs through manual handling and release. Juvenile fish would be able to pass through the pickets of the weir.

**The Lostine River Hatchery**

The Lostine River spring/summer Chinook salmon program is currently operated using the Lookingglass Fish Hatchery as a primary spawning and rearing facility. A new hatchery on the Lostine River has been proposed for construction adjacent to the site of the current Lostine River acclimation facility. The new facility would provide full production of the Lostine/Wallowa spring/summer Chinook salmon program onsite, and use of the Lookingglass Fish Hatchery for this program would be eliminated.

The Lostine spring/summer Chinook salmon program is not dependent on the construction of the new facility, and the program goals, production numbers, adult collection numbers, adult collection points, juvenile release strategies, and juvenile release locations would be the same. The effects of operating the program are expected to be the same regardless of movement to a new hatchery facility. Though they would typically be reviewed together, construction impacts are considered separate from the operation of the program in this instance because a complete environmental review has already occurred on the construction of the Lostine River Hatchery under both the National Environmental Policy Act (NEPA) and ESA (BPA 2004; NMFS 2004a), and effects related thereto are included in the environmental baseline.

## 1.4. Action Area

The "action area" means all areas to be affected directly or indirectly by the Proposed Action, in which the effects of the action can be meaningfully detected measured, and evaluated (50 CFR 402.02). The action area resulting from this analysis includes the Snake River from its confluence with the Imnaha River downstream to its confluence with the Columbia River. Within this reach and included in the action area are three major tributaries to the Snake River: (1) the Imnaha River basin, (2) the Grande Ronde River basin (which includes the Wenaha, Wallowa, Minam, upper Grande Ronde and Lostine Rivers and Lookingglass and Catherine Creeks), and (3) the Tucannon River. The action area includes locations where fish are captured, reared, and released, as well as areas where they may be monitored, or stray. The Minam and Wenaha River basins serve as a reference within the region because there are no supplementation programs located within those watersheds; they would be included in monitoring plans that are part of the proposed action.

Additionally, each of the programs operates a screw trap to monitor juvenile outmigration of both hatchery- and natural-origin smolts. The screw trap locations would generally be in the same areas each year because of stream morphology, ability to capture target outmigrants, access for trap installation and monitoring, and annual consistency (Table 11).

In addition, several facilities may be used to incubate eggs and rear juveniles from the safety net component of the Upper Grande Ronde program. Small numbers of fish are transported to and from the Lyons Ferry Hatchery (Snake River in Washington), Irrigon Hatchery (Columbia River, near Irrigon, Oregon), the Wallowa Hatchery (Wallowa River, a tributary to the Grande Ronde River), the Oxbow Hatchery (Columbia River in Oregon), and the Bonneville Hatchery (Columbia River in Oregon) for short stages of rearing prior to release. These facilities are included in the action area.

NMFS considered whether the mainstem Columbia River, the estuary, and the ocean should be included in the action area. The potential concern is a relationship between hatchery production and density-dependent interactions affecting salmon growth and survival. However, the number of fish released from this Proposed Action is ~ 1.62 million, 1.2 percent of the 130-145 million that are released into the Columbia River annually. Thus, NMFS has determined that, based on best available science and the small proportion of fish released by the programs, it is not possible to establish any meaningful causal connection between hatchery production on the scale anticipated in the Proposed Action and any such effects.

## 1.5. Interrelated and Interdependent Actions

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, and were consulted on previously (NMFS 2013b). 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 2008d). 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 for past fisheries and cumulative effects for future fisheries that have not undergone ESA consultation.

# 2. Endangered Species Act: Biological Opinion and Incidental Take Statement

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

## 2.1. Introduction to the Biological Opinion

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

This biological opinion relies on the definition of "destruction or adverse modification", which is "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).

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 sometimes called "primary constituent elements" or PCEs). Status of the species and critical habitat are discussed in Section 2.2.

*Describing 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 2.3 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 2.5 of this opinion.

*Integration and synthesis*
Integration and synthesis occurs in Section 2.6 of this opinion. In this step, NMFS adds the effects of the Proposed Action (Section 2.4) to the status of ESA protected populations in the Action Area under the environmental baseline (Section 2.3) and to cumulative effects (Section 2.5). Impacts on individuals within the affected populations are analyzed to determine their effects on the VSP parameters for the affected populations. These impacts are combined with the overall status of the MGP to determine the effects on the ESA-listed species (ESU/DPS), which will be used to formulate the agency's opinion as to whether the hatchery action is likely to: (1)

result in appreciable reductions in the likelihood of both survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution; or (2) reduce the value of designated or proposed critical habitat.

*Jeopardy and adverse modification*
Based on the Integration and Synthesis analysis in section 2.6, 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 a RPA or RPAs to the proposed action.

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

This opinion examines the status of each species and designated critical habitat that would be affected by the Proposed Action. The species and the designated critical habitat that are likely to be affected by the Proposed Action, and any existing protective regulations, are described in Table 13[3]. Status of the species is the level of risk that the listed species face based on parameters considered in documents such as recovery plans, status reviews, and ESA listing determinations. The species status section helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02. The opinion also examines the status and conservation value of critical habitat in the action 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 ESA listed species considered in this consultation.

| Species | Listing Status | Critical Habitat | Protective Regulations |
|---|---|---|---|
| **Chinook salmon (*Oncorhynchus tshawytscha*)** | | | |
| Snake River Spring/Summer Run | Threatened June 28, 2005; 70 FR 37160 | October 25, 1999; 64 FR 57399 | June 2, 2005; 70 FR 37160 |
| **Steelhead (*O. mykiss*)** | | | |
| Snake River | Threatened January 5, 2006; 71 FR 834 | September 2, 2005; 70 FR 52630 | June 28, 2005; 70 FR 37160 |

[3] ESA-listed bull trout (*Salvelinus confluentus*) are administered by the FWS and the proposed hatchery program is currently covered under a separate FWS section 7 consultation (FWS ref # 01E0FW00-2015-F-0154). Take associated with hatchery monitoring and evaluation activities is covered under USFWS TE-702631, sub-permit MCFRO-13.

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

Spring/summer-run Chinook salmon from the Snake River basin exhibit stream-type life history characteristics. The spring-run Chinook salmon return to the Columbia River from the ocean in early spring and pass Bonneville Dam from early March to the first week of June. The summer-run Chinook salmon return to the Columbia River from June through August. Returning fish hold in deep mainstem and tributary pools until late summer, when they emigrate up into tributary areas and spawn. Snake River spring-run Chinook salmon tend to spawn in higher-elevation reaches of major Snake River tributaries from mid- through late August. Snake River summer-run Chinook salmon spawn approximately one month later than spring-run fish and tend to spawn lower in the Snake River drainages, although their spawning areas often overlap with spring-run spawners.

The eggs that Snake River spring and summer Chinook salmon deposit in late summer and early fall, 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. Depending on the tributary and the specific habitat conditions, juveniles may migrate extensively from natal reaches into alternative summer-rearing or overwintering areas. 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.

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

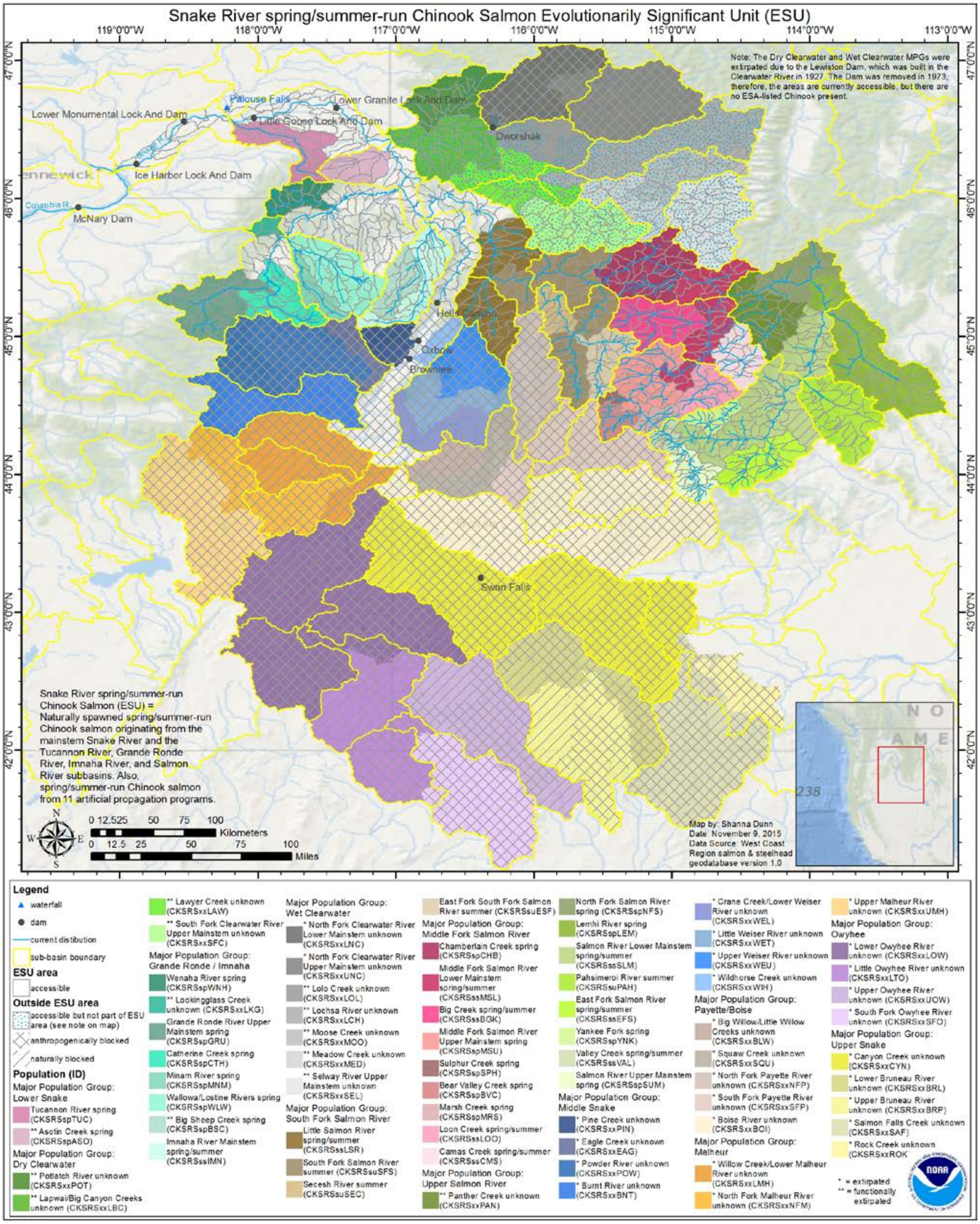


Figure 2. Snake River spring/summer Chinook Salmon ESU with populations and major population groups.

**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 Spring/summer-run Chinook salmon ESU, is at risk and remains at threatened status. A more detailed description of the MPGs that are the focus of this consultation follows.

Table 14. Matrix used to assess population status across VSP parameters or attributes. Percentages for abundance and productivity scores represent the probability of extinction in a 100-year time period (ICTRT 2007).

| Risk Rating for Abundance /Productivity | Risk Rating for Spatial Structure / Diversity: Very Low | Low | Moderate | High |
|---|---|---|---|---|
| **Very Low (<1%)** | Highly Viable | Highly Viable | Viable | Maintained |
| **Low (<5%)** | Viable | Viable | Viable | Maintained |
| **Moderate (<25%)** | Maintained | Maintained | Maintained | High Risk |
| **High** | High Risk | High Risk | High Risk | High Risk |

**Lower Snake River MPG**

There are two independent populations within this MPG: Tucannon River and Asotin Creek. The ESA Recovery Plan for SEWA (SRSRB 2011) requires that the Tucannon River population be at low risk (no more than a 1 percent risk of extinction in 100 years). The Tucannon River population is required to meet highly viable status (Table 14) for delisting of the ESU because the Asotin Creek population is considered extirpated. Both populations should reach a level of spatial structure and diversity that restores the distribution to previously occupied areas and allows natural patterns of genetic and phenotypic diversity to be expressed. This corresponds to a threshold of at least “viable” status for the Asotin Creek population and “highly viable” status for the Tucannon population. The most recent status review by NMFS (NWFSC 2015) maintains that, based on available information, the Tucannon River population remains at high risk and the Asotin Creek population should be considered for reintroduction efforts, and restored to viable status.

Table 15. Risk levels and viability ratings for Lower Snake River MPG spring/summer Chinook salmon populations (NWFSC 2015); ICTRT = Interior Columbia Technical Recovery Team. Data are from 2005-2014.

| **Population** | **Abundance and productivity** | | | | **Spatial structure and diversity** | | | **Overall viability risk rating** |
|---|---|---|---|---|---|---|---|---|
| | ICTRT minimum threshold | Geometric mean natural spawning abundance (standard error) | Geometric mean productivity (standard error) | Risk | Natural processes risk | Diversity risk | Integrated SS/D risk | |
| Tucannon 2005-2014 | 750 | 267 (0.19) | 0.69 (0.23) | High | Low | Moderate | Moderate | High |
| Asotin Creek | Extirpated | | | | Extirpated | | | Not applicable |

Abundance and productivity remain at low levels for the Tucannon population, although abundance has increased in recent years (Table 15; Figure 3). Poor natural productivity continues to be a major concern. Although spatial structure and diversity are a moderate risk to this population, the low abundance and productivity lead to an overall high risk to the viability of the Tucannon population.

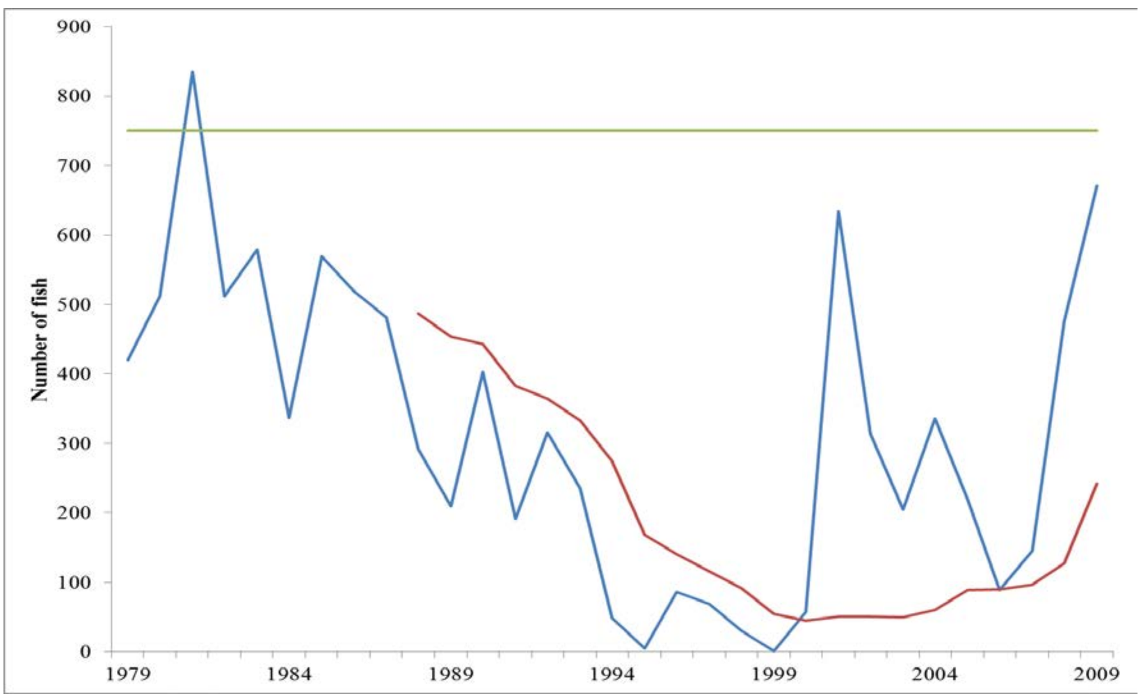


Figure 3. Abundance of natural-origin spawners in the Tucannon River population of spring/summer Chinook salmon (blue line). Green line is the ICTRT's minimum abundance threshold (geomean), and the red line is the 10-year geomean. Data from NOAA salmon population summary database: https://www.webapps.nwfsc.noaa.gov/apex/f?p=238:home:0

Spawning has been documented in the upper mainstem of Asotin Creek (above Charley Creek) and in North Fork Asotin Creek from its confluence with Lick Creek to near the border of the Umatilla National Forest (SRSRB 2011). The WDFW and ICTRT have both classified Asotin Creek spring/summer Chinook salmon as functionally extirpated because of extremely low redd counts. The origin of the small number of spawners is unknown.

**Grande Ronde/Imnaha MPG**

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

Table 16. Risk levels and viability ratings for Grande Ronde/Imnaha MPG spring/summer Chinook salmon populations (NWFSC 2015); ICTRT = Interior Columbia Technical Recovery Team. Data are from 2005-2014.

| Population | Abundance and productivity | | | | Spatial structure and diversity | | | Overall viability risk rating |
|---|---|---|---|---|---|---|---|---|
| | ICTRT minimum threshold | Geometric mean natural spawning abundance (standard error) | Geometric mean productivity (standard error) | Risk | Natural processes risk | Diversity risk | Integrated SS/D risk | |
| Wenaha | 750 | 399 (0.12) | 0.93 (0.21) | High | Low | Moderate | Moderate | High |
| Lostine/Wallowa | 1000 | 332 (0.24) | 0.98 (0.12) | High | Low | Moderate | Moderate | High |
| Minam | 750 | 475 (0.12) | 0.94 (0.18) | High | Low | Moderate | Moderate | High |
| Catherine Creek | 1000 | 110 (0.31) | 0.95 (0.15) | High | Moderate | Moderate | Moderate | High |
| Up. Grande Ronde | 1000 | 43 (0.26) | 0.59 (0.28) | High | High | Moderate | High | High |
| Imnaha River | 750 | 328 (0.21) | 1.2 (0.09) | High | Low | Moderate | Moderate | High |
| Lookingglass Creek | 500 | Extirpated | | | Extirpated | | | Not applicable |
| Big Sheep Creek | Not applicable | Extirpated | | | Extirpated | | | Not applicable |

For the most recent period (2005-2014), abundance has increased for all the extant populations except for the Wenaha River. Despite increases, abundances are well below the minimum threshold. Productivity values have increased for all six extant populations, and are close to or exceed replacement for all populations except for the Upper Grande Ronde. Despite these improvements, all six populations are at high risk in terms of abundance and productivity (NWFSC 2015). Although spatial structure and diversity are less of a risk for most of these populations, the overall risk to viability for all six populations remains high (Table 16).

The natural-origin return proportions based on 10-year adult return averages is about 24 percent in the Lostine River, 36 percent in Catherine Creek, 11 percent in the upper Grande Ronde, 32 percent in the Imnaha River, and 17 percent in Lookingglass Creek (Feldhaus 2013).

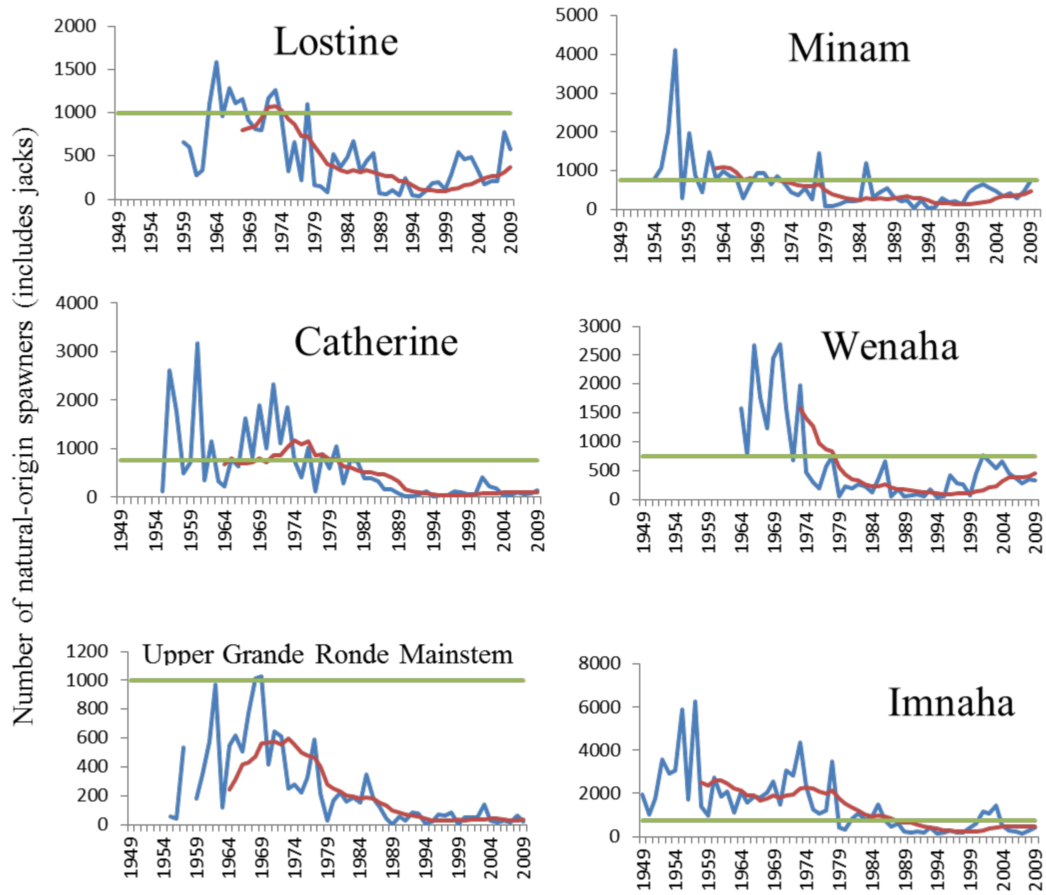


Figure 4. Abundance of natural-origin spawners in the Grande Ronde-Imnaha MPG of spring/summer Chinook salmon. Green line is the ICTRT's minimum abundance threshold (geomean), and the red line is the 10-year geomean. Data from NOAA salmon population summary database: [https://www.webapps.nwfsc.noaa.gov/apex/f?p=238:home:0](https://www.webapps.nwfsc.noaa.gov/apex/f?p=238:home:0)

### 2.2.2. Range-wide Status of Critical Habitat

This section of the opinion examines the range-wide status of designated critical habitat for the affected salmonid species. For Snake River spring/summer Chinook salmon, critical habitat is designated in 64 FR 57399 (October 25, 1999). Critical habitat includes the Columbia River from its mouth, including all estuarine areas and river reaches proceeding upstream to the confluence of the Columbia and Snake Rivers as well as all Snake River reaches from the confluence of the Columbia River upstream to Hells Canyon Dam. Critical habitat also includes river reaches presently or historically accessible (except reaches above impassable natural falls (including Napias Creek Falls, and Dworshak and Hells Canyon Dams) to Snake River spring/summer Chinook salmon. For the action area, this includes accessible reaches in the following hydrologic units: Hells Canyon, Imnaha, Lower Grande Ronde, Lower Snake-Asotin, Lower Snake-Tucannon, Upper Grande Ronde, and Wallowa.

NMFS determines the range-wide status of critical habitat by examining the condition of its physical and biological features (also called "primary constituent elements," or 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 Chinook salmon (64 FR 57399, October 25, 1999), including the populations being consulted on within this biological opinion, include:

(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.

Within the three subbasins that are the focus of this consultation, there are 37 watersheds. NMFS (2005a) ranked watersheds within designated critical habitat at the scale of the fifth-field hydrologic unit code (HUC 5) in terms of the conservation value they provide to each listed species they support[4]; the conservation rankings are high, medium, or low (Table 19). To determine the conservation value of each watershed to species viability, NMFS (2005a) evaluated the quantity and quality of habitat features (e.g., spawning gravels), the relationship of the area compared to other areas within the species' range, and the importance to the ESU/DPS

[4] The conservation value of a site depends upon "(1) the importance of the populations associated with a site to the ESU [or DPS] conservation, and (2) the contribution of that site to the conservation of the population through demonstrated or potential productivity of the area" (NMFS 2005a).

of the population occupying that area. Thus, even a location that has poor habitat quality could be assigned a high conservation value if it were essential. This assignment would be based on factors such as limited availability (e.g., one of a few spawning areas), a unique contribution to the population it served (e.g., the extreme end of geographic distribution), or another important role (e.g., obligate area for migration to upstream spawning areas).

Table 17. Summary of watershed conservation value ratings within the three subbasins (NMFS 2005a).

| Subbasin | Number of watersheds | Rating |
|---|---|---|
| Lower Snake/Tucannon and Asotin | 9 | 3 high; 2 medium; 4 low |
| Grande Ronde | 24 | 21 high; 3 medium |
| Imnaha | 5 | 5 high |

#### 2.2.2.1. Life History and Current Rangewide Status of Northeast Oregon and Southeast Washington Portion of the Snake River Basin Steelhead DPS

*O. mykiss* exhibit perhaps the most complex suite of life-history traits of any species of Pacific salmonid. They can be anadromous or freshwater resident, and under some circumstances, yield offspring of the opposite form. Steelhead are the anadromous form. The present distribution of steelhead extends from Kamchatka in Asia, east to Alaska, and down to southern California (NMFS 1999), although the historical range extended at least to the Mexican border (Busby et al. 1996). 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 migrate a substantial distance from the ocean (up to 1,500 km) and use high-elevation tributaries (typically 1,000–2,000 m above sea level) for spawning and juvenile rearing. Snake River steelhead occupy habitat that is considerably warmer and drier (on an annual basis) than other steelhead DPSs. Snake River basin steelhead are generally classified as summer-run, based on their adult run-timing patterns. Summer-run steelhead enter the Columbia River from late June to October. After holding over the winter, summer-run steelhead spawn the following spring (March to May). Managers classify Snake River summer steelhead runs into two groups based primarily on ocean age and adult size on return to the Columbia River: A-run steelhead are predominantly age-1 ocean fish, while B-run steelhead are larger, predominated by age-2 ocean fish.

Resident *O. mykiss* are believed to be present in many of the drainages used by Snake River steelhead. Very little is known about interactions between co-occurring resident and anadromous forms within this DPS.

The Snake River Basin Steelhead DPS "…includes all naturally spawned anadromous *O. mykiss* populations below natural and manmade impassable barriers in streams in the Snake River Basin of southeast Washington, northeast Oregon, and Idaho as well as six artificial production programs: the Tucannon River, Dworshak NFH, Lolo Creek, North Fork Clearwater River, East

Fork Salmon River, and the Little Sheep Creek/Imnaha River Hatchery steelhead hatchery programs" (71 FR 20802).

There are five major population groups (MPGs): the Lower Snake River MPG (two extant populations); the Grande Ronde MPG (four extant populations); the Imnaha MPG (one extant population); the Clearwater MPG (five extant and one extirpated population); and the Salmon River MPG (12 extant populations; Figure 5). In addition, the ICTRT concluded that small tributaries entering the mainstem Snake River below Hells Canyon Dam may have historically been part of a larger population with a core area currently cut off from anadromous access. That population would have been part of one of the historical upstream MPGs. 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, is at risk and remains threatened. A more detailed description of the MPGs that are the focus of this consultation follows.

Many factors affect the abundance, productivity, spatial structure, and diversity of the Snake River Steelhead DPS. Factors that limit the DPS's survival and recovery include: migration through the FCRPS; the degradation and loss of estuarine areas that help fish transition between fresh and marine waters; spawning and rearing areas that have lost deep pools, cover, side-channel refuge areas, high quality spawning gravels, and; interbreeding and competition with hatchery fish that outnumber natural-origin fish.

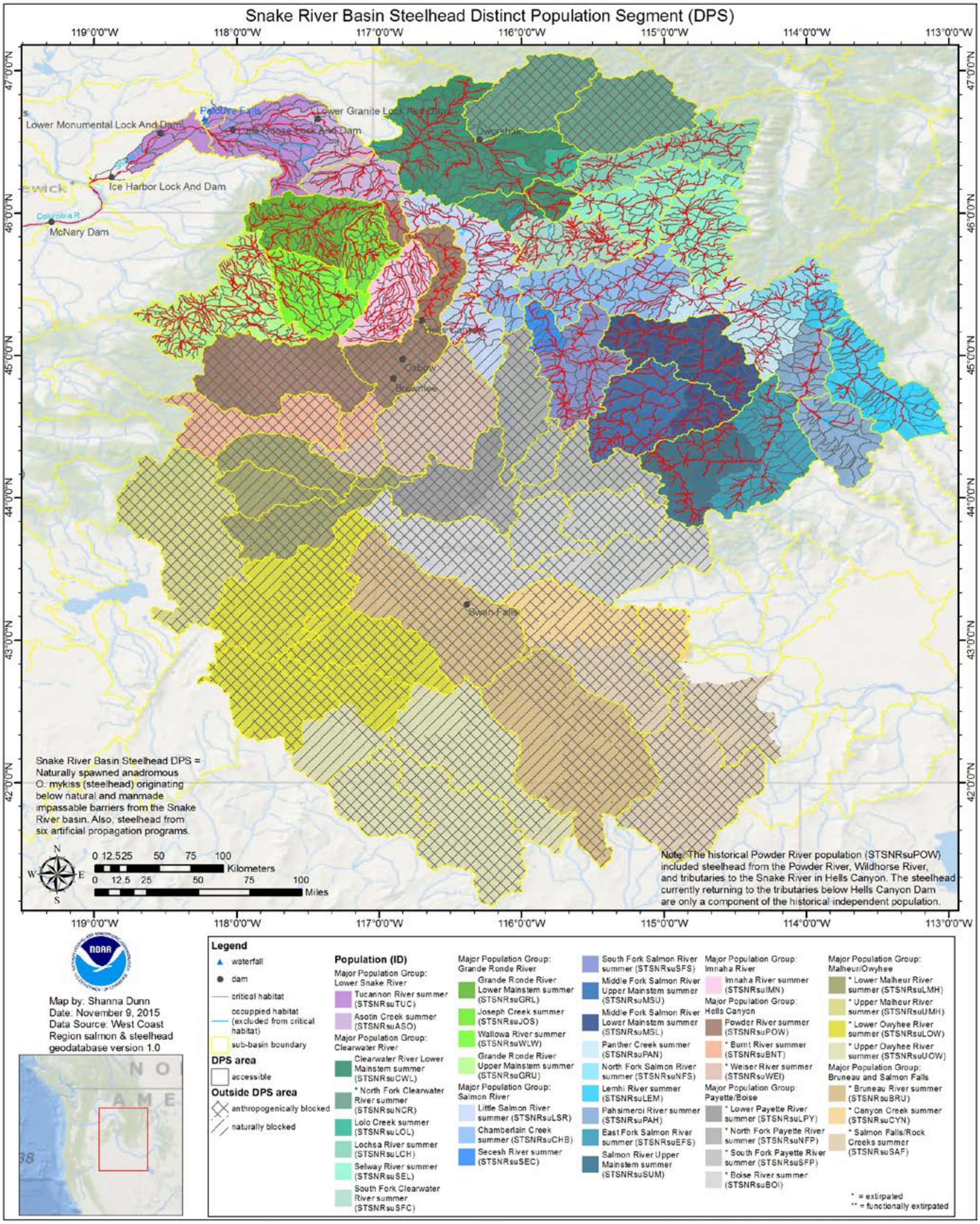


Figure 5. Snake River basin steelhead DPS with populations and major population groups.

**Lower Snake River MPG**
There are two independent populations within this MPG: Tucannon River and Asotin Creek. The ESA Recovery Plan for southeast Washington (SRSRB 2011) requires that the Tucannon River population be at moderate risk (no more than a 5 percent risk of extinction in 100 years) and for the Asotin Creek population to be at low risk (no more than a 1 percent risk of extinction in 100 years) of extinction. This corresponds to a threshold of at least "viable" status for the Tucannon population and "highly viable" status for the Asotin Creek population (SRSRB 2011). The most recent status review by NMFS (NWFSC 2015) maintains that, based on available information, the Tucannon River population remains at high risk, and the Asotin Creek population is maintained (Table 18).

Bumgarner and Dedloff (2013) used smolt trap estimates of natural-origin steelhead, in conjunction with adult PIT tag detections, to estimate the total number of natural-origin adults returning to the Tucannon River basin. They estimated that between 150 and 750 (average 354) Tucannon River steelhead have passed over Ice Harbor Dam annually between 2000 and 2009. Until 2008, the trend had been decreasing. The number that enters the Tucannon River to spawn may be approximately 50 percent of what passes Ice Harbor Dam (SRSRB 2011). Because the Tucannon River population relies on hatchery spawners to maintain the current abundance, it is not viable (McElhany et al. 2000).

There is more information on the Asotin Creek population than the Tucannon population due to more intensive monitoring since 2005. However, the weir in Asotin Creek is at Rkm 4.7 does not include George, Alpowa, or Almota Creeks because they are downstream of the weir and thus are excluded from the data. Redd counts upstream of the weir have been conducted since the mid-1980s, and have averaged 386, and ranged between 200 and 900. The Asotin Creek drainage is currently managed for natural production only, but some hatchery steelhead return to this stream, averaging about 12 percent between 2005 and 2010 (SRSRB 2011).

Table 18. Risk levels and viability ratings for SR steelhead populations (NWFSC 2015). Parentheses indicate range. Data are from 2004-2015. ID = insufficient data; ICTRT = Interior Columbia Technical Recovery Team.

| **Population** | **Abundance and productivity metrics** | | | | **Spatial structure and diversity metrics** | | | **Overall risk viability rating** |
|---|---|---|---|---|---|---|---|---|
| | ICTRT minimum threshold | Natural spawning abundance | Productivity | Integrated A/P risk | Natural processes risk | Diversity risk | Integrated SS/D risk | |
| Tucannon River | 1000 | ID | ID | High[1] | Low | Moderate | Moderate | High[1] |
| Asotin Creek | 500 | ID | ID | Moderate[1] | Low | Moderate | Moderate | Maintained[1] |
| Lo. Grande Ronde | 1000 | ID | ID | [1] | Low | Moderate | Moderate | Maintained[1] |
| Joseph Creek | 500 | 1839 | 1.86 | Very low | Very low | Low | Low | Low |
| Up. Grande Ronde | 1500 | 1,649 (0.21) | 3.15 (0.4) | Moderate | Very low | Moderate | Moderate | Low |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wallowa River | 1000 | Insufficient data | Insufficient data | High[1] | Very low | Low | Low | Maintained[1] |
| Imnaha River | 1000 | Insufficient data | Insufficient data | Moderate[1] | Very low | Moderate | Moderate | Maintained[1] |

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

**Grand Ronde MPG**
There are currently four independent populations of steelhead within the Grande Ronde MPG: Joseph Creek, Lower Grande Ronde River, Upper Grande Ronde River, and Wallowa River. The Draft ESA Recovery Plan for northeast Oregon (NMFS 2012a) requires that the Upper Grande Ronde and Wallowa River populations be at no greater than moderate risk, the Joseph Creek population maintain its current low risk status, and the Lower Grande Ronde population be at low or moderate risk. This corresponds to a threshold of at least "viable" status for the Upper Grande Ronde, Wallowa River, and Lower Grande Ronde populations and "highly viable" status for the Joseph Creek, and possibly Lower Grande Ronde populations. Overall, the MPG will need to show improvements in all four of the VSP criteria for these populations to move toward recovery.

For the most recent period (2005-2014), abundance of the Joseph Creek population has decreased, but still remains well above the minimum viability threshold. Productivity dropped slightly, but still remains above replacement (Table 18). Therefore, the integrated abundance and productivity risk is very low. Spatial structure and diversity remain at low risk (Table 18), leading to an overall low risk rating.

NWFSC (2016) found that current total abundance (number of adults spawning in natural production areas) is unknown for the Lower Grande Ronde population. There are no data (weir, trap, or redd surveys) to enumerate adult abundance. Surveys of juvenile density or abundance have been conducted in some stream reaches in the past. However, the number of hatchery-origin fish that spawn naturally in this population is unknown.

The most recent status review (NWFSC 2015) also found that current total abundance (number of adults spawning in natural production areas) is unknown for the Wallowa River population. There are no data (weir, trap, or redd surveys) to enumerate adult abundance in the population and thus this population was rated moderate risk based on uncertainty in current abundance/productivity. More information exists on population distribution and diversity, with current spawning distribution similar to historical distribution, leading to a low risk for spatial structure/diversity.

The Upper Grande Ronde is one of two populations that have been collecting adequate information for the ICTRT to assess status trends. The viability risk rating is moderate because abundance is above the minimum viability threshold and productivity substantially exceeds replacement (NWFSC 2015). Current spawning distribution is nearly identical to historical distribution, with all major spawning areas and most minor spawning areas occupied. Occupied areas cover the entire historical range from lower tributaries to the upper headwaters (NMFS 2012a).

**Imnaha MPG**
There is currently one independent population of steelhead within the Imnaha MPG, the Imnaha River population. The Draft ESA Recovery Plan for northeast Oregon (NMFS 2012a) requires that the Imnaha River population achieve low risk. This corresponds to a threshold of "highly viable" status for the population. The most recent status review by NMFS (NWFSC 2015) maintains that information for this population is insufficient, but the population is most likely "maintained," which suggests the risk is moderate (Table 18).

### 2.2.3. Range-wide Status of Critical Habitat

This section of the opinion examines the range-wide status of designated critical habitat for the affected salmonid species. For Snake River steelhead, critical habitat is designated in 70 FR 52630 (September 2, 2005). It includes all Columbia River estuarine areas and upstream river reaches, following the Snake River to Hells Canyon Dam, as well as specific stream reaches in the following subbasins: Tucannon, Clearwater, Asotin, Grand Ronde, Imnaha, and Salmon.

NMFS determines the range-wide status of critical habitat by examining the condition of its physical and biological features (also called "primary constituent elements," or 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 SR steelhead (70 FR 52731, September 2, 2005), including the populations being consulted on within this opinion, include:

(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.

Within the three subbasins that are the focus of this consultation, there are 37 watersheds. NMFS (2005a) ranked watersheds within designated critical habitat at the scale of the fifth-field hydrologic unit code (HUC 5) in terms of the conservation value they provide to each listed species they support[5]; the conservation rankings are high, medium, or low (Table 19). To determine the conservation value of each watershed to species viability, NMFS' critical habitat analytical review teams (NMFS 2005a) evaluated the: quantity and quality of habitat features (e.g., spawning gravels, wood and water condition, and side channels); the relationship of the area compared to other areas within the species' range; and the importance to the species of the population occupying that area. Thus, even a location that has poor habitat quality could have a high conservation value if it were essential. Essential criteria include limited availability (e.g., one of a very few spawning areas), a unique contribution of the population it served (e.g., a population at the extreme end of geographic distribution), or the fact that it serves another important role (e.g., obligate area for migration to upstream spawning areas).

Table 19. Summary of watershed conservation rankings within the three subbasins in northeast Oregon and southeast Washington (NMFS 2005a)

| Subbasin | Number of watersheds | Ranking |
|---|---|---|
| Lower Snake/Tucannon and Asotin | 9 | 3 high; 2 medium; 4 low |
| Grande Ronde | 24 | 21 high; 3 medium |
| Imnaha | 5 | 5 high |

### 2.2.4. Climate Change

Climate change has negative implications for designated critical habitats in the Pacific Northwest (CIG 2004; ISAB 2007; Scheuerell and Williams 2005; Zabel et al. 2006). Average annual Northwest air temperatures have increased by approximately 1ºC since 1900, or about 50% more than the global average over the same period (ISAB 2007). The latest climate models project a warming of 0.1 ºC to 0.6 ºC per decade over the next century. According to the Independent Scientific Advisory Board (ISAB), these effects pose the following impacts over the next 40 years:

- Warmer air temperatures will result in diminished 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, 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.

[5] The conservation value of a site depends upon "(1) the importance of the populations associated with a site to the ESU [or DPS] conservation, and (2) the contribution of that site to the conservation of the population through demonstrated or potential productivity of the area" (NMFS 2005a).

- 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.

There remains uncertainty both with climate trends in the region and with the effect on Snake Basin populations of variations in ocean conditions. Recently, researchers examining data from 1990-2009 found that temperatures in the region 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.

The effects of climate change on salmon and steelhead is also uncertain. 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.

### 2.3. Environmental Baseline

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

In order to understand what is affecting a species, it is first necessary to understand the biological requirements of the species. Each stage in a species’ life-history has its own biological requirements (Groot and Margolis 1991; NRC 1996; Spence et al. 1996). Anadromous fish require clean water with cool temperatures and access to thermal refugia, dissolved oxygen near 100 percent saturation, low turbidity, adequate flows and depths to allow passage over barriers to reach spawning sites, and sufficient holding and resting sites. Anadromous fish select spawning areas based on species-specific requirements of flow, water quality, substrate size, and groundwater upwelling. Embryo survival and fry emergence depend on substrate conditions (*e.g.*, gravel size, porosity, permeability, and oxygen concentrations), substrate stability during high flows, and, for most species, water temperatures of 13ºC or less. Habitat requirements for juvenile rearing include seasonally suitable microhabitats for holding, feeding, and resting.

Migration of juveniles to rearing areas, whether the ocean, lakes, or other stream reaches, requires free access to these habitats.

Wide varieties of human activities have affected Snake River spring/summer Chinook salmon and PCEs in the action area. These activities, more recently, include reclamation actions that are having beneficial effects.

### 2.3.1. Description of Area and Historical Effects on the Landscape

#### 2.3.1.1. Lower Snake River Subbasin (From SRSRB 2011)

Tributaries to the Snake River that have perennial flow include streams draining the north side (Alkali Flat, Penawawa, Almota, Wawawai, and Steptoe Canyon Creeks), and streams draining the south side (Alpowa, Deadman, and Meadow Creeks). These streams flow down very steep canyons and, under typical conditions, do not convey much water; however, during thunderstorms or rain-on-snow events they are capable of carrying large volumes of water and debris.

Land ownership patterns within the region vary by county, although private landowners hold the majority of land in all counties. The State of Washington manages a number of parks and wildlife management areas; the U.S. Forest Service is the largest Federal landowner in the area. The largest amount of Federal land is found in Columbia County, primarily in the U.S. Forest Service's Umatilla National Forest. Approximately 62 percent (111,048 acres) of the wilderness area is within the Action Area.

Irrigation withdrawals have reduced flows in the Tucannon River and Asotin Creek. Many floodplains in the two subbasins have been altered by channelization to reduce flooding and by clearing to convert land to agricultural and residential uses. Flood control structures have been constructed in the Tucannon River and Asotin Creek. These have accelerated surface water runoff and decreased groundwater recharge, contributing to lower summer stream flows. 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.

Many of the streams and rivers in the region do not comply with water quality standards for temperature, primarily due to low summer flows. This may be exacerbated in the future by climate change. Past and current agricultural practices such as manufacturing, and erosion, among other activities, have resulted in impaired water quality. Some of these activities have also introduced pesticides such as DDT into the water and have raised levels of fecal coliform and PCBs as well as other constituents. In some water bodies, pH has been negatively affected.

Since the arrival of settlers in the 19th century, much of the riparian habitat has been lost or modified. Today, much of the herbaceous, prairie grassland, and shrub-steppe vegetation has been converted to cropland and livestock pasture. The Federal Conservation Reserve Program (CRP) has successfully assisted farm operators and owners in conserving and improving soil, water, and wildlife resources. Under the CRP, highly erodible and other environmentally sensitive lands that have produced crops are converted to a long-term resource-conserving vegetative cover. Participants in the CRP are required to seed native or introduced perennial grasses or a combination of shrubs and trees with native forbs and grasses.

The Asotin subbasin riparian vegetation is a mixture of mature alders, young cottonwood, willow, and sparse immature conifers in the mid to lower reaches and primarily mature cottonwood and conifers in the upper reaches. Forested riparian vegetation along Asotin Creek and other subbasin streams remains in transition, having been affected by flooding events in 1996 and 1997. Damage to riparian cover in the upper portion of the watershed reduced the canopy cover by approximately half compared to pre-flood (1993) surveys.

The Alpowa-Deadman Subbasin includes the lower, middle, and upper reaches of Alpowa and Deadman Creeks. The Soil Conservation Service described the lower reaches of Alpowa Creek as having been heavily grazed within the riparian zone. The result was poor herbaceous vegetation quality and quantity. Shrubby vegetation was described as poor along most of the creek and absent along the remainder. The trees were considered to be in poor to fair condition and were described as “relicts” of little or no reproductive value.

Livestock grazing and some cultivation are present on the middle reach. Grazing is “heavy” to “moderate” on the banks leading to poor herbaceous, shrubby, and tree vegetation throughout the middle reach. Noxious weeds, such as false indigo, have invaded the area.

Riparian vegetation is minimal along the upper reach. Herbaceous and shrubby streambank vegetation was either in poor condition or completely lacking in 1981. Trees were in fair condition on more than half of the streambanks and poor on the remainder. This reach contained streambanks that were substantially more vegetated and stable than the middle reach.

The Tucannon riparian vegetation is made up of mature alders, young cottonwood, willow, and sparse immature conifers in the mid to lower reaches and primarily mature cottonwood and conifers in the upper reaches. Tree species present along the streambanks include black cottonwood, white alder, Douglas-fir, grand fir, Douglas hawthorn, and Engelmann spruce. Common tree species in the riparian plant community include western larch, ponderosa pine, golden willow, and locust. Common shrub species include chokecherry, coyote willow, wild rose, sticky currant, and snowberry. Few-flowered spike rush, various sedge species, and a variety of weedy forbs are common. Conifer species were dominant in the higher elevations and deciduous species were dominant in the lower elevations.

The riparian vegetation in the Lower and Middle Snake River has been described as including forbs, grasses, sedges, rushes, grazed pasture, and some shrubs and trees. In some areas, the riparian trees are as tall as 30 feet and the buffer as wide as 40 feet. Much of the riparian areas are grazed.

The Salmonid Habitat Limiting Factors reports prepared for WRIAs 32, 33, 34, and 35 contain assessments of the riparian condition along fish-bearing streams within the region. The evaluation system was applied to riparian corridors, wetlands, intermittent headwater streams, and other areas where proper ecological functioning is crucial to maintenance of the stream’s water, sediment, woody debris, and nutrient delivery systems (Kuttle 2001; Kuttle 2002). This report was based on conditions in the 1990’s and conditions have improved considerably in the last decade, primarily due to implementation of the Conservation Reserve and Enhancement Program (CREP) where nearly 80 percent of all CREP-eligible/salmon bearing streams now have riparian buffers and other salmon recovery actions through the Snake River Salmon Recovery Board (SRSRB).

#### 2.3.1.2. Grande Ronde and Imnaha River Subbasins (NMFS 2012a)

Of the 4,880 square miles of land in northeastern Oregon, 54 percent is Federally owned, 45 percent is privately held, and less than 1 percent is partitioned for both state and tribal use. The region is dominated by agricultural and rangeland use, as well as forestlands used for recreational purposes.

Past land use practices across the region over the last 200 years contributed to causing many of the factors now limiting salmonid abundance and productivity. While some past land use practices were less destructive than other practices, the overall impact was a reduction in habitat quality and complexity, water quality, and a general disruption in the proper functioning of watershed processes in many parts of the Grande Ronde and Imnaha subbasins.

The ODFW Expert Panel (2007; in NMFS 2012a) found that past and/or present land use activities affect viability of Oregon Snake River steelhead populations. Depending on the population, the panel listed the following as either key or secondary concerns attributable to land use: (1) impaired upstream and downstream movement of juvenile and adult steelhead; (2) impaired physical habitat quality; (3) impaired water quality due to elevated water temperatures and fine sediment; (4) reduced water quantity and/or modified hydrograph. These concerns affect salmon and steelhead abundance, productivity, and spatial structure.

Habitat conditions in many areas are improving, despite the effects of land-use practices and climate change. While harmful land-use practices continue in some areas, many land management activities, including forestry and agricultural 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. Riparian areas also receive more protection under current forest management. Agriculture activities have also improved. Many landowners are implementing good conservation practices to farming and grazing so that important ecosystem processes and functions can recover. Many are also protecting and restoring stream corridors. They have protected many miles of stream adjacent to farmland in Union and Wallowa Counties through easement programs that protect streambanks and riparian vegetation through land management contracts. Such changes are slowly improving habitat conditions for Oregon Snake River spring/summer Chinook salmon and steelhead, and other fish and wildlife species, while also restoring overall watershed health.

### 2.3.2. Historical hatchery operations in the region

A variety of hatchery practices conducted under the Lower Snake River Compensation Plan (LSRCP) for over 25 years have affected N.E. Oregon and S.E. Washington spring/summer Chinook salmon populations. The hatchery programs were initiated to mitigate for impact of the construction of the lower four Snake River dams on salmon and steelhead in the Snake River basin. LSRCP hatcheries produce and release salmon, steelhead, and resident rainbow trout in the Snake River basin as part of the program's mitigation responsibility. The hatchery programs—summarized below based on their descriptions in the submitted HGMPs—augment fisheries, supplement existing populations, and reintroduce fish into areas where they have been extirpated.

### 2.3.2.1. Tucannon River (WDFW 2011)

Artificial production of spring Chinook salmon began in 1962 with small releases of stocks from other areas. These releases were discontinued in 1965 when flooding destroyed rearing ponds. In 1985, natural-origin returns were collected to begin a supplementation program, and smolts have been released since 1987 in the Tucannon. When first initiated, between 8 (1985) and 127 (1988) natural-origin adults were collected to create the broodstock. Broodstock numbers have varied in an effort to produce sufficient returns to the program, and have ranged between 100 and 170 fish annually, to achieve a release goal of 225,000 smolts annually. Beginning in 1989, the broodstock was integrated with hatchery-origin returns. An integrated program has provided all juvenile releases since 2002 (WDFW 2011). A captive broodstock program was also in place from 1997-2002, which raised fish to adulthood. The last releases of captive broodstock were in 2008.

In some years, fish shortages required WDFW to collect all fish (natural or hatchery-origin) that returned to the Tucannon Fish Hatchery adult trap. For example, in 1995 this amounted to 43 total fish, of which 10 were natural-origin. The co-managers inclusion of the entire run was intended to reduce the demographic risk to the population. Because of inconsistent and often low returns, the hatchery has contributed, and is likely to continue to contribute, a high proportion of the fish in the Tucannon population.

Since 2010, high levels of pre-spawn mortality after fish passage above the adult trap has been a concern for the Tucannon population. Redd surveys have shown that the female per redd ratio has been over 1.5 females per redd in 2010, and from 2012-2014 (Joe Bumgarner, WDFW, pers. comm.).

### 2.3.2.2. Upper Grande Ronde (Confederated Tribes of the Umatilla Indian Reservation (CTUIR) 2011)

A hatchery release of spring Chinook salmon in the Grande Ronde basin occurred in 1972 from Marion Forks Hatchery. Hatchery releases did not occur again until the Lookingglass Hatchery was completed in 1982. Carson Hatchery and Rapid River Hatchery stock were released into the Grande Ronde River (and throughout the basin) until 1994 (Confederated Tribes of the Umatilla Indian Reservation (CTUIR) 2011; HSRG 2009).

The program continues to use both hatchery- and natural-origin adults for broodstock. A safety net program also exists, which takes eggs from the conventional program and raises them to adulthood in captivity to be released in the wild to spawn naturally. Between 2003 and 2012, the population consisted primarily of hatchery-origin spawners. Low natural-origin returns have contributed to reliance on hatchery returns for broodstock (Feldhaus et al. 2014b).

Because of extremely low returns in the early 1990's (4 redds in 1994), a captive broodstock program was initiated in 1995 with the collection of wild parr. A conventional hatchery program began in 2001 using natural-origin returns to the basin. During this time, the captive broodstock program continued, and adults were incorporated into conventional production. Returning adults from the captive program were released to spawn in the wild, but were not used in the conventional broodstock. In 2008, the captive program shifted to a safety net program in which conventional eggs were raised to adulthood to be released into the wild to spawn. The safety net program was terminated in 2015.

### 2.3.2.3. Lostine/Wallowa River (Nez Perce Tribe 2011)

The Lostine River spring Chinook salmon program is one of four components that make up the LSRCP mitigation program for the Grande Ronde River Basin. A captive brood program was initiated in the Lostine River in 1995 in response to severely declining abundance of spring Chinook salmon. The first adults for conventional broodstock were trapped in 1997.

For the captive program, parr were collected and reared to maturity for spawning and were incorporated into the Lostine River endemic program. The release of captive broodstock smolts in the Lostine River first occurred in 1998. As the production of smolts from the integrated program increased to the planned production of 250,000, the production of captive smolts decreased and began phasing out with brood year 2007. The final release of captive smolts occurred in 2011. Monitoring and evaluation of adult returns from captive smolt releases continues under the Lostine River Monitoring and Evaluation program.

In addition to smolt releases in the Lostine River, fry and parr releases have occurred in other Wallowa River tributaries (Bear Creek and Prairie Creek) within the habitat of the Wallowa/Lostine Spring Chinook salmon population when surplus offspring are available. Additionally, the supplementation program has outplanted a portion of the returning adult hatchery-origin Chinook salmon into Bear Creek beginning in 2002 and in the Upper Wallowa River beginning in 2004 in under seeded and vacant habitat. Redd surveys in both Bear Creek and the upper Wallowa River have documented an increase in redds after outplanting compared to years when no outplanting occurred. In 2009, a portion of the redds in Bear Creek were genetically identified as the redds of offspring from hatchery-outplants in 2004 and 2005.

From 2009-2015 outplants have occurred into Bear Creek in 2009, 2013, and 2014, ranging from 48 to 477 fish. In 2013 and 2014, only jacks were outplanted. This occurred late in the season for nutrient enhancement. In the Lostine/Wallowa basin outplanting occurred in 2012, 2014, and 2015 ranging from 29-208 fish. While consideration is given to balance sex ratios and age structure, the proportion of jacks in the outplant group has ranged from 7 to 94 percent.

### 2.3.2.4. Catherine Creek (ODFW 2011a)

The Catherine Creek spring/summer Chinook salmon propagation program was initiated in 1995 with the collection of wild parr for the captive broodstock program. The captive broodstock was the only source for broodstock between 1998-2000. Starting in 2001, wild adults were captured at the weir and incorporated into the captive program until 2004. In 2005, wild, captive, and conventional adults were used for production, and the captive program was phased out in favor of the conventional program. From 2001-2010, carcass surveys suggested that an average of 61 percent of the spawners in Catherine Creek were hatchery-origin.

Like other programs in the basin, Catherine Creek has had few natural-origin spawners in recent years, and the population is largely supported by hatchery returns. Catherine Creek was supplemented with Carson and Rapid River hatchery stocks beginning in the early 1980s. These stocks were released into Catherine Creek (and throughout the Grande Ronde basin) until 1994 (HSRG 2009). Prior to 1993, hatchery-origin spawners originated from these non-local broodstock releases; however, once this practice was discontinued, non-local origin returns were actively removed at Lower Granite Dam during the transition period.

Adult outplanting of excess hatchery-origin adult Catherine Creek fish has occurred in Indian and Lookingglass Creek. Outplanting in Indian Creek took place in 2004, 2010-2012, and 2015. The number of adults averaged about 82 and ranged from 46-106. Outplanting in Lookingglass Creek took place in 2004, 2009-2010, 2012, and 2015. The number of adults averaged 139 and ranged from 1 to 351 (Zimmerman and Johnson 2016).

#### 2.3.2.5. Lookingglass Creek (ODFW 2012)

The LSRCP program completed Lookingglass Hatchery in 1982. The hatchery construction included an intake that blocked passage of adults above the facility. Though fish were not released into the upper portions of Lookingglass Creek, the first releases of Rapid River stock spring Chinook salmon occurred in 1980 (1978 brood) in Lookingglass Creek and throughout the Grande Ronde basin. Rapid River and Carson-origin fish were released in the early 1980s, and the use of non-native stocks continued through the 1990s. Returning adults were able to spawn in the lower portions of Lookingglass Creek, and interbreed with any remaining Lookingglass Creek fish. The last Rapid River fish were released as parr in Lookingglass Creek in 2000. Lookingglass Hatchery then transitioned from rearing and releasing composite stocks to indigenous Grande Ronde Basin stocks using captive and conventional broodstocks.

The Lookingglass Creek spring Chinook salmon program currently operates as a reintroduction program to restore spring Chinook salmon to Lookingglass Creek. The native population of spring Chinook salmon in Lookingglass Creek is considered extirpated. Because out-of-basin stocks heavily influenced the original Lookingglass Creek stock, co-managers selected spring Chinook salmon from Catherine Creek as the appropriate stock for reintroduction into Lookingglass Creek. Juvenile spring Chinook salmon from the Catherine Creek Hatchery program were first released into Lookingglass Creek in 2001 and adult spring Chinook salmon from Catherine Creek were first released in 2004.

Because the Lookingglass Creek population was extirpated, and supplementation with Rapid River stock fish genetic introgression from the Rapid River fish is more apparent in this population than in other Grande Ronde River populations; however, most of this historical introgression has been lost, and Lookingglass Creek now closely resembles the Catherine Creek stock it was founded with (Van Doornik et al. 2013).

#### 2.3.2.6. Imnaha River (ODFW 2011b)

Hatchery supplementation in the Imnaha began in 1982 with the collection of wild adults from the Imnaha River. Though broodstock for the Imnaha program originate from natural-origin returns, broodstock was originally founded between 1982-1985 by removing the entire component of the latest part of the run (Carmichael and Messmer 1995 in Hoffnagle et al. 2008). In the early years, broodstock was composed of a large proportion of natural-origin returns, but that shifted in the late 1980s as hatchery-origin returns from the program steadily increased. By the early 2000s, broodstock composition had shifted to over 70 percent hatchery-origin broodstock in most years.

Similarly, fish spawning in the wild were dominated by hatchery-origin returns as the program increased in size. For most years, a sliding scale approach to manage hatchery-origin adults in the basin was used, although it has changed over time. Management constraints and difficulties with the weir have limited the ability to manage to the intended targets. In addition, about 40 percent of the spawning area in the Imnaha is below the weir, and returning hatchery-origin adults cannot be managed below the weir.

Outplanting in Big Sheep and Lick Creeks has occurred annually in 19 out of 23 years since 1993. The number of outplanted fish has ranged from 1 to 517 with an average of 272 fish per year.

### 2.3.3. Other

Information relevant to the environmental baseline is discussed in detail in Chapter 5 of the Supplemental Comprehensive Analysis (SCA) (NMFS 2008e), which cross-references back to the related 2008 FCRPS biological opinion (NMFS 2008c). Chapter 5 of the SCA and related portions of the FCRPS Opinion provide an analysis of the effects of past and ongoing human and natural factors on the status of the species, their habitats, and ecosystems, within the entire Columbia River Basin. In addition, Chapter 5 of the SCA, and related portions of the FCRPS Opinion evaluate the effects of those ongoing actions on designated critical habitat with that same area. Those portions of Chapter 5 of the SCA and environmental baseline section of the FCRPS Opinion that deal with effects in the action area (described in Section 1.4) are hereby incorporated by reference.

### 2.3.4. Fisheries

Ocean and mainstem fisheries for spring/summer Chinook salmon take place from January 1 to June 15, annually. The effects of the fisheries’ operation on the ESA-listed Snake River Spring/summer Chinook Salmon ESU and Snake River Steelhead DPS were previously analyzed by NMFS. NMFS found that the action did not appreciable reduce the likelihood of survival and recovery of the listed species (NMFS 2008d). The percentage of the natural-origin Chinook salmon incidentally caught in the fishery was limited from 5.5 to 17 percent, with an average catch of 10.2 percent of the natural-origin fish from the entire ESU. Steelhead encounters in these fisheries are rare because the timing of the steelhead run occurs in the fall, well after the closure of the spring/summer Chinook salmon fisheries (NMFS 2008d).

Fisheries also occur within the Columbia River tributary subbasins in northeast Oregon. These fisheries typically take place from May to July. Management of these fisheries limits catch of natural-origin fish to a certain percentage of the natural-origin abundance (i.e., a sliding scale). The effects of the fisheries’ operation on the ESA-listed Snake River Spring/summer Chinook Salmon ESU and the Snake River Steelhead DPS were previously analyzed by NMFS. NMFS also found, as with ocean and mainstem Columbia River fisheries, above, that the action did not appreciable reduce the likelihood of survival and recovery of the listed species (NMFS 2013b). Based on recent natural-origin abundances, the percentage of natural-origin Chinook salmon caught in tributary fisheries ranges from 1 to 9 percent across all subbasins. Steelhead are rarely encountered (1 fish reported from 2001 to 2009) in tributary fisheries for spring Chinook salmon because they spawn from April to early June, which overlaps with the spring Chinook fishery from June through July for only a short time (NMFS 2013b).

There is a small tribal spring Chinook salmon fishery in the Tucannon River. In 2011, six clipped spring Chinook salmon and eleven unclipped spring Chinook salmon were caught. No spring Chinook salmon were caught in 2012, 2013 or 2015 (https://www.fws.gov/lsnakecomplan/Reports/NPTreports.html).

## 2.4. Effects on ESA Protected Species and on Designated Critical Habitat

This section describes the effects of the Proposed Action, independent of the Environmental Baseline and Cumulative Effects. The methodology and best scientific information NMFS follows for analyzing hatchery effects is summarized first in Section 2.4.1 and then application of the methodology and analysis of the Proposed Action itself follows in Section 2.4.2. The "effects of the action" means the direct and indirect effects of the action on the species and on designated critical habitat, together with the effects of other activities that are interrelated or interdependent, that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the Proposed Action and are later in time, but still are reasonably certain to occur. Effects of the Proposed Action that are expected to occur later in time (i.e., after the 10-year timeframe of the Proposed Action) are included in the analysis in this opinion to the extent they can be meaningfully evaluated. The Proposed Action, the status of ESA-protected species and designated critical habitat, the Environmental Baseline, and the Cumulative Effects are analyzed comprehensively to determine whether the Proposed Action is likely to appreciably reduce the likelihood of survival and recovery of ESA protected species or result in the destruction or adverse modification of their designated critical habitat.

### 2.4.1. 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. These documents are available upon request from the NMFS Salmon Management Division in Portland, Oregon. "Pacific Salmon and Artificial Propagation under the Endangered Species Act" (Hard et al. 1992) was published shortly following the first ESA-listings of Pacific salmon on the West Coast and it includes information and guidance that is still relevant today. In 2000, NMFS published "Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units" (McElhany et al. 2000) and then followed that with a "Salmonid Hatchery Inventory and Effects Evaluation Report" for hatchery programs up and down the West Coast (NMFS 2004b). In 2005, NMFS published a policy that provided greater clarification and further direction on how it analyzes hatchery effects and conducts extinction risk assessments (NMFS 2005b). NMFS then updated its inventory and effects evaluation report for hatchery programs on the West Coast (Jones 2006) and followed that with "Artificial Propagation for Pacific Salmon: Assessing Benefits and Risks & Recommendations for

Operating Hatchery Programs Consistent with Conservation and Sustainable Fisheries Mandates" (NMFS 2008a). More recently, NMFS published its biological analysis and final determination for the harvest of Puget Sound Chinook salmon, which included discussion on the role and effects of hatchery programs (NMFS 2011b).

A key factor in analyzing a hatchery program for its effects, positive and negative, on the status of salmon and steelhead are the genetic resources that reside in the program. Genetic resources that represent the ecological and genetic diversity of a species can reside in a hatchery program. "Hatchery programs with a level of genetic divergence relative to the local natural population(s) that is no more than what occurs within the ESU are considered part of the ESU and will be included in any listing of the ESU" (NMFS 2005b). NMFS monitors hatchery practices for whether they promote the conservation of genetic resources included in an ESU or steelhead DPS and updates the status of genetic resources residing in hatchery programs every five years. Jones (2011) provides the most recent update of the relatedness of Pacific Northwest hatchery programs to 18 salmon ESUs and steelhead DPSs listed under the ESA. Generally speaking, hatchery programs that are reproductively connected or "integrated" with a natural population, if one still exists, and that promote natural selection over selection in the hatchery, contain genetic resources that represent the ecological and genetic diversity of a species and are included in an ESU or steelhead DPS.

When a hatchery program actively maintains distinctions or promotes differentiation between hatchery fish and fish from a native population, then NMFS refers to the program as "isolated". Generally speaking, isolated hatchery programs have a level of genetic divergence, relative to the local natural population(s), that is more than what occurs within the ESU and are not considered part of an ESU or steelhead DPS. They promote domestication or selection in the hatchery over selection in the wild and select for and culture a stock of fish with different phenotypes, for example different ocean migrations and spatial and temporal spawning distribution, compared to the native population (extant in the wild, in a hatchery, or both). 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, including abundance, productivity, spatial structure, and diversity. The effects of a hatchery program on the status of an ESU or steelhead DPS "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 also analyzes and takes into account the effects of hatchery facilities, for example, weirs and water diversions, on each VSP attribute and on designated critical habitat.

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 on the general type of effect of that aspect of hatchery operation in the context of the specific application in each of the areas where hatchery origin fish may spawn naturally with each other or natural-origin populations. This allows for quantification (wherever possible) of the various factors of hatchery operation to be applied to each applicable life-stage of the listed species at the population level (in Section 2.4.2), which in turn allows the combination of all such effects with other effects accruing to the species to determine the likelihood of posing jeopardy to the species as a whole (Section 2.7).

The effects, positive and negative, for two categories of hatchery programs are summarized in Table 20. Generally speaking, effects range from beneficial to negative for programs that use local fish[6] for hatchery broodstock and from negligible to negative when a program does not use local fish for broodstock[7]. 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 avoiding co-occurrence and effects that potentially disadvantage fish from natural populations. The range in effects for a specific hatchery program are refined and narrowed after available scientific information and the circumstances and conditions that are unique to individual hatchery programs are accounted for.

[6] 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).
[7] Exceptions include restoring extirpated populations and gene banks.

Table 20. Overview of the range in effects on natural population viability parameters from 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**<br>Hatcheries are unlikely to benefit productivity except in cases where the natural population's small size is a predominant factor limiting population growth (i.e., productivity) (NMFS 2004). | **Negligible to negative effect**<br>This 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 affect). |
| **Diversity** | **Positive to negative effect**<br>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. Broodstock collection that homogenizes population structure is a threat to population diversity. | **Negligible to negative effect**<br>This 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 affect). |
| **Abundance** | **Positive to negative effect**<br>Hatchery-origin fish can positively affect the status of an ESU by contributing to the abundance and productivity of the natural populations in the ESU (70 FR 37204, June 28, 2005, at 37215). | **Negligible to negative effect**<br>This is dependent on the level of isolation achieved by the hatchery program, handling, RM&E and facility operation, maintenance and construction effects. |
| **Spatial Structure** | **Positive to negative effect**<br>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 that hatchery stock(s) add to (rather than replace) natural populations" (70 FR 37204, June 28, 2005). | **Negligible to negative effect**<br>This 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 affect). |

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 seven 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,

(4) hatchery fish and the progeny of naturally spawning hatchery fish in the migration corridor, estuary, and ocean,

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

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

(7) 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. The categories are:

(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 the status of an ESU will depend on which of the four key attributes are currently limiting the ESU, and how the hatchery within the ESU affect each of the attributes" (NMFS 2005b). The category of affect assigned is based on an analysis of each factor weighed against the affected population(s) current risk level for abundance, productivity, spatial structure and diversity, the role or importance of the affected natural population(s) in ESU or steelhead DPS recovery, the target viability for the affected natural population(s), and the Environmental Baseline including the factors currently limiting population viability.

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

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

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

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

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

There are two aspects to this part of the analysis: genetic effects and ecological effects. NMFS generally views genetic effects as detrimental because at this time, based on the weight of available scientific information, 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. Hatchery fish thus pose a threat to natural population rebuilding and recovery when they interbreed with fish from natural populations.

However, NMFS recognizes that there are benefits 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). Furthermore, NMFS also recognizes there is considerable uncertainty 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, for species with multiple life-history types, and for species subjected to different hatchery practices and protocols remains 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 2011b).

#### 2.4.1.2.1. Genetic effects

Hatchery fish can have a variety of genetic effects on natural population productivity and diversity when they interbreed with natural-origin fish. Although there is biological interdependence between them, NMFS considers three major areas of genetic effects of hatchery programs: within-population diversity, outbreeding effects, and hatchery-influenced 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 risk.

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 ($N_e$). Effective population size, which is basically census size adjusted for variation in sex ratio and reproductive success, determines the level of genetic diversity that can be maintained by a population, and the rate at which diversity is lost. Effective size 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 and Barrowclough 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 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, 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. 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). $N_e$ can also be 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). Factorial mating schemes, in which fish are systematically mated multiple times, can be used to increase $N_e$ (Busack and Knudsen 2007; Fiumera et al. 2004). An extreme form of $N_e$ reduction is the Ryman-Laikre effect (Ryman et al. 1995; Ryman and Laikre 1991), when $N_e$ is reduced through the return to the spawning grounds of large numbers of hatchery fish from very few parents.

Inbreeding depression, another $N_e$-related phenomenon, is caused by the mating of closely related individuals (e.g., sibs, half-sibs, 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 are caused by gene flow from other populations. Gene flow occurs naturally among salmon and steelhead populations, a process referred to as straying (Quinn 1993; Quinn 1997). Natural straying serves a valuable function in preserving diversity that would otherwise be lost through genetic drift and in re-colonizing vacant habitat, and straying is considered a risk only when it occurs at unnatural levels or from unnatural sources. Hatchery programs can result in straying outside natural patterns for two reasons. First, hatchery fish may exhibit reduced homing fidelity relative to natural-origin fish (Goodman 2005; Grant 1997; Jonsson et al. 2003; Quinn 1997), resulting in unnatural levels of gene flow into recipient populations, either in terms of sources or rates. Second, even if hatchery fish home at the same level of fidelity as natural-origin fish, their greater 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 2007), and the greater potential for outbreeding depression. For this reason, NMFS advises hatchery action agencies to develop locally derived hatchery broodstocks. Additionally, unusual rates of straying into other populations within or beyond the population's MPG or 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 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 hatchery affects. Adult salmon may wander on their return migration, entering and then leaving tributary streams before finally spawning (Pastor 2004). These "dip-in" fish may be detected and counted as strays, but may eventually spawn in other areas, resulting in an overestimate of the number of strays that potentially interbreed with the natural population (Keefer et al. 2008). Caution must also be taken in assuming that strays contribute genetically in proportion to their abundance. Several studies demonstrate little genetic impact from straying despite a considerable presence of strays in the spawning population (Blankenship et al. 2007; Saisa et al. 2003). The causative factors for poorer breeding success of strays are likely similar to those identified as responsible for reduced productivity of hatchery-origin fish in general, e.g., differences in run and spawn timing, spawning in less productive habitats, and reduced survival of their progeny (Leider et al. 1990; McLean et al. 2004; Reisenbichler and McIntyre 1977; Williamson et al. 2010b).

Hatchery-influenced selection (often called domestication) 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, typically from the same population. 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 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). On an individual level, exposure time in large part equates to fish culture, both the environment experienced by the fish in the hatchery and natural selection pressures, independent of the hatchery environment. On a population basis, exposure is determined by the proportion of natural-origin fish being used as hatchery broodstock and the proportion of hatchery-origin fish spawning in the wild (Ford 2002b; Lynch and O'Hely 2001), and then by the number of years the exposure takes place. In assessing risk or determining impact, all three levels 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 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.

Besides the Hood River steelhead work, a number of studies are available on the relative reproductive success (RRS) of hatchery-origin and natural-origin fish (e.g.,Berntson et al. 2011; Ford et al. 2012; Hess et al. 2012; Theriault et al. 2011). All have shown that generally hatchery-origin fish have lower reproductive success, though the differences have not always been statistically significant and in some years in some studies, the opposite is 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 interbreeding 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.

Critical information for analysis of hatchery-influenced 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[8]. 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 6).

[8] Gene flow between natural-origin and hatchery-origin fish is often, and quite reasonably, 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.

More recently, the Hatchery Scientific Review Group (HSRG) developed gene flow criteria/guidelines based on mathematical models developed by Ford (2002a) and by Lynch and O'Hely (2001). Guidelines for isolated programs are based on pHOS, but guidelines for integrated programs are also based 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)[9]. 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. For a population of high conservation importance their guidelines are a pHOS of no greater than 5% for isolated programs or a pHOS no greater than 30% and PNI of at least 67% for integrated programs (HSRG 2009). Higher levels of hatchery influence are acceptable, however, when a population is at high risk or very high risk of extinction due to low abundance and the hatchery program is being used to conserve the population and reduce extinction risk, in the short-term. HSRG (2004) offered additional guidance regarding isolated programs, stating that risk increases dramatically as the level of divergence increases, especially if the hatchery stock has been selected directly or indirectly for characteristics that differ from the natural population. The HSRG recently produced an update report (HSRG 2014) in which they stated that the guidelines for isolated programs may not provide as much protection from fitness loss as the corresponding guidelines for integrated programs.

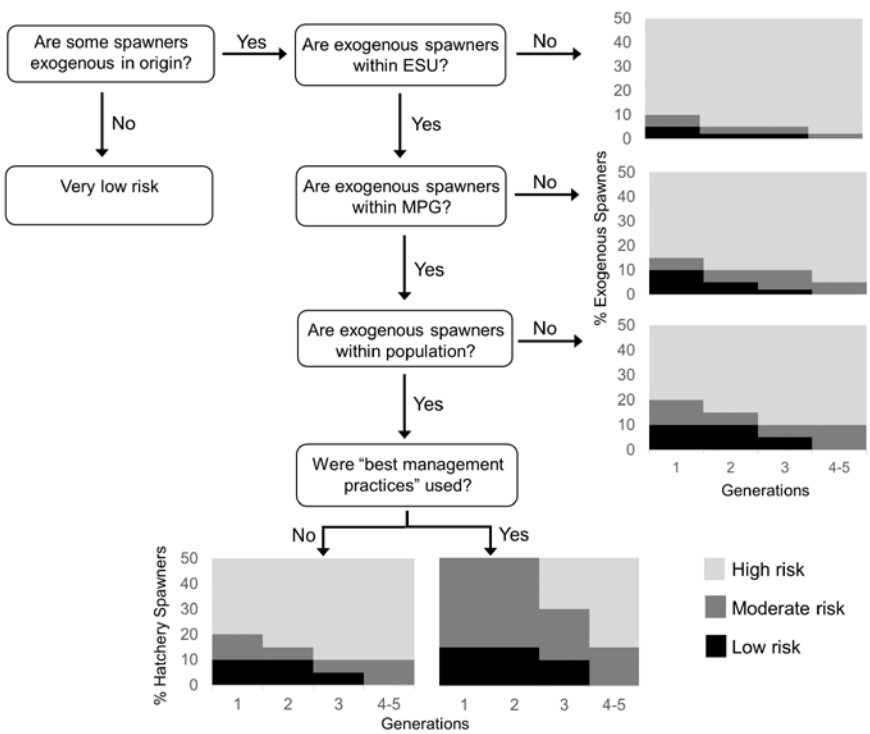


Figure 6. ICTRT (2007) risk criteria associated with spawner composition for viability assessment of exogenous spawners on maintaining natural patterns of gene flow. Exogenous fish are assumed to be hatchery-origin, and non-normative strays of natural-origin.

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[9] PNI is computed as pNOB/(pNOB+pHOS). This statistic is really an approximation of the true proportionate natural influence (HSRG 2009), but operationally the distinction is unimportant.

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%. 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% in most cases, although, in supplementation or reintroduction programs, the acceptable pHOS could be much higher than 5%, even approaching 100% at times. They also recommended for conservation programs that pNOB approach 100%, but pNOB levels should not be so high they pose demographic risk to the natural population.

Discussions involving pHOS can be problematic due to variation in its definition. Most commonly the term pHOS refers to the proportion of the total natural spawning population consisting of hatchery fish, and the term has been used in this way in all NMFS documents. However, the HSRG has defined pHOS inconsistently in its Columbia Basin system report, equating it with “the proportion of the natural spawning population that is made up of hatchery fish” in the Conclusion, Principles and Recommendations section (HSRG 2009), but with “the proportion of *effective* hatchery origin spawners” in their gene flow criteria. In addition, in their Analytical Methods and Information Sources section (HSRG 2009, appendix C) they introduce a new term, *effective pHOS*. Despite these inconsistencies, their overall usage of pHOS indicates an intent to use pHOS as a surrogate measure of gene flow potential. This is demonstrated very well in the fitness effects appendix (HSRG 2009, appendix A1), in which pHOS is substituted for a gene flow variable in the equations used to develop the criteria. This confusion was cleared up in the 2014 update document (HSRG 2014), where it is clearly stated that the metric of interest is effective pHOS.

In the 2014 report, the HSRG explicitly addressed the differences between *census* pHOS and *effective* pHOS (HSRG 2014). In the document, the HSRG defined PNI as

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

where $pHOS_{eff}$ is the effective proportion of hatchery fish in the naturally spawning population (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).

NMFS feels that adjustment of census pHOS by RRS should be done very cautiously, not nearly as freely as the HSRG document would suggest. The basic reason is quite simple: the Ford (2002a) model, 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. An example of a case in which an adjustment by RRS might be justified is that of Wenatchee spring Chinook salmon (Williamson et al. 2010a), 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 this, 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 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 information in the underlying models rather than make ad hoc adjustments to a statistic that was only intended to be a 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 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 7 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 randomly10. For example, at a census pHOS level of 10%, expectations are that 81% of the matings will be NxN, 18% will be NxH, and 1% 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% will have an 81% chance of having two natural-origin parents, etc.

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

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 and with no overlap the proportion of NxN matings is (1-pHOS) and the proportion of HxH matings is pHOS. RRS does not affect the mating type proportions directly, but changes their effective proportions. Overlap and RRS can be related. 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. 2010a). In that particular situation, the hatchery-origin fish were spawning in inferior habitat.

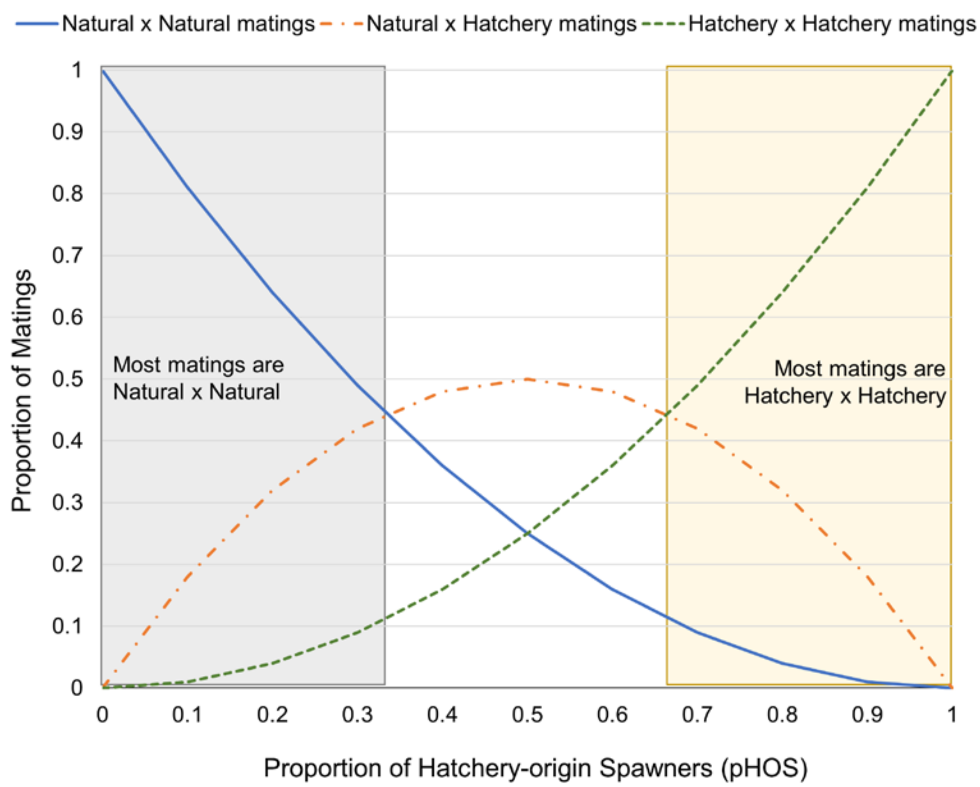


Figure 7. Relative proportions of mating types as a function of proportion of hatchery-origin fish on the spawning grounds (pHOS).

#### 2.4.1.2.2. Ecological effects

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

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

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

The analysis also considers the effects from encounters with natural-origin that are incidental to the conduct of 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 volunteering into the hatchery itself, 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 to 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. NMFS analyzes effects on fish, juveniles and adults, from encounters with these structures and effects on habitat conditions that support and promote viable salmonid populations. NMFS wants to know, for example, if 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. NMFS also analyzes changes to riparian habitat, channel morphology and habitat complexity, water flows, and in-stream substrates attributable to the construction/installation, operation, and maintenance of these structures. NMFS also analyzes the effects of structures, either temporary or permanent, that are used to remove hatchery fish from the river or stream and prevent them from spawning naturally, effects on fish, juveniles and adults, from encounters with these structures and effects on habitat conditions that support and promote viable salmonid populations.

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

NMFS also analyzes the potential for competition, predation, and premature emigration 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.

#### 2.4.1.3.1. Competition

Generally speaking, competition and a corresponding reduction in productivity and survival may result from direct interactions when hatchery-origin fish interfere with the accessibility to limited resources by natural-origin fish or through indirect means, when the utilization of a limited resource by hatchery fish reduces the amount available for fish from the natural population (SIWG 1984). Naturally produced fish may be competitively displaced by hatchery fish early in life, especially when hatchery fish are more numerous, are of equal or greater size, when hatchery fish take up residency before naturally produced fry emerge from redds, and if hatchery fish residualize. Hatchery fish might alter naturally produced salmon behavioral patterns and habitat use, making them more susceptible to predators (Hillman and Mullan 1989; Steward and Bjornn 1990). Hatchery-origin fish may also alter naturally produced salmonid migratory responses or movement patterns, leading to a decrease in foraging success (Hillman and Mullan 1989; Steward and Bjornn 1990). Actual impacts on naturally produced 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 naturally produced salmonids may include competition for food and rearing sites (NMFS 2012b). In an assessment of the potential ecological impacts of hatchery fish production on naturally produced salmonids, the Species Interaction Work Group (SIWG 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. Although newly released hatchery smolts are commonly larger than natural-origin fish, and larger fish usually are superior competitors, 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 life stages 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 naturally produced juvenile salmonids from occupied stream areas, leading to abandonment of advantageous feeding stations, or premature out-migration (Pearsons et al. 1994). 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 naturally produced 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 near the release point. These non-migratory smolts (residuals) may directly compete for food and space with natural-origin juvenile salmonids of similar age. They also may prey on younger, smaller-sized juvenile salmonids. 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 from residual Chinook salmon and coho hatchery salmon on naturally produced salmonids is definitely a consideration, 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 near hatchery release points may be necessary to determine the significance or potential effects of hatchery smolt residualism on natural-origin juvenile salmonids.

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

- Releasing hatchery smolts that are physiologically ready to migrate. Hatchery fish released as smolts emigrate seaward soon after liberation, minimizing the potential for competition with juvenile naturally produced fish in freshwater (California HSRG 2012; Steward and Bjornn 1990).
- Operating hatcheries such that hatchery fish are reared to sufficient size that smoltification occurs in nearly the entire population.
- Releasing hatchery smolts in lower river areas, below areas used for stream-rearing naturally produced juveniles.
- Monitoring the incidence of non-migratory smolts (residuals) after release and adjusting rearing strategies, release location and 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,[11] 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,

[11] "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.

distribution, and timing for juvenile hatchery fish in the action area; and the size of hatchery fish relative to co-occurring natural-origin fish.

#### 2.4.1.3.2. Predation

Another potential ecological effect of hatchery releases is predation. Salmon and steelhead are piscivorous and can prey on other salmon and steelhead. Predation, either direct (direct consumption) 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 and by the progeny of naturally spawning hatchery fish and by 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. The progeny of naturally spawning hatchery fish also can prey on fish from a natural population and pose a threat. In general, the threat from predation is greatest when natural populations of salmon and steelhead are at low abundance and when spatial structure is already reduced, when habitat, particularly refuge habitat, is limited, and when environmental conditions favor high visibility.

SIWG (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. 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 salmon 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 timing and release protocols used widely in the Pacific Northwest were shown to be associated with negligible predation by migrating hatchery steelhead on fall Chinook salmon 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 (SIWG 1984). Due to their location in the stream or river, size, and time of emergence, newly emerged salmonid fry are likely to be the most vulnerable to predation. Their vulnerability is believed to be greatest immediately upon emergence from the gravel and then their vulnerability decreases as they move into shallow, shoreline areas (USFWS 1994). Emigration out of important rearing areas and foraging inefficiency of newly released hatchery smolts may reduce the degree of predation on salmonid fry (USFWS 1994).

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

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

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

#### 2.4.1.3.3. Disease

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. 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)—which has only been identified in Japan, where masou salmon (*Oncorhynchus masou)* are endemic—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):

- 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 from natural populations. 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 is because both hatchery and natural 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), making it difficult to eliminate pathogen exposure.

Adherence to a number of State, Federal, and tribal fish health policies limits the disease risks associated with hatchery programs (IHOT 1995; NWIFC and WDFW 2006; ODFW 2003; USFWS 2004). Specifically, the policies govern the transfer of fish, eggs, carcasses, and water to prevent the spread of exotic and endemic reportable pathogens. For all pathogens, both reportable and non-reportable, pathogen spread and amplification are minimized through regular monitoring (typically monthly), removal of mortalities, and disinfection of all eggs. Vaccines may provide additional protection from certain pathogens. 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; in such a case, if an epizootic occurs, 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. This practice limits the presence of fish susceptible to pathogen infection to prevent 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., ozone; Naish et al. 2008). Although preventing the exposure of fish to any pathogens prior to their release into the natural environment may make them more susceptible to infection, reduced fish densities in the natural environment compared those in 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 when their effluent mixes with saltwater, killing pathogens before they can be transmitted to fish.

Noninfectious diseases are those that cannot be transmitted between fish and are typically caused by genetic or environmental factors (e.g., a low level of dissolved oxygen). Hatchery facilities routinely use a variety of chemicals for treatment and sanitation purposes. Chlorine levels, 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 monitors settleable and unsettleable solids, temperature and dissolved oxygen 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. The exception to this are diseases caused by nutritional deficiencies, which are expected to occur rarely if ever in current hatchery operations due to the vast literature available on successful rearing of salmon and trout in aquaculture.

#### 2.4.1.3.4. Acclimation

One factor the can affect hatchery fish distribution and the potential to spatially overlap with natural-origin spawners, and thus the potential for genetic and ecological impacts, is the acclimation of hatchery juveniles before release. Acclimation of hatchery juveniles before release increases the probability that hatchery adults will home back to the release location reducing their potential to stray into natural spawning areas. Dittman and Quinn (2008) provide an extensive literature review and introduction to homing in 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 and migrating from it years earlier (Dittman and Quinn 2008; Keefer and Caudill 2013). Fisheries managers use this innate ability for salmon and steelhead to home to specific streams when using acclimation ponds to support the reintroduction of species into newly accessible habitat or into areas where they have been extirpated as well as a way to provide for fisheries (Dunnigan 2000; Quinn 1997; YKFP 2008).

Having hatchery salmon and steelhead home to a particular location is one measure that can be taken to reduce the proportion of hatchery fish in the naturally spawning population. By having the hatchery fish home to a particular location, those fish can be removed (e.g., through fisheries, use of a weir) or they can be isolated from primary spawning areas. Factors that can affect the success of this measure include: (1) timing the acclimation when a majority of the hatchery juveniles are going through the parr-smolt transformation during acclimation; (2) whether the water source attracts returning adults; (3) whether the hatchery fish can access the stream reach where they were released; and (4) whether the water quantity and quality is such that returning hatchery fish will hold in that area before removal and/or their harvest in fisheries

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 to reduce straying into other areas (Bentzen et al. 2001; Fulton and Pearson 1981; Hard and Heard 1999; Kostow 2009; Kostow 2012; Quinn 1997; Westley et al. 2013), although it does not always show a clear benefit (e.g., (Clarke et al. 2011; Kenaston et al. 2001). Acclimating fish also allows them to recover from the stress due to transporting the fish to the release location and from handling.

### 2.4.1.4. Factor 4. Hatchery fish and the progeny of naturally spawning hatchery fish in the migration corridor, in the estuary, and in the ocean

Based on a review of the scientific literature, NMFS' conclusion is that the influence of density-dependent interactions on the growth and survival of salmon and steelhead is likely small compared with the effects of large-scale and regional environmental conditions. While there is evidence that large-scale hatchery production can effect salmon survival at sea, the degree of effect or level of influence is not yet well understood or predictable. The same is true for mainstem rivers and estuaries. NMFS will watch for new research to discern and to measure the frequency, the intensity, and the resulting effect of density-dependent interactions between hatchery and natural-origin fish. In the meantime, NMFS will monitor emerging science and information and will consider that re-initiation of section 7 consultation is required in the event that new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not considered in this consultation (50 CFR 402.16).

#### 2.4.1.5. Factor 5. 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 critical uncertainties. RM&E actions including but not limited to collection and handling (purposeful or inadvertent), holding the fish in captivity, sampling (e.g., the removal of scales and tissues), tagging and fin-clipping, and observation (in-water or from the bank) can cause harmful changes in behavior and reduced survival. These effects 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 over effects of the Proposed Action 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 agencies, 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.

#### 2.4.1.6. Factor 6. 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. It can also degrade habitat function and reduce or block access to spawning and rearing habitats altogether. Here, NMFS analyzes changes to: riparian habitat, channel morphology and habitat complexity, in-stream substrates, and water quantity and quality attributable to operation, maintenance, and construction activities; and confirms whether water diversions and fish passage facilities are constructed and operated consistent with NMFS criteria. The level of effect for this factor ranges from neutral or negligible to negative.

#### 2.4.1.7. Factor 7. Fisheries that exist because of the hatchery program

There are two aspects of fisheries that are potentially relevant to NMFS' analysis of HGMP effects in a section 7 consultation. One is where there are fisheries that exist because of the HGMP (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 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 2005b). In any event, fisheries must be strictly regulated based on the take, including catch and release effects, of ESA-listed species.

### 2.4.2. Effects of the Proposed Action

Each program included in this analysis must be considered separately. All of the programs use hatchery broodstock that were included in the Snake River Chinook salmon ESU (Jones 2011). All of the programs are integrated with the natural population. An analysis of the Proposed Action identified the factors in the tables below that are likely to have an effect on Snake River spring/summer Chinook salmon and on designated critical habitat. An overview of the analysis is described below in Table 21. Because of the similarity of all six programs, effects for all six are described together in the table.

Table 21. A summary of the general effects of all six spring/summer Chinook salmon program on Snake River spring/summer Chinook salmon, Snake River steelhead, and their associated designated critical habitat. The framework NMFS followed for analyzing effects of the hatchery program is described in Section 2.4.1 of this opinion.

<table>
<tr><th rowspan="2">Factor</th><th rowspan="2">Range in Potential Effects for this Factor</th><th colspan="2">Analysis of Effects on Natural-origin Fish for Each Factor</th></tr>
<tr><th>Chinook Salmon</th><th>Steelhead</th></tr>
<tr><td>(1) The hatchery program does or does not remove fish from the natural population and use them for broodstock</td><td>Negligible to Beneficial effect</td><td>Negative effect<br>1. All six programs remove natural-origin fish for broodstock<br>2. Removal is limited by abundance based sliding scales to reduce risk to the natural-origin population<br>3. All programs use native broodstock or in the case of Lookingglass Creek, a stock selected for genetic similarity since the native fish were extirpated</td><td>Negligible effect<br>No natural-origin fish are removed for broodstock</td></tr>
<tr><td>(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</td><td>Negative to Beneficial effect</td><td>Beneficial effect<br>1. Maintain genetic reserves for local populations by using local, integrated stock<br>2. Increase the low local population abundance at a greater rate than would be expected naturally<br>3. Hatchery-origin spring/summer Chinook salmon contribute marine-derived nutrients to the system<br>4. Productivity may be reduced through hatchery-influenced selection when the proportion of hatchery-origin adults is high within each population<br>5. Adult collection at weirs and traps could delay migrating fish and introduces the likelihood of physical harm from handling</td><td>Negative effect<br>1. Steelhead are a different species and do not interbreed with Chinook salmon<br>2. Run timing and spawning of steelhead differs temporally from spring Chinook salmon<br>3. Steelhead are encountered during broodstock collection for spring/summer Chinook salmon</td></tr>
<tr><td>(3) Hatchery fish and the progeny of naturally spawning hatchery fish in juvenile rearing areas</td><td>Negligible to negative effect</td><td colspan="2">Negative effect<br>1. Predation indices are low, but competition indices are high<br>2. Substantial temporal overlap, but less spatial overlap<br>3. Relatively short residence/migration times and low hatchery survival post-release limit interactions</td></tr>
</table>

| Factor | Range in Potential Effects for this Factor | Analysis of Effects on Natural-origin Fish for Each Factor | |
|---|---|---|---|
| | | Chinook Salmon | Steelhead |
| (4) Hatchery fish and the progeny of naturally spawning hatchery fish in the migration corridor, estuary, and ocean | Negligible to negative effect | **Negligible effect**<br>Fish produced are a small proportion of Chinook salmon production throughout the Columbia River basin | |
| (5) RM&E that exists because of the hatchery program | Beneficial to negative effect | **Beneficial effect**<br>1. Would inform adaptive management<br>2. Would inform natural-origin population trends<br>3. Post-release survival and migration monitoring may improve release strategies<br>4. Trapping operations have the potential to harm, delay, or kill individual fish | |
| (6) Construction, operation, and maintenance of facilities that exist because of the hatchery program | Beneficial to negative effect | **Negative effect**<br>1. The surface water diversion withdrawals for Lookingglass Fish Hatchery and the future Lostine Hatchery may leave only a small amount of water instream between the diversion and hatchery effluent in low water years<br>2. Maintenance of instream structures, occurring on an "as needed" basis, may have a minor short-term negative impact on water quality<br>3. The current intake at Lookingglass Hatchery and Imnaha does not satisfy NMFS screen criteria (NMFS 2011a) | |
| (7) Fisheries that exist because of the hatchery program | Beneficial to Negative effect | **Not Applicable (for this action)** | |

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

The proposed hatchery programs all remove fish from the local natural population for broodstock leading to a negative effect for Chinook salmon. The effect is negligible for steelhead because no steelhead are propagated by the proposed programs.

Five of the six programs (Catherine Creek, upper Grande Ronde, Imnaha, Lostine, and Tucannon) were founded using returning adults that were native to the populations that they supplement. The exception is the Lookingglass Creek population. Because the original population was extirpated, ESA-listed hatchery-origin Catherine Creek adults were used to initiate the Lookingglass program. Though the Lookingglass broodstock was not native to Lookingglass Creek, they are within the major population group, and were chosen by co-manager agreement to repopulate Lookingglass Creek. However, the removal of natural-origin broodstock is limited by abundance-based sliding scales to reduce risk to the naturally spawning population, which are explained and analyzed in detail below (2.4.2.2.1).

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

The proposed hatchery programs pose both genetic and ecological risks, but based on the current scientific understanding, the net effect on spring/summer Chinook salmon is beneficial. Only ecological and adult collection effects are relevant for steelhead. The overall effect of this factor on steelhead is negative.

#### 2.4.2.2.1. Genetic effects

Because these programs do not propagate steelhead, and Chinook salmon and steelhead do not interbreed, there are no genetic effects from the six Chinook salmon programs on natural-origin steelhead. Thus, the remainder of the genetic effect discussion focuses on effects of the six programs on natural-origin spring/summer Chinook salmon.

**Mating Protocols**
Each program attempts to select broodstock at random based on adult maturity on a spawning day; however, the Catherine Creek, Imnaha, Lostine, and Lookingglass Creek programs emphasize the use of larger males for a portion of the broodstock. Larger male selection is based on the notion that larger males may have a competitive advantage, and spawn more successfully in the wild (Berejikian et al. 2000; Chebanov and Riddell 1998)—thus, this mating scheme may be an improvement over random mating. The Catherine Creek, Upper Grande Ronde, and Lookingglass Creek programs also propose to re-use natural-origin males if male availability is low, which could affect both spawning sex ratio as well as reduce effective population size. Overall, the proposed mating protocols seem unlikely to cause substantial impacts on diversity or fitness of the populations and may be helpful over the near term.

**Straying**
Straying of salmonids is a natural phenomenon and can be highly variable. Ford et al. (2015) found that natural-origin Chinook salmon can stray anywhere from 0 to 99 percent from their natal tributary. Thus, it is not surprising that hatchery-origin fish stray to locations other than where they were released. For the populations included in this consultation, stray rates are low (less than one percent) for most areas. However, both the Minam and Wenaha Rivers, where no hatchery programs are located, have the highest percentage of strays on average (Table 22). The high proportion of hatchery-fish in the Wenaha River specifically, may be due to its geographic proximity to supplemented Rivers. The Wenaha is the first tributary hatchery-origin fish from the Grande Ronde Basin would swim past on their way to Lookingglass, Catherine Creek or the Upper Grande Ronde. The Wenaha and Minam Rivers are also in wilderness areas and habitat conditions there are more suitable for salmonids than other portions of the Grande Ronde, Lostine or Imnaha Basins, which may explain the higher stray rates to these unsupplemented areas. In both systems hatchery fish of unknown hatchery origin contribute a large amount to the overall stray percentage.

The ICTRT (2007) stated that exogenous spawners within the MPG would have a low risk on the population they are spawning with if levels are less than 10 percent for the first two generations, 5 percent for the third generation, and 0 percent for generations beyond that. Moderate risk equates to 20 percent for the first generation, 15 percent for the second generation, and 10 percent for generations after (Figure 6). However, the Minam and Wenaha populations are small and even a small number of fish from hatchery programs could result in a large percentage of the population being comprised of hatchery-origin spawners. The same is also true of the Tucannon population. Thus, as natural-origin returns increase, this proportion will decrease without the need for any additional management.

For the MPG to contribute to recovery of the ESU, the potential recovery scenario suggested by the ICTRT (2007) states that one of the two unsupplemented rivers must reach viability, along with two of the three large populations (Upper Grande Ronde, Lostine/Wallowa and Catherine Creek), and the Imnaha population. The draft recovery plan (NMFS 2014a) recommends that both Minam and Wenaha achieve viability along with viable populations in the Imnaha (run timing), the Lostine/Wallowa (large size) and Catherine Creek (NMFS 2014a). However, the plan also acknowledges that other recovery scenarios are possible without the Wenaha River population reaching a viable level.

NMFS most recent status review (NWFSC 2015) shows that abundance has increased for all the extant populations in the MPG except for the Wenaha River. However, productivity has increased for all six extant populations, and is close to or exceed replacement except for the Upper Grande Ronde. Because the other populations (Minam, Imnaha, Lostine/Wallowa, and Catherine Creek) in the ICTRT recovery scenario have increasing trends for abundance and productivity, the Wenaha may not be needed for the ESU to recover. Still, maintaining hatchery strays in both populations below the 10 percent level suggested by the ICTRT for moderate risk would allow for more recovery options in the future given the variability and unpredictability of environmental conditions.

Table 22. The percent of the northeast Oregon/southeast Washington populations made up of stray fish[1]. Data includes years 2005-2014 (Feldhaus 2016; Feldhaus 2015b; Feldhaus 2015c; Gallinat and Ross 2015). Hatchery programs with an asterisk contribute the most to strays.

| Population | % Average Strays (range) | Contributing Programs within this Consultation |
|---|---|---|
| Catherine Creek | 0.10 (0-0.56) | Lostine, Upper Grande Ronde, Lookingglass |
| Imnaha River | 0.04 (0-0.14) | Lostine, Upper Grande Ronde, Umatilla |
| Lostine River | 0.04 (0-0.32) | Lookingglass, Catherine Creek, Upper Grande Ronde |
| Minam River | 6.5 (0-17.3) | Imnaha, Lostine*, Lookingglass*, Upper Grande Ronde, Catherine Creek* |
| Upper Grande Ronde River | 0.12 (0-0.57) | Lookingglass, Catherine Creek, Lostine |
| Tucannon River | 3.0 (0.2-11.2) | Imnaha, Lostine, Lookingglass, Upper Grande Ronde, Catherine Creek |
| Wenaha River | 14.7 (0-38.8) | Imnaha, Lostine, Lookingglass*, Upper Grande Ronde, Catherine Creek |

[1]The majority of strays in most years were of unknown hatchery origin.

**Effective Population Sizes**

Typically, in hatchery consultations no explicit information on effective size is available, and inferences about effective size must be based on census size and assumptions about its relationship to effective size. However, effective population size data are available in this case, allowing more detailed exploration of the effect of the hatchery programs on diversity in these populations. Broodstocks have been sampled annually since 2008, and effective size has been estimated each year (Steele et al. 2011; Steele et al. 2012; Steele et al. 2013; Steele et al. 2014). Assuming the broodstock samples were random samples of the populations with which they are integrated, the 2008-2013 data are estimates of the effective number of breeders (spawners) ($N_b$) in 2004-2009. The table also presents per-generation effective population size[12].We compared the $N_b$ estimates to the census number of breeders ($N_c$) (spawners plus broodstock) to calculate

[12] Calculated as the product of the generation time and the harmonic mean effective number of breeders Waples, R. S. 2004. Salmonid insights into effective population size. Pages 295-314 *in* A. P. Hendry, and S. C. Stearns, editors. Evolution illuminated: salmon and their relatives. Oxford University Press..

$N_b/N_c$ ratios[13]. Results are presented in Table 23. The Lookingglass population is not included because of its overlap with Catherine Creek production. The effective size estimates are subjcct to bias, and this is accounted for in the table.[14]

Estimated per-generation effective size ranges in these populations from 282 in the Upper Grande Ronde to 993 in the Imnaha, without the bias correction; fully corrected for bias, the estimates range from 176 to 621. Clearly, as a group, these populations are at the lower end of "several hundreds" (Section 2.4.1), but this is to be expected of populations that are being supported by conservation hatchery operations. Diversity metrics such as heterozygosity show that these populations are typical of the Snake Chinook salmon populations Steele et al. have sampled (e.g., Steele et al. 2011), and in terms of diversity there is little differnece between the populations with the largest and smallest estimated effective sizes (Imnaha and Grande Ronde, respectively). Almost certainly, in these populations, broodstock size rather than escapement is a very important driver of effective size. So there is no indication of acute effective population size depression in these populations.

Turning to $N_b/N_c$ ratios, Waples (2015) has suggested, based on studies of which he is aware, a nominal range of 0.2 to 0.4. Based on this, these populations are definitely on the low side, suggesting wide variation in success of spawning fish in producing adult progeny. This is likely partly due to variation in success of spawning pairs in nature, but possibly mainly attributable to differences between natural spawners and hatchery spawners in success in producing adults, a result that is expected and desired. Based on this, and the analysis above, the Proposed Action is unlikely to adversely affect the effective sizes, and thus the overall genetic diversity levels, of the Chinook salmon populations it influences. This is true both of the near and long term.

Table 23. $N_b$ and $N_b/N_c$ (in parentheses) estimates calculated for brood years 2004-2009 (and for $N_b$, harmonic mean over all six years) for Imnaha, Tucannon, Lostine, Catherine, and Upper Grande Ronde Chinook salmon populations. First $N_b/N_c$ value in parentheses is uncorrected for bias, second assumes maximum expected bias. $N_b$ data are from Steele et al. (2011), Steele et al. (2012), Steele et al. (2013), and Steele et al. (2014); $N_c$ are from Feldhaus (2013), Feldhaus (2015a), and Gallinat and Ross (2015). Confidence intervals for $N_b$ data are available in original sources.

| **Brood Year** | **Imnaha** | | **Tucannon** | | **Lostine** | | **Catherine Creek** | | **Upper Grande Ronde** | |
|---|---|---|---|---|---|---|---|---|---|---|
| 2004 | 257 | (0.14,0.09) | 137 | (0.21,0.13) | 99 | (0.1,0.06) | 39 | (0.18,0.11) | 68 | (0.1,0.07) |
| 2005 | 317 | (0.29,0.18) | 159 | (0.28,0.17) | 142 | (0.21,0.13) | 63 | (0.26,0.16) | 47 | (0.11,0.07) |

13 We assumed a four-year generation time, assuming 3-yr old and 5-yr old spawners were not a major factor. We also ignored captive brood production in the Catherine, Upper Grande Ronde, Lostine, and Tucannon programs.

14 Estimates were based on linkage disequilibrium, so may be biased because the "signal" from linkage disequilibrium also in part is a signal from previous generations Waples, R. 2015. Discussion of LD effective size estimates. C. Busack, editor, Waples, R. S., T. Antao, and G. Luikart. 2014. Effects of Overlapping Generations on Linkage Disequilibrium Estimates of Effective Population Size. Genetics 197(2):769-780.. With a stable 4-year generation time, the $N_b$ estimate may be as much 60% above true value. Thus, the true $N_b$ for the Imnaha populaiton in 2004 may be as low as 160. The table does not present $N_b$ estimates, but does present unbiased $N_b/N_c$ ratios. The $N_b/N_c$ ratio for the Imnaha population for 2004, for example, could be as low as 0.09.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 2006 | 237 | (0.23,0.15) | 114 | (0.44,0.27) | 100 | (0.16,0.1) | 108 | (0.52,0.32) | 80 | (0.4,0.25) |
| 2007 | 217 | (0.2,0.12) | 143 | (0.25,0.16) | 159 | (0.33,0.2) | 110 | (0.56,0.35) | 96 | (1.02,0.64) |
| 2008 | 238 | (0.09,0.06) | 178 | (0.25,0.16) | 151 | (0.09,0.05) | 126 | (0.52,0.32) | 62 | (0.13,0.08) |
| 2009 | 244 | (0.09,0.06) | 307 | (0.16,0.1) | 117 | (0.08,0.05) | 196 | (0.87,0.54) | 98 | (0.15,0.09) |
| Mean $N_b$ | 248 | | 157 | | 123 | | 82 | | 70 | |
| Per generation $N_e$ | 993 | | 628 | | 494 | | 329 | | 282 | |

**Evaluation of Adult Management Sliding Scales**

We evaluated the sliding scales for the Catherine Creek, Lostine, Imnaha, and Tucannon programs for their ability to control hatchery effects. To model what PNI would result from the application of the sliding scales, we used estimates provided by ODFW of adult (> 3 years of age) hatchery and wild fish returning to the river mouth from 2003-2014 provided by ODFW (Feldhaus 2015b) for the Oregon populations and by WDFW (Gallinat and Ross 2015) for the Tucannon population. For the Lostine and Catherine Creek programs, we assumed 100 percent of returnees were available for adult management[15]. For the Imnaha and Tucannon programs, we assumed that 65 and 50 percent, respectively, were available based on weir location. The Oregon scales allow considerable flexibility in execution; we applied the rules that maximized pNOB, unless that would restrict broodstock. The Catherine Creek sliding scale rules made analysis of two options easy, one maximizing pNOB and the other minimizing pNOB, subject to the constraint that it did not restrict broodstock collection. For Tucannon, we used the spreadsheet tool included in the sliding scale appendix to the HGMP (WDFW 2011; WDFW 2013), which automatically incorporates the rule set, and thus required no interpretation. We realize that in reality there are many sources of variability in applying the sliding scale, but felt this approach was an appropriate way to test sliding scale function under optimal conditions, and thus a good way to evaluate sliding scale approaches for this consultation.

Results are presented in Figures 8-11 below. The figures plot realized PNI against the total number of adults, with each dot representing a single return year between 2003 and 2014. The sliding scale rules for Catherine Creek were based on total adult returns, whereas the rules for the other three sliding scales were based on natural-origin adult returns, so an argument could be made for plotting PNI against either total or natural-origin adult returns, or both. Natural-origin and total returns were sufficiently correlated that there was negligible difference in PNI trend between the two approaches.

[15] Could be captured and distributed as desired according to the appropriate sliding scale, to be passed upstream, used for broodstock, or removed from the system.

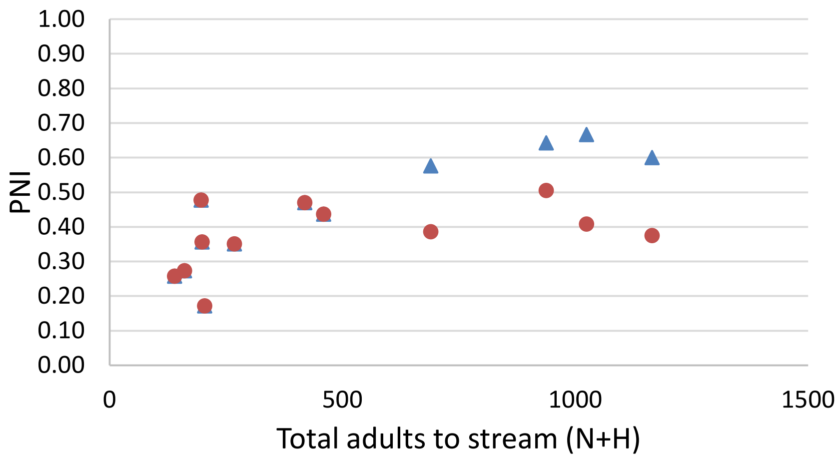


Figure 8. Modeled PNI as a function of total spring Chinook salmon adult returns under sliding-scale adult management in Catherine Creek. The geomean PNI value was 0.41 for the max pNOB option and 0.36 for the min pNOB option. The mean hatchery proportion in returns was 65%, and on the spawning grounds 60%. Triangles represent results of the max pNOB option. PNI results between the two options only differed in output for the four rightmost data points.

Until recent years, the Catherine Creek sliding scale has been used on low return years, which allows higher proportions of hatchery-origin fish above the weir and in broodstock than in high return years. Since 2002, hatchery-origin fish have contributed over 50% of the adults spawning in nature and over 60% of adults in the broodstock (Carmichael et al. 2011b). The PNI for the Catherine Creek population has generally been low, but has varied between 0.183 and 0.328 since 2004 (Carmichael et al. 2011b).

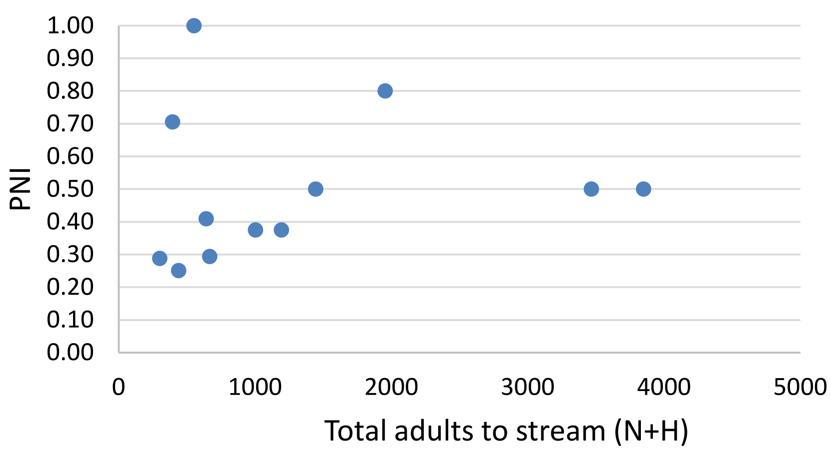


Figure 9. Modeled PNI as a function of total spring Chinook salmon adult returns under sliding-scale adult management in the Lostine River. The geomean PNI value was 0.46. The mean hatchery proportion in returns was 70%, and on the spawning grounds 45%.

Until recent years, the Lostine River sliding scale has been applied for relatively low return years, which allows higher proportions of hatchery-origin fish above the weir and in broodstock (Nez Perce Tribe 2011). Since 2002, hatchery-origin fish have contributed over 50% (67% average) of the adults spawning in nature and over 60% of adults in the broodstock in recent years, though the use of almost entirely natural-origin broodstock in the early 2000's brings the average down closer to 50% (Feldhaus 2013; Nez Perce Tribe 2011). The PNI for the Lostine River population has generally been low in recent years, but has varied between 0.278 and 0.638 since 2002 (Feldhaus 2013).

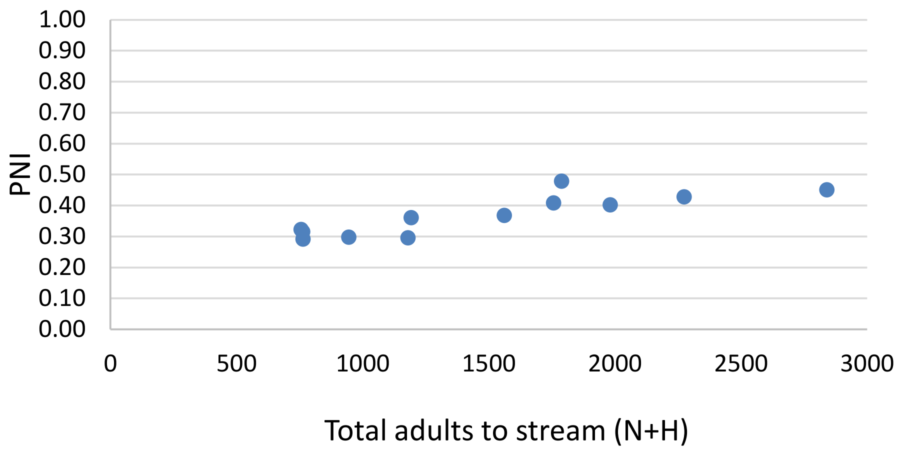


Figure 10. Modeled PNI as a function of total spring Chinook salmon adult returns under sliding-scale adult management in the Imnaha River. The geomean PNI value was 0.36. The mean hatchery proportion in returns was 72%, and on the spawning grounds 37%.

Between 2000 and 2010, hatchery-origin fish from the Imnaha program have contributed an average of 66% the adults spawning in nature and an average of 76% of adults in the broodstock (Carmichael et al. 2011b). The success of the program at returning hatchery-origin adults, combined with a large proportion of fish spawning below the weir, and the inability to control early returning adults, has resulted in a low PNI for the Imnaha River population in recent years, ranging from 0.218-0.279 (Carmichael et al. 2011a). The PNI for fish above the weir has been similar to the total population PNI.

Because collection of adults is only possible in the later portion of the run (due to difficulty with weir installation), there is now divergence in run timing between hatchery- and natural-origin returns (Carmichael et al. 2011a; Hoffnagle et al. 2008; ODFW 2011b). A higher proportion of hatchery-origin fish also return at a younger age than natural-origin fish, and approximately 50% of the total hatchery male returns are age-3 males (Carmichael et al. 2011a).

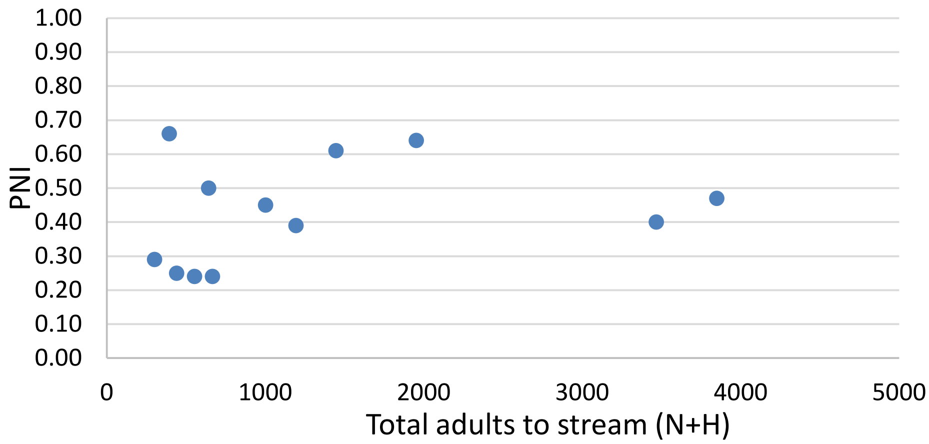

Figure 11. Modeled PNI as a function of total spring Chinook salmon adult returns under sliding-scale adult management in the Tucannon River. The geomean PNI value was 0.40. The mean hatchery proportion in returns was 71%.

Though the sliding scale for the Tucannon program has not been implemented in the current form in past years, based on recent returns, the scale would likely be applied to low natural-origin returns that allow more hatchery fish in broodstock and in the wild. Between 2003 and 2012, the program was only below the target of 0.50 PNI in 2008, with a PNI of 0.47, and was above for the remaining nine years, with an average of 0.63 during that time (Gallinat and Ross 2013).

Although the graphs differ somewhat because of the individual sliding scale rules and population histories, the geometric mean of PNI varied little between programs, as did the mean proportion of returns consisting of hatchery fish. All four figures show the same trend of increasing PNI with increased abundance, but some more sharply than others. Tucannon and Catherine Creek displayed the greatest response in PNI with increasing abundance, Imnaha the least. On the other hand, the Imnaha scale resulted in the greatest reduction in hatchery fish on the spawning grounds. An interesting characteristic of the Tucannon and Lostine scales is that, at very high hatchery escapements, even with substantial natural-origin returns, lower PNIs are obtained than with some lower escapements. Operationally this makes sense, because, as escapement rises, the ability to manage adults is reduced.

All four sliding scales do balance demographic and genetic factors in the predictable way that, when returns increase, PNI increases, which would likely reduce hatchery-influenced selection impacts. As mentioned above, they differ in their aggressiveness toward increasing PNI, but all seem to have the effect of substantially increasing either PNI or reducing pHOS from what it would have been without adult management. In addition, the operators propose to modify sliding scale management over time as population condition improves. Currently, demographic risks to these populations are substantial and may be increasing due to recent downturns in ocean conditions and other climate challenges (Section 2.3).

Neither the Lookingglass Creek program nor the Grande Ronde program have a sliding scale because of very low natural-origin fish abundance. Since 2004, in Lookingglass Creek, hatchery-origin fish have contributed over 70% of the total returns (80% in recent years). The PNI for the

Lookingglass Creek population has generally been low with an average of 0.154, but has varied between 0 and 0.446 since 2004 (Feldhaus 2013). Since 2004, hatchery-origin fish from the Grande Ronde program have contributed at least 50% of the adults spawning in nature and over 50% of adults in the broodstock (Carmichael et al. 2011d). The PNI for the Upper Grande Ronde population has generally been low, but has varied between 0.076 and 0.512 since 2004 (Carmichael et al. 2011d).

Outplanting of hatchery-origin adults is not included in these sliding scales. However, there may be some genetic risk to the target populations because of outplanting. Outplanting for the Catherine Creek and Imnaha programs is also mostly conducted in areas where natural-origin fish have been extirpated (Lookingglass and Big Sheep Creeks, respectively), which means that no natural-origin fish are likely to be available for spawning on the spawning grounds. In addition, natural-origin fish in Lookinglgass Creek are likely from the Lookingglass hatchery program, which was founded using Catherine Creek fish. Fish from the Imnaha River are within the same MPG as the Big Sheep Creek population. Using fish from the same MPG to outplant in extirpated areas minimizes the risk of losing genetic diversity and causing outbreeding depression.

For the Lostine and a portion of the Catherine Creek outplanting, fish are placed in areas where natural-origin returns are low (Bear, Indian, Hurricane Creeks, and the Wallowa River) and where habitat is underseeded or vacant. Though there is some genetic risk in the outplanted areas due to the presence of natural-origin fish available to spawn with hatchery-origin fish, the risk is outweighed by using within-population fish to boost abundance in areas that would otherwise contribute very little or nothing to the MPG. Outplanting into the Lostine/Wallowa Basin and into Indian Creek also aims to contribute to a balanced sex ratio and age structure, to mimic characteristics of natural population returns in the region. Finally, the large proportion of jacks outplanted for nutrient enhancement into the Wallowa/Lostine is a low genetic risk because they are outplanted late in the run when most naturally-spawning females have spawned, thereby limiting the possibility of gene flow from the hatchery to the wild population. .

In the long-term, outplanting of fish collected only from the later part of the Imnaha program run into Big Sheep and Lick Creeks may be a concern. This is because these fish could migrate back into the Imnaha and spawn, biasing the genetic contribution towards the later portion of the run. However, since outplanting began in 1993, only two outplanted fish have been recovered in the Imnaha River (ODFW and NPT 2016). This slight back migration demonstrates that fish removed for adult management can be used for production in these other areas without compromising Imnaha gene flow management, and likely also provides ecological benefits to underutilized areas.

Given the status and site-specific conditions of all these populations, hatchery supplementation is likely considerably reducing extinction risk and reducing loss of diversity due to drift, which more than offsets the risk of hatchery-influenced selection due to supplementation that is mediated by these sliding scales. In addition, the outplanting of adults in areas where natural-origin fish are extirpated or that are underseeded could increase genetic diversity by allowing colonization of new areas that could lead to local-adaptation of hatchery-origin fish.

#### 2.4.2.2.2. Ecological Effects

**Adult Nutrient Contribution**
The return of hatchery fish for each of the six proposed programs likely contributes nutrients to the action area. Table 24 shows that adult hatchery fish spawning naturally contribute an estimated 233.9 kg of phosphorous to the action area annually. Contribution of phosphorous from natural-origin fish is about 42.9 kg (natural-origin returns from Table 16). Thus, hatchery-origin fish increase phosphorous concentrations by about 5.5 times, which likely compensates for some marine-derived nutrients lost from declining numbers of natural-origin fish.

Table 24. 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). Escapement and pHOS are used to calculate number of hatchery-origin adults in the escapement. Escapement and pHOS data sources: (Feldhaus et al. 2012a; Feldhaus et al. 2011; Feldhaus et al. 2012b; Feldhaus et al. 2014a; Feldhaus et al. 2014b).

| Program | Mean Total Escapement (Years) | pHOS | Number of Hatchery-origin Adults | Adult mass (kg) | Concentration of phosphorous (kg/adult) | Phosphorous imported (kg/year) |
|---|---|---|---|---|---|---|
| Lookingglass | 1377 (2008-2012) | 0.86 | 1184 | 5.5 | 0.0038 | 24.8 |
| Up. Grande Ronde | 1373 (2008-2012) | 0.89 | 1222 | 5.5 | 0.0038 | 25.5 |
| Catherine Creek | 1178 (2008-2012) | 0.69 | 813 | 5.5 | 0.0038 | 17.0 |
| Lostine | 3827 (2008-2012) | 0.81 | 3100 | 5.5 | 0.0038 | 64.8 |
| Imnaha | 5395 (2008-2012) | 0.85 | 4586 | 5.5 | 0.0038 | 95.8 |
| Tucannon | 634 (2000-2009) | 0.45 | 285 | 5.5 | 0.0038 | 6.0 |

**Spawning Site Competition**

*Lookingglass Creek*
Because the natural-origin population was extirpated, hatchery-origin adults typically outnumber natural-origin returns. In addition, any natural-origin adults in Lookingglass Creek are likely to be strays from other areas or are progeny of hatchery-origin fish spawning naturally. Thus, competition and redd superimposition between hatchery- and natural-origin spawning adults is negligible.

*Catherine Creek*
There is complete overlap in the range of spawning between hatchery- and natural-origin adults, though higher proportions of natural-origin adults spawn in the lower reaches, and hatchery-origin adults concentrate near release sites (Carmichael et al. 2011b). Less than 5 percent of adult carcasses are recovered below the weir (Feldhaus et al. 2012a). Therefore, below-weir interactions between spawning hatchery-origin adults are likely small enough to not play a role in affecting population viability. Above the weir, the sliding scale limits adult competition

concerns because reductions in pHOS occur as total fish abundance increases, just as available spawning habitat becomes more rare.

The outplanting of excess Catherine Creek hatchery-origin adults into Lookingglass and Indian Creeks may result in spawning site competition and redd superimposition with natural-origin spring Chinook salmon. Since adult outplants are considered surplus to the program, they are typically outplanted during the peak to the end of the spring Chinook salmon run in June (ODFW and CTUIR 2016) and may potentially mate with natural-origin fish. However, both creeks have low numbers of natural-origin fish present because the natural population in Lookingglass Creek is considered extirpated and redds in Indian Creek ranged from 0-2 in 1992 through 1994 (Zimmerman and Johnson 2016). Therefore, it is unlikely that hatchery-origin fish would come in contact with natural-origin fish.

*Upper Grande Ronde*

There is overlap in the range of spawning between hatchery- and natural-origin adults, though hatchery-origin adults concentrate further upstream near release sites (Carmichael et al. 2011c). Over the last 10 years, about 25 percent of the total abundance in the river occurs below the weir; in the last three years, it has been less than 5 percent (Feldhaus 2013), reducing the amount of adult competition. Because hatchery-origin fish dominate adult returns (approximately 11 percent of the fish are natural-origin), natural-origin fish are likely to interact with hatchery-origin returns; however, the low total abundance limits competition because space and habitat are not limiting.

*Imnaha River*

There is complete overlap in the range of spawning between hatchery- and natural-origin adults, though hatchery-origin adults concentrate further downstream near release sites (Carmichael et al. 2011a). Because hatchery fish are predominant below the weir, spawning distributions of hatchery fish may not mimic historical distributions for the entire population (Feldhaus 2013; Hoffnagle et al. 2008). Though the total number of spawners has increased, the total number of natural-origin returns has not. In addition, productivity has decreased, indicating that hatchery-origin spawners are less productive than natural-origin spawners (Carmichael et al. 2011a). While the precise level of competition is unknown (Carmichael et al. 2011a), competition between hatchery- and natural-origin adults in the Imnaha River would be greater than in the other programs considered in this opinion because of the number of returning hatchery-origin adults.

Outplanting of surplus hatchery-origin fish into Big Sheep Creek may also result in spawning site competition and redd superimposition. Excess Imnaha fish are outplanted throughout the spring Chinook salmon run and thus may overlap spatially and temporally with natural-origin fish. However, the natural-origin population in Big Sheep Creek has been extirpated and annual surveys indicate that fewer than two natural fish are recovered there per year (ODFW and NPT 2016). It is likely that any natural-origin spring/summer Chinook salmon spawning in Big Sheep Creek are progeny of outplanted hatchery-origin Imnaha fish. In addition, because fish from the Imnaha program are collected and outplanted late in the run, early-late August (ODFW and NPT 2016), the degree of overlap is limited. Thus, there is unlikely to be any spawning site competition with or redd superimposition by hatchery-origin fish.

*Lostine River*
Though spawning does occur in other areas in the subbasin (Wallowa River, Bear and Hurricane Creeks), most spawning occurs in the Lostine River (Cleary and Edwards 2011). There is overlap in the range of spawning between hatchery- and natural-origin adults, though hatchery-origin adults concentrate farther upstream near release sites (Cleary and Edwards 2011; Feldhaus et al. 2012a). Due to the spatial separation, spawning site competition and redd superimposition is negligible.

Outplanting of surplus hatchery-origin fish into Bear and Hurricane Creeks and the Wallowa River may also result in spawning site competition and redd superimposition. Excess Lostine program fish are outplanted after July 20 through the remainder of the spring Chinook salmon run and thus may overlap spatially and temporally with natural-origin fish. In all three locations, carcass surveys showed that natural-origin fish are present and account for the majority of fish. Chinook salmon adults in Bear Creek were comprised of an average of 79 percent (ranged from 54-100 percent) natural-origin fish. The Wallowa River/Hurricane Creek was comprised of an average of 72 percent (ranged from 60-89 percent) natural-origin fish (NPT and ODFW 2016). However, habitat in the Wallowa River has been and continues to be restored, increasing the amount of anadromous fish habitat available (Nez Perce Tribe 2011; NPT and ODFW 2016). In addition, the ICTRT (ICTRT 2007) classified the Wallowa/Lostine population as large with a minimum abundance threshold of 1,000 fish. The current 10-year geometric mean is 320 fish. Thus, the current numbers of outplanted fish is well below the minimum abundance threshold (NPT and ODFW 2016), so competition for spawning sites is unlikely and, therefore, so is likelihood of redd superimposition.

*Tucannon River*
In the Tucannon River, competition between hatchery- and natural-origin adults may be more pronounced because of limited habitat availability due to land use and habitat degradation (Gallinat and Ross 2012). There is overlap in the range of spawning between hatchery- and natural-origin adults, though hatchery adults have begun to spawn farther upstream since releases began farther upstream at the Curl Lake Acclimation Site (Gallinat and Ross 2012). WDFW modeled carrying capacity and predicted that carrying capacity in the Tucannon River ranges from 383 to 1,684 redds. However, the modeled redd carrying capacity is not being exceeded in most years (Gallinat and Ross 2013), suggesting that spawning site competition and redd superimposition are unlikely.

*Summary*
For five of the six systems above, spawning site competition and redd superimposition are unlikely events. For the Imnaha River, there is some evidence that suggests that spawning site competition and redd superimposition are occurring with a higher likelihood than in the other five systems, based on observation of the decreases in productivity and lack of an increase in natural-origin spawners. To be able to assess the effects of competition and redd superimposition, more data on the comparison of abundance trends between the two unsupplemented rivers (i.e., Minam and Wenaha) and the six systems with hatchery supplementation are needed. This is because competition may have greater effects on abundance in the rivers, Imnaha, Lostine, Lookingglass, Catherine, Grande Ronde and Tucannon, where

natural populations are supplemented with hatchery fish than in the Minam and Wenaha rivers where no supplementation is occurring.

A difference in relative abundance of 20 percent between the unsupplemented rivers and supplemented rivers and creeks (i.e., Imnaha, Lostine, Lookingglass, Catherine, Grande Ronde and Tucannon) may indicate that spawning site competition and redd superimposition are limiting the growth of the population using a five-year average. Although the Imnaha population is the only population with data that suggests it may be impacted by spawning site competition and redd superimposition, given the difficulty in assessing these effects, monitoring of the other five populations ensures that any potential effects will be observed. While some year-to-year variability in abundance not connected to hatchery production is expected, increasing differences in relative abundances can indicate adverse repercussions of hatchery production. NMFS considers, in the absence of more specific information, that a 20 percent difference in abundance warrants greater consideration. For example, a drop of 11 percent in the natural-origin abundance in the Imnaha River, and a 10 percent increase in abundance in the Minam and Wenaha Rivers would equal a 21% change, and suggest that competition resulting from the hatchery programs is having a measurable effect. To account for the effects of year-to-year variability, NMFS will measure the relative abundance changes using a five-year average.

**Competition with Steelhead for Spawning Sites**

Competition between adult hatchery-origin spring/summer Chinook salmon and summer steelhead is likely negligible due to differences in run-timing, holding, and spawn timing. Steelhead begin their entry into freshwater during the last portion of the Chinook salmon migration and reach the action area after spring/summer Chinook salmon have held over the summer and spawned (Table 25).

Table 25. Run-timing, holding, and spawn timing of spring/summer Chinook salmon and summer steelhead (ODFW 2011a).

| Species | Run Timing | Holding | Spawning |
|---|---|---|---|
| Spring/Summer Chinook Salmon | March-May | April-July | Early August-mid September |
| Summer Steelhead | May-August | September-April | March-early June |

### 2.4.2.2.3. Adult Collection

The operation of weirs and traps for broodstock collection for all six programs would result in the capture and handling of both natural- and hatchery-origin spring/summer Chinook salmon as well as natural-origin steelhead during Chinook salmon broodstock collection, resulting in negative effects for both species. Though weir installation timing varies annually, each program intends to install the weir early enough in the run to trap and handle all spring/summer Chinook salmon returning to the basin. In addition, about 1650 natural-origin steelhead are likely to be trapped for enumeration and sampling annually across all the programs and the operators would quickly handle and pass adult steelhead. Because fish in these programs are nearing the end of their long journey inland, and are typically near death already, NMFS anticipates that up to 1% of adults may die from handling.

Another effect of weir operations is the potential for delayed migration. Though adult passage may be delayed slightly, weir operation guidelines and monitoring of weirs by the co-managers (Section 1.3.1) minimize the delays to and impacts on fish. For the Tucannon, Lostine, and Lookingglass programs, fish would be delayed for no more than 24 hours throughout the trapping season. For the Imnaha, Catherine Creek, and Upper Grande Ronde programs, fish would be delayed for up to 72 hours, but this is likely limited to the early and late parts of the return when few fish are returning and the trap remains below capacity.

In addition, the spatial distribution of juvenile and adult spring Chinook salmon and Snake River basin steelhead is not expected to be affected by weir operation in these areas. The one exception is in the Tucannon River. Based on increased below-weir redd density compared to historical spring Chinook salmon radio tag data, the Tucannon weir and trap may be a passage impediment to fish trying to reach better spawning and rearing habitat above the weir (Gallinat and Ross 2013). However, adult handling frequency (every 24 hours) and passage of fish above the weir minimizes this potential weir effect, because fish will only potentially be delayed for a short period of time. Juvenile fish passage up and downstream is generally unimpeded by weir operation, because weir pickets are large enough to allow juvenile passage.

Weir efficiency must also be considered because poor weir efficiency could make it difficult to control the numbers of hatchery origin-fish above the weir. Half of the weirs are close to 100 percent efficient at capturing all the adults that return to the weir. The exceptions are the Imnaha, Lostine, and Tucannon weirs. Trapping efficiency at the Imnaha weir is about 60 percent because of high flows, which make it difficult to install the weir during the earliest part of the run. Once the new weir is constructed, trapping across the run should be possible, and a much higher proportion of both natural- and hatchery-origin spring/summer Chinook salmon returning to the basin would be trapped. The Lostine River weir was replaced in 2010 with a pneumatic weir intended to improve efficiency and safety. It has not operated as well as expected and efficiency is highly variable (Rich Carmichael, ODFW, pers. comm.). However, efficiency is expected to improve because the mechanical issues (i.e., pump failure) that led to weir inefficiency. The Tucannon weir captures about 60 percent of the fish that return to the trap. Despite these inefficiencies, the analysis of the sliding scales above suggests that management objectives can be met.

The proposed extra handling and holding of adults returning to the Tucannon weir to offset the effects of the high prespawn mortality on the spawning grounds in recent years may result in some additional mortality and stress. In 2015, 252 fish encountered at the weir (both hatchery and natural) were brought to the hatchery and held. Of these, ten fish died (4 percent) before spawning during holding at the hatchery and 10 were used to backfill a shortage of Lyons Ferry broodstock. Of the remaining 232 fish released for natural spawning, 30 percent were recovered; because no pre-spawn mortalities were detected, it is assumed that essentially all the released fish spawned, and, thus, that survival from release after holding to spawning is 90 to 100 percent. During the same period, only 10 percent of the fish passed upstream with no holding (470) were recovered. Assuming recovery of the two groups was equally likely and three times more fish were recovered from the group held in the hatchery compared to the group passed upstream, survival of the fish passed upstream was estimated at about 30 percent (Bumgarner 2016). Although some natural-origin fish died during the holding period (4 percent), and because this is based on only one year of data, we estimate this could be as high at 10 percent, which is less than what would have occurred without holding. Therefore, the Proposed Action is likely to lead to higher survival rates (estimated at 90-100 percent in 2015) and allow three times more natural-origin fish to spawn naturally compared to natural-origin fish that are not held in the hatchery (e.g., the 141 survivors (30 percent survival x 470 total fish passed) in 2015 likely represent what would have been 423 (90 percent survival x 470 total fish passed) with hatchery holding).

NMFS also had concerns related to disease risk associated with holding of natural-origin fish in the hatchery. However, we expect this to be negligible because fish are held on cool, pathogen-free well-water that does not pass from other holding vessels, the effluent from the adult holding vessel also does not flow into other holding vessels and fish are given formalin to treat fungal infections as needed (Bumgarner 2016). Thus, adverse effects from the additional handling and holding are likely outweighed by the benefits in fish survival to spawning.

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

The effects of competition and predation are negative for natural-origin spring/summer Chinook salmon and steelhead, but negligible for disease. Thus, the overall effect of this factor is negative for both species.

##### 2.4.2.3.1. Hatchery release competition and predation effects

Hatchery staff rear and feed the fish until they reach a physiological stage in their development (i.e., smoltification) that prompts them to leave freshwater for the ocean. Holding hatchery fish until smoltification and allowing volitional release limits competition for in-river rearing space and food during critical rearing phases.

Pearsons and Busack (2012) developed a model that provides indices of competition and predation based primarily on the sizes of hatchery- and natural-origin juveniles. Although the model has not been parameterized for Snake River populations, we can, based on the limited information available, determine indices specific for these populations using the R model developed by (Busack 2014). This will provide some measure of how likely predation and competition are to occur. For a more detailed description of the model and how we have used it in other consultations, see NMFS (2014b).

Both Chinook salmon and steelhead naturally co-occur in the action area, but the degree of habitat overlap is difficult to estimate. However, estimates of habitat segregation between hatchery spring Chinook salmon and natural-origin spring Chinook salmon and summer steelhead are available in the upper Columbia (HETT 2014; Mackey et al. 2014). We used the estimates of 30 and 60 percent segregation, for natural-origin Chinook salmon and steelhead respectively, to aid in the calculation of our competition and predation indices above (Table 26).

The six programs considered in this opinion release Chinook salmon smolts at about 120 mm in size. This size class means that smolts are more likely to compete with natural-origin Chinook salmon and steelhead than to prey on them. The predation index in Table 26 shows that age-0 natural-origin Chinook salmon and steelhead are the most likely to be preyed upon with interactions of fish of a consumable size occurring 0.2 and 3 percent of the time, respectively (during 10,000 simulated pairings of hatchery and natural-origin fish). The likelihood of predation decreases to zero for age-1 natural-origin fish of both species. The competition indices for age-0 fish of both species are high, with all pairings resulting in a competitive interaction. The likelihood for competitive interactions decreases for age-1 fish and to just a few percent for age-2 steelhead (Table 26).

It is more difficult to assess the ecological effects of outplanting of eyed-eggs/fry by five of the programs (Table 9). It is unlikely that predation would occur because these fish would be the same size as the natural-origin juveniles. Competition is likely to occur with natural-origin Chinook salmon, but because egg/fry outplanting is limited under the proposed action (21,000 to 95,000 depending on program; Table 9), only about 7 percent of eggs/fry are expected to survive to the smolt stage (Bradford 1995). Therefore, we expect 1470 to 6650 eggs/fry to survive to the smolt stage from each of the four programs. In addition, NMFS anticipates egg/fry outplanting to be a rare event; in the last 18 years, occurrences have ranged from 2 to 7 instances across the four programs. Thus, NMFS does not expect this relatively small number of smolts to result in a measureable effect on the natural-origin fish.

Table 26. Predation and Competition indices for spring/summer Chinook salmon and summer steelhead. Size data sources: (Clarke et al. 2015; Jonasson 2016; Jonasson et al. 2015; Olsen et al. 2015).

| **Species** | **Age Class** | **Size in mm (SD)** | **Predation Index** | **Competition Index** |
|---|---|---|---|---|
| Spring/summer Chinook salmon | 0 | 62 (10.0) | 0.002 | 1.000 |
| | 1 | 89 (10.0) | 0.000 | 0.743 |
| Summer steelhead | 0 | 71 (9.7) | 0.000 | 0.990 |
| | 1 | 134 (21.1) | 0.000 | 0.195 |
| | 2 | 170 (24.2) | 0.000 | 0.028 |
| | 3 | 235 (24.2) | 0.000 | 0.000 |

Many other variables are important for considering the potential of ecological interactions between hatchery and natural-origin fish, including residence time, survival of hatchery fish post-release, and the temporal and spatial overlap between hatchery and natural-origin fish. For the proposed programs, residence/migration time post-release is typically around 25 days, but was closer to 14 days for hatchery fish migrating out of the Upper Grande Ronde (Gallinat and Ross 2013; Gallinat and Ross 2014; Monzyk et al. 2009). Survival of hatchery fish ranged from about 35 to 77 percent, with a mean of 58 percent across the programs to Lower Granite Dam

(Oregon programs) or Lower Monumental Dam (Tucannon). Thus, we expect that hatchery fish will emigrate within 25 days of release, with 90% or more exiting the system in this time. As a result, the release of hatchery juveniles will continue to have low competition and predation effects on listed fish.

During mid-March to mid-April, when hatchery fish are released, juvenile, natural-origin spring/summer Chinook salmon and steelhead are present in the action area. Spring Chinook salmon fry emerge from January to June and reside in the action area until the fall or spring of the following year (ODFW 2011a). Natural-origin spring Chinook salmon smolts typically emigrate from late March to mid-May with a peak from early April to mid-May (Gallinat and Ross 2014). Because summer steelhead spawn from March to June with a peak from April to May in the action area (Busby et al. 1996), it is unlikely that any age-0 steelhead would have emerged in time to interact with the hatchery smolts as they migrate downstream. Summer steelhead smolts typically rear in the action area for two years before emigrating from late February to May, but are not of a size that is vulnerable to spring Chinook salmon smolts. Both species also have a smaller earlier fall to early winter migration, but there is unlikely to be any overlap with juvenile hatchery fish during this period.

#### 2.4.2.3.2. Naturally-produced progeny competition

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

For the Tucannon program, modeling suggests that density-dependent mortality is occurring in years with higher abundance. Large adult escapement numbers have resulted in smaller smolt sizes at migration and lower parent-per-progeny returns (Gallinat and Ross 2013). In contrast, smaller adult escapement numbers resulted in larger smolt body sizes at migration and parent-per-progeny ratios above replacement (Gallinat and Ross 2013). It is unknown what drives this survival difference, but it could be due to resource competition when smolts are more numerous because smolts of a larger size are more likely to survive to adulthood.

Density dependence may also be a factor in the Imnaha River. Total spawners and spawner density has increased in the Imnaha River, but has not resulted in a correlated increase in natural-origin recruits (Carmichael et al. 2011a).

Because spring Chinook salmon historically coexisted in substantial numbers with steelhead, it follows that there must have been adequate passage and habitat to allow both species to be productive and abundant. It does not follow automatically, however, that the historical situation can be restored under present-day conditions. Habitat and passage conditions have changed considerably over time to the point that both species are so depleted that they are listed under the ESA. However, ecological impacts may increase in the future if the spring Chinook salmon populations grow. Should the situation arise where spring Chinook salmon natural production is limiting steelhead natural production, recovery planners would have to prioritize one species over another. NMFS expects that the monitoring efforts would detect negative impacts before they reach problematic levels, and we include language in the ITS (Section 2.8.4) to ensure that appropriate monitoring takes place.

#### 2.4.2.3.3. Disease

Two endemic pathogens are of concern for these Chinook salmon programs: infectious hematopoietic necrosis virus (IHNV) and Bacterial Kidney Disease (BKD). To prevent outbreaks and reduce the amplification of IHNV in natural environments, hatchery staff drain the coelomic fluid from females during spawning and treat eggs with an iodophor solution, controlling, to some extent, the transmission of IHNV. Because of these preventative measures, epidemics of IHNV in the hatcheries have been rare in recent years. In addition, spawning surveys have found that the prevalence of BKD in natural spawners is less than one percent (Confederated Tribes of the Umatilla Indian Reservation (CTUIR) 2011; Nez Perce Tribe 2011; ODFW 2011a; ODFW 2011b; ODFW 2012; WDFW 2011). This suggests that the control of BKD by culling female fish with levels of the BKD-causing pathogen above a specific threshold is effective.

### 2.4.2.4. Factor 4. Hatchery fish and the progeny of naturally spawning hatchery fish in the migration corridor, estuary, and ocean

NMFS has been investigating this factor for some time. The Proposed Recovery Plan for Snake River Salmon (NMFS 1995b) described the issue in this manner. There is intense debate over the issues of carrying capacity and density-dependent effects on natural populations of salmon. However, there is little definitive information available to address the effects of ecological factors on survival and growth in natural populations of Pacific salmon. The proposed recovery plan called on hatchery operators and funding entities to “limit annual releases of anadromous fishes from Columbia Basin hatcheries” and, in fact, releases have declined substantially. Hatchery releases for the entire Columbia River Basin now vary between 130 and 145 million fish annually compared to a previous annual production of approximately 200 million fish back in the late 1990s.

NMFS has also reviewed the literature for new and emerging scientific information over the role and the consequences of density-dependent interactions in estuarine and marine areas. While there is evidence of density-dependent effects on salmon survival, the currently available information does not support a meaningful causal link to hatchery programs. The SCA for the FCRPS opinion (NMFS 2008a) and the September 2009 FCRPS Adaptive Management Implementation Plan (NMFS 2009) both concluded that available knowledge and research abilities are insufficient to discern any important role or contribution of hatchery fish in density-dependent interactions affecting salmon and steelhead growth and survival in the mainstem Columbia River, the Columbia River estuary, and the Pacific Ocean.

At full production, releases from the six programs would constitute less than 1.5 percent of the total hatchery production in the Columbia Basin. Upon release into the wild, following a year of hatchery rearing, fewer than half of these fish survive the journey to the Pacific Ocean to join tens of millions of other juvenile salmon and steelhead. There is CWT recovery information from marine fish harvest, but these data do not provide information on fish behavior or interactions among stocks in the ocean (USFWS 2009).

From the scientific literature, the general conclusion is that the influence of density-dependent interactions on growth and survival is likely small compared with the effects of large scale and regional environmental conditions. Although there is evidence that hatchery production, on a scale many times larger than the proposed action, can impact salmon survival in the migration corridor, estuary, and ocean, the degree of impact or level of influence is not yet understood or predictable. Regardless, hatchery production on the scale considered in this opinion is very unlikely to substantially affect salmon survival or recovery in these life stages. Thus, the effects of the Proposed Action on the Snake River Spring/summer Chinook Salmon ESU and Steelhead DPS in the migration corridor, in the estuary, and in the Pacific Ocean are negligible.

#### 2.4.2.5. Factor 5. Research, monitoring, and evaluation that exists because of the hatchery program

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 in general. Because the intent is to improve our understanding of listed population status, the information gained outweighs the risks to the populations based on the small proportion of fish encountered, resulting in an overall beneficial effect of RM&E on spring/summer Chinook salmon and steelhead. Because co-occurring Snake River steelhead would be captured at the same time, they would be included in similar monitoring efforts. Categories of RM&E effects are described individually below.

##### 2.4.2.5.1. Methodology

RM&E in the Proposed Action falls into two categories: that directly associated with fish culture, which focuses on the immediate effects, and that not directly associated with fish culture, which is aimed at post-release performance of the hatchery fish and the effects of the hatchery program on natural production.

The proposed RM&E directly related to fish culture uses well-established (e.g., AHSWG 2008) methods and protocols. For the programs included in this proposed action, the egg-to-smolt survival ranges from 72 to 87 percent (Confederated Tribes of the Umatilla Indian Reservation (CTUIR) 2011; Nez Perce Tribe 2011; ODFW 2011a; ODFW 2011b; ODFW 2012; WDFW 2011). These rates are anticipated prior to egg takes, and generally pose little to no risk to the population because these survival rates are incorporated into management, and 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)).

Methodology for RM&E associated with the hatchery programs are well established, and have been applied to Snake River spring/summer Chinook salmon without problems. These include use of PIT-tags, screw traps, seines, weirs, adult traps, and genetic analysis of small tissue samples.

The primary effect of the proposed RM&E activities on listed species is to capture, handle, and release fish. This leads to stress and other sub-lethal effects that are difficult to assess in terms of their impact on individuals, let alone entire species. The following subsections describe the types of activities being proposed. Each is described in terms broad enough to apply to all the permits. The effects of the activities are well documented in annual reports and discussed in detail below.

The proposed research activities would have no measurable effects on the listed salmonid habitat.

#### 2.4.2.5.2. 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 the 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. Redds may be visually inspected, but would not be walked on. These avoidance behaviors are likely to be in the range of normal predator and disturbance behaviors.

#### 2.4.2.5.3. 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 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. The co-managers have extensive experience capturing, handling, and releasing listed species in these areas, and have demonstrated low mortality rates through past implementation. with the exception of a large juvenile mortality event in 2016 associated with a screw trap on the Upper Grande Ronde. In this case, the loss of five natural-origin steelhead, 71 natural-origin juvenile spring Chinook salmon, and 8,811 hatchery-origin juvenile spring Chinook salmon occurred coinciding with the release of hatchery-origin fish from the acclimation ponds. However, the applicants propose to prevent loss like this in the future by performing nighttime trap checks following hatchery releases, and to cease trap operation on the first day following volitional release and forced migration of remaining fish. Thus, based on co-manager expertise (Jason Vogel, Nez Perce Tribe, pers. comm., April 24, 2013), NMFS anticipates that mortality from capture and handling would be 0.5% annually.

### 2.4.2.5.4. 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. Studies comparing the growth of clipped and unclipped fish generally have shown no differences between them (Brynildson and Brynildson 1967; Gjerde and Refstie 1988). While growth may be unaffected, some work has shown that fish without an adipose fin may have a more difficult time swimming through turbulent water (Buckland-Nicks et al. 2011; Reimchen and Temple 2003). Moreover, wounds caused by fin clipping usually heal quickly, especially those caused by partial clips.

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).

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

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

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 the fact 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).

Fish with internal tags often die at higher rates than fish tagged by other means because of the handling during tagging, since tagging is a complicated and stressful process. Mortality is both acute (occurring during or soon after tagging) and delayed (occurring long after the fish have been released into the environment). Acute mortality is caused by trauma induced during capture, tagging, and release—it can be reduced by handling fish as gently as possible. Delayed mortality occurs if the tag or the tagging procedure harms the animal in direct or subtle ways. 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. Based on co-manager expertise specific to northeast Oregon (Jason Vogel, Nez Perce Tribe, pers. comm., April 24, 2013), NMFS anticipates that mortality from production marking and tagging would be 1%.

#### 2.4.2.5.5. Masking

In listed populations, the presence of unmarked hatchery-origin fish complicates assessment of natural productivity and production (i.e., masking). At present, 100% of the fish produced by all of the hatchery programs are marked in some way, and this would continue under the Proposed Action. The northeast Oregon programs (Catherine Creek, Upper Grande Ronde, Lostine, and Lookingglass) adipose fin-clip all releases for visual identification. The Tucannon River spring/summer Chinook salmon program does not adipose fin-clip all releases, but all releases are marked in some fashion, so that returning hatchery-origin can be distinguished using electronic detection equipment (PIT and CWT readers) when they are handled.

#### 2.4.2.5.6. Summary of RM&E impacts

NMFS has developed general guidelines to reduce impacts when collecting listed adult and juvenile salmonids (NMFS 2000b; NMFS 2008a) that have been incorporated as terms and conditions into section 10 and section 7 permits for research and enhancement (e.g., NMFS 2007c). Additional monitoring principles for supplementation programs have been developed (AHSWG 2008).

Though capturing and handling of juveniles salmonids is expected to adversely affect individual fish, in general, the accumulated incidental mortality of capture, handling, and tagging for monitoring activities will be small (2% or less). The proposed research activities will have no measurable effects on the listed salmonids' habitat.

### 2.4.2.6. Factor 6. Construction, operation, and maintenance of facilities that exist because of the hatchery program

Operation, maintenance, and construction activities included in the Proposed Action would have a negative effect on ESA-protected spring Chinook salmon and Snake River steelhead or their designated critical habitat[16].

[16] Though new construction would take place (Lostine River Hatchery and Imnaha weir), these impacts have been analyzed separately in separate consultations, and are not considered here.

Table 27. Program water source and use.

| Hatchery Facility[1] | Maximum Surface Water Use (cfs) | Maximum Ground or Spring Water Use (cfs) | Surface Water Source/ Discharge Location | Diversion Distance (km) | Minimum Mean Monthly Surface Water Flows During Operation (cfs) | Maximum Percent Surface Water Diverted |
|---|---|---|---|---|---|---|
| Catherine Creek Acclimation Facility | 5 | 0 | Catherine Creek | 0.15 | 240 (April) | 2 |
| Lookingglass Hatchery | 50 | 5 | Lookingglass Creek | 0.45 | 53 (September) | 94 |
| Upper Grande Ronde Acclimation Facility | 5 | 0 | Upper Grande Ronde | 0.15 | 3,030 (February) | 0.2 |
| Lostine Acclimation Facility | 5.7 | 0 | Lostine River | 0.1 | 47 (February) | 12 |
| Lostine River Hatchery [2] | 18 | 3.2 | Lostine River | 0.85 | 47 (February) | 38 |
| Imnaha River Satellite Facility | <15 | 0 | Imnaha River | 0.15 | 236 (February) | 6 |
| Tucannon Hatchery[3] | 8.83 | 1.76 | Tucannon River | 1.3 | 61 (August) | 5 |
| Curl Lake Acclimation Pond | 6 | 0 | Tucannon River | 0.15 | 246 (February) | 2 |

[1] Acclimation facilities operate from approximately February through April.
[2] Not currently in operation.
[3] Approximately 30 percent of the spring water and 35 percent of the surface water at the Tucannon Hatchery is used for the steelhead program. The Tucannon Hatchery also propagates rainbow trout.

Under the Proposed Action, there is no change in water withdrawal levels from the current operation. Thus, the effects of water withdrawals are expected to have similar effects into the future. With the exception of Lookingglass Creek, surface water withdrawals are small and will not cause a change in habitat use or decrease availability (Table 27). Water withdrawals from Lookingglass Creek reduce flow substantially during low flow periods in late summer between the intake and the effluent outfall (0.45 km; USFWS 2011), which straddles the weir. In extreme low water conditions, which occur during the summer months (July to September), the Lookingglass Hatchery water right exceeds the total flow available for withdrawal (USFWS 2011). During this time, spring Chinook salmon adults have already migrated into the area and typically spawn from August to September (Table 25); any redds would have been constructed during the lowest flows possible and are not expected to be in danger of dewatering (ODFW 2012). The risk of dewatered steelhead redds is also low. Steelhead are passed above the weir from March to June. Steelhead passed above the weir from 2002 to 2015 averaged 206 fish with only 2.1 percent passed in June. The average number of redds identified from Lookingglass Creek during steelhead spawning (2003-2006) was 69[17] (Yanke 2016). However, it is unlikely that many redds would fall within the intake and discharge points for three reasons. The first is that few adults are passed in June, so most of the redds would be deposited before then. The second is that data has shown that the peak of age-0 steelhead outmigration/emergence is in June, before the low summer flows (Naylor 2016). The third is a large portion of Lookingglass Creek (21 of 25 rkm) is available for spawning above the weir. If this distance were divided by the distance between the intake/discharge (0.45 km) and if steelhead redds are assumed to be distributed equally in each portion, ~1.6 redds would be deposited in each section.

Low flows during the summer months may also affect juvenile rearing, but few juveniles are present as most spring Chinook and steelhead smolts would have emigrated in the late spring to early summer. Juveniles may also choose to move to deeper pools for holding during periods of low flow. (Note that, because climate change trends indicate that juveniles may outmigrate earlier with less tributary water available, the risk of dewatering on juvenile rearing during the summer months under likely changes in climate conditions is reduced even further (Dittmer 2013)). The Lookingglass Fish Hatchery intake is also not currently compliant with mesh size and sweeping velocity requirements for screens (NMFS 2011a; USFWS 2011). As a result, Chinook salmon and steelhead juveniles could enter raceways where they would be trapped—no observations of trapped juveniles have been reported, so few, if any, are likely to be trapped during the duration of the Proposed Action. The intake also physically blocks fish passage upstream (USFWS 2011). The Imnaha Satellite Facility has not been evaluated by NMFS for screening and could potentially trap some fish when it is in operation, but this number is likely to be low, because the facility is used for approximately six weeks for the proposed Action. In any case, neither facility is likely to have a measurable adverse effect on the population.

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

**Facilities Used for Short Periods of Rearing**

There are several facilities that may be used to incubate eggs and rear juveniles from the Upper Grande Ronde program. Small numbers of fish are transported to and from the Lyons Ferry Hatchery (Snake River in Washington), Irrigon Hatchery (Columbia River, near Irrigon, Oregon), the Wallowa Hatchery (Wallowa River, a tributary to the Grande Ronde River), the Oxbow Hatchery (Columbia River in Oregon), and the Bonneville Hatchery (Columbia River in Oregon) for short stages of rearing prior to release. Both the Irrigon and Lyons Ferry Hatcheries exclusively use groundwater, except for emergencies, which has no effect on listed species. The proportion of fish from this program at Oxbow hatchery represents less than 15 percent of the production, and both the Wallowa and Bonneville Hatcheries use less than two percent of their surface water source for rearing fish from these programs (NMFS 2013a). Thus, using small

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[17] It is difficult to assess steelhead redds safely due to high flows that coincide with spawning. Therefore, steelhead redd surveys were halted in Lookinglgass Creek after 2006.

amounts of water at these facilities for short periods of rearing is unlikely to result in any measurable effects on listed species.

#### 2.4.2.7. Factor 7. Fisheries that exist because of the hatchery program

Fisheries are not part of this Proposed Action, but are included in the environmental baseline (see Section 2.3.4).

#### 2.4.2.8. Effects of the Action on Critical Habitat

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

The existing hatchery facilities have not led to altered channel morphology and stability, reduced and degraded floodplain connectivity, excessive sediment input, or the loss of habitat diversity. In addition, no new facilities are proposed. Construction of the Lostine River Hatchery and the Imnaha weir have been previously consulted on and are included in the environmental baseline (NMFS 2004a). Except for the ladder entrance and water diversion, structures associated with hatchery facilities do not affect designated critical habitat.

Most facilities that use surface water diversions return that water to the river a short distance from the diversion point (Table 26). Because the uses are non-consumptive, and proportionally small, these withdrawals would not affect adult spawning and juvenile rearing critical habitat of ESA-listed spring Chinook salmon or steelhead. Lookingglass Hatchery may divert the majority of surface water in Lookingglass Creek during the summer months (July to September), but its use during this time as spawning or rearing habitat is minimal

Water withdrawals at most facilities are only a small proportion of the total surface water volume. Thus, any contaminants in the effluent will be diluted further when mixed with the remaining water in the creek or river, leading to no change in water quality. Despite using a large proportion of creek water to supply Lookingglass Hatchery, the effluent is diverted into pollution abatement ponds before being discharged into the creek, minimizing pollution risk. This is in accordance with NPDES permit requirements. Thus, the effects on water quality in spawning and rearing critical habitat are negligible.

Hatchery maintenance activities are expected to retain existing conditions, and would have minimal adverse effects on designated critical habitat.

## 2.5. Cumulative Effects

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

Current non-Federal actions described in Section 2.3 are expected to continue to affect Snake River spring Chinook salmon and steelhead in the Grande Ronde and Tucannon River Basins at similar levels of intensity.

State, tribal, and local governments have developed plans and initiatives to benefit listed species and these plans must be implemented and sustained in a comprehensive manner for NMFS to consider them "reasonably foreseeable" in its analysis of cumulative effects. It is acknowledged, however, that such future state, tribal, and local government actions would likely be in the form of legislation, administrative rules, or policy initiatives, and land use and other types of permits and that government actions are subject to political, legislative and fiscal uncertainties.

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

## 2.6. Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the Proposed Action. In this section, NMFS adds the effects of the Proposed Action (Section 2.4.2) to the environmental baseline (2.3) and to cumulative effects (2.5) to formulate the agency's opinion as to whether the Proposed Action is likely to: (1) result in appreciable reductions in the likelihood of both survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution; or (2) reduce the value of designated or proposed critical habitat. This assessment is made in full consideration of the status of the species and critical habitat and the status and role of the affected population(s) in recovery (Sections 2.2.1, 2.2.2, and 2.2.3).

In assessing the overall risk of the Proposed Action on each species, NMFS considers the risks of each factor discussed in Section 2.4.2., above, in combination, considering their potential additive effects with each other and with other actions in the area (environmental baseline and cumulative effects). This combination serves to translate the positive and negative effects posed by the Proposed Action into a determination as to whether the Proposed Action as a whole would appreciable reduce the likelihood of survival and recovery of the listed species and their designated critical habitat.

### 2.6.1. Snake River Spring/Summer Chinook salmon

Best available information indicates that the species, in this case the Snake River Spring/Summer Chinook Salmon ESU, is at high risk and remains at threatened status. Based on the VSP criteria, all seven extant populations within the action area remain at high risk of extinction. The most serious risk factor for the Snake River spring/summer Chinook salmon populations was low natural productivity (spawner-to-spawner return rates) and the associated decline in abundance to extremely low levels relative to historical returns (Ford 2011). The biological review team (Ford 2011) was concerned about the high level of production from hatchery programs across the ESU, because these programs represent ongoing risks to natural populations and can make it difficult to assess trends in natural productivity.

The programs have demonstrated that they can increase and will likely continue to increase short-term total abundance (ESA-listed natural and hatchery-origin fish combined), and have a long-term goal of increasing the number of natural spawners to at least the ICTRT minimum abundance thresholds (i.e., 750 to 1000 depending on the population). The proposed hatchery programs use broodstock from the ESA-listed Snake River spring/summer Chinook salmon populations from the local or immediate areas. Although the proposed hatchery programs use fish only from their associated populations for broodstock collection, a high proportion of hatchery spawners, no matter their origin, pose a threat to ESA-listed naturally spawning populations. Implementation of adult management measures in the HGMPs will reduce the risk of outbreeding effects and reduction in within-population diversity resulting from straying of adult hatchery-origin fish relative to the current environmental baseline. The sliding scales are intended to prevent “mining” of the ESA-listed spring Chinook salmon populations, improve overall PNI within each population, and move toward selection in nature over selection in the hatchery.

Operation of the weirs will result in the handling of substantial numbers of natural-origin spring Chinook salmon. This effect on spring/summer Chinook salmon is limited because each weir would be monitored to keep it clear of debris and ensure proper function to minimize delays. All spring Chinook salmon would be held for a short duration (typically less than 24 hours), which should minimize delay. Fish in excess of broodstock goals would be released upstream immediately. This is expected to limit any effects of weir operation and placement on spawning distribution because fish would still have access to spawning areas above the weir, although fish may choose to avoid the weir and spawn downstream, there is currently no evidence from annual spawning ground surveys that distribution has been altered as a result of weirs. Surplus hatchery fish may be removed to reduce both genetic and ecological risk to the natural population.

The presence of hatchery fish and the progeny of naturally spawning hatchery fish in the juvenile rearing areas is likely to result in competition between hatchery- and natural-origin Chinook salmon populations (see Section 2.4.2.3), but is expected to have a small effect on spring/summer Chinook salmon, because the populations are below capacity and therefore the habitat can support additional spawning. Predation is unlikely to occur because hatchery-origin smolts are not large enough to prey upon natural-origin spring Chinook salmon. In addition, smolts are released volitionally at a time when they are physiologically ready to migrate, thus reducing their residence time in spawning and rearing areas. Disease has not been a problem in past operation of the programs, and is not expected to be in the future because fish health is continuously monitored to reduce the probability of pathogen transmission through hatchery juvenile releases. In addition, because productivity in the Grande Ronde, Catherine Creek, and Lostine populations are below replacement, and the Imnaha population is just above replacement at 1.2 (NWFSC 2015), it is likely that the outplanting of additional eggs/fry will provide a net benefit to the population through increased juvenile abundance, which supplements the low productivity.

Juveniles would be captured, handled, and may be tagged during the operation of rotary screw traps. Collecting, sampling, and tagging could lead to mortalities. However, the number of juveniles killed is expected to be low, with less than 1.5% of all of the juveniles encountered being lost. Adults would be encountered during spawning surveys and may be encountered at the juvenile screw traps, but these encounters are unlikely to result in mortality. Information gained from RM&E will be used to evaluate survival and growth, and hatchery fish effects on productivity, genetic diversity, run and spawn timing, spawning distribution, age and size at maturity, and program management. Although monitoring poses some adverse effects on the populations, NMFS believes the information gathered is an overall benefit.

Risks posed by the hatchery program operations include water withdrawals (surface and ground), effluent discharge, and maintenance. Surface water withdrawals to support the hatchery operations would be small relative to the total volume of water available for fish. Water use for all programs is not consumptive (water is returned to the stream after flowing through the facility), and the points of withdrawal and discharge are relatively short distances apart (Table 26). All programs are screened in accordance with NMFS criteria. However, both Lookinglass Hatchery and the Imnaha satellite facility have observed entrainment of juveniles and thus require screening upgrades to the most recent NMFS screening criteria (see associated permits for condition). Effluent discharge is regulated under Federal NPDES permits (or exempt due to small size), to reduce hatchery-related water quality impacts. Maintenance activities (e.g., ,sediment removal on intake screens) would cause only minor short-term impacts, such as turbidity, that would dissipate quickly and not likely result in mortality.

After taking into account the current depressed viability status of the species, the Environmental Baseline, the effects of the proposed hatchery programs, and cumulative effects, NMFS concludes that the Proposed Action is not likely to appreciably reduce the likelihood of survival and recovery of the Snake River Spring/summer Chinook Salmon ESU. Though there are adverse effects of artificial propagation, including genetic introgression, competition, predation, hatchery-influenced selection, and facility operation, the magnitude of these effects is relatively small. Furthermore, these effects are monitored and programs can be adaptively managed to minimize these effects.

### 2.6.2. Snake River Basin Steelhead

Best available information indicates that the species, in this case the Snake River Basin steelhead DPS, is at high risk and remains at threatened status (Ford 2011). Based on the combined ratings for abundance/productivity and spatial structure/diversity, all three extant populations within the action area remain at high risk of extinction. Ford (2011) determined that all populations remain below minimum natural-origin abundance thresholds. In addition, the biological review team identified the lack of direct data on spawning escapements and pHOS in the individual population tributaries as a key uncertainty, rendering quantitative assessment of viability for the DPS difficult (Ford 2011).

The primary source of effects on the ESA-listed Snake River steelhead resulting from the Proposed Action occur during broodstock collection and during activities included as part of the large research, monitoring, and evaluation (Factor 5) component that is necessary for the evaluation of all six hatchery programs. These actions will occur throughout the Grande Ronde, Imnaha, and Tucannon basins.

Although no steelhead are removed for broodstock, broodstock collection facilities may temporarily affect passage or the spatial distribution of listed juvenile and adult steelhead because it creates a barrier in the river when the fish trap is operational, delaying upstream migration of listed fish. However, differences in peak migration times limit the number of steelhead encountered at weirs; spring Chinook salmon run from March to May and summer steelhead from May to August (Table 24).

The presence of hatchery fish and the progeny of naturally spawning hatchery fish in the juvenile rearing areas is likely to result in competition (Section 2.4.2.3), but this competition is expected to have a small effect on steelhead, because habitat use is segregated by species with 60% of steelhead habitat not utilized by hatchery spring Chinook salmon smolts. The Proposed Action would also acclimate smolts prior to release to improve homing fidelity, release hatchery smolts that are physiologically ready to migrate, and volitionally release smolts, such that they immediately begin moving downstream to reduce interactions in rearing areas. Predation on natural-origin steelhead would be low because hatchery spring/summer Chinook salmon are released as smolts and emigrate quickly from the system, and hatchery-origin smolts are generally not large enough to prey on natural-origin steelhead of the same year class.

The Proposed Action includes several similar RM&E activities that would handle and sample ESA-listed steelhead. Juveniles would be captured, handled, and may be tagged during the operation of rotary screw traps. Handling associated with collecting, sampling, and tagging could kill juvenile steelhead, but the number of juveniles killed is expected to be low, with less than 1.5% of all of the juveniles encountered being lost. The RM&E would result in a better understanding of the status of the populations in the two MPGs (Grande Ronde and Lower Snake) affected by the action.

Steelhead can be affected by the operation of the hatchery facilities under the Proposed Action from water withdrawal and maintenance activities. The same risks apply to steelhead that apply to Chinook salmon: the large volume of water and distance of the diversion from Lookingglass Creek, which could lead to redd dewatering and adult migration delays, and the screens at Lookingglass Hatchery and the Imnaha satellite facility require upgrading to avoid entrainment of listed fish. The associated permits for the Lookingglass and Imnaha programs apply conditions to address the screening issues.

After taking into account the current depressed viability status of the species, the Environmental Baseline, the effects of the proposed hatchery programs, and cumulative effects, NMFS concludes that the Proposed Action is not likely to appreciably reduce the survival and likelihood of recovery of the Snake River Steelhead ESU. However, there are adverse effects of artificial propagation, including competition, predation, and facility operation, but the magnitude of these effects is relatively small. Furthermore, these effects are monitored and programs will be adaptively managed to minimize these effects.

### 2.6.3. Critical Habitat

The hatchery water diversion and the discharge pose a negligible effect on designated critical habitat in the action area (Section 2.4.2.6). 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. Lookingglass Fish Hatchery may withdraw enough water to reduce flows in Lookingglass Creek in some circumstances, but the reduction in streamflow is for a short duration in areas with limited use by spring/summer Chinook salmon and steelhead. The impact on the spawning, rearing, and migration PCEs will be small in scale, and will not appreciably diminish the capability of the critical habitat to satisfy the essential requirements of the species.

Climate change may have some effects on critical habitat as discussed in Section 2.3.1. With continued losses in snowpack and increasing water temperatures, it is possible that increases in the density and residence time of fish using cold water refugia could result in increases in ecological interactions between hatchery and natural-origin fish of all life stages. However, the continued restoration of habitat, especially in the Lostine subbasin, should alleviate some of this potential pressure for suitable rearing and spawning habitat.

New facilities (Lostine Hatchery) or changes to existing facilities (Imnaha weir) have been analyzed separately, and were determined to not destroy or adversely modify critical habitat (NMFS 2004a).

Critical habitat for ESA-listed Snake River spring/summer Chinook salmon and Snake River steelhead is described in Section 2.2.2 of this opinion. After reviewing the Proposed Action and conducting the effects analysis, NMFS has determined that the Proposed Action will not impair PCEs designated as essential for spawning, rearing, juvenile migration, and adult migration purposes.

## 2.7. Conclusion

After reviewing the current status of the listed species, the environmental baseline within the action area, the effects of the Proposed Action, including effects of the Proposed Action that are likely to persist following expiration of the Proposed Action, and cumulative effects, it is NMFS' biological opinion that the Proposed Action is:

Not likely to jeopardize the continued existence or recovery of the Snake River Spring/summer Chinook Salmon ESU, or destroy or adversely modify its designated critical habitat.

Not likely to jeopardize the continued existence or recovery of the Snake River Basin Steelhead ESU, or destroy or adversely modify its designated critical habitat.

## 2.8. Incidental Take Statement

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by regulation to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering (50 CFR 17.3). Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. For the purposes of this consultation, we interpret "harass" to mean an intentional or negligent action that has the potential to injure an animal or disrupt its normal behaviors to a point where such behaviors are abandoned or substantially altered.[18] 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.

### 2.8.1. Amount or Extent of Take

The primary form of take of ESA-listed spring/summer Chinook salmon is direct take, authorized in the permit for each program. However, NMFS also expects incidental take of ESA-listed spring/summer Chinook salmon and steelhead will occur as a result of the proposed action.

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

**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**

*Chinook Salmon*
Effects of hatchery fish on the genetics of natural-origin fish can occur through a reduction in genetic diversity, outbreeding depression, and hatchery-influenced selection. Take due to these genetic effects cannot be directly measured because it is not possible to observe gene flow or interbreeding between hatchery and wild fish in a reliable way. NMFS will therefore rely on a surrogate take indicator that relates to the type of take identified: the strict implementation of the agreed-upon adult management scales for each program as a surrogate (Tables 3-8). For example, for Catherine Creek as described in Table 4, if adult escapement is between 250-500 fish, the pHOS limit for the purpose of this surrogate take limit is 70 percent; if escapement is over 500, the take limit drops to 50 percent pHOS, and so on. Use of the sliding scales will result in the removal of hatchery-origin fish to meet pHOS goals, or restricted passage of fish (both hatchery- and natural-origin) upstream of the weir in the case of Lookingglass Creek, dependent

[18] NMFS has not adopted a regulatory definition of harassment under the ESA. The World English Dictionary defines harass as "to trouble, torment, or confuse by continual persistent attacks, questions, etc." The U.S. Fish and Wildlife Service defines "harass" in its regulations as an intentional or negligent act or omission that creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering (50 CFR 17.3). The interpretation we adopt in this consultation is consistent with our understanding of the dictionary definition of harass and is consistent with the U.S. Fish and Wildlife interpretation of the term.

on the natural-origin run size. Limiting the number of hatchery-origin fish on the spawning grounds also limits the opportunity for spawning with natural-origin fish, which can lead to incorporation of genes that have undergone hatchery-influenced selection into the natural population. Therefore, the take surrogate is logically related to the take pathway. Moreover, through spawning ground surveys, the take surrogate can be reliably measured and monitored.

There is further take caused by ecological interactions between hatchery- and natural-origin adults; specifically, spawning site competition and redd superimposition. It is not possible to quantify the take associated with ecological interactions between adults on the spawning grounds because this interaction is not observable. However, the abundances of the two unsupplemented rivers (Minam and Wenaha) can be added together and used as a reference for expected relative abundance in each of the supplemented areas. Therefore, NMFS applies a surrogate take indicator for interactions between natural-origin spring/summer Chinook salmon and naturally spawning hatchery-origin salmon as follows: the most-recent 5-year moving average[19] of natural-origin population abundances in Catherine Creek, Upper Grande Ronde River, Imnaha River, Lostine River, and Tucannon River cannot decline greater than 20 percent relative to the combined abundance of the Wenaha and Minam populations. For example, if the 5-year moving average of the unsupplemented populations declines by less than 10%, but the average for one or more supplemented extant population declines by 30 percent, then this triggers the 20 percent relative decline standard. This standard has a rational connection to the amount of take expected from ecological interactions, because interactions between adults can result in decreased productivity. Furthermore, it can be reliably measured and monitored. The 20 percent relative decline (as measured with a 5-year moving average) was selected because it allows for some annual variation due to environmental factors unique to each population.

*Steelhead*

No take of steelhead due to genetic or ecological effects of the programs is expected. Take associated with operation of facilities for spring Chinook salmon broodstock collection is detailed in Table 28.

[19] Starting in 2016, however, if it is apparent, from numbers observed in years prior to the fifth year, that the average is certain to exceed 20 percent after five years, co-managers will contact NMFS in the year the likely exceedance is discovered.

Table 28. Permissible annual incidental take of Snake River basin steelhead associated with spring Chinook salmon adult broodstock collection.

| Trap Location | Lifestage | Maximum Natural-origin Handled, Marked, and Passed | Maximum Mortality* |
|---|---|---|---|
| Catherine Creek | Adult | Up to 50 | 1%<br>Up to 2 |
| Upper Grande Ronde River | Adult | Up to 10 | 1%<br>Up to 2 |
| Imnaha River | Adult | Up to 30 | 1%<br>Up to 2 |
| Lookingglass Creek | Adult | Up to 50 | 1%<br>Up to 2 |
| Lostine River | Adult | Up to 20 | 1%<br>Up to 2 |
| Tucannon River | Adult | Up to 50** | 1%<br>Up to 2** |

* Where total number killed would be one, NMFS rounds the total to two, so that operations are not halted completely at the first mortality.
** The 50 and 2 here applies to each origin type (hatchery and natural)

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

*Chinook Salmon and Steelhead*
Predation, competition, or pathogen transmission, collectively referred to as ecological interactions, between juvenile Chinook salmon and steelhead and Chinook salmon hatchery smolts released from the acclimation ponds can occur. The take of juvenile natural-origin spring/summer Chinook salmon and summer steelhead through ecological interactions with juvenile hatchery fish cannot be directly or reliably measured. For this factor, NMFS applies a surrogate take variable that relates to the proportion of hatchery fish in the rearing areas after release. As discussed in subsections 2.4.1.3.1 and 2.4.1.3.2, hatchery releases are expected to exit the system quickly. Specifically, the extent of take from interactions between hatchery and natural-origin juvenile salmonids in rearing areas are as follows: the proportion of emigrating juvenile hatchery salmonids shall exceed 90 percent on or after the 25th day following hatchery release. This is a reasonable, reliable and measurable surrogate for incidental take because if 10 percent or more are remaining in the river past 25 days, it is a sign that fish are not exiting the basin as quickly as expected. This threshold will be monitored using emigration estimates from PIT tags, screw traps, or other juvenile monitoring technique developed by the operators and approved by NMFS.

**Factor 5: Research, monitoring, and evaluation that exists because of the hatchery program**

*Chinook Salmon*
Take associated with RM&E activities on juveniles is considered direct and is covered under the permit for each program. However, RM&E effects on adults and jack Chinook salmon associated with trapping of juveniles are detailed in Table 29.

Table 29. Permissible annual take of adult Snake River spring/summer Chinook salmon for RM&E activities associated with juvenile screw traps.

| Trap Location | Lifestage | Maximum Number Natural-origin Captured and Released | Maximum Number Natural-origin Mortality* | Maximum Number Hatchery-origin Captured and Released | Maximum Number Hatchery-origin Mortality* |
|---|---|---|---|---|---|
| Catherine Creek | Adult or jack | Up to 5 | Up to 2 | Up to 10 | Up to 2 |
| Upper Grande Ronde River | Adult or jack | Up to 5 | Up to 2 | Up to 10 | Up to 2 |
| Imnaha River | Adult or jack | Up to 10 | Up to 2 | Up to 20 | Up to 2 |
| Lookingglass Creek | Adult or jack | Up to 5 | Up to 2 | Up to 10 | Up to 2 |
| Lostine River | Adult or jack | Up to 5 | Up to 2 | Up to 10 | Up to 2 |
| Tucannon River | Adult or jack | Up to 5 | Up to 2 | Up to 10 | Up to 2 |
| Minam River | Adult or jack | Up to 10 | Up to 2 | Up to 10 | Up to 2 |

* Where total number killed would be one, NMFS rounds the total to two, so that operations are not halted completely at the first mortality.

*Steelhead*

Take associated with RM&E activities is considered direct and is covered under the permit for each program. However, RM&E effects on adult and jack steelhead associated with trapping of juveniles are detailed in Table 30.

Table 30. Permissible annual take of adult Snake River basin steelhead for RM&E activities associated with juvenile screw traps.

| Trap Location | Lifestage | Maximum Number Natural-origin Handled, Marked, and Passed | Maximum Number Natural-origin Mortality* |
|---|---|---|---|
| Catherine Creek | Adult or jack | Up to 10 | Up to 2 |
| Upper Grande Ronde River | Adult or jack | Up to 15 | Up to 2 |
| Imnaha River | Adult or jack | Up to 5 | Up to 2 |
| Lookingglass Creek | Adult or jack | Up to 10 | Up to 2 |
| Lostine River | Adult or jack | Up to 10 | Up to 2 |
| Minam River | Adult or jack | Up to 20 | Up to 2 |

* Where total number killed would be one, NMFS rounds the total to two, so that operations are not halted completely at the first mortality.

**Factor 6: Construction, operation, and maintenance of facilities that exist because of the hatchery program**

*Chinook Salmon and Steelhead*

Because the Lookingglass hatchery and Imnaha satellite facility intakes do not currently meet NMFS screening criteria, there is a small likelihood that fish could be entrained or injured by these screens. NMFS believes these occurrences will be rare, but sets the level of take at five juvenile spring/summer Chinook salmon and five juvenile steelhead annually that may be killed at each facility by these screens.

Water withdrawals in Lookingglass Creek may also result in take. NMFS believes that up to 100 juvenile Chinook salmon or steelhead will become stranded and die in Lookingglass Creek between the intake and outfall annually. Lookingglass Creek. NMFS authorizes the dewatering of up to two steelhead redds annually, including the resulting lethal take of any eggs or fry present in those redds.

**Factor 7: Fisheries that exist because of the hatchery program**

*Chinook Salmon and Steelhead*
Take for this factor is covered by previous consultations (NMFS 2008b; NMFS 2013b).

### 2.8.2. Effect of the Take

In Section 2.7, NMFS determined that the level of anticipated take, coupled with other effects of the Proposed Action, is not likely to jeopardize the continued existence of the Snake River Spring/summer Chinook Salmon ESU or Snake River Basin Steelhead DPS or result in the destruction or adverse modification of their designated critical habitat.

### 2.8.3. 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 Action Agency (NMFS) shall ensure, when issuing its permits, that:

1. The applicants implement the hatchery programs and operate the hatchery facilities as described in the Proposed Action (Section 1.3) and in the submitted HGMPs.
2. The applicants follow all conditions specified in each permit issued as well as guidelines specified in this opinion for their respective programs.
3. The applicants provide reports to SFD annually for all hatchery programs, and for all RM&E activities associated with the hatchery programs.

### 2.8.4. Terms and Conditions

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

1. Ensure that the applicants implement the hatchery programs as described in the Proposed Action (Section 1.3) and in the submitted HGMPs.

a. NMFS' SFD will require applicants to provide advance notice of any change in hatchery program operation and implementation that potentially increases the amount or extent of take, or results in an effect of take not previously considered.
b. NMFS' SFD will require applicants to provide notice if monitoring reveals an increase in the amount or extent of take, or discovers an effect of take not previously considered.

2. Require that applicants follow all conditions prescribed in the respective permits for each program.
    a. NMFS SFD must be notified within one week if handling, tagging, or numbers killed identified in take tables are exceeded by more than 1 percent.
    b. NMFS SFD will ensure that applicants exercise care during spawning ground surveys to avoid disturbing ESA-listed adult salmonids when they are spawning. Visual observation must be used instead of intrusive sampling methods, especially when just determining fish presence.
    c. NMFS will be allowed to accompany any employee or representative field personnel while they conduct activities covered by their permit and this Biological Opinion.
3. NMFS' SFD requires applicants to supply annual reports of program implementation by March 31st of each year. All reports, as well as all other notifications required in the permit, should be submitted electronically to the NMFS point of contact for this opinion:

    Brett Farman (503) 231-6222, brett.farman@noaa.gov
    NMFS – Sustainable Fisheries Division
    Anadromous Production and Inland Fisheries Branch
    1201 N.E. Lloyd Boulevard, Suite 1100
    Portland, Oregon 97232

    a. Applicants will notify NMFS SFD as soon as possible, but no later than two days, after any authorized take is, or is likely to be, exceeded. This includes the take of any ESA-listed species not otherwise included in this ITS. The applicants shall submit a written report detailing why the authorized take was or is likely to be exceeded.
    b. Applicants provide annual reports to SFD that summarize numbers, pounds, dates, tag/mark information, locations of artificially propagated fish releases, RM&E activities that occur within the hatchery environment, and the number and spatial and temporal distribution of hatchery fish that return to any naturally spawning area and to hatchery facilities. Reports shall also include any preliminary analyses of scientific research data, any problems that may have arisen during conduct of the authorized activities, a statement as to whether or not the activities had any unforeseen effects, and steps that have been and will be taken to coordinate the RM&E with other researchers. These annual reports can include, but are not limited to, reports provided to the LSRCP or BPA. The reports shall be submitted to SFD by March 31st of the year following release (e.g., brood year 2014, release year 2015, report due March 2016).
    c. Reports on incidental steelhead take during broodstock collection and RM&E for the Tucannon spring Chinook salmon program will be submitted with the LSRCP steelhead program report.

## 2.9. 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. The applicants should pursue funding to reduce flow impacts on Lookingglass Creek from hatchery withdrawals associated with program production.
2. The applicants should develop models to estimate long-term productivity of natural-origin populations within the program area that incorporate sliding scale management outcomes (e.g., realized pHOS and pNOB), weir efficiencies, and habitat availability.
3. Continue to monitor straying into the Minam and Wenaha populations. Revisions of hatchery rearing and release practices may be needed to target a straying rate into both populations (all sources) that remains within the ICTRT guidelines of 10 percent for no more than moderate risk to the population.

## 2.10. Re-initiation of Consultation

As provided in 50 CFR 402.16, re-initiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take 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. In addition, reinitiation is required if implementation of the Proposed Action is continued beyond December 31, 2027.

## 2.11. "Not Likely to Adversely Affect" Determinations

The applicable standard to find that a Proposed Action is "not likely to adversely affect" ESA listed species or critical habitat is that all of the effects of the action are expected to be discountable, insignificant, or completely beneficial (USFWS and NMFS 1998). Beneficial effects are contemporaneous positive effects without any adverse effects on the species. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are extremely unlikely to occur.

NMFS has determined that the Proposed Action may affect, but is not likely to adversely affect, Snake River fall Chinook salmon and Snake River sockeye salmon. Both species are present downstream from facilities and release locations, but are not expected to occupy areas where habitat or water quality will be impacted. Snake River fall Chinook salmon and sockeye salmon use the mainstem Columbia and Snake Rivers as migratory corridors, and would swim past the mouth of the Grande Ronde, Tucannon, and Imnaha Rivers where they join the Snake River. In these reaches, outmigrating smolts intermingle as they migrate toward the ocean. As discussed in Section 2.4.1.4, impacts from interactions between hatchery smolts from these programs and natural-origin smolts migrating out to the ocean is small, and their effects insignificant. Because adult spring Chinook salmon return at slightly different times (Table 31) and spawn further upstream than sockeye or fall Chinook salmon, interactions between migrating adults are also expected to be small, and their effects insignificant.

Table 31. Run-timing, holding, and spawn timing of spring/summer, and fall Chinook salmon, and sockeye salmon (NMFS 2015; ODFW 2011a).

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

In addition to using mainstem Columbia and Snake River migratory corridors, Snake River fall Chinook salmon use the lower reaches of the Grande Ronde and Tucannon Rivers for spawning and rearing. Because of differences in spawning habitat preferences, timing between spring/summer and fall Chinook salmon, and distance between known spawning areas, hatchery spring Chinook salmon are not expected to compete with fall Chinook salmon in these areas, so the effects would be discountable.

Because of the limited overlap in spawning and rearing habitat, temporal differences in migration, and small impacts from juvenile migration interactions, NMFS has determined that the Proposed Action is not likely to adversely affect Snake River fall Chinook salmon and Snake River sockeye salmon. This determination was made pursuant to section 7(a)(2) of the ESA implementing regulations at 50 CFR 402, and agency guidance for preparation of letters of concurrence[20].

[20] Memorandum from D. Robert Lohn, Regional Administrator, to ESA consultation biologists (guidance on informal consultation and preparation of letters of concurrence) (January 30, 2006).

## 3. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT CONSULTATION

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

This analysis is based, in part, on descriptions of EFH for Pacific Coast salmon (PFMC 2003) contained in the fishery management plans developed by the Pacific Fishery Management Council (PFMC) and approved by the Secretary of Commerce.

### 3.1. Essential Fish Habitat Affected by the Project

The Proposed Action is the implementation of six hatchery programs in the Lower Snake River basin, as described in Section 1.3. The action area (Figure 1) of the Proposed Action includes habitat described as EFH for Chinook and coho salmon (PFMC 2003) within the areas identified below.

- Grande Ronde River basin (including Catherine Creek and Lookingglass Creek) – Chinook and coho salmon.
- Wallowa River basin (including Lostine River) – Chinook and coho salmon
- Imnaha River – Chinook salmon
- Lower Snake and Tucannon River basin – Chinook and coho salmon
- Lower Snake River – Chinook salmon

As described by PFMC (2003), the freshwater EFH for Chinook and coho salmon has five habitat areas of particular concern (HAPCs): (1) complex channels and floodplain habitat; (2) thermal refugia; (3) spawning habitat; (4) estuaries; and (5) marine and estuarine submerged aquatic vegetation. HAPCs 1-3 are potentially affected by the Proposed Action.

Because EFH has not been described for steelhead, the analysis is restricted to the effects of the Proposed Action on EFH for Chinook and coho salmon.

### 3.2. Adverse Effects on Essential Fish Habitat

The Proposed Action has small effects on the major components of EFH. The operation of the programs has the potential to affect streamflow from water withdrawals, which could affect all four of the major components above (spawning and incubation, juvenile rearing, juvenile migration corridors, and adult migration corridors).

As described in Section 2.4.2, water withdrawal for hatchery operations can adversely affect salmon by reducing streamflow, impeding migration, or reducing other stream-dwelling organisms that could serve as prey for juvenile salmonids. Water withdrawals can also kill or injure juvenile salmonids through impingement upon inadequately designed intake screens or by entrainment of juvenile fish into the water diversion structures. The proposed hatchery programs include designs to minimize each of these effects. In general, water withdrawals are small enough in scale that changes in flow would be undetectable, and impacts would not occur; however, at Lookingglass Fish Hatchery, water withdrawals during low summer flows would reduce streamflow in Lookingglass Creek. During the time of impact, adult migration is complete, spawning is complete, and most juveniles have migrated downstream. The impacts are limited to a short stretch between the hatchery intake and the effluent outfall (about 1,500 feet), and limited to a time when the major components of the EFH are not critical for the species.

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 2.4.1); the effects on coho salmon are typically much smaller, due to the species-specific nature of many of the interactions and relatively small overlap in habitat usage by the two species. Ecological effects of juvenile and adult hatchery-origin fish on natural-origin fish are small and are discussed in Sections (1)(2)(3)(4). Hatchery fish returning to the Lower Snake River basin are expected to largely spawn and rear near the hatchery and not compete for space with spring Chinook or coho salmon. Some Chinook salmon from the programs would stray into other rivers but not in numbers that would exceed the carrying capacities of natural production areas, or that would result in increased incidence of disease or predators. Predation by adult hatchery salmon on juvenile natural Chinook or coho salmon is unlikely due to timing differences and because adult salmon typically stop feeding by the time they reach spawning areas. Predation and competition by juvenile hatchery salmon on juvenile natural-origin Chinook or coho salmon is small because these fish outmigrate relatively quickly and at sizes that limit these types of interactions.

### 3.3. Essential Fish Habitat Conservation Recommendations

For each of the potential adverse effects by the Proposed Action on EFH for Chinook and coho salmon, NMFS believes that the Proposed Action, as described in the HGMPs and the ITS (Section 2.8) includes the best approaches to avoid or minimize those adverse effects in most areas. However, NMFS believes that implementing the following conservation recommendations will further reduce the likelihood of impacts on Chinook and coho salmon EFH:

1. The applicants should pursue funding to reduce flow impacts in Lookingglass Creek from hatchery withdrawals associated with program production.
2. To address the potential effects on EFH of hatchery fish on natural fish in natural spawning and rearing areas, the PFMC (2003) provided an overarching recommendation that hatchery programs, "[c]omply with current policies for release of hatchery fish to minimize impacts on native fish populations and their ecosystems and to minimize the percentage of nonlocal hatchery fish spawning in streams containing native stocks of salmonids."

In addition, the Reasonable and Prudent Measures, and Terms and Conditions included in the ITS constitute NMFS recommendations to address potential EFH effects. In abiding by the Terms and Conditions of the opinion, the applicants are implementing NMFS' EFH conservation recommendations.

### 3.4. Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, the Federal agency must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation from NMFS. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH Conservation Recommendations, unless NMFS and the Federal agency have agreed to use alternative time frame for the Federal agency response. The response must include a description of measures proposed by the agency for avoiding, mitigating, or offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with NMFS Conservation Recommendations, the Federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(k)(1)).

In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency.

### 3.5. Supplemental Consultation

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

# 4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

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

## 4.1. Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. NMFS has determined, through this ESA section 7 consultation, that operation of the six spring/summer Chinook salmon hatchery programs as proposed will not jeopardize ESA-listed species and will not destroy or adversely modify designated critical habitat. Therefore, NMFS can issue an ITS. The intended users of this opinion are the NMFS (permitting entity), and the BPA and USFWS (funding entities). The scientific community, resource managers, and stakeholders benefit from the consultation through the anticipated increase in returns of salmonids to the Grande Ronde, Imnaha, Lostine, and Tucannon Rivers as well as Lookingglass and Catherine Creeks, and through the collection of data indicating the potential effects of the operation on the viability of natural populations of Snake River steelhead and Chinook salmon. This information will improve scientific understanding of hatchery-origin Chinook salmon effects that can be applied broadly within the Pacific Northwest area for managing benefits and risks associated with hatchery operations. This opinion will be posted on NMFS' West Coast Region web site (http://www.westcoast.fisheries.noaa.gov). The format and naming adheres to conventional standards for style.

## 4.2. Integrity

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

## 4.3. Objectivity

Information Product Category: Natural Resource Plan

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

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

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

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

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