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

Mid-Columbia River Steelhead and Spring Chinook Salmon Hatchery Programs Reinitiation 2018

NMFS Consultation Number: WRCO-2018-01252 PCTS:WCR-2018-10511
(previously WCR-2017-7615)

Action Agencies: Bonneville Power Administration
U.S. Fish and Wildlife Service
National Marine Fisheries Service

Operators: Confederated Tribes of the Warm Springs Reservation, Oregon
Confederated Tribes of the Umatilla Indian Reservation
Washington Department of Fish and Wildlife
Oregon Department of Fish and Wildlife

Affected Species and Determinations:

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Mid-Columbia River	Threatened	Yes	No	No
Snake River	Threatened	Yes	No	No

Pacific Coast Salmon	Yes	Yes

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

Issued By: For Kelly L. Ames

Date: April 23, 2019

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1. Introduction

The original biological opinion (WCR-2017-7615) was signed on February 8, 2018 and covered the three Proposed Actions that are described below (this hereafter will be referred to as the February opinion). At the time that the original opinion was being completed, the Washington Department of Fish and Wildlife (WDFW), the U.S. Fish and Wildlife Service (USFWS), along with other fisheries co-managers, were developing a proposal to release hatchery spring Chinook salmon into the Touchet River to meet mitigation responsibilities under the Lower Snake River Compensation Plan (LSRCP). The details of how the proposed Touchet River Spring Chinook Salmon program would be operated were not available, and as a result, the program could not be included in the opinion completed in February. On May 10, 2018, the Touchet River Spring Chinook Salmon program was approved by the *U.S. v. Oregon* Policy Committee, and an HGMP was formally submitted to NMFS via a letter from WDFW dated May 16, 2018 (Kinne Letter 2018). Subsequently, the USFWS submitted a letter to NMFS requesting ESA section 7 consultation on their funding of the Touchet River Spring Chinook Salmon program.

The February opinion was reinitiated (WCR-2018-10511) to include an analysis of the effects of the proposed Touchet River Spring Chinook Salmon program on ESA listed species. This analysis has been added throughout the February opinion. The other hatchery programs evaluated in the February opinion (see Table 1) remain unchanged and continue to operate as proposed.

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

There are three Proposed Actions in this opinion:

(1) the funding of the Touchet River Endemic Steelhead program and the Touchet River Spring Chinook Salmon program by the U.S. Fish and Wildlife Service (USFWS).

(2) NOAA's National Marine Fisheries Service's (NMFS) decision on requests from the Confederated Tribes of the Warm Springs Reservation Oregon (CTWS), Confederated Tribes of the Umatilla Indian Reservation (CTUIR), the Washington Department of Fish and Wildlife (WDFW), and the Oregon Department of Fish and Wildlife (ODFW) for ESA authorization under limit 5 of the 4(d) rule for the operation of the Touchet River Endemic Summer Steelhead program, the Umatilla River Summer Steelhead program, and the Round Butte Hatchery Spring Chinook Salmon program (Table 1).

(3) the funding of the operation, maintenance, and monitoring and evaluation of the Umatilla River Steelhead and Walla Walla Hatchery spring Chinook programs by the Bonneville Power Administration (BPA) under the Pacific Northwest Electric Power Planning and Conservation Act of 1980, 16 U.S.C.§§ 839 et seq. (Northwest Power Act).

The USFWS proposes to fund the WDFW for the production and release of up to 150,000 summer steelhead and up to 250,000 spring Chinook salmon smolts into the Touchet River. The

BPA proposes to fund the production and release of 150,000 summer steelhead into the Umatilla River, the production and release of up to 500,000 spring Chinook salmon into the Walla Walla River and Touchet River, as well as the associated monitoring, research, and evaluation measures. NMFS proposes to issue a determination pursuant to its ESA §4(d) regulations for the tribal and state operations of some of these hatchery programs (Table 1).

This biological opinion does not predetermine the outcome of the 4(d) decision and only provides NMFS' opinion on the effects of the Proposed Action and whether it is likely to jeopardize listed species and/or adversely modify critical habitat. The CTUIR, WDFW, and ODFW are program operators and neither this opinion nor a proposed approval provides any authorization for those programs. The 4(d) rule exempts the take of salmon and steelhead listed as threatened species under the Endangered Species Act (ESA) if the entity follows a resource management plan (represented here by each Hatchery and Genetics Management Plan (HGMP)) that NMFS has determined meets the criteria under limit 5 of the ESA 4(d) rule for salmon and steelhead (50 CFR 223.203(b)(5)).

Table 1. Middle Columbia River HGMPs and the program operators.

Hatchery and Genetics Management Plan	Operator	ESA Pathway
Touchet River Endemic Summer Steelhead	WDFW	Section 4(d) Limit 5
Walla Walla Hatchery Spring Chinook Salmon	CTUIR and WDFW	Section 7
Umatilla River Summer Steelhead	CTUIR and ODFW	Section 4(d) Limit 5
Round Butte Hatchery Spring Chinook Salmon	ODFW and CTWS	Section 4(d) Limit 5
Touchet River Spring Chinook Salmon	WDFW	Section 7

1.1. Background

The Opinion and incidental take statement (ITS) portions of this document were prepared by NMFS in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531, *et seq*.), and implementing regulations at 50 CFR 402.

The NMFS also completed an Essential Fish Habitat (EFH) consultation. It was prepared 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.

The Opinion, ITS, and EFH conservation recommendations are in compliance with section 515 of the Treasury and General Government Appropriations Act of 2001 (Public Law 106-5444) ("Data Quality Act") and underwent pre-dissemination review. 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 Upper Columbia River (UCR) steelhead were listed under the ESA (62 FR 43937, August 18, 1997) and following the expiration of the previous opinion on December 31, 1998 (NMFS 1999). That opinion concluded that Federal and non-Federal hatchery programs jeopardize Lower Columbia River (LCR) steelhead and Snake River steelhead protected under the ESA and described RPAs necessary to avoid jeopardy. Those measures and conditions included restricting the use of non-endemic steelhead for hatchery broodstock and limiting stray rates of non-endemic salmon and steelhead to less than 5% of the annual natural population in the receiving stream. Soon after, NMFS reinitiated consultation when LCR Chinook salmon, UCR spring Chinook salmon, Upper Willamette Chinook salmon, Upper Willamette steelhead, Columbia River chum salmon, and Middle Columbia steelhead were added to the list of endangered and threatened species (Smith 1999).

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

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

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

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

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

Touchet River Endemic Summer Steelhead

The Touchet River Endemic Summer Steelhead program (here after Touchet Endemic) was initiated as a result of the 1999 biological opinion on hatchery programs in the Columbia River Basin (NMFS 1999). In that jeopardy opinion, an RPA stated “[t]he action agencies shall restrict the use of non-endemic hatchery steelhead and begin planning the transition to locally-adapted stocks.” The Touchet Endemic program was designed to test the feasibility of using natural-origin summer steelhead for broodstock and still be able to produce a one-year smolt by capturing and releasing adults at the Dayton Acclimation Pond (Figure 1). This ongoing program has been funded through the Lower Snake River Compensation Plan (LSRCP) administered by the USFWS to provide harvest as mitigation of the construction of hydroelectric projects on the Snake River. In 2017, an HGMP was submitted to NMFS by the USFWS with a cover letter requesting formal consultation under section 7 of the ESA for their funding of the Touchet Endemic program (Collins 2017). That same year, the WDFW submitted a letter to NMFS requesting ESA authorization under limit 5 of the 4(d) rule for the operation of the Touchet Endemic program (Kinne 2017). NMFS sent a letter to the USFWS stating that the HGMP and supporting materials provided enough information that consultation could be initiated (Purcell 2017d).

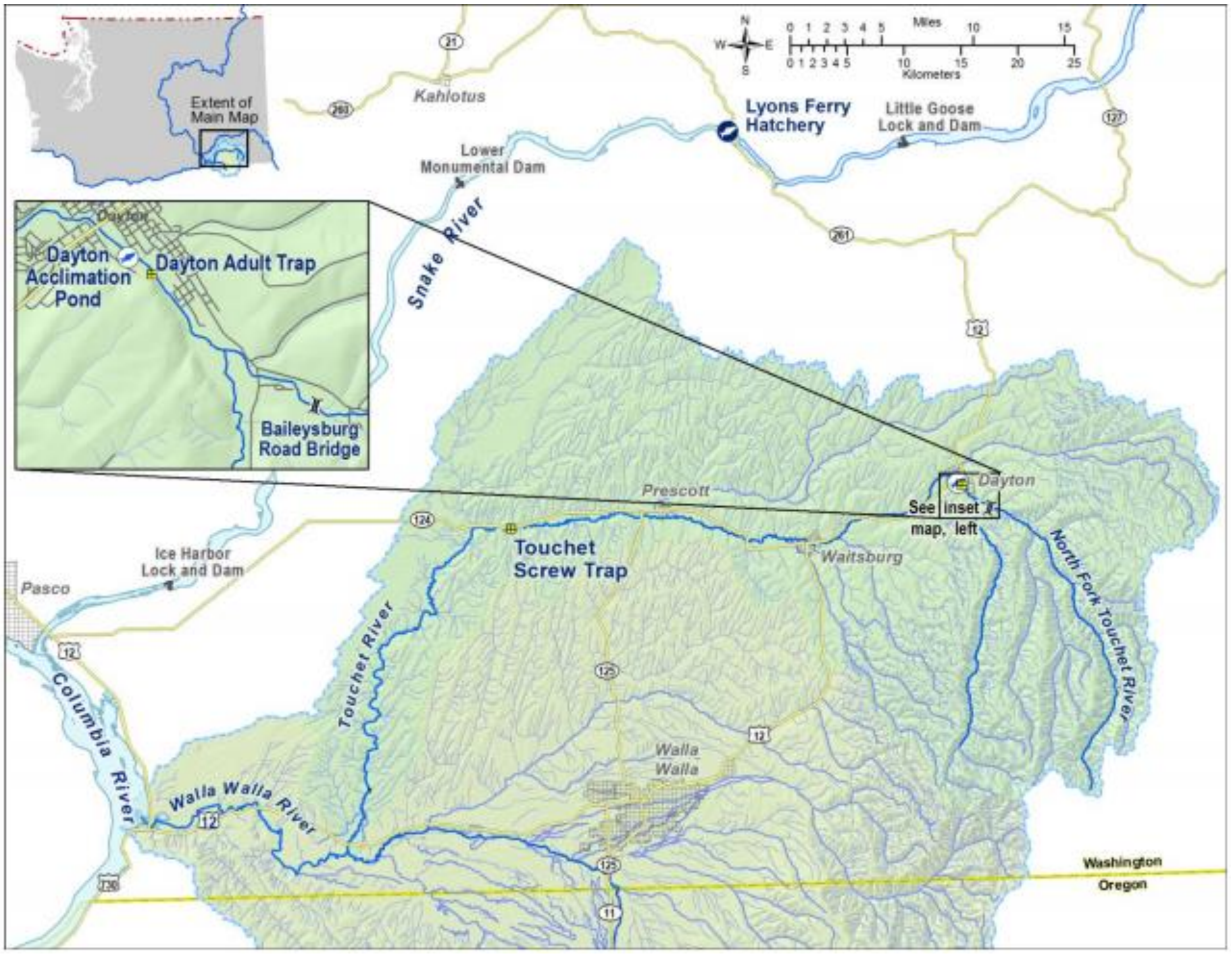

Figure 1. Map of the Lyons Ferry Hatchery (LFH) Complex and Associated Broodstock Collection, Acclimation, and Release Sites (WDFW 2015).

Walla Walla Hatchery Spring Chinook Salmon

Spring Chinook salmon in the Walla Walla River have been extirpated since the mid-1900s. In attempt to reintroduce spring Chinook salmon, hatchery adults returning to the Ringold Springs Hatchery and the Umatilla River were out-planted into the Walla Walla from 2000 to 2008 in a program funded by BPA. The South Fork out-plants were discontinued in 2009 as natural and hatchery returns to the upper Walla Walla increased. The Mill Creek out-plants have continued. Since 2005, NMFS through the Mitchell Act has funded the production and release of 250,000 spring Chinook salmon smolts from the Carson National Fish Hatchery (NFH) into the South Fork Walla Walla River. In 2017, the BPA submitted, with a cover letter, an HGMP that proposes to add incubation and rearing facilities to the current South Fork Adult Holding and Spawning Facility (AHSF) (Figure 2) to create the Walla Walla Hatchery and to replace, over time, the current production of smolts from Carson NFH with smolts, from adults spawned and reared at the Walla Walla Hatchery (CTUIR 2017a; Purcell 2017c). NMFS sent a letter to BPA stating that the HGMP and supporting materials provided enough information that consultation could be initiated (Purcell 2017c).

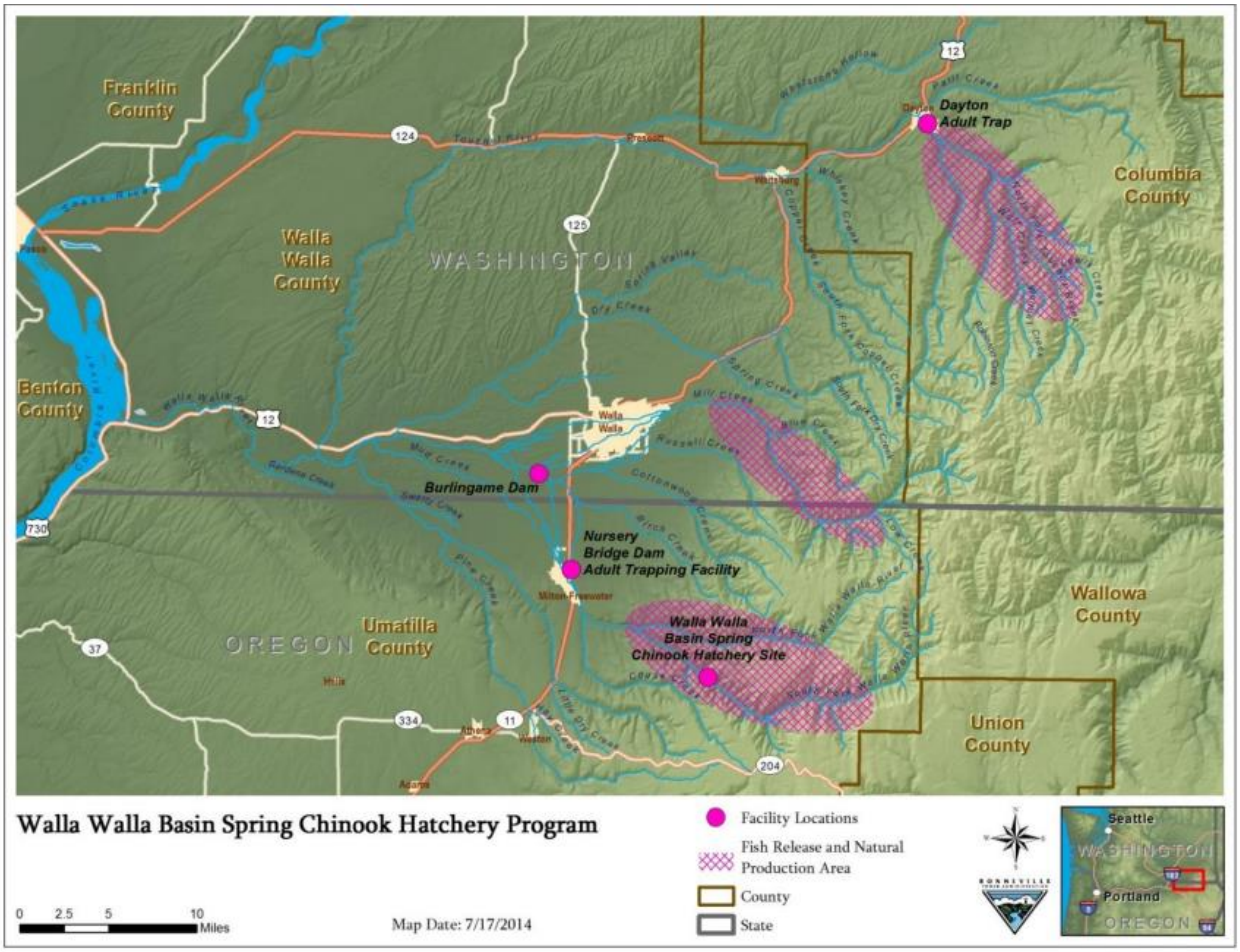

Figure 2. Map of the Walla Walla Subbasin (CTUIR 2017a).

Umatilla River Summer Steelhead

Hatchery steelhead have been released into the Umatilla River Basin since 1967, and Umatilla derived steelhead have been used since 1975. The current program at the Umatilla Hatchery began in 1991 with smolt releases beginning in 1992 and continues to use Umatilla River summer steelhead for broodstock (ODFW and CTUIR 2017). The proposed summer steelhead program is currently funded by BPA along with a spring Chinook salmon, fall Chinook salmon, coho salmon, freshwater mussel, and lamprey Research, Monitoring and Evaluation (RM&E) programs in the Umatilla River Basin (Figure 3). The salmon programs have been evaluated in previous consultations, along with evaluation of the U.S. Army Corps of Engineers' funding of a fall Chinook salmon production program and NMFS' Mitchell Act funding of coho salmon (NMFS 2011c; 2016b). In 2017, an updated HGMP was provided by ODFW in a letter along with other correspondence describing minor changes to the program (Latif 2015; 2017; Purcell 2017c). NMFS sent a letter to BPA stating that the HGMP and supporting materials provided enough information that consultation could be initiated (Purcell 2017b).

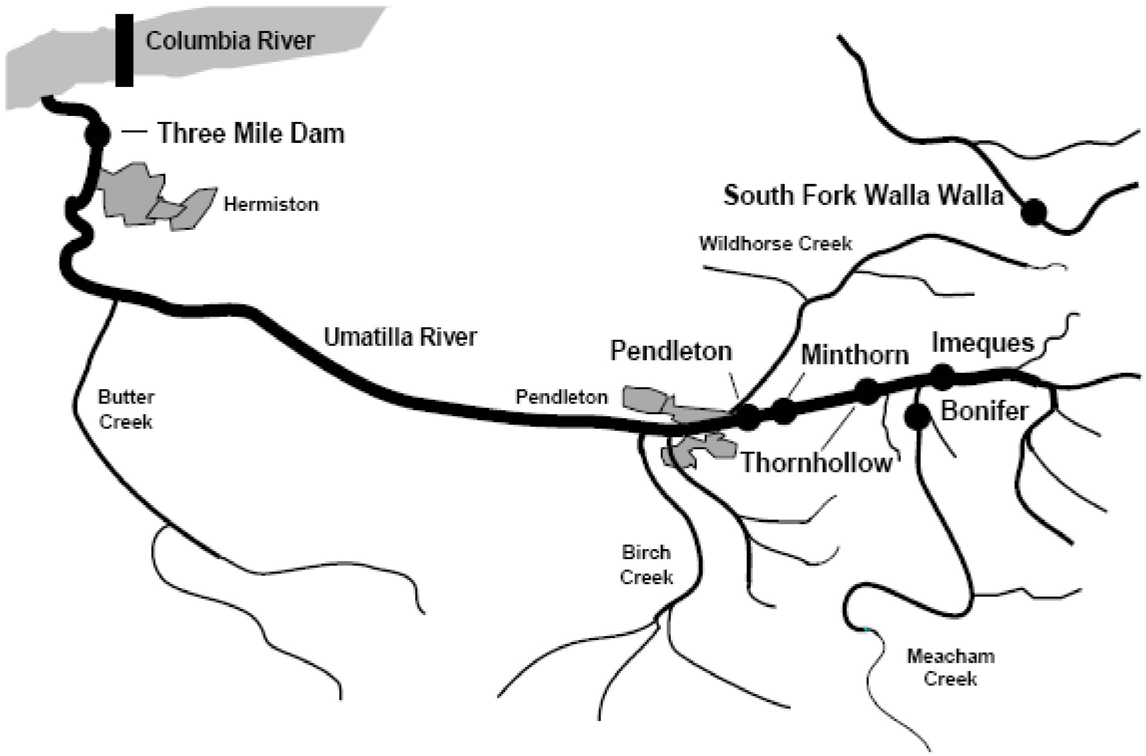

Figure 3. Map of the Umatilla River Basin (NMFS 2011c).

Round Butte Hatchery Spring Chinook Salmon

The production of spring Chinook salmon at Round Butte Hatchery (RBH) is to mitigate for lost harvest opportunities due to the construction and operation of the Pelton Round Butte Project. The RBH was constructed in 1974 after initial efforts for downstream fish passage around the Pelton Round Butte Project failed. The RBH spring Chinook salmon program is operated by ODFW in cooperation with the Confederated Tribes of the Warm Springs Reservation Oregon (CTWS); the facility is funded by Portland General Electric (PGE) and the facilities are located on PGE property below Round Butte Dam (Figure 4). In 2017, ODFW submitted an updated HGMP under a cover letter requesting concurrence under limit 5 of the ESA 4(d) rule (McIntosh 2017; ODFW 2017b). NMFS sent a letter to ODFW stating that the HGMP and supporting materials provided enough information that consultation could be initiated (Purcell 2017a).

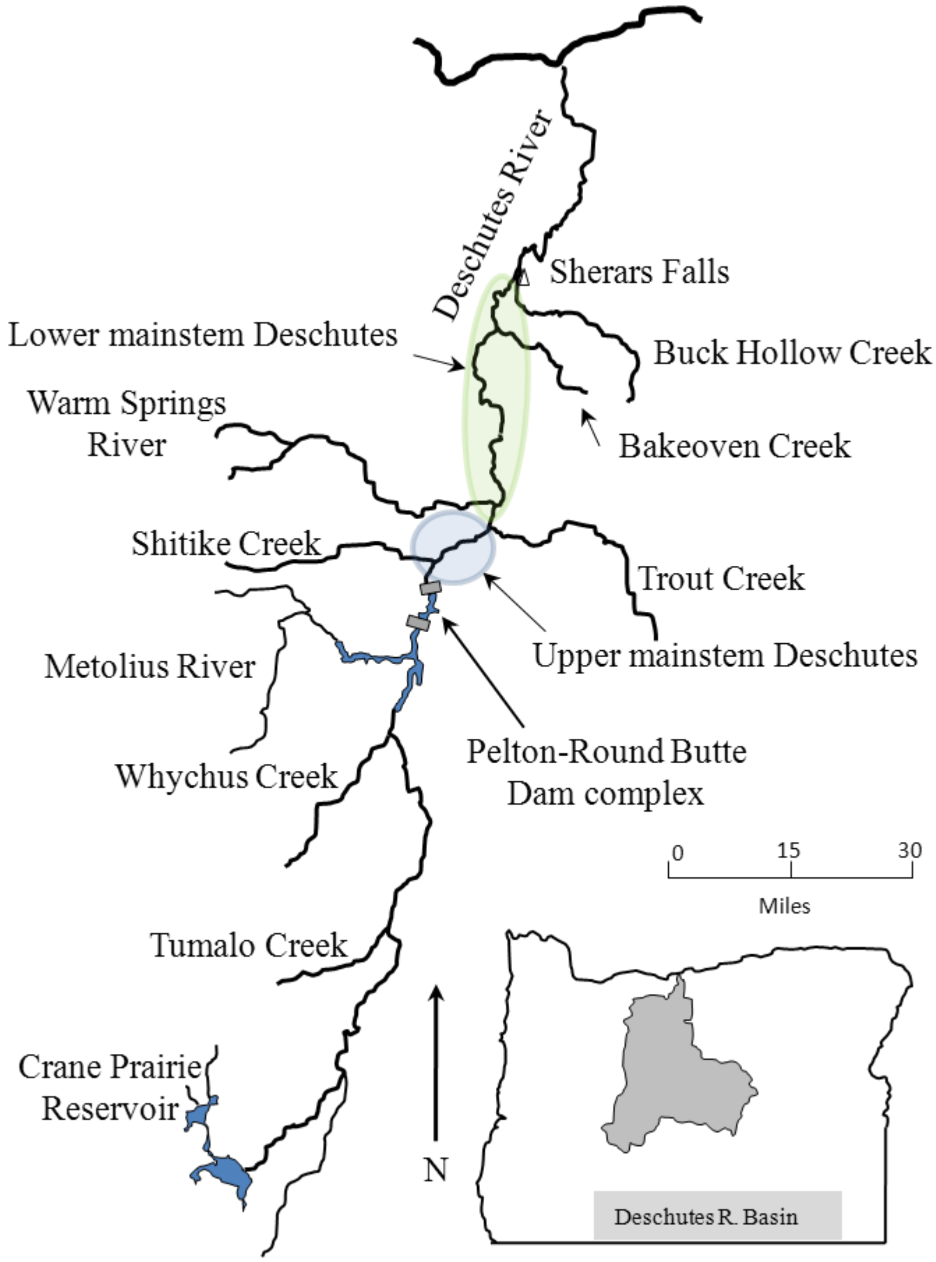

Figure 4. Map of the Deschutes River Basin (from Hawkins et al. (2011)).

Touchet River Spring Chinook Salmon

Spring Chinook salmon in the Touchet River have been extirpated since the mid-1900s. The Touchet River Spring Chinook Salmon program (hereafter Touchet Spring) is a new program that will be funded through the LSRCP, administered by the USFWS, to provide harvest as mitigation for the construction and operation of hydroelectric projects on the Snake River. Spring Chinook salmon from the Carson National Fish Hatchery (NFH) will be spawned and green eggs will be transferred to the Lyons Ferry Hatchery for incubation and rearing to smolt stage. The spring Chinook salmon smolts will then be released directly into the upper Touchet River Basin above the Dayton Adult Trap (Figure 1). In 2018, an HGMP (WDFW 2018), along with a cover letter (Kinne 2018), was submitted to NMFS by the WDFW as the operators of the program.

That same year, the USFWS submitted a letter to NMFS, referring to the HGMP submitted by WDFW, requesting formal consultation under section 7 of the ESA for their funding of the Touchet Spring program (Collins 2017). NMFS sent a letter to the USFWS stating that the HGMP and supporting materials provided enough information that consultation could be initiated (Purcell 2018).

1.3. Proposed Action

"Action," as applied under the ESA, means all activities, of any kind, authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR 402.02). For EFH consultation, "Federal action" means any on-going or Proposed Action authorized, funded, or undertaken by a Federal Agency (50 CFR 600.910). In this section we describe: the proposed hatchery programs that are part of the "Proposed Action" using information provided in the HGMPs and other correspondence and the funding of those programs by the BPA. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification (50 CFR 402.02). Interdependent actions are those that have no independent utility apart from the action under consideration (50 CFR 402.02).

The first federal action considered in the opinion is the proposal for the USFWS to fund the operation of the Touchet Endemic and Touchet Spring program.

The second federal action considered in the opinion is NMFS' determination on three hatchery programs under limit 5 of the 4(d) rule (Touchet Endemic, Umatilla summer steelhead, and Round Butte Hatchery spring Chinook salmon). Under limit 5 of the 4(d) rule, those hatchery programs that have been evaluated and received concurrence that they meet the criteria in the limit will not be subject to the take prohibitions of ESA §9 with respect to the program's take of threatened salmon and steelhead. Under limit 5, NMFS requires annual reporting on the operation of the HGMPs, the associated RM&E activities, and the status of the ESA-listed populations affected by the HGMPs, as well as a comprehensive review every 5 years. If the HGMPs and RM&E activities are not implemented as proposed or there is a change in circumstances, NMFS can reinitiate consultation on its concurrence that the HGMPs meet the 4(d) rule criteria based on information provided in the annual and 5-year comprehensive reports. All of these actions are explicitly incorporated into this biological opinion and ITS. If they do not occur or are implemented differently than analyzed here, NMFS may reinitiate consultation in accordance with its regulations.

The third federal action considered in the opinion is for BPA to fund the construction of hatchery facilities and their operation in support of the Walla Walla spring Chinook salmon program and to fund the operation of the Umatilla steelhead program, along with the operation and maintenance of associated facilities. BPA's federal action also includes research, monitoring, and evaluation in support of the Walla Walla spring Chinook program and Umatilla steelhead program; ongoing natural population monitoring in the Umatilla and Walla Walla basins, including the Touchet River basin; and lamprey and mussel research in the Umatilla River and Walla Walla River basins.

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). In this case, the Proposed Action is represented by the five HGMPs (Table 1) that propose to release spring Chinook salmon and summer steelhead into tributaries of the MCR. Approval of the five HGMPs would provide take coverage for the action agencies and underlying operators with regards to the operation of the hatchery programs in the MCR and their potential effects on ESA-listed species. Approval will also ensure that the operation of the proposed hatchery programs will be closely monitored and the effects of the programs will be evaluated and routinely reported.

The policy and scientific basis and support for developing the Proposed Action come from several different sources. Deliberations over the Proposed Action and the development of the corresponding HGMPs were timed to take advantage of several investigations that are particularly relevant to this situation, including the ESA Recovery Plan for LCR salmon and steelhead listed under the ESA (Haggerty 2015), the LCR Conservation & Recovery Plan for Oregon Populations of Salmon and Steelhead (Recovery Plan) (ODFW 2010), and a 2009 report by the Hatchery Science Review Group (HSRG) (HSRG 2009). Each of these documents describes how hatchery programs in the Walla Walla, Touchet, Deschutes, and Umatilla River Basins can operate consistent with the conservation of listed salmon and steelhead. Other information cited in the HGMPs includes, Oregon's Native Fish Conservation Policy (ODFW 2003c) and Fish Hatchery Management Policy (ODFW 2003a) and the HRPP (CTWSR 2009).

Fisheries are not part of the Proposed Action and those fisheries that do occur in the basins where the fish are released under the Proposed Action will be operated under Fisheries Management and Evaluation Plans (FMEP) (NMFS 2003b; 2008c).

1.3.1. Touchet Endemic Steelhead

There are two goals for the Touchet River Endemic Stock Summer Steelhead program: (1) to provide mitigation as specified under the LSRCP by providing harvest opportunities established under *U.S. v. Oregon* for tribal and recreational fisheries; and (2) to provide a conservation benefit by having program adults contribute to the naturally spawning population to produce viable progeny that will contribute to the conservation and recovery of the Touchet River population of the MCR Distinct Population Segment (DPS).

Overview of Touchet Program

Currently, there are two hatchery steelhead programs operated in the Touchet River, one is a long-standing harvest mitigation program that has been in operation since the early 1980's, and has used out-of-basin hatchery stocks (either Lyons Ferry or Wallowa) to provide fish for harvest. The other has been a test program in operation since 2000, which utilizes natural-origin fish for broodstock. The testing of this program involves the feasibility in collecting broodstock, and producing a fish with high enough survival to return as adults, with the goal of replacing the out-of-basin stock with the Touchet Endemic program utilized for harvest mitigation in the future. The Touchet Endemic program is still under evaluation by the managers. Presented in the paragraphs below is more detail for each program.

The LSRCP (through the U.S. Fish and Wildlife Service) currently funds production of mitigation fish that are released into the Touchet River from the Lyons Ferry Hatchery (LFH). For the LSRCP harvest mitigation program, the expected return is typically about 750 fish annually, and was derived from current release number and mean survival to returning adult. The previous LFH stock, or the current Wallowa stock summer steelhead used for these harvest mitigation releases, were derived from steelhead endemic to the Touchet Rivers, but derived from other established hatchery programs outside the Touchet River.

The LSRCP summer steelhead program in Washington has been operated since 1983 to provide harvest mitigation for the construction of the four lower Snake River dams. Transference of a portion of that mitigation to the Walla Walla/Touchet basin was deemed acceptable by fishery managers in the early 1980's because of the loss of fishing opportunities created by the dam impoundments. Prior to 2001, all hatchery steelhead production released into the Touchet River came from the LFH stock steelhead (Schuck et al. 1998), which was replaced in 2013 with Wallowa stock, with releases in both the Walla Walla and Touchet rivers as off-site, out-of-basin harvest mitigation (WDFW 2013). An April 1999 biological opinion issued by NMFS determined that the continued use of non-endemic steelhead stocks (such as LFH) in the MCR steelhead DPS jeopardized the continued existence and chance of recovery of natural steelhead populations within the Columbia River. NMFS recommended investigations into the development of endemic stock programs to replace the use of non-endemic hatchery production. The Touchet River Endemic Summer Steelhead program was initiated in 2000 with a goal to evaluate the potential to use endemic summer steelhead as broodstock to develop a program that could eventually replace the previous or current releases of LFH/Wallowa stock summer steelhead in the Touchet River. Currently, 100,000 Wallowa stock summer steelhead are reared at LFH and acclimated and released at the Dayton Acclimation Pond facility (Dayton AP)(Figure 1), down from previous releases of 125,000 smolts annually, but up slightly (15,000 more) following 2017 consultations with NMFS. The release of the Wallowa stock summer steelhead from LFH was considered in separate biological opinions (NMFS 2007; 2017d) and will not be considered in this opinion.

WDFW identified that even though a hatchery stock based on endemic steelhead from the Touchet River for mitigation may not increase natural productivity, it will serve several other purposes, including providing harvest mitigation while complying with the Reasonable and Prudent Alternative described in the 1999 opinion, and maintaining or increasing the abundance and productivity of naturally reproducing Touchet River steelhead. This program may also assist in the long-term preservation of the Touchet River steelhead population to support recovery while other limiting factors are addressed in the basin. It would also minimize the potential for genetic introgression and depression that may occur with the continued use of Wallowa stock summer steelhead currently used for harvest mitigation.

The original production goal based on the 2000 proposed program was to release 50,000 endemic program smolts into the upper watershed above the trap at Dayton, Washington. The actual number released annually could exceed 50,000 if fecundity and survival are greater than expected. The production has not been adipose fin-clipped, but would be if the program was deemed successful and the program was expanded to full production (up to 150,000 smolts) to allow for harvest.

In the November 6, 2015, HGMP, the program will continue to be operated as an "integrated" program with the intent to minimize the genetic and reproductive fitness differences between the locally derived hatchery broodstock and the naturally spawning population. WDFW is working with the tribal co-manager CTUIR to be consistent with the *U.S v. Oregon* Agreement. At the time of the HGMP submission, the program had been operated with the production goal of 50,000 smolts direct stream-released at the Baileysburg Bridge, located about 2.5 miles above the adult trap in Dayton, Washington (Figure 1). At full implementation, direct stream releases may continue to occur here in the future. The program could be expanded up to 150,000 juveniles in the future if survival and rearing facility capacities increase, but what the full program size would be is still under discussion and the Proposed Action is limited to the 50,000-smolt production level.

Specific changes to the program have been identified in this 2015 HGMP compared to previous submissions and these include:

1) Testing performance (survival), both in-hatchery and post-release, on two groups of Touchet endemic stock steelhead beginning with the 2015 brood (2016 release). The two groups being tested are derived from either natural-origin x natural-origin (NxN) crosses, or natural-origin x Hatchery (NxH) crosses. WDFW will operate the program such that the two groups are relatively equal in size so that rearing densities are similar for each group that will be reared in separate ponds. To accomplish this, WDFW will collect 6-8 hatchery-origin females (first generation returns from the endemic program) and 6-8 natural-origin females for broodstock. All males used in the broodstock will be natural-origin. Overall, about 25% of the broodstock will consist of first generation hatchery-origin fish from the Touchet endemic stock program, with about ½ of the resultant juveniles having hatchery-origin parentage.
2) Each study group will receive 5,000 PIT tags for monitoring juvenile downstream migration success, but will be primarily used to estimate adult returns to McNary Dam, or into the Touchet River at instream PIT tag arrays.
3) In the past, all smolts from this program were released into the North Fork Touchet River. Beginning in 2016, all smolts (from each study group) were and will be released from the Dayton AP. Depending on their size during the spring months prior to release, smolts from this program will be mixed in with the Wallowa stock smolts in April during the last period of their acclimation, or will be put in the Dayton AP immediately following the release of Wallowa stock steelhead. It is anticipated that the Touchet endemic stock will generally have about a 2-3 week acclimation period.

The program goal of 50,000 smolts would generally require 36 adults, consisting of a mixture of up to 25% hatchery endemic and 75% natural-origin to fulfill study needs (Table 2). From 2000 to 2014, no hatchery fish were used in the broodstock, but beginning in 2015, 25% of the broodstock has consisted of returning Touchet endemic stock. Equal sex ratios in the spawning population were originally identified as a goal for the program. However, having enough ripe males to spawn with ripe females was difficult. Further, fecundity has generally been greater than originally planned. In the AOP for the LFH (WDFW 2017), the goal is to collect 16 females and 20 males for the program and to use a matrix-type spawning protocol, (2x1; two males to every female), to increase the effective breeder population (Nb) due to the relatively small founding population for this program, and to increase the hatchery population diversity. If not enough males are ripe to achieve this goal, 1:1 spawning is employed. Additional males are generally collected, or live spawned and released at the Dayton Adult Trap (DAT) to ensure adequate males are available on spawning days.

Broodstock collection occurs at the DAT at river mile (RM) 53.3 on the Touchet River within the city of Dayton, Washington. The DAT is at the top of the adult ladder that provides passage over the dam used to supply water to the Dayton AP. Trapping of Touchet River endemic stock generally begins in January or February (depending on seasonal weather) and is generally completed by early May. The trap continues to be operated into late September or early October depending on when leaf debris prevents the operation of the trap. At this time the trap is open to allow for free passage. During broodstock operations up to 800 NOR summer steelhead could be encountered at the DAT annually.

Table 2. Natural-origin adults collected and retained for broodstock, the number of adults spawned, effective population size and smolts produced; NA = not available. Note that beginning with the 2015 broodyear returning endemic program hatchery fish were incorporated into the broodstock.

Brood Year	Collected Adults		Spawned Adults		Effective Population Size	Eggs Collected	Smolts Produced
	Female	Male	Female	Male			
2010	18	17	15	13	28	75,596	62,037
2011	14	20	12	13	25	74,408	54,386
2012	18	14	17	13	29	81,555	38,726
2013	15	15	10	8	18	65,469	49,523
2014	16	16	14	15	29	63,758	48,711
2015[1]	16	16	15	14	29	63,582	47,675
2016[1]	16	16	16	12	27	65,207	NA

[1] Eight hatchery-origin females were collected and spawned for both of these years.

Captured fish are crowded to one side of the holding area, netted, and placed in 8in PVC pipe (top third cut away). Each end of the PVC pipe has been fitted with aluminum plates, which are provided with 60V max electrical current (electro-narcosis). After origin has been determined (natural, endemic broodstock, or hatchery Wallowa stock), the fish are either collected for broodstock, passed upstream, or removed from the river (Wallowa stock only). Some natural-origin returns may have scales and DNA samples collected from them before release. Fish collected for broodstock are PIT tagged in the dorsal sinus for identification and to assist in the tracking of matings in the broodstock, mainly because there have been times when males were used multiple times. PIT tagging allows WDFW to better manage the number of times individual males are used.

The program initially began with collection of fish throughout the run. However, it soon became apparent that the extended and late spawn timing was creating difficulties in the hatchery rearing cycle (one-year smolt program). Currently, the broodstock are collected over a three-week time period near the middle of the run (mid-March to first week in April).

All trapped Wallowa stock fish are: (1) transferred to the Dayton Juvenile Fishing Pond to remove them from the river and provide additional fishing opportunities within Dayton, (2) sacrificed for CWT retrieval, and/or (3) donated to a local food bank. The number of natural-origin summer steelhead encountered at the trap during broodstock collection activities varies from year to year and has averaged 197 adults in recent years (2011-2015) with a maximum of 601 handled in 2009. Those adults retained for broodstock are transported to LFH for holding and spawning. The effects on ESA-listed species from the operation of the LFH has been evaluated in a separate consultation (NMFS 2017d) and will not be considered in this opinion.

Historically, fish have been reared at LFH through mid-April, at which time all of the endemic progeny have been transported to the Touchet River upstream of Dayton and released directly to the NF Touchet River. Some releases may still occur upstream of the trap to ensure some hatchery-origin fish return to the trap location. Beginning in 2016, a 2-3 week acclimation/volitional release period has been/will be used on the Touchet endemic stock steelhead. Depending on their size during the spring months, fish will be brought into Dayton AP two to three weeks prior to the completed release of Wallowa stock smolts in April, and will be released as part of that group. Acclimation occurs with Touchet River water, which will provide the chemistry and temperature regime of the Touchet basin prior to out-migration. The operation of the Dayton AP and its effects on ESA-listed species was considered in a separate consultation for the Wallowa stock program (NMFS 2017d).

Under the current program, 100% of the smolts are coded-wire tagged, but none are externally marked. In addition, a portion (about 5,000) from each NxN or NxH study group will be PIT tagged to evaluate downstream migrant success, but more importantly, adult returns from each group. If the program is expanded in the future, WDFW would propose that 100% of these would be adipose fin clipped for harvest opportunities; with a portion of the annual release continuing to receive CWT's and PIT tags. Future marking and tagging levels will be negotiated with the CTUIR.

Monitoring and evaluation activities

To determine the distribution of salmonids, their relative abundance, and stock status in the Walla Walla River Basin, WDFW has proposed a number of activities described below. Take of ESA-listed MCR steelhead from these activities is summarized in Table 3 (NMFS 2017f).

Coppei, Patit, and Dry Creek Adult Traps

In addition to the broodstock collection activities at the DAT, WDFW may also install temporary adult traps in Coppei Creek and Patit Creek, smaller tributaries to the Touchet River that run through either the city of Waitsburg, about 10 miles below the city of Dayton (Coppei), through the city of Dayton (Patit), or through the city of Dixie (Dry Creek flows into the Walla Walla River). All fish captured in these traps will be sampled for origin, sex, fork length, any marks/tags, scanned for PIT tags and released. Scales will be collected from all fish that appear to be of natural-origin. Any ADLV+CWT or AD+CWT fish (most likely Wallowa Stock) will be immediately sacrificed for retrieval of the coded wire tag information. Based on previous information, WDFW fish management staff anticipates that, annually, up to 200 and up to 50 steelhead may return to Coppei Creek and Patit Creek, respectively. Because trapping has never occurred in Dry Creek, WDFW is unsure how many may be captured on an annual basis, but believe it will be less than 100 fish. Depending on stream flows, the traps may be disabled for periods of the trapping season; hence it is unlikely that all returning steelhead to Coppei, Patit, or Dry Creeks will be trapped/handled.

Rotary Screw Trapping and PIT Arrays

The Co-managers will operate a smolt trap on the Touchet River to: 1) Estimate the number, timing, and age composition of natural-origin steelhead smolts emigrating from the river, and 2) allow downriver migration comparisons between natural and hatchery-origin fish by PIT tagging nearly all natural-origin steelhead captured at the smolt trap (>70mm). In addition, estimated smolt-to-adult survival will be calculated for both natural and hatchery-origin fish, along with estimating total adult returns to Bonneville Dam, McNary Dam, and to the Touchet River (based on instream PIT tag Arrays). If possible, returns to the Touchet River will be broken out by location and origin as determined by PIT Tag Arrays. Currently, there are three instream arrays in the mainstem Touchet (Harvey Shaw Rd., Bolles Bridge, and just below DAT), with two additional arrays at the mouths of Coppei and Patit Creeks. In addition to steelhead juveniles, spring Chinook salmon juveniles collected at the screw traps will also be PIT-tagged.

Juvenile Abundance and Distribution

In the future quantitative and qualitative surveys may be used to estimate the total abundance of steelhead and spring Chinook salmon juveniles within a specific section of stream. Qualitative sampling would be used at a number of sites to determine the presence, size of fish (age class) and their relative abundance. Collected fish are anesthetized and the following information is collected: identification (genus species), fork length, scale and/or genetic samples, and any notation on marks and tags. Electrofishing, hook and line sampling using barbless hooks and no bait, and beach seines may be used to supplement species distribution and abundance data, for tagging purposes, or for genetic sampling. These methods may also be used in the future to increase the number of PIT tagged natural-origin juveniles.

Spawning Ground Surveys

The Co-managers will conduct spawning ground surveys to estimate the number of redds and spawners, and use trapping data to estimate the proportions of natural, endemic brood hatchery, and other hatchery-origin steelhead in the spawning population. Spawning ground surveys typically are done in the North, South, Wolf, and Robinson forks above the city of Dayton. Surveys have also been conducted in Coppei and Patit creeks, but on a less regular basis. The Co-managers will also conduct spring Chinook salmon spawning ground surveys in the Touchet River Basin to estimate total redds, redd distribution, fish per redd, sex ratios, age composition, size frequency, spawn timing, and smolts per adult as part of the Walla Walla Spring Chinook Salmon program.

Spawned steelhead adults (kelts) and carcasses returning to the weirs will be sampled (length, sex, origin, etc.). These fish will be checked for opercle punches (or other marks) that were given to upstream migrating fish and are used for mark-recapture estimates. Any downstream migrating fish that did not pass upstream through the trap will be sampled including length, sex, origin, scanned for CWT and PIT tags, and will have tissue (for genetics) and scale samples collected.

Freshwater Mussel Research

Freshwater mussel research activities in the Touchet River are part of the Freshwater Mussel Research and Restoration project (2002-037-00), and include surveys to identify and monitor remaining freshwater mussel populations, the potential collection of freshwater mussels for broodstock and/or genetic analysis, and survey, salvage and translocation efforts associated with in-channel restoration work. These activities may encounter adult and juvenile steelhead (CTUIR 2017b) though no physical handling of ESA-listed species would be expected to occur. However, fish may be observed during surveys and disturbed by in-water activities. Freshwater mussel surveys are conducted as visual surveys by snorkeling or wading methods, avoiding redds and spawning fish, and typically do not occur in deeper pools that may serve as salmonid habitat refugia. The number of ESA-listed steelhead that could be encountered for these activities is provided in Table 3.

Table 3. The number of natural-origin Middle Columbia River summer steelhead adults and juvenile *O. mykiss*[1] encountered, sampled, tagged, and associated mortality during broodstock collection and monitoring and evaluation activities in the Touchet River Basin.

	Adult Steelhead				Juvenile *O. mykiss*				
Activity	**Encountered**	**Sampled**	**Tagged**	**Mortality**	**Encountered**	**Sampled**	**Tagged**	**Mortality**	**Notes**
Dayton Adult Trapping	800	800	800	16					
Retained for Broodstock		28	28	4					
Touchet Endemic Adults	150	150							
Retained for Broodstock		15	15	3					
Coppei Creek Trapping	200	200	200	4					
Patit Creek Trapping	50	50	50	1					
Dry Creek Trapping	100	100	100	2					
Rotary Screw Trapping									
Touchet River	20	20	0	1	12,000	12,000	8,000	360	
Juvenile Abundance									
Electrofishing					2,500	2,500	2,500	75	
Hook and Line					150	150	150	2	
Beach Seine					1,000	1,000	1,000	10	
Redd Surveys (observed)	200			0					
Freshwater Mussel Research					50	0	0	1	
Totals	1,370	1,170	1,150	28	15,650	15,650	9,650	448	

[1] Juvenile rainbow trout and anadromous juvenile steelhead cannot be easily distinguished, so the genius and species name (*O. mykiss*) is used.

1.3.2. Umatilla River Summer Steelhead

The original goals for the Umatilla River Summer Steelhead Program were:

1. Enhance production through supplementation of hatchery produced fish using 100% natural-origin (NOR) broodstock (pNOB);
2. Provide sustainable tribal and non-tribal harvest opportunities (augmentation); and
3. Maintain the genetic influence of the natural population (PNI >0.67) over hatchery produced fish (pHOS<0.33) in the natural spawning grounds above Three Mile Falls Dam (TMFD).

These were the goals of the program until brood year 2014 when instead of using 100% NOR steelhead for broodstock, returning hatchery summer steelhead were incorporated into the broodstock. Under the current proposal, returning Umatilla River hatchery summer steelhead will be incorporated into the broodstock at a rate of no more than 33% of the actual spawners and there would be no hatchery x hatchery crosses (Latif 2015).

The Umatilla River Summer Steelhead Program is currently funded by the BPA as part of a larger group of hatchery programs (spring Chinook, fall Chinook, and coho salmon) within the Umatilla River Basin funded by the BPA, the U.S. Army Corps of Engineers (Corps), and NMFS through the Mitchell Act (NMFS 2016b; 2017e). Hatchery steelhead from a number of different sources have been released into the Umatilla River since at least 1967, with releases of fish originating from the Umatilla River beginning in 1975. It was in 1991 that the program switched to 100% NOR adults for broodstock and this continued until the program was adjusted in 2014. Umatilla Hatchery summer steelhead were also retained from 1991 through 2007-08 to ensure that enough adults were available to meet broodstock goals. Because of concerns with hatchery strays from other basins being incorporated into the broodstock beginning in 2004, only Umatilla Hatchery steelhead identified by a coded-wire tag (CWT) have been used for broodstock.

The annual production goal for the program is 150,000 smolts, which generally requires up to 110 adults for broodstock. Beginning with the 2014 brood, the program collects 70 natural-origin adults and 40 Umatilla River hatchery adults. Note that extra adults are collected to ensure that enough fish are ripe at the time of spawning. To ensure that non-Umatilla River hatchery adults are not used for broodstock, only Umatilla Hatchery CWT hatchery adults will be used. Any natural-origin adults not used for broodstock will be outplanted in Meacham Creek and the hatchery adults will be sacrificed to collect the CWTs. The broodstock goals are to collect healthy, naturally produced adults, from across the run based on arrival at the TMFD collection facility (Figure 3), collect males and females at a one-to-one ratio, and collect one-salt[2] and two-salt adults at the same ratio as observed in the returning adults.

Broodstock collection occurs at the TMFD. Broodstock will be collected from September through mid-April. Beginning in December, adults returning to TMFD are trapped for five days and allowed to volitionally migrate for nine days. Broodstock are collected during the five day

[2] A one-salt is an adult that has spent one year in the ocean before returning and two-salt is an adult that has spent two years in the ocean before returning.

trapping periods. Monthly collection rates are established prior to the return season by averaging the monthly return percentages over the last five years. The proportion of one-salt and two-salt adult returns is monitored continuously throughout the season and a similar proportion of one-salt and two-salt adults are selected for brood. Determinations of one-salt and two-salt adults are based on a fork length of less than and greater than 26 inches, respectively. The 1:1 male to female ratio in the brood is not representative of the ratio in the total return. Females generally make up 60-70% of the total run in recent years.

Adults returning to TMFD ascend a vertical slot fish way ladder, but are precluded from swimming upstream by use of a barrier gate at the top of the ladder. Adults then ascend a Denil steep-pass fishway and fall into an adult holding pond where they are trapped. Disposition of the fish trapped generally occurs daily in order to minimize upstream passage delays. During periods when few adults are being trapped, adults may be held up to 72 hours. During handling operations, all adults are anesthetized with CO_2 to minimize stress. Mortality of listed steelhead can occur during the holding and handling operations at TMFD. Over the last eight years, average annual mortality at the facility has been 0.074% with a range of 0.00%-0.23%.

Adults are transported and held until spawning at the Minthorn Adult Holding facility (Figure 3), and spawning occurs from late March to late May. Males and females are spawned separately and the gametes are shipped to Umatilla Hatchery. The gametes are generally mixed one male to one female and a 3 x 3 spawning matrix is utilized whenever possible and matings are random. When only two females are available, a 2 x 2 matrix is used and when only one female is available, the eggs are fertilized with the milt from a single male. Each 1 x 1, 2 x 2, or 3 x 3 cross is considered a single-family group.

The eggs are incubated and the resulting juveniles are reared at the Umatilla Hatchery. The juveniles are reared on station until late March and then two groups of 50,000 juveniles are shipped to the Pendleton Acclimation Pond. The third group of 50,000 smolts are acclimated at Thornhollow (RM 73.5) in late April. The acclimated groups (Pendleton AP and Thornhollow) are released in late April at 4.5 fpp. The acclimated groups are allowed to volitionally release for the final week of holding and then, at the end of the release period the ponds are lowered and the remaining fish are crowded out.

All (100%) hatchery steelhead released into the Umatilla River are adipose fin clipped. Program goals are evaluated by annually tagging 40% of each release group with CWT (20,000 fish in each group of 50,000). In addition, 1,500 juveniles in each release group of 50,000 are PIT-tagged to monitor out migration timing, survival, and straying.

The effects on ESA-listed species from the operation and maintenance activities associated with the TMFD facilities, the Umatilla Hatchery, and the acclimation ponds were considered in previous consultations (NMFS 2016b; 2017e) and will not be considered in this opinion. However, the operation of the Minthorn Springs Adult holding facility will be reconsidered in this opinion to ensure that all effects were considered.

The Minthorn Springs facility is located on Minthorn Springs Creek. The creek is approximately one mile long with the facility located near the mouth at approximately Umatilla RM 64.

Minthorn Springs receives its water from Minthorn Springs Creek, which is formed from the inflow of several springs located immediately south of the Umatilla River. Water flowing through the brood holding area is supplied by gravity and ranges from approximately 500 to 2,100 gpm. During the summer steelhead adult holding period (mid-September to late May), average monthly water temperatures range from approximately 7 to 13°C (45 to 55°F). High sediment loads are experienced in some years during high flow conditions. The location of the Minthorn Springs facility blocks approximately 200ft of habitat in Minthorn Springs Creek that might be utilized for spawning and rearing. Summer utilization for rearing is limited, however; flows are as low as 500 gpm and temperatures often exceed 20ºC (68ºF) during the period of June to September, making conditions not conducive to rearing.

Monitoring and Evaluation Activities

The effects of the monitoring and evaluation activities within the Umatilla River Basin on MCR steelhead were considered previously in the 2011 Biological Opinion (NMFS 2011c) and determined not to jeopardize the continued existence of the MCR Steelhead DPS. NMFS is re-evaluating these activities to address changes in the projects and to evaluate new projects including research on freshwater mussels and lamprey in the Umatilla River. The descriptions of the RM&E activities are based on the statements of work for the following projects: ODFW's Evaluation of Juvenile Salmonid Outmigration and Survival in the Lower Umatilla River Basin project (#1989-024-01), CTUIR's Umatilla Basin Natural Production Monitoring and Evaluation project (#1990-005-01), the Pacific Lamprey Research and Restoration Project (#1994-020-00), Freshwater Mussels in Umatilla and John Day (2002-037-00), and The Fish Passage Operations project (2000-033-00).

ODFW also conducts evaluations of the hatchery programs under the Umatilla Hatchery Monitoring and Evaluation project (#1990-005-00) with the goal of comparing rearing performance, smolt condition, juvenile migration performance, and smolt-to-adult survival for steelhead released at the different acclimation facilities. Similar evaluations are also conducted on the fish from the fall Chinook salmon yearling and subyearling programs and the spring Chinook salmon program. ODFW will also conduct fish health monitoring activities that include monthly and pre-liberation evaluations. All of these activities occur within the hatchery and are not expected to impact ESA-listed steelhead.

Three Mile Falls Dam Collection Facility

The TMDF adult collection facility is operated on a daily basis from August 16 until approximately December 1st. During this time period, the facility is operated to collect fall Chinook, coho salmon, and summer steelhead broodstock and to enumerate and record biological data on all returning salmonids. All adults collected are anesthetized with CO_2. Fish not collected for broodstock are transferred to recovery tanks prior to release back into the Umatilla River.

Beginning around December 1st, the trapping facility is generally operated for five days and is then closed for nine days. Returning adults are allowed to volitionally migrate upstream when the trap is not being operated and adult returns are video-enumerated. During this time period, the trap is operated to collect summer steelhead and spring Chinook broodstock and to collect biological data. Trapping and transportation of all salmonids is implemented in the spring when passage flow criteria of at least 150 cfs for 30 days after release cannot be met. The trap is generally not operated from July 15 to August 16. During broodstock collection and monitoring operations at the TMFD facility, up to 3,500 adults, may be sampled and/or handled (Table 4).

Juvenile Outmigration (ODFW)

In cooperation with CTUIR, ODFW monitors juvenile outmigration in Birch Creek and the lower Umatilla River at Three Mile Falls Dam. This project is designed to collect data to determine smolt abundance and survival, smolt-to-adult survival, egg-to-smolt survival, and smolts-per-spawner that can be tracked through time and will provide data to estimate Viable Salmonid Population (VSP) parameters for ESA-listed populations.

Smolt outmigration will be monitored using a rotary screw trap (RST) operated at the mouth of Birch Creek from December through June and using an inclined plane trap in the juvenile bypass facility within the West Extension Canal at TMFD between March and June. Captured fish will be identified by species, race, and origin. In addition, biological data (length, weight, condition, and health) will be collected from natural-origin summer steelhead. Fish will be examined for marks and tags and unmarked summer steelhead will be given a PIT tag. Up to 9,000 juvenile natural-origin steelhead will be PIT-tagged annually (Table 4). ODFW will also operate and maintain the PIT tag detection system at TMFD. Currently, there are arrays in both the juvenile bypass and adult fishway at TMFD.

Spawning Ground Surveys

ODFW and the CTUIR will conduct steelhead redd surveys for the Umatilla River steelhead population using standard ODFW methods and a Generalized Random-Tessellation Stratified (GRTS) sampling design. A minimum of 25 sites will be selected annually and visited on a bi-weekly basis. Redds will be counted and spatially referenced. Steelhead surveys are not needed to estimate abundance which is determined at TMFD, but are used to evaluate habitat improvement projects, comparing redd distribution and density between treatment and control sites. The CTUIR also conducts steelhead redd surveys at legacy index sites to maintain long term trend data (non GRTS sites).

Spring Chinook, fall Chinook, and coho salmon redd surveys are conducted to monitor redd distribution, and pre-spawning mortality. To determine age, growth, and life history characteristics for natural-origin salmon and steelhead, scales will be collected from 250 natural-origin salmon and 120 natural-origin steelhead either from fish retained for broodstock or natural spawners (Table 4).

Adult Passage Evaluations

Passage conditions below TMFD, the falls above Chinaman's Hole, and potentially other locations in the basin will be evaluated using radio tagged and PIT tagged coho and fall Chinook salmon. No steelhead will be radio tagged as part of this evaluation.

Juvenile Outmigration (CTUIR)

In cooperation with the outmigration monitoring conducted by ODFW, the CTUIR will capture and PIT tag steelhead emigrating from Meacham Creek and the Umatilla River above the mouth of Meacham Creek. The monitoring will provide abundance estimates of steelhead leaving those watersheds. RSTs will be used to collect outmigrating juveniles. Data collected will include species, length, fish condition, sex if known, and weight. The goal is to PIT tag up to 7,000 steelhead juveniles. The traps will be operated from September through May and possibly into June, if flows allow. Low flows may stop or delay trapping before the end of May and the resumption of trapping in September. Several adult kelt steelhead may be encountered during the operation of the RSTs (Table 4).

Pacific Lamprey Research

To monitor the outmigration of larval and metamorphosed lampreys, an RST will be operated from October through May (CTUIR 2017c). The trap will be located at RM 1.9 on the lower mainstem Umatilla River. The trap will be operated 24 hours per day and checked twice a day by CTUIR personnel. Any ESA-listed steelhead will be identified to life stage, enumerated, weighed or measured, and released immediately below the RST. The number of ESA-listed steelhead that could be encountered is provided in Table 4.

To monitor larval abundance and distribution annual electro-fishing surveys will be conducted in 40 index sites within the Umatilla River Basin. In addition, genetic samples of lamprey will be collected and analyzed. Areas targeted for sampling will be Type I habitat that primarily consists of margins, backwaters, alcoves, and side channel habitat that are highly comprised of sand/silt. The Advanced-backpack electro-fisher 2 (AbP-2) will be used to sample lamprey habitat. Settings will be 125-volts, 3-pulse per second with a 25% duty cycle. Sampling rate will be 90 sec/m2. Any ESA-listed steelhead will be identified to life stage, enumerated, weighed or measured and released immediately. The number of ESA-listed steelhead that could be encountered is provided in Table 4.

Adult Pacific Lamprey spawning ground surveys will be conducted weekly from May-July annually in the upper basin. Surveys are not needed to estimate abundance as adult enumeration is conducted at Three Mile Falls Dam. Redds will be enumerated and geo-referenced. Surveys are conducted from RM 76 to 89.5 in the Umatilla River and from RM 3-11.5 in Meacham Creek. The number of ESA-listed steelhead that could be encountered is provided in Table 4.

Freshwater Mussel Research

Freshwater mussel research activities in the Umatilla River Basin include surveys to identify and monitor remaining freshwater mussel populations, the potential collection of freshwater mussels as broodstock or for genetic analysis, the potential experimental rearing of freshwater mussels in the Umatilla River, and survey, salvage, and translocation efforts associated with in-channel stream restoration work. These activities may encounter adult and juvenile steelhead (CTUIR 2017b), though no physical handling of ESA-listed summer steelhead would be expected to occur; however, fish may be observed during surveys and disturbed by in-water activities. Freshwater mussel surveys are conducted as visual surveys utilizing snorkeling or wading methods, avoid redds and spawning fish, and typically do not occur in deeper pools that may serve as salmonid habitat refugia. The number of ESA- listed steelhead that could be encountered is provided in Table 4.

Table 4. Number of natural-origin adult steelhead and juvenile *O. mykiss* expected to be encountered, sampled, and tagged, and anticipated mortality during broodstock collection, and monitoring and evaluation activities in the Umatilla River Basin.

	Adult Steelhead				**Juvenile *O. mykiss***			
Activity	Encountered	Sampled	Tagged	Mortality	Encountered	Sampled	Tagged	Mortality
Three Mile Dam trapping								
Broodstock	70	70		≤70				
Adult Monitoring	3,500	3,500		35				
Juvenile Outmigration								
Rotary Screw Traps	5			1				
Three Mile Falls Dam	35			5	4,000	4,000	3,000	50
Birch Creek					8,000	8,000	6,000	100
Spawning Ground Surveys	400	0	0	0				
Natural Production Monitoring								
Rotary Screw Traps								
Meacham Creek	5			1	7,000	7,000	3,500	45
Upper Umatilla	5			1	7,000	7,000	3,500	45
Pacific Lamprey								
Rotary Screw Trap	10	0	0	1	100	0	0	2
Electrofishing	10	0	0	1	1,000	1,000	0	15
Lamprey Spawning	10	0	0	0	1,000	0	0	0
Freshwater Mussel Research					55	0	0	0
	3,580	3,500		45	28,155	27,000	11,400	257

1.3.3. Walla Walla Spring Chinook Salmon

There are two goals for the proposed Walla Walla spring Chinook salmon hatchery program: (1) to provide harvestable spring Chinook salmon for treaty and non-treaty fisheries in the Walla Walla basin and other fisheries, and (2) to develop a locally adapted hatchery population of spring Chinook salmon that would become self-sustaining.

The BPA has requested ESA Section 7 consultation on their funding of the Walla Walla Spring Chinook Salmon program after determining their funding would not result in jeopardy. The Proposed Action includes the construction, operation, and maintenance of the Walla Walla Spring Chinook Salmon Hatchery (Walla Walla Hatchery). The current South Fork Adult Holding and Spawning Facility (AHSF) (Figure 2) will be upgraded into the Walla Walla Hatchery that will be operated year-round, providing for adult holding, spawning, incubation, rearing, and release. The BPA, as part of the Proposed Action, will fund the operation of the Nursery Bridge Dam fishway for broodstock collection, and monitoring and evaluation activities conducted by the CTUIR and WDFW.

The indigenous Walla Walla River spring Chinook were extirpated in the early to mid-1900s. From 2000 to 2008, adult spring Chinook from Ringold Springs Hatchery and the Umatilla River were out-planted into both the South Fork Walla Walla River (Oregon) and Mill Creek (Washington) in a program funded by BPA. These fish successfully spawned and produced the first returns in 2004. The South Fork out-plants were discontinued in 2009 as natural and hatchery returns to the upper Walla Walla increased. Out-plants in Mill Creek and recently the Touchet River and expected to continue and would transition to Walla Walla Hatchery stock as adult returns allow. Lack of a consistent source of adults for out-planting and continued infusion of out-of-basin adults limit the ability of recent and current actions to provide enough returning adults to supply local broodstock and to meet harvest and natural production goals for the Walla Walla basin. Natural-origin spring Chinook salmon returning to the Walla Walla River are not listed under the ESA. NMFS in its evaluation of ecological interactions determined that the MCR Steelhead DPS would be the only ESA-listed DPSs affected by the Walla Walla Spring Chinook salmon program (see Section 2.10)

Beginning in 2005, NMFS' Mitchell Act-funded program began releasing 250,000 yearling smolts in the basin from the Little White Salmon National Fish Hatchery (NFH). In 2009, the production was shifted to the Carson NFH. The release of 250,000 smolts from Carson NFH will continue until this program is fully implemented. Carson NFH fish may be used to backfill smolt production if shortages occur in the future.

The BPA's proposed program for reintroduction of spring Chinook salmon into the Walla Walla River will be broken down into three phases:

- Phase 1: Local Adaptation, Natural Spawning, and Harvest
- Phase 2: Harvest Augmentation and Transition to an Integrated Program
- Phase 3: Integrated Harvest and Demographic Safety Net

The purpose of the hatchery program in Phase 1 is to:

- Develop a locally adapted hatchery population of spring Chinook salmon
- Produce the fish needed to populate habitat in the South Fork Walla Walla River, Touchet River, and Mill Creek (Figure 2)
- Provide harvest in terminal areas when run size allows

BPA and the CTUIR anticipate that Phase 1 might be accomplished within five years after the new hatchery begins production.

The purpose of the program in Phase 2, which might be achieved within 15 years, is to:

- Provide fish for terminal tribal and sport fisheries (the primary purpose)
- Begin the transition toward an integrated hatchery program
- Continue to produce the fish needed to populate habitat in the South Fork Walla Walla River, Touchet River, and Mill Creek.

The purpose of the hatchery program in Phase 3 is to:

- Provide harvest augmentation through an integrated harvest program
- Create a demographic cushion for the natural population
- Populate habitat in the Touchet River and Mill Creek with hatchery-origin adults

BPA and the CTUIR are optimistic that achieving the purposes of Phase 3 could be completed in 20 to 25 years.

The program production goal is to release up to 400,000 smolts from the Walla Walla Hatchery into the South Fork Walla Walla River at RM 5.2, and up to 100,000 smolts directly released into the Touchet River (RM 53-55). In addition, surplus hatchery adults will be outplanted into the Touchet River and Mill Creek (up to 450 in each subbasin). To achieve the release goals, a total of 310 adults will be needed for brood with a minimum of 296 adult spawners. The program's planned overall smolt-to-adult survival goal is 0.55%, which would be expected to provide enough returning adults to meet broodstock needs and provide surplus adults for outplanting. Presently, no spring Chinook salmon returning to the Walla Walla River Basin have been used for broodstock. Under the proposed program the proportion of NORs in the broodstock (that is, pNOB) will vary by phase. The pNOB targets by phase are:

- Phase 1 - 10%
- Phase 2 - 20%
- Phase 3 - 50%

Broodstock will be collected at the Nursery Bridge Dam fishway (NBDF) at RM 44.7 on the mainstem Walla Walla River. Broodstock collection will occur from May through June. To trap upstream migrants, an exclusion panel will be installed within the ladder to guide fish into the trapping facility, which consists of an Alaskan Steeppass (ASP) fishway, pumped water supply, holding tank, fish crowder, anesthetic tank, and recovery tank. The ASP is used to attract and convey fish towards the holding tank. Fish are then directed to an anesthetic tank where they are sorted; spring Chinook salmon broodstock are removed for transport, and non-target fish are directed to a recovery tank. Initial plans are to use CO_2 anesthesia, which has no withdrawal requirement, as fish may be released into fishery areas. Once the fish have recovered, they can move volitionally back into the fish ladder (above the exclusion panel) to continue their upstream migration. Adults collected for the out-planting program will be handled the same as the broodstock.

The HGMP proposed that broodstock may also be collected downstream at the Burlingame Dam (RM 36.7), but after further review this location is not an option. In the future, after returns to the Touchet River become established, broodstock may also be collected at the existing Dayton Trap. If insufficient fish return to the Walla Walla to meet broodstock needs, Umatilla River or other Carson stock programs may be utilized as backup brood sources, possibly into Phase 3.

During the past five years, an average of 27 adult steelhead have been enumerated at Nursery Bridge Dam during May (range of 8 to 51), an average of 4.7% of the run. No fish have been enumerated in June during the past five years. The HGMP estimates that fewer than 250 NOR steelhead adults will be captured, handled, and released during broodstock collection activities.

The existing AHSF currently holds and spawns broodstock for the Umatilla spring Chinook program. Once the hatchery is operational, broodstock for both the Walla Walla and Umatilla spring Chinook programs would be held and spawned there in separate holding ponds – capacity already exists to accommodate both programs.

Adult spring Chinook salmon are generally spawned at a 1:1 male to female ratio but could be changed to adjust for jacks and the use of larger males. Eggs will be hardened in iodophor solution to control vertical transmission of pathogens including IHNV and *Renibacterium Salmoninarum* (BKD); an egg culling program will also be implemented to control vertical transmission of BKD. The goal of the program will be to only use eggs from females with ELISA titer OD values <0.200.

The existing AHSF, site of the proposed Walla Walla Hatchery, is located at RM 5.2 on the South Fork of the Walla Walla River and has a total surface water right of 20.3665 cfs for the production facility (Table 5). Use of groundwater for incubation and rearing was not an option at this facility due to high water temperatures, poor water quality, and limited sustained yield. Surface water will be used and passed through a filtration and treatment using ultraviolet light to provide for a disease-free water source for incubation and early rearing.

Table 5. Water rights information for the SF Walla Walla adult holding and spawning facility.

Water Right	Permit/Certificate	Issued to	Date
19.4 cfs	S-53028	BPA	12/11/1996
0.61 cfs	88733	CTUIR	12/31/2013
0.124 cfs	88582	BPA	7/19/2013
0.195 cfs	88581	BPA	7/19/2013
0.0375 cfs	88134	BPA	6/27/2013

Currently, the South Fork Walla Walla AHSF includes an intake structure capable of passing up to 58 cfs of water through its concrete intake channel, trash rack, forebay, juvenile bypass, Johnson screen, and pump house. An analysis conducted in 2013-2014 indicated a need to modify the existing intake in order to supply sufficient water for hatchery operation, because the river elevation has lowered since the facility opened. However, new information shows sufficient water (up to the existing water right of 20.3665 cfs) can be brought into the facility with the introduction of a weir/sluice gate or notched weir at the downstream end of the intake channel. Therefore, there will be no construction related to upgrading the intake pipe.

The OWRD has established minimum flow requirements for the SF Walla Walla River (see Table 3-2 in (BPA et al. 2014). To reduce the potential that the hatchery withdrawals reduce instream flows below the required minimum flows at any time, gauges and a pumpback system would be installed at the new facility. Flows as recorded at a new gauge planned to be installed by OWRD near Harris Park (3 miles upstream of the hatchery) would be electronically monitored at the hatchery on a daily basis (the new gauge is expected to be in place by the time the new hatchery is operating).

Under current operations, withdrawals for hatchery processes (up to 20.3665 cfs) could affect approximately 500 feet of stream habitat, between the intake and the pollution abatement pond outfall. A new discharge pipe will be constructed immediately below the intake pipe. The outfall would be separated by a concrete wall from the intake pipe; the distance between the two is less than 1 foot, which will allow about 15 cfs of water to be returned to the river immediately below the intake. The outfall is separated by a concrete wall from the intake pipe; the distance between the two is less than 1 foot.

The remaining 5 cfs of the 20 cfs withdrawn will be routed through the abatement pond and returned to the river, either through the new discharge pipe (immediately below the intake) or through the current abatement pond outfall (~500 feet downstream of the intake). That is, when monitoring indicates that the minimum instream flow requirements would not be met due to hatchery withdrawals, up to 5 cfs of water that must pass through the abatement pond will be returned to the river using the pumpback system and the new discharge pipe near the intake so that all hatchery withdrawal is returned immediately below the intake.

This new discharge pipe could require a small amount of construction work in or adjacent to the South Fork Walla Walla River. The HGMP contains a draft technical memorandum from BPA's design contractor regarding the expected "worst-case" level of in-water construction at the facility (CTUIR 2017a). Any in-water work would take place during the July 1 to August 15 work window, as specified by ODFW. Before in-water construction begins, the work areas would be isolated using cofferdams. To minimize exposure to suction dredging, risk of impingement, and asphyxiation, fish would be removed using either nets or electrofishing.

Currently, AHSF withdraws water for the hatchery using the same pipeline as the juvenile fish bypass system that requires an additional 4 to 6 cfs of water, which reduces stream flow for a distance of 250 feet. After the pumpback system is installed, the 4 to 6 cfs of water needed to operate the juvenile bypass, would still need to be released at the current location because the 4-6cfs would not be included in the proposed pumpback system due to the potential for injury to fish using the bypass. BPA and the CTUIR have determined that operating the juvenile bypass system could adversely impact the minimum flow requirement within this section of the river. To address these impacts, BPA proposes that the hatchery operators close the juvenile bypass system when daily monitoring shows the potential for the operation of the juvenile bypass system to reduce instream flows below the minimum flow requirement for that time of year. BPA, based on historical flow data, estimated that the number of times per year that the bypass would potentially be closed is limited with the average number of days per month provided in Table 6. It is expected that the days in the particular month would not be consecutive.

Table 6. Average number of days per month that the juvenile bypass at the Walla Walla Hatchery would close to meet instream minimum flows in the South Fork Walla Walla River.

Month	**Days Bypass Closed**
December	5
January	4
February	10
March	4
May	1
June	1

Fish would be spawned and reared at the Walla Walla Hatchery until release at a target size of 12 fpp. The planned release date for the program fish would be mid-April. The Touchet River releases would be direct stream releases in mid-April in the reach between the town of Dayton upstream to the confluence of the North Fork Touchet River and Wolf Creek (RM 53-55). The Touchet River releases may be acclimated in the future at Dayton Acclimation Pond as the result of changes to the steelhead programs.

The effects from annual routine maintenance at the AHSF to remove silt and debris from the intake channel was considered as part of a biological opinion for the Umatilla Hatchery program and was found to have minimal effects on ESA-listed steelhead (NMFS 2016b). The effects from the operation and maintenance of the Nursery Bridge Dam and other facilities were considered in previous biological opinions (NMFS 2006; 2011b) and were found not likely to jeopardize the continued existence of ESA-listed MCR steelhead.

Monitoring and Evaluation Activities

As stated in the HGMP, monitoring and evaluation activities for the hatchery program will be conducted as part of the ongoing Walla Walla Basin Natural Production Monitoring and Evaluation Project (WWBNPME, BPA Project # 2000-039-00). Descriptions of activities and take levels from NMFS (2017b) (Table 7).

Table 18 in the HGMP provides a detailed description of Hatchery Facility and Operations Monitoring activities that will occur within the hatchery that are not expected to have any take of listed steelhead (CTUIR 2017a). Table 18 also describes activities related to the natural production of spring Chinook salmon released under the program including spawning surveys to estimate the pHOS and PNI, and to monitor the success of outplanted adults.

Spawning Surveys

The Co-managers will conduct spawning ground surveys to estimate the abundance and distribution of spring Chinook salmon (July through October) and steelhead (February through June) redds. Redds are counted and recorded and spring Chinook salmon carcasses will be sampled for scales, length, egg/milt retention, and location. The Walla Walla River, Mill Creek, and the Touchet River are walked in three to four complete passes per season – with as little disturbance to spawning salmon as possible. WDFW has walked sections of the North Fork Touchet, Wolf Fork and mainstem Touchet River weekly during out-plant years on the Touchet River from the week after out-planting until the completion of spawning.

Rotary Screw Traps

Rotary screw traps will be used to collect out-migrating salmonids. CTUIR will operate up to three rotary screw traps to sample out-migrating summer steelhead and spring Chinook salmon. Traps will be fished in upper Walla Walla River (i.e., Basel cellars site Rm 39), in the lower Walla Walla River (Rm 7), and in lower Mill Creek (Rm 10.5). The traps will be operated continuously during fall through spring as stream conditions allow. The CTUIR intends to PIT-tag actively migrating steelhead and spring Chinook smolts. Healthy target fish will be measured, weighed and scanned for PIT-tags prior to a new tagging event. Steelhead (> 125mm, F.L.) and spring Chinook (> 65mm, F.L.) will be manually PIT-tagged and released on site. These tagging efforts will supplement those conducted by project collaborator WDFW in the Touchet River. These tagging levels will allow for estimates of smolt survivals and run timing to the lower Walla Walla, McNary Dam, and for smolt-to-adult survival back to the subbasin. The estimated mortality for activities in the Walla Walla River would be 160 juvenile MCR steelhead out of the 8,000 juveniles collected (Table 7).

Fish Salvage

The co-managers will salvage stranded fish from irrigation facilities and other locations throughout the Walla Walla River Basin. Each year, often at the close of irrigation season, the fisheries co-managers assist in the salvage of fish at diversion dams, irrigation canals, construction sites, and other locations. Seines and backpack electro-fishing gear are used to collect fish from isolated pools or reaches in dewatered areas. Rescued fish are either returned directly to the river above or below the affected area or trucked several miles upstream depending on the suitability of stream conditions. The maximum expected take for this activity is provided in Table 7.

Pacific Lamprey Research

CTUIR will conduct presence/absence electro-fishing surveys for lamprey annually throughout the Walla Walla River Basin to better understand current abundance and distribution of lamprey. In addition, genetic samples of lamprey will be collected and analyzed. Areas targeted for sampling will be Type I habitat that primarily consists of margins, backwaters, alcoves, and side channel habitat that are highly comprised of sand/silt. The Advanced-backpack electro-fisher 2 (AbP-2) will be used to sample lamprey habitat. Settings will be 125-volts, 3-pulse per second with a 25% duty cycle. Sampling rate will be 90 sec/m2. Any ESA-listed steelhead will be identified to life stage, enumerated, weighed or measured and released immediately. The number of ESA-listed steelhead that could be encountered is provided in Table 7. The maximum expected take for this activity is provided in Table 7.

Freshwater Mussel Research

Freshwater mussel research activities in the Walla Walla Basin include surveys to identify and monitor remaining freshwater mussel populations, the potential collection of freshwater mussels for broodstock and/or genetic analysis, and survey, salvage and translocation efforts associated with in-channel stream restoration work. These activities may encounter adult and juvenile steelhead (CTUIR 2017b) though no physical handling of ESA-listed summer steelhead would be expected to occur, however, fish may be observed during surveys and disturbed by in-water activities. Freshwater mussel surveys are conducted as visual surveys by snorkeling or wading, will avoid redds and spawning fish, and typically do not occur in deeper pools that may serve as salmonid habitat refugia. The collection of non-salmonid host fish will also occur in the Walla Walla Basin in support of freshwater mussel propagation activities. The primary method for collection of host fish (Cottoidea, Cyprinoidea) will be to utilize ‘by-catch’ fish from CTUIR RSTs operating in the basin, though if numbers are insufficient, host fish may also be collected by electroshocking methods. The number of ESA-listed steelhead that could be encountered during these activities is provided in Table 7.

Table 7. The number of natural-origin Middle Columbia River summer steelhead adults and juvenile *O. mykiss* expected to be encountered, sampled, tagged, and associated mortality during broodstock collection and monitoring and evaluation activities in the Walla Walla River Basin conducted by the CTUIR (see Touchet Endemic Summer Steelhead Program for other M&E activities in the Walla Walla Basin).

	Adult Steelhead				**Juvenile *O. mykiss***			
Activity	Encountered	Sampled	Tagged	Mortality	Encountered	Sampled	Tagged	Mortality
Nursery Bridge Dam Adult Trapping	250	250	250	5				
Rotary Screw Trapping					8,000	8,000	8,000	160
Fish Salvage (seines and electro-fishing)	250	0	0	5	1,500	0	0	20
Redd Surveys (observed)	200	0	0	0				
Pacific Lamprey								
Surveys	100	0	0	0				
Electro-fishing					500	0	0	8
Freshwater Mussel Research								
Surveys	10	0	0	0				
Electro-fishing					100	0	0	2
	610	250	250	10	9,100	8,000	8,000	190

1.3.4. Round Butte Spring Chinook Salmon

The Pelton-Round Butte Project was constructed in the 1950s and 1960s with fish passage facilities; however, the facilities were not successful in providing for the downstream migration of juvenile anadromous fish, so fish passage was abandoned in 1968. Mitigation for lost habitat and salmon and steelhead production mandated that both summer steelhead and spring Chinook salmon smolts be reared and released from Round Butte Hatchery into the Deschutes River below the Pelton Regulating Dam (RM 100.1)(Figure 4).

The current RBH spring Chinook salmon program has two functions: an Isolated Harvest program that rears and releases up to 380,000 smolts (the HGMP goal is 310,000 smolts but an additional 70,000 smolts will be reared as part of size at release study), and an Isolated Recovery program to support the reintroduction of spring Chinook salmon into streams above the Pelton Round Butte Project that currently releases up to 430,000 fry (ODFW 2017a) and additional 50,000 smolts. In addition to these two programs, the RBH also rears 75,000 spring Chinook salmon juveniles for transfer to the Moving Falls Acclimation facility on the West Fork Hood River, as part of a program to rebuild spring Chinook salmon in the Hood River (this will increase to 100,000 beginning in 2019). Broodstock for this program now comes from returns to the Hood River basin, though RBH adults can be used as broodstock to address production short falls if they occur in the future. This Hood River production is currently going through separate ESA consultation (CTWSRO and ODFW 2017).

To produce 380,000 smolts for the harvest program and the 430,000 fry and 50,000 smolts for the reintroduction program, a total of 1,100 adults will need to be collected annually. The program has not incorporated natural-origin adults into the broodstock since 2000 due to concerns regarding introduction of diseases into the Deschutes River above Round Butte Dam and only hatchery-origin adults will be used.

Broodstock for the spring Chinook salmon program will be collected in the Buckley Type Fish Trap at the Pelton Reregulating Dam (RM 100.1). The trap is operated year-round but spring Chinook salmon return to the basin from May through late August. Steelhead may overlap with spring Chinook salmon collection during the month of August, but none have been encountered during broodstock collection activities. The trap is checked once or twice per week depending on the numbers of fish captured and the time of year. From the holding area, fish are pushed toward a hopper gate by a wooden brail system. When about 20 fish are in the hopper, it is raised via a system of pulleys to the level of the working floor. A ramp placed on the hopper gate facilitates the movement of fish from the hopper into an anesthetic tank that is charged with carbon dioxide, oxygen, and a buffer. When the fish have been anesthetized, they are separated into broodstock, river returns, or fish to be given away for human consumption. Broodstock spring Chinook salmon are inoculated with Erythromycin and returned to a holding area inside the hopper. When one batch has been processed, the hopper is raised and moved above the liberation truck for a water-to-water transfer. Broodstock adults are transported to the RBH for holding and spawning.

The original broodstock for this program was derived from adults collected at a trap at Sherars Falls and are assumed to be primarily from the Warm Springs River due to the collapse of natural-production that occurred above Round Butte Dam after the loss of passage. ODFW has proposed to incorporate spring Chinook salmon adults collected at the Warm Springs NFH to supplement broodstock collected at the Pelton trap in order to increase the genetic and life history diversity of the hatchery broodstock (Requa 2017).

Under agreement with the CTWS, all spring Chinook salmon in excess of broodstock are provided to the Tribe (CTWS Resolution No. 1935, January 20, 1961). Those in excess of tribal needs are offered to local food banks or food share organizations. Fish that are not up to the standard for human consumption, or carcasses from spawning, pond mortality, or culls are buried on Ivan Flat near the PGE Pelton-Round Butte Hydro Maintenance office.

Table 8. Adult spring Chinook salmon trapped at the Pelton adult trap and their final disposition.

Brood Year	Total Trapped	Natural-origin released/mortalities	Retained for Broodstock	Surplus Hatchery	Released upstream (RM/LM)
2007	1,761	20/0	589	1,125	0
2008	1,604	29/0	843	207	0
2009	5,216	35/0	942	4,133	0
2010	2,087	66/0	739	1,216	0
2011	2,832	0/0	863	1,775	0
2012	1,335	24/0	798	537	24
2013	1,774	22/0	818	990	22
2014	559	24/0	371	155	24
2015	1,145	128/0	552	347	53
2016	827	39/0	524	118	54

Source: ODFW's HMS database

Broodstock are examined to determine the presence of reportable viral pathogens, and samples are taken from 100% of the broodstock. If fish being utilized for production needs are found to be infected with moderate to high levels of BKD or IHN, fertilized eggs of infected fish are culled from the incubation trays. Only fertilized eggs that are from 100% virus-free parents will be utilized for the reintroduction effort.

Eggs will be incubated at RBH and reared on-station until November. One group of 310,000 spring Chinook salmon reared to 20 fish per pound and another group of 85,000 reared to a size of 13.5 fish per pound are transferred to the Pelton Ladder for final rearing. The Pelton Ladder, is a 2.8-mile long, 10-feet wide, 6-feet deep conventional pool and drop fish ladder located on the east bank of the Deschutes. The fish are placed into one of six sections (cells) of the Pelton Ladder for rearing. These cells are separated from one another by electrically driven rotary screens for both RBH mitigation and for BPA sponsored Hood River supplementation. The water for the ladder comes from either a surface or a deep intake in Lake Simtustus and travels over 2 miles down the ladder before reaching the rearing cells at the lower end of the ladder.

Because the water is not filtered through any substrate, it contains a variety of food organisms. These fish are also fed on varying schedules. Water temperature in the ladder varies from 1°C to 12°C during the period that spring Chinook are reared. The rearing temperature in the ladder is controlled by PGE staff through a series of valves on Pelton Dam. The flow regime of the ladder more closely approximates a stream rearing situation in that flows are higher and more unidirectional than a standard raceway. Predators are more numerous in the ladder area since hatchery workers are infrequent visitors to the area. Additionally, workers believe that the presence of at least some natural food and the competitive interaction for that food increases the fitness and overall survival rate of fish from this rearing strategy. Juveniles rearing in the ladder are fed on demand one day per week from the day they are moved from RBH to the ladder on November 1 through the end of February, and then also on demand five days per week from March 1 until release in mid-April. Currently, the porthole gates in the Pelton Ladder are opened around mid-April and remain open until June 1st. During this time frame, the smolts are no longer fed to encourage their migration. Any Chinook smolts that remain in the Pelton Ladder after June 1st are removed and sacrificed. Sampling of these fish has shown that the vast majority are precocious males.

Juvenile spring Chinook salmon are reared to the unfed fry stage at RBH and transported and released into the Metolius River (277,000), Whychus Creek (47,000), and the Crooked River (105,000) in early March as part of the reintroduction program. In addition, ODFW is currently transferring 64,000 eyed eggs to Wizard Falls Hatchery on the Metolius River to produce 50,000 smolts that will be used to evaluate juvenile fish passage facility in Lake Billy Chinook at Round Butte Dam (Figure 4).

RBH is located 15 miles upstream from the Pelton trap. RBH receives its water from the west bank grout tunnel drilled into the canyon wall immediately west of the hatchery. The hatchery is located on the powerhouse deck at Round Butte Dam. When the dam was being constructed during the early 1960s, tunnels were drilled into the basalt canyon walls at several elevations on each side of the dam site. Liquid grout was pumped into the tunnels and used to fill cracks in the basalt in an attempt to minimize seepage through the rock on either side of the dam. After Lake Billy Chinook filled in 1964, some delayed seepage did find its way through the cracks in the basalt and was captured in the lower tunnels that open above the powerhouse on each side. When the hatchery was sited, it was the presence of the delayed seepage water on the west bank that was the factor for determining the location. Although this is seepage water, it travels through enough rock that it emerges at about 50°F year around. Approximately two weeks after there is turbidity in the tailrace from run-off out of the Crooked River basin, the hatchery water becomes slightly off-color. This indicates a mean seepage delay time of at least that long.

Hatchery water is not withdrawn from a live stream but rather is derived from the west bank grout tunnel drilled into the canyon wall immediately west of the hatchery. Round Butte Hatchery has two water right permits for fish rearing purpose (Permit #37974 for 20.0 cfs, and Permit #52642 for 0.27 cfs). The source of the water rights is the Round Butte Reservoir, and the facility complies with the limits.

Also, the Pelton Ladder has a water right permit (Permit #32372) for withdrawing 13.30 cfs water from the Deschutes River, and complies with the withdrawal limit. Both facilities (Round Butte Hatchery and Pelton Ladder) are operated under the NPDES General Permits 300-J (EPA File #ORG13700-6 and #ORG13701-4, respectively) issued to PGE. The PGE staff monitor and report the effluents' water quality data quarterly to the Oregon Department of Environmental

Quality (DEQ) to comply with the water quality standards and limits. Meeting these legal standards should minimize the potential take of listed species.

RBH spring Chinook salmon for the mitigation program are 100% adipose-clipped and coded wire tagged to identify fry rearing origin (rearing cell) of returned adults for evaluation purposes.

To differentiate reintroduction fish from other fish in the Deschutes River Basin, ODFW determined that a differential mark is warranted. ODFW will be using a left maxillary clip for the smolts reared at other hatcheries and a right maxillary clip for the naturally reared smolts. ODFW will not be removing the adipose fins. The objective of marking the fish in this way is so that returning reintroduction fish can be differentiated from the Round Butte Hatchery mitigation fish. This identifying mark will assist hatchery ODFW staff during collection of adults at the Pelton trap. Fish originating from above the project can be segregated and passed above the project while mitigation adults can be transported to the hatchery. Also, because current fishing regulations state that if any portion of the adipose fin is intact the fish must be released, leaving the adipose fin intact will allow for reduced in-river harvest impacts.

Non-listed fall Chinook salmon are also handled and released during broodstock collection activities at the Pelton adult trap (Table 9). Since 2011, marked hatchery adults have been retained and provided to the tribe or local food banks, or placed in a landfill.

Table 9. Non-listed Fall Chinook Salmon collected at the Pelton adult trap and their final disposition.

Brood Year	Total Trapped	Natural-origin released	Hatchery-origin released	Mortalities
2007	423	232	182	9
2008	520	49	470	0
2009	451	110	338	3
2010	802	213	587	0
2011	775	775	0	0
2012	2,646	2,645	0	1
2013	1,879	1,833	0	46
2014	1,643	1,643	0	0
2015	1,389	1,389	0	0
2016	775	775	0	0

Monitoring and Evaluation Activities

RM&E activities below Pelton Dam have not been proposed for consideration in this opinion.

1.3.5. Touchet Spring Chinook Salmon

The goal of the hatchery program is to provide mitigation, as specified under the LSRCP, by providing harvest opportunities established under *U.S. v. Oregon* for tribal and recreational fisheries. The LSRCP mitigation goal for spring Chinook salmon is 58,700 adults back to the

Project Area. The goal has never been reached and additional production is needed it to meet it. LSRCP migration in the Walla Walla and Touchet River Basins has been implemented for summer steelhead under WDFW's LSCRP program since 1983. This production has been counted towards WDFW's summer steelhead mitigation to the project area, and the same would apply to the proposed spring Chinook salmon program for WDFW and the LSRCP.

Overview of Touchet Program

The LSRCP hatchery spring Chinook salmon mitigation target for Washington is 1,152 adults. This mitigation has historically been confined to the Tucannon River and over the last 10 years has averaged 440 hatchery fish, only 38% of the target. Due primarily to ESA restrictions in the Tucannon River, there are limited opportunities to expand that program to a level needed to meet the mitigation targets (note that the Tucannon River population is listed as threatened under the ESA). The only other areas within the Washington LSRCP footprint, where it is feasible to initiate a spring Chinook salmon program, are the Touchet River and Asotin Creek. Co-managers are developing a re-introduction plan for spring Chinook salmon into Asotin Creek, but it is not yet operational. The Touchet River is the only available near-term mitigation opportunity.

The program goal is to release 250,000 smolts annually. For the first 5 years, the broodstock for the program will use green eggs and milt collected from adult returns to Carson NFH. As mentioned above, spring Chinook salmon were extirpated from the Walla Walla River Basin in the early 1900s, and to support the reintroduction and tributary fisheries, Carson stock hatchery adults have been released into the basin since 2000. The Touchet Spring program would be in addition to the Walla Walla Spring Chinook Salmon program described above.

A total of 200 adults are needed for broodstock to meet program goals. These adults will be surplus to the current program needs at the Carson NFH. The long-term goal would be to collect adults returning to the Touchet River for broodstock making the program self-sustaining. Collection of returning hatchery adults for broodstock would occur at the Dayton Adult Trap and possibly the Nursery Bridge Dam Fishway in the mainstem Walla Walla River. Descriptions of the operation of these two facilities are provided in Sections 1.3.1 and 1.3.3 above. As noted above, the operation of the Dayton AP and its effects on ESA-listed species was considered in a separate consultation for the Wallowa stock program (NMFS 2017d). WDFW will continue to coordinate with the USFWS and Yakima Tribe on the use of Carson NFH spring Chinook salmon for broodstock, and the potential for collecting Carson stock spring Chinook salmon broodstock from other facilities.

WDFW staff will work with hatchery managers to assist with spawning and transport of green eggs and milt to Lyons Ferry Hatchery. The green eggs will be fertilized and water hardened at the Lyons Ferry Hatchery. Eggs will be incubated and reared at the hatchery until they are released 16 months later. Smolts will be released in Mid-March to Mid-April directly into either (1) the mainstem Touchet River in the city of Dayton, (2) the North Fork, or (3) Wolf Creek at approximately 12 fpp (Figure 1). The effects on ESA-listed species from the operation of LFH has been evaluated in a separate consultation (NMFS 2017d) and will not be considered further in this opinion.

All of the spring Chinook salmon smolts will be adipose fin-clipped with a representative group given CWTs, and a group PIT tags to estimate adult returns, fisheries contributions, and straying.

Monitoring and Evaluation Activities

Monitoring of this program will include:

- spawning and survival within the Lyons Ferry Hatchery,
- smolt out-migration via PIT tags,
- incidental catches of marked hatchery fish at the Touchet River smolt trap,
- fishery monitoring within the Columbia River and Walla Walla River Basins,
- estimating and tracking adult migration and returns from PIT tags within the Columbia River and within the Walla Walla River Basin,
- adult trapping (Dayton Adult Trap),and
- spawning ground surveys in the Touchet River basin.

1.4. 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 (NMFS 2003a).

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.

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

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

2.1. Analytical Approach

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

This biological opinion relies on the definition of "destruction or adverse modification", which 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" (50 CFR 402.02).

The designation(s) of critical habitat for (species) use(s) the term primary constituent element (PCE) or essential features. Subsequent critical habitat regulations (81 FR 7414) replace this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a ‘‘destruction or adverse modification’’ analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

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

Range-wide status of the species and critical habitat

This section describes the status of species and critical habitat that are the subject of this opinion. The status review starts with a description of the general life history characteristics and the population structure of the ESU/DPS, including the strata or major population groups (MPG) where they occur. NMFS has developed specific guidance for analyzing the status of salmon and steelhead populations in a "viable salmonid populations" (VSP) paper (McElhany et al. 2000). The VSP approach considers four attributes, the abundance, productivity, spatial structure, and diversity of each population (natural-origin fish only), as part of the overall review of a species' status. For salmon and steelhead protected under the ESA, the VSP criteria therefore encompass the species' "reproduction, numbers, or distribution" (50 CFR 402.02). In describing the range-wide status of listed species, NMFS reviews available information on the VSP parameters including abundance, productivity trends (information on trends, supplements the assessment of abundance and productivity parameters), spatial structure and diversity. We also summarize available estimates of extinction risk that are used to characterize the viability of the populations and ESU/DPS, and the limiting factors and threats. To source this information, NMFS relies on viability assessments and criteria in technical recovery team documents, ESA Status Review updates, and recovery plans. We determine the status of critical habitat by examining its physical and biological features. 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 2.6 of this opinion.

Analyze the effects of the Proposed Action on both the species and their habitat

Section 2.7 (and the Appendix A) first describes the various pathways by which hatchery operations can affect ESA-listed salmon and steelhead, then applies that concept to the specific programs considered here.

Cumulative effects

Cumulative effects, as defined in NMFS' implementing regulations (50 CFR 402.02), are the effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the Action Area. Future Federal actions that are unrelated to the Proposed Action are not considered because they require separate section 7 consultation. Cumulative effects are considered in Section 2.15 of this opinion.

Integration and synthesis

Integration and synthesis occurs in Section 2.16 of this opinion. In this step, NMFS adds the effects of the Proposed Action (Section 5) to the status of ESA protected populations in the Action Area under the environmental baseline (Section 2.6) and to cumulative effects (Section 2.15). 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 2.16, the opinion determines whether the Proposed Action is likely to jeopardize ESA-protected species or destroy or adversely modify designated critical habitat in Section 2.17.

Reasonable and prudent alternative(s) to the Proposed Action

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

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

This opinion examines the status of each species and designated critical habitat that would be affected by the Proposed Action (Table 10). 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.

"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.

In determining which species to consider in this Opinion, NMFS evaluated the potential impacts on the ESA-listed species listed in Table 10. All of these species were considered because they would be present in the mainstem Columbia River at the same time as hatchery fish released under the Proposed Action. NMFS in its evaluation determined that only the MCR Steelhead and Snake River Steelhead DPSs would be affected by the Proposed Action and thus will be considered in this opinion (see Section 2.10).

Table 10. 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)*			
Lower Columbia River	Threatened, 79 FR 20802, April 14, 2014	70 FR 52706, September 2, 2005	70 FR 37160, June 28, 2005
Upper Columbia River spring-run	Endangered, 70 FR 20816, April 14, 2014	70 FR 52732, September 2, 2005	Issued under ESA Section 9
Snake River spring/summer-run	Threatened, 79 FR 20802, April 14, 2014	64 FR 57399, October 25, 1999	70 FR 37160, June 28, 2005
Snake River fall-run	Threatened, 79 FR 20802, April 14, 2014	58 FR 68543, December 28, 1993	70 FR 37160, June 28, 2005
Willamette River spring-run	Threatened, 79 FR 20802, April 14, 2014	70 FR 52720, September 2, 2005	70 FR 37160, June 28, 2005
Sockeye salmon *(O. nerka)*			
Snake River	Endangered, 79 FR 20802, April 14, 2014	68 FR 68543, December 28, 1993	Issued under ESA Section 9
Steelhead *(O. mykiss)*			
Lower Columbia River	Threatened, 79 FR 20802, April 14, 2014	70 FR 52808, September 2, 2005	70 FR 37160, June 28, 2005

Species	Listing Status	Critical Habitat	Protective Regulations
Upper Columbia River	Threatened, 79 FR 20802, April 14, 2014	70 FR 52630, September 2, 2005	71 FR 5178, February 1, 2006
Snake River	Threatened, 79 FR 20802, April 14, 2014	70 FR 52769, September 2, 2005	70 FR 37160, June 28, 2005
Middle Columbia River	Threatened, 79 FR 20802, April 14, 2014	70 FR 52808, September 2, 2005	70 FR 37160, June 28, 2005
Coho Salmon (*O. kisutch*)			
Lower Columbia River	Threatened, 79 FR 20802, April 14, 2014	81 FR 9252, February 24, 2016	70 FR 37160, June 28, 2005
Chum Salmon (*O. nerka*)			
Columbia River	Threatened, 79 FR 20802, April 14, 2014	70 FR 52746, September 2, 2005	70 FR 37160, June 28, 2005

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).

Escapement data has been updated where available. However, recent information for many of the populations is unavailable or inadequate to indicate changes in species status.

2.3. Snake River Steelhead

O. mykiss exhibit perhaps the most complex suite of life-history traits of any species of Pacific salmonid. They can be anadromous or freshwater resident, and under some circumstances, yield offspring of the opposite form. Steelhead are the anadromous form. Steelhead can spend up to 7 years in fresh water prior to smoltification, and then spend up to 3 years in salt water prior to first spawning. This species can also spawn more than once (iteroparous), whereas all other species of *Oncorhynchus*, except *O. clarkii*, spawn once and then die (semelparous). Snake River steelhead are classified as summer-run because they enter the Columbia River from late June to October. However, summer run steelhead can be divided into two sub-types; A-run steelhead, which return to spawning areas beginning in the summer, and B-run steelhead, which exhibit a larger body size and begin their migration in the fall (NMFS 2011a). After holding over the winter, summer steelhead spawn the following spring (March to May).

The Snake River Steelhead DPS remains threatened (NWFSC 2015). Factors that limit the DPS's survival and recovery include: migration through the FCRPS; the degradation and loss of estuarine areas that help fish transition between fresh and marine waters; spawning and rearing areas that have lost deep pools, cover, side-channel refuge areas, high quality spawning gravels, and; interbreeding and competition with hatchery fish that outnumber natural-origin fish. Factors affecting habitat conditions are likely to affect most if not all populations within the DPS. Hatchery effects are likely more pronounced when the program releases fish within a listed population. Those populations within the DPS with hatchery fractions > 50 percent are the Tucannon, Asotin Creek, Lolo Creek, South Fork Clearwater, Little Salmon River, Pahsimeroi, Lemhi, East Fork Salmon and Upper Salmon River, based on a preliminary run reconstruction model (see Table 29; NWFSC 2015). Those populations in the Clearwater and Salmon River Basins are most likely to be affected by the programs in this Proposed Action.

The Snake River Basin Steelhead DPS includes all naturally spawned anadromous *O. mykiss* originating below natural and manmade impassable barriers in streams in the Snake River Basin of southeast Washington, northeast Oregon, and Idaho (NWFSC 2015). The Snake River Basin Steelhead DPS comprises twenty-four extant populations within five MGPs. In addition, a number of populations may have existed above Hells Canyon Dam, constituting a sixth MPG. Four out of the five extant MPGs are not meeting the specific objectives in the draft Snake River Recovery Plan, and the status of many individual populations remains uncertain. Within the geographic range of the DPS, 19 steelhead hatchery programs are currently operational. Six of these artificial programs are included in the DPS. A great deal of uncertainty still remains regarding the relative proportion of hatchery-origin fish in natural spawning areas near major hatchery release sites within individual populations (NWFSC 2015). A more detailed description of the populations that are the focus of this consultation follows.

There are two independent populations within the Lower Snake River 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 and for the Asotin Creek population to be at low risk of extinction. The most recent status review (NWFSC 2015) found that the Tucannon River population remains at high risk, and the Asotin Creek population is maintained (Table 11). However, both populations have insufficient data on abundance and productivity to assess accurately these metrics.

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

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

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

2.4. Middle Columbia River Steelhead

The proposed summer steelhead and spring Chinook salmon programs have the potential to interact with ESA-listed MCR steelhead through broodstock collection activities, from competition interactions with the progeny of naturally spawning hatchery fish, and through the release of hatchery juveniles.

On March 25, 1999, NMFS listed the MCR Steelhead DPS as a threatened species (64 FR 14517). The threatened status was reaffirmed in 2006 (71 FR 834) and again most recently on April 14, 2014 (79 FR 20802). Critical habitat for the MCR steelhead was designated on September 2, 2005 (70 FR 52808) (Table 10).

The MCR Steelhead DPS includes naturally spawned anadromous *O. mykiss* originating from below natural and manmade impassable barriers from the Columbia River and its tributaries upstream of the Wind River (Washington) and Hood River (Oregon) to and including the Yakima River, excluding the Upper Columbia River tributaries (upstream of Priest Rapids Dam) and the Snake River (Figure 5). Four MPGs, composed of 19 historical populations (2 extirpated), make up the MCR Steelhead DPS (Figure 5). Inside the geographic range of the DPS, 11 hatchery steelhead programs are currently operational. Seven of these artificial programs are included in the DPS (Table 12).

Table 12. MCR Steelhead DPS description and MPGs (Jones Jr. 2015; NWFSC 2015).

DPS Description	
Threatened	Listed under ESA as threatened in 1999; updated in 2014 (see Table 10)
4 major population groups	19 historical populations (2 extirpated)
Major Population Group	***Populations***
Cascades Eastern Slope Tributaries	Deschutes River Eastside, Deschutes River Westside, Fifteenmile Creek*, Klickitat River*, Rock Creek*
John Day River	John Day River Lower Mainstem Tributaries, John Day River Upper Mainstem Tributaries, MF John Day River, NF John Day River, SF John Day River
Yakima River	Naches River, Satus Creek, Toppenish Creek, Yakima River Upstream Mainstem
Umatilla/Walla Walla rivers	Touchet River, Umatilla River, Walla Walla River
Artificial production	
Hatchery programs included in DPS (7)	Touchet River Endemic summer, Yakima River Kelt Reconditioning summer (in Satus Creek, Toppenish Creek, Naches River, and Upper Yakima River), Umatilla River summer, Deschutes River summer
Hatchery programs not included in DPS (2)	Wallowa Stock release into the Touchet River. Skamania Stock summer, released into the Klickitat River.

* These populations are winter steelhead populations. All other populations are summer steelhead populations.

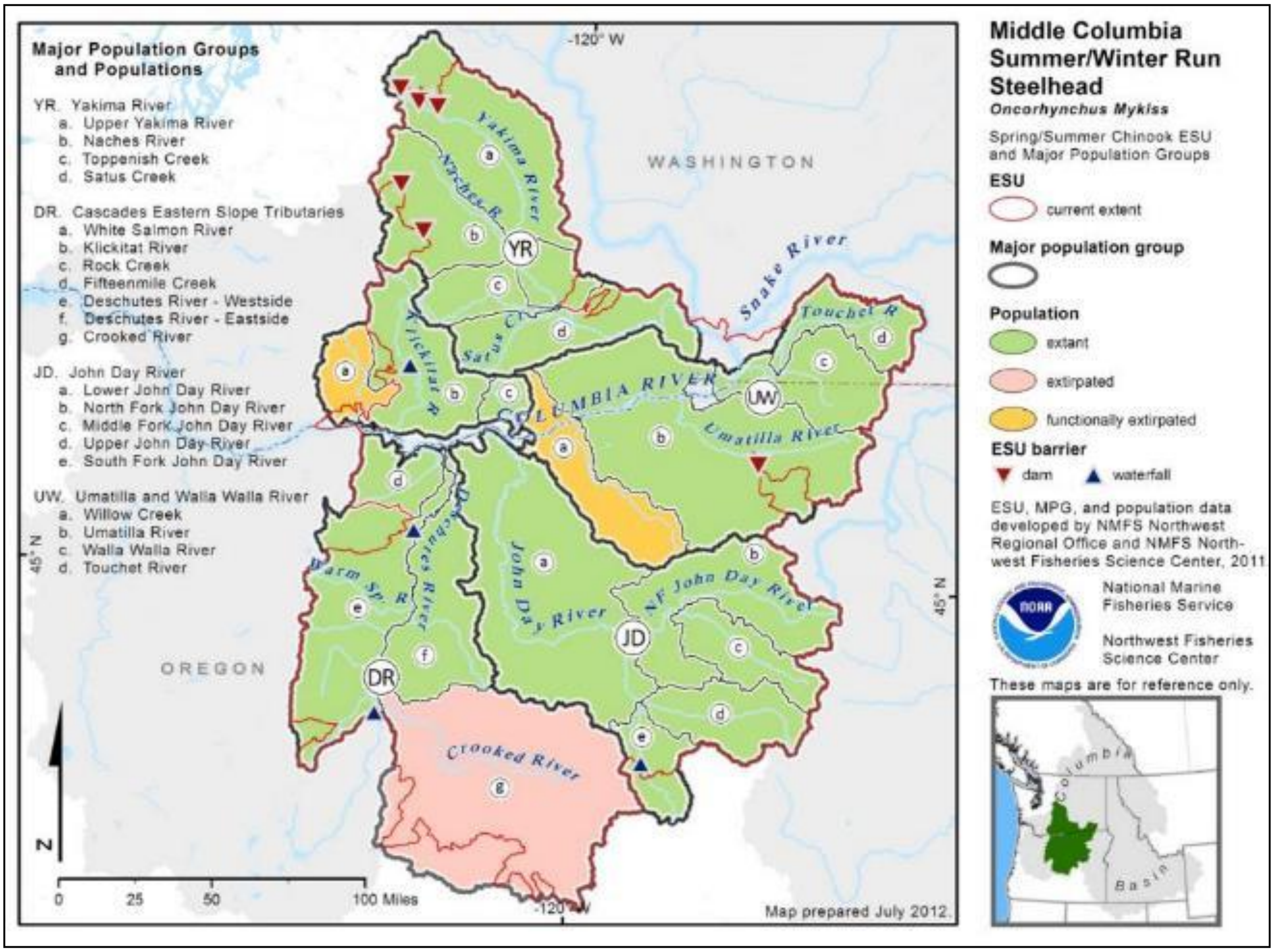

Figure 5. Map of the MCR Steelhead DPS's spawning and rearing areas, illustrating populations and MPGs (NWFSC 2015).

MCR steelhead exhibit a complex life history. Steelhead are rainbow trout (*O. mykiss*) that migrate to and from the ocean (i.e., they are anadromous). Resident and anadromous life history patterns are often represented in the same populations, with either life history pattern yielding offspring of the opposite form. Steelhead are iteroparous, meaning they can spawn more than once. Repeat spawners are called "kelts" (NMFS 2013b).

MCR basin populations include summer and winter steelhead (Table 13). The two life history types differ in degree of sexual maturity at freshwater entry, spawning time, and frequency of repeat spawning (NMFS 2013b). Generally, summer steelhead enter fresh water from May to October in a sexually immature condition, and require several months in fresh water to reach sexual maturity and spawn between late February and early April. Winter steelhead enter fresh water from November to April in a sexually mature condition and spawn in late April and early May. Iteroparity (repeat spawning) rates for Columbia Basin steelhead have been reported as high as 2% to 6% for summer steelhead and 8% to 17% for winter steelhead (Leider et al. 1986; Busby et al. 1996; Hulett et al. 1996).

Historically, winter steelhead were likely excluded from Interior Columbia River subbasins by Celilo Falls. Winter steelhead favor lower elevation and coastal streams. However, winter steelhead populations are present in the Klickitat River and in Oregon's Fifteenmile Creek.

Table 13. Life history and population characteristics of MCR steelhead.

Characteristic	Life History Features	
	Summer	**Winter**
Number of extant population	10	23
Life history type	Stream	Stream
River entry timing	May-November	November-April
Spawn timing	late February-May	late April-June
Spawning habitat type	Upper watersheds, streams	Rivers and tributaries
Emergence timing	March-July	March-July
Duration in freshwater	1-3 years (mostly 2)	1-3 years (mostly 2)
Rearing habitat	River and tributary main channels	River and tributary main channels
Estuarine use	Briefly in the spring, peak abundance in May	Briefly in the spring, peak abundance in May
Ocean migration	North to Canada and Alaska, and into the N Pacific	North to Canada and Alaska, and into the N Pacific
Age at return	3-5, occasionally 6 years	3-5, occasionally 6 years
Recent natural spawners	1,500	3,500
Recent hatchery adults	2,000	9,000

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 MCR Steelhead DPS is at moderate risk and remains at threatened status. The most recent status update (NWFSC 2015) used updated abundance and hatchery contribution estimates provided by regional fishery managers to inform the analysis on this DPS. However, this DPS has been noted as difficult to evaluate in several of the reviews for reasons such as: the wide variation in abundance for individual natural populations across the DPS, chronically high levels of hatchery strays into the Deschutes River, and a lack of consistent information on annual spawning escapements in some tributaries (NWFSC 2015).

Abundance and productivity are linked, as populations with low productivity can still persist if they are sufficiently large, and small populations can persist if they are sufficiently productive. A viable natural population needs sufficient abundance to maintain genetic health and to respond to normal environmental variation, and sufficient productivity to enable the population to quickly rebound from periods of poor ocean conditions or freshwater perturbations (Table 14) (NMFS 2009).

Table 14. Ecological subregions, natural populations, and scores for the key elements (A/P, diversity, and SS/D) used to determine current overall viability risk for MCR Steelhead DPS based on MCR Recovery Plan (NMFS 2009).

Ecological Subregions	Population (Watershed)	A/P	Diversity	Integrated SS/D	Overall Viability Risk
Cascade Eastern Slope Tributaries	Fifteenmile Creek	L	L	L	Viable
	Klickitat River	M	M	M	MT
	Eastside Deschutes River	L	M	M	Viable
	Westside Deschutes River	H	M	M	H*
	Rock Creek	H	M	M	H
	White Salmon[2]				E*
	Crooked River[3]				E*
John Day River	Upper Mainstem	M	M	M	MT
	North Fork	VL	L	L	Highly Viable
	Middle Fork	M	M	M	MT
	South Fork	M	M	M	MT
	Lower Mainstem	M	M	M	MT
Walla Walla and Umatilla rivers	Umatilla River	M	M	M	MT
	Touchet River	M	M	M	H
	Walla Walla River	M	M	M	MT
Yakima River	Satus Creek	M	M	M	Viable (MT)
	Toppenish Creek	M	M	M	Viable (MT)
	Naches River	H	M	M	H
	Upper Yakima	H	H	H	H

[1] Risk ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH), and extirpated (E). Maintained (MT) population status indicates that the population does not meet the criteria for a viable population but does support ecological functions and preserve options for recovery of the DPS. Extirpated populations were not evaluated as indicated by the blank cells.

* Re-introduction efforts underway (NMFS 2009).

[2] This population is re-establishing itself following removal of Condit Dam.

[3] This population was designated an experimental population on January 15, 2013 (78 FR 2893)

Limited population abundance data are available for the populations in the MCR Steelhead DPS. Of the 17 populations in this DPS, data on natural-origin spawner abundances for 14 populations are provided below; such information for the remaining three populations is not available. In the 2010 status review, Ford et al. (2011) summarized that natural-origin and total spawning escapements have increased in the most recent brood cycle, relative to the period associated with the 2005 BRT review, for all four populations in the Yakima River MPG. It is apparent that this trend is continuing through the recent years as well (Table 15). The 15-year trend in natural-origin spawners was positive for the West Side Deschutes population, and negative for the East Side Deschutes run (Table 15). There is significant tribal and sport harvest associated with the Klickitat steelhead run, with the sport harvest being targeted on hatchery fish (NWFSC 2015). Overall, natural-origin spawning estimates are highly variable relative to minimum abundance

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Table 15. MCR Steelhead DPS natural-origin spawner abundance estimates for the populations with data available (from WDFW SCORE1 and ODFW Salmon & Steelhead Recovery Tracker2)*: NA = not available.

Year	Deschutes River Eastside[2]	Deschutes River Westside[2]	John Day River Lower[2]	John Day River Upper[2]	North Fork John Day River[2]	Middle Fork John Day River[2]	South Fork John Day River[2]	Umatilla River[2]	Walla Walla River[1]	Touchet River[1]	Klickitat River[1,3]	Naches River[1]	Satus Creek[1]	Toppenish Creek[1]	Yakima Upstream[1]
1997	929	315	911	341	961	436	173	909	439	228	n/a	310	268	233	47
1998	471	369	625	704	978	457	110	769	568	445	n/a	304	348	131	61
1999	1,712	290	1,894	326	1,626	945	103	1,019	419	369	n/a	329	335	201	41
2000	2,510	471	5,524	567	2,143	1,066	263	2,027	772	295	n/a	507	397	434	59
2001	8,637	766	5,544	566	2,235	1,063	526	2,451	1,118	296	n/a	983	645	909	161
2002	5,149	949	7,381	1,599	4,097	3,140	987	3,546	1,746	502	n/a	1,454	1,155	1,129	260
2003	3,984	1,284	2,200	771	2,878	1,104	708	2,014	905	482	n/a	709	646	460	133
2004	1,847	516	1,031	415	1,027	723	304	2,001	602	267	n/a	886	567	790	195
2005	1,802	562	516	392	1,674	234	206	1,615	855	459	1,577	1,092	890	801	223
2006	1,000	452	508	148	707	214	269	1,373	825	290	1,751	646	746	260	123
2007	2,071	565	1,449	590	1,264	707	618	2,465	464	381	205	492	521	263	79
2008	1,945	521	840	914	1,241	972	1,142	2,098	675	314	144	976	946	585	190
2009	1,665	329	3,563	732	3,904	2,968	1,756	2,356	862	279	1,290**	1,114	1,044	693	216
2010	1,393	913	1,124	736	2,918	2,597	416	3,722	1,623	827	1,111**	2,138	2,751	621	367
2011	1,467	1,195	2,191	1,057	2,890	5,372	910	3,869	1,632	468	2,483**	1,963	2,274	799	364
2012	1,949	563	3,538	1,035	4,588	5,117	2,057	3,122	1,210	294	1,063**	2,203	1,812	667	475
2013	1,303	601	1,121	1,490	2,094	5,248	1,704	2,408	741	501	1,222**	1,683	928	510	334
2014	1,909	569	9,070	1,247	2,190	6,510	1,488	2,600	428	163	2,956**	1,506	919	356	423
2015	NA	NA	NA	NA	NA	NA	NA	4,915	963	228	3,270	1,785	1,093	504	550
2016	NA	NA	NA	NA	NA	NA	NA	3,549	971	179	544	1,409	1,233	295	528

[1]Data available at: https://fortress.wa.gov/dfw/score/score/maps/map_details.jsp?geoarea=SRR_MiddleColumbia&geocode=srr (Date accessed: April 28, 2016)
[2]Data available at: http://odfwrecoverytracker.org/explorer/ and (Contor 2018).
[3]Estimates combine both summer and winter counts
**Source for 2009-2014 data: TAC (2016). Data are verified using mark-recapture estimates at Lyle Falls.

thresholds across the populations in the DPS. Natural-origin returns to the Umatilla, Walla Walla, John Day, and Klickitat rivers have increased over the last several years (Table 15).

The most recent status review update (NWFSC 2015) revealed that updated information on spawner and juvenile rearing distributions does not support a change in the spatial structure status for the MCR Steelhead DPS natural populations. Status indicators for within population diversity have changed for some populations, although in most cases the changes have not been sufficient to shift composite risk ratings for any particular populations (NWFSC 2015).

The Mid-Columbia Recovery Plan identifies a set of most likely scenarios to meet the ICTRT recommendations for low risk populations at the MPG level. In addition, the management unit plans generally call for achieving moderate risk ratings (maintained status) across the remaining extant populations in each MPG. Table 16 shows the most recent abundance, productivity, spatial structure, and diversity metrics for the 17 populations in the DPS. Overall viability ratings for the populations in the MCR Steelhead DPS remained generally unchanged from the prior five-year review (Table 16). One population, Fifteen Mile Creek, shifted downward from viable to maintained status as a result of a decrease in natural-origin abundance to below its ICTRT minimum abundance threshold. The Toppenish River population (in Yakima MPG) dropped in both estimated abundance and productivity, but the combination remained above the 5% viability curve, and, therefore, its overall rating remained as viable (Table 16). The majority of the populations showed increases in estimates of productivity (NWFSC 2015).

Limiting Factors

There are many factors that affect the abundance, productivity, spatial structure, and diversity of the MCR Steelhead DPS. Factors that limit the DPS have been, and continue to be, hatchery selection influence for out-of-basin hatchery strays, loss and degradation of spawning and rearing habitat, impacts of mainstem hydropower dams on upstream access and downstream habitats, and the legacy effects of historical harvest; together, these factors have reduced the viability of natural population in the MCR Steelhead DPS. Historically, extensive beaver activity, dynamic patterns of channel migration in floodplains, human settlement and activities, and loss of rearing habitat quality and floodplain channel connectivity in the lower reaches of major tributaries, all impacted the MCR Steelhead DPS populations (NMFS 2016d).

Table 16. Summary of 2015 MCR Steelhead DPS status relative to the ICTRT viability criteria, grouped by MPG (NWFSC 2015). Comparison of updated status summary vs. draft recovery plan viability objectives; upwards arrow=improved since prior review. Downwards arrow=decreased since prior review. Oval=no change. Shaded populations are the most likely combinations within each MPG to be improved to viable status. Current abundance and productivity estimates are expressed as geometric means (standard error) (NWFSC 2015).

Population	Abundance/Productivity Metrics				Spatial Structure and Diversity Metrics			Overall Viability Rating
	ICTRT Minimum Threshold	Natural Spawning Abundance	ICTRT Productivity	Integrated A/P Risk	Natural Processes Risk	Diversity Risk	Integrated SS/D Risk	
Eastern Cascades MPG								
Fifteen Mile Creek	500	↓ 356 (.16)	↑ 1.84 (.19)	Moderate	Very Low	Low	Low	Maintained
Deschutes (Westside)	1,500 (1,000)	↑ 634 (.13)	↑ 1.16 (.15)	High	Low	Moderate	Moderate	High Risk
Deschutes (Eastside)	1,000	↓ 1,749 (.05)	↑ 2.52 (.24)	Low	Low	Moderate	Moderate	Viable
Klickitat River	1,000			Moderate	Low	Moderate	Moderate	Maintained
Rock Creek	500				Moderate	Moderate	Moderate	High Risk
Crooked River (ext)	2,000							Extirpated
White Salmon R.(ext)	500							Extirpated.
Yakima River MPG								
Satus Creek	1,000 (500)	↑ 1127 (.17)	↑ 1.93 (.12)	Low	Low	Moderate	Moderate	Viable
Toppenish Creek	500	↓ 516 (.14)	↓ 2.52 (.19)	Low	Low	Moderate	Moderate	Viable
Naches River	1,500	↑ 1,244 (.16)	↑ 1.83 (.10)	Moderate	Low	Moderate	Moderate	Moderate
Upper Yakima River	1,500	↑ 246 (.18)	↑ 1.87 (.10)	Moderate	Moderate	High	High	High Risk
John Day River MPG								
Lower John Day Tribs	2,250	↓ 1,270 (.22)	↓ 2.67 (.19)	Moderate	Very Low	Moderate	Moderate	Maintained
Middle Fork John Day	1,000	↑ 1,736 (.41)	↑ 3.66 (.26)	Low	Low	Moderate	Moderate	Viable
North Fork John Day	1,000	↑ 1,896 (.19)	↓ 2.48 (.23)	Very Low	Very Low	Low	Low	Highly Viable
South Fork John Day	500	↑ 697 (.27)	↑ 2.01 (.21)	Low	Very Low	Moderate	Moderate	Viable

Upper John Day	1,000	641 (.21)	1.32 (.18)	Moderate	Very Low	Moderate	Moderate	Maintained
Umatilla/Walla Walla MPG								
Umatilla River	1,500	2,379 (.11)	1.20 (.32)	Moderate	Moderate	Moderate	Moderate	Maintained
Walla Walla River	1,000	877 (.13)	1.65 (.11)	Moderate	Moderate	Moderate	Moderate	Maintained
Touchet River	1,000	382 (.12)	1.25 (.11)	High	Low	Moderate	Moderate	High Risk

Overall, there have been improvements in the viability ratings for some of the component populations, but the MCR Steelhead DPS, as a whole, is not currently meeting the viability criteria (adopted from the ICTRT) in the Mid-Columbia Steelhead Recovery Plan (NWFSC 2015). In addition, several factors cited by the 2005 BRT remain as concerns or key uncertainties. Natural-origin returns to the majority of the populations in two of the four MPGs (Yakima River MPG and John Day River MPG) in this DPS increased modestly relative to the levels reported in the previous five-year review. Abundance estimates for 2 of 3 populations with sufficient data in the remaining two MPGs (Cascades Eastern Slope Tributaries MPG and Umatilla/Walla Walla MPG) were marginally lower (NWFSC 2015). Natural-origin spawning estimates are highly variable relative to minimum abundance thresholds across the populations in the DPS. In general, the majority of the population level viability ratings remained unchanged from prior reviews for each MPG within the DPS.

2.4.1. 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. NMFS has reviewed the status of critical habitat affected by the Proposed Action. Within the Action Area (defined below in Section 2.5 Action Area) is critical habitat for the MCR Steelhead and Snake River Steelhead DPSs. Critical habitat for these species includes the stream channels within designated stream reaches and a lateral extent, as defined by the ordinary high-water line (33 CFR 319.11).

NMFS determines the range-wide status of critical habitat by examining the condition of its physical and biological features, or PBFs, that were identified when critical habitat was designated. These features are essential to the conservation of the listed species because they support one or more of the species' life stages. An example of some PBFs are listed below.

(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.

For steelhead, NMFS categorized watersheds as high, medium, or low in terms of the conservation value that the watersheds provide to each listed species they support within designated critical habitat at the scale of the fifth-field hydrologic unit code (HUC5). To determine the conservation value of each watershed to species viability, NMFS's critical habitat analytical review teams (CHARTs) evaluated the quantity and quality of habitat features (i.e., spawning gravels, wood and water condition, side channels), the relationship of the specific geographic area being examined compared to other areas within the species' range, and the significance to the species of the population occupying that area (NMFS 2005b). Thus, even a location that has poor quality of habitat could be ranked with a high conservation value if it were essential because of factors such as limited availability (e.g., one of a very few spawning areas), a unique contribution to the population it served (e.g., for a population at the extreme end of geographic distribution), or the fact that it serves another important role besides providing habitat (e.g., obligate area for migration to upstream spawning areas). The HUCs that have been identified as critical habitat for these species are largely ranked as having high conservation value. Conservation value reflects several factors: (1) how important the area is for various life history stages, (2) how necessary the area is to access other vital areas of habitat, and (3) the relative importance of the populations the area supports relative to the overall viability of the ESU or DPS.

Middle Columbia River Steelhead

The Action Area for this Proposed Action includes the tributary streams in the Touchet and Walla Walla River Basin, the Umatilla River Basin, and the Deschutes River Basin below Pelton Dam that are accessible to anadromous fishes. Also included is the mainstem Columbia River down to Bonneville Dam (as described in Section 2.5). For MCR steelhead, these basins have been designated as essential for spawning, rearing, juvenile migration, and adult migration.

The ESA Recovery Plan for MCR salmonid species (recovery plan) (NMFS 2009; 2013b) described the major factors affecting PBFs within these basins as did the CHART review. The MCR Steelhead DPS's range includes 111 watersheds. The CHART assigned low, medium, and high conservation value ratings to 9, 24, and 78 watersheds, respectively (NMFS 2005b). They also identified one watershed with an unknown conservation value. Of the 111 watersheds, 9 covered the Walla Walla subbasin (including Touchet River), with five rated as having high, three as having medium, and one (Pine Creek) rated as having low conservation value. The Umatilla subbasin contains 10 watersheds occupied by this DPS, with six being rated as having high, one as having medium, and three being rated as having low conservation value. The Lower Deschutes subbasin contains 9 watersheds occupied by this DPS, with all watersheds being rated as having a high conservation value except White River, which has the rating of low conservation value. The following are the major factors limiting the conservation value of critical habitat for MCR steelhead:

- Agriculture

- Channel modifications/diking
- Dams,
- Forestry
- Fire activity and disturbance
- Grazing
- Irrigation impoundments and withdrawals,
- Urbanization
- Road building/maintenance

Snake River Steelhead

The Snake River Steelhead DPS's range includes 291 watersheds. The CHART assigned low, medium, and high conservation value ratings to 14, 43, and 230 watersheds, respectively (NMFS 2005a). They also identified 4 watersheds that had no conservation value. Of the 291 watersheds, 8 covered the Tucannon Lower Snake Area, with two rated as high, two rated as medium and 4 rated as having a low conservation value (NMFS 2005a). The following are the major factors limiting the conservation value of critical habitat for Snake River steelhead in the Tucannon and Lower Snake Rivers:

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

2.5. 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 Tucannon, Walla Walla, Umatilla, and Deschutes River Basins along with the mainstem Columbia River from the mouth of the Snake River down to Bonneville Dam (Figure 5). The Action Area includes locations where fish are captured, reared, and released, as well as areas where they may be monitored, or stray.

NMFS made several considerations in delineating the Action Area this way. The Action Area was not extended to the estuary/plume for two reasons. The first was that both the spring Chinook salmon and steelhead move relatively quickly through the migratory corridor and estuary to the ocean, and, therefore, would be expected to have a low potential for interacting meaningfully with fish migrating through the mainstem or utilizing the estuary for rearing (Section 2.10). Second, the NMFS (2017a) Opinion on Mitchell Act funding considered the effects of hatchery fish downstream of Bonneville Dam in the estuary and ocean, and found that subyearling Chinook salmon and coho salmon are the most likely hatchery fish to have effects in these areas due to their long residence times and relatively high predation rates, respectively, and so, because neither of these life histories is produced by the Proposed Action, these effects are unlikely to apply. Based on these two considerations, and an evaluation of ecological interactions (see Section 2.10), NMFS did not included the area below Bonneville Dam within the Action Area.

Furthermore, NMFS considered all ESA-listed salmon and steelhead ESU/DPSs (Table 10) because they would be present in the mainstem Columbia River above Bonneville Dam at the same time as hatchery fish released under the Proposed Action. NMFS in its evaluation of ecological interactions determined that the MCR Steelhead and Snake River Steelhead DPSs would be the only ESA-listed DPSs affected by the Proposed Action (see Section 2.10). As a result, the Action Area for analyzing the Proposed Action includes the Tucannon, Walla Walla, Umatilla, and Deschutes River Basins along with the mainstem Columbia River from the mouth of the Snake River down to Bonneville Dam.

2.6. Environmental Baseline

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

2.6.1. Habitat and Hydropower

A discussion of the baseline condition of habitat and hydropower throughout the Columbia River Basin occurs in our Biological Opinion on the Mitchell Act Hatchery programs (NMFS 2017e). Here we summarize some of the key impacts on salmon and steelhead habitat, primarily in the lower Columbia River and estuary because some of the effects from the Proposed Action are in this subarea.

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

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

- Food webs, including both predators and prey (food/prey and safe passage in the migration corridor)

Furthermore, the mainstem dams and the associated reservoirs present fish-passage hazards, causing passage delays and varying rates of injury and mortality. The altered habitats in project reservoirs reduce smolt migration rates and create more favorable habitat conditions for fish predators (NMFS 2017e). Mainstem dams and reservoirs can also affect water quality by influencing temperature due to storage, diversions, and irrigation return flows, reducing turbidity, increasing total dissolved gas, and contributing toxic contaminants. All of these impacts affect the migration of adults and juveniles in the mainstem Columbia River.

The habitat of affected species is defined as its region, and the discussion here considers the extent to which impacts to the habitat regions shape the species status and baseline. This is a much broader area than the Action Area, which is defined above and comprises a portion of the habitat regions. NMFS' jeopardy determination will be based on effects of the Proposed Action within the Action Area.

Middle Columbia River Region

In the MCR region, only steelhead are listed among the salmonid species present, so to the extent this action may affect listed species via habitat issues, we focus on effects to steelhead habitat. The range of the MCR Steelhead DPS extends over approximately 35,000 square miles in the Columbia plateau of eastern Washington and eastern Oregon. Major drainages within the range of this DPS are the Deschutes, John Day, Umatilla, Walla Walla, Yakima, and Klickitat River systems. The Cascade Mountains form the western border of the plateau in both Oregon and Washington, while the Blue Mountains form the eastern edge. The southern border is marked by the divides that separate the upper Deschutes and John Day basins from the Oregon high desert and drainages to the south. The Wenatchee Mountains and Palouse areas of eastern Washington border the MCR Basin on the north.

Temperatures and precipitation vary widely, usually depending on elevation, with cooler and wetter climates in the mountainous areas at the western and eastern boundaries and warmer and drier climates at the lower elevations. The mountainous regions are predominately coniferous forests, while the arid regions are characterized by sagebrush steppe and grassland.

Most of the region is privately owned (64%), with the remaining area under Federal (23%), tribal (10%) and state (3%) ownership. The landscape, throughout the range of this DPS, is heavily modified for human use, even where populations are low. Most of the landscape consists of rangeland and timberland with significant concentrations of dryland agriculture in parts of the range. Irrigated agriculture and urban development are generally concentrated in valley bottoms and human populations in these regions are growing.

Habitat degradation from past and/or present land use impacts the steelhead populations in this DPS. Extensive beaver activity created diverse instream habitats, with deep pools and strong connections to the floodplains. Many stream channels contained abundant large wood from surrounding riparian forests, which included cottonwood, aspen, willow, and upstream conifers. Stream temperatures sufficient to support all steelhead life stages throughout the year were common. Upland and riparian conditions allowed for the storage and release of cool water during the dry summer months and provided sufficient shade to keep water temperatures cool. Extensive and abundant riparian vegetation armored stream banks, providing protection against erosion and supporting an abundant food supply. Dynamic patterns of channel migration in floodplains continually created complex channel, side channel, and off-channel habitats.

Today, nearly all historical habitat lies in areas modified by human settlement and activities. Historical land use exerted a large and widespread impact on steelhead habitat quality and quantity across the range of the DPS. These development practices included removal of wood from streams that occurred through the 1980s; removal of riparian vegetation; timber harvest; road construction; agricultural development; livestock grazing; urbanization; wetland draining; gravel mining; alteration of channel structure through stream relocation, channel confinement, and straightening; beaver removal; construction of dams for multiple purposes; and direct withdrawal of water for irrigation or human consumption.

While some streams and stream reaches retain highly functional habitat conditions to this day, these various human activities have degraded streams and stream reaches across the range of the MCR Steelhead DPS, leaving them with insufficient large wood in channels, insufficient instream complexity and roughness, and inadequate connectivity to associated wetlands and off-channel habitats. Many streams lack sinuosity and associated meanders and suffer from excessive streambank erosion and sedimentation, as well as altered flow regimes and higher summer water temperatures. In many areas, the contemporary watershed conditions created by past and current land use practices are so different from those under which native fish species evolved that these conditions now pose a significant impediment to achieving recovery. The recovery plans contain detailed descriptions of tributary habitat threats and limiting factors.

The human population in the Yakima River subbasin is growing (now over 300,000) and most likely will continue to grow. Planners expect that most land use and development for future population growth will occur near the Yakima River mainstem and major tributary corridors. Water storage and delivery systems have major impacts on the Yakima River subbasin’s hydrology. An extensive water supply system, run by the BOR’s Yakima Irrigation Project, stores and delivers water for over 400,000 acres (~156 square miles) of irrigated agriculture and, to a lesser degree, industrial, domestic, and hydropower use. Management of water storage and delivery systems results in stream flows across the subbasin that are often out of phase (e.g., heavy flows at times when naturally there would be low flows) with the life history requirements of native salmonids (Fast et al. 1991) and riparian species such as cottonwoods (Braatne and Jamieson 2001).

Snake River Region

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

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

2.6.2. Climate Change

Climate change has negative implications for designated critical habitats in the Pacific Northwest (Climate Impacts Group 2004; Scheuerell and Williams 2005; Zabel et al. 2006; ISAB 2007). Average annual Northwest air temperatures have increased by approximately 1ºC since 1900, or about 50% 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 streamflows in the June through September period. River flows in general and peak river flows are likely to increase during the winter due to more precipitation falling as rain rather than snow.
- Water temperatures are expected to rise, especially during the summer months when lower streamflows co-occur with warmer air temperatures.

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

To mitigate for the effects of climate change on listed salmonids, the ISAB (2007) recommended in 2007 to prepare for future climate conditions by implementing protective tributary, mainstem, and estuarine habitat measures, as well as protective hydropower mitigation measures. In particular, the ISAB (2007) suggests increased summer flow augmentation from cool/cold storage reservoirs to reduce water temperatures or to create cool water refugia in mainstem reservoirs and the estuary; and the protection and restoration of riparian buffers, wetlands, and floodplains.

While planning for future general effects, it is important to note that climate change is already actively altering environments around the globe as temperature and precipitation patterns change and become more variable. The year 2015 broke numerous global records, including the highest greenhouse gas concentration and highest land and sea surface temperatures ever recorded (Blunden and D.S. Arndt 2016). The year 2016 surpassed global temperature records set in 2015 (NOAA website, *http://www.ncdc.noaa.gov/cag*), and has already set records for minimum sea ice extent in the Arctic (2nd lowest on record) and annual maximum sea ice extent in the Antarctic (lowest on record; http://nsidc.org/arcticseaicenews).

Projections of how earth's climate will continue to change depend on the rate of anthropogenic emissions. By the end of the 21st century, global temperatures are expected to increase by 0.3°C (with reduced emissions), to 4.8°C (high emissions) from the present, with more frequent extreme hot temperatures and fewer extreme cold temperatures (IPCC 2014). Precipitation is also expected to change, with some areas becoming wetter and others drier. Extreme precipitation events will very likely become more intense and more frequent (IPCC 2014). In the ocean, global sea level is expected to rise by 0.3 meters (low emissions) to 0.9 meters (high emissions) by the end of the century. The oceans are also expected to become more acidic as more CO_2 is absorbed by the world's oceans (IPCC 2014).

In the Pacific Northwest (generally southern British Columbia, Washington, and Oregon), it is likely that some air and stream temperature changes due to climate change have already occurred. Into the immediate future, there is likely to be no easily discernible trend in precipitation over this period (neither strongly increase nor decrease), although summers may become drier and winters wetter due to changes in the same amount of precipitation being subjected to altered seasonal temperatures (Mote and Eric P. Salathé Jr. 2010; PCIC 2016). Warmer winters will result in reduced snowpack throughout the Pacific Northwest, leading to substantial reductions in stream volume and changes in the magnitude and timing of low and high flow patterns (Beechie et al. 2013; Dalton et al. 2013). Many basins that currently have a snowmelt-dominated hydrological regime (maximum flows during spring snow melt) will become either transitional (high flows during both spring snowmelt and fall-winter) or rain-dominated (high flows during fall-winter floods; (Beechie et al. 2013; Schnorbus et al. 2014). Summer low flows are expected to be reduced from 10-70% in areas west of the Cascade

Mountains over the next century, while increased precipitation and snowpack is expected for the Canadian Rockies. More precipitation falling as rain and larger future flood events are expected to increase maximum flows by 10-50% across the region (Beechie et al. 2013).

In marine waters of the Pacific Northwest, sea surface temperatures (SSTs) are expected to increase by 1.2°C by 2040 (Mote and Eric P. Salathé Jr. 2010) and up to 2°C in northern British Columbia and Alaska (Hollowed et al. 2009; Foreman et al. 2014). Increased temperatures will increase water column stratification, which can be beneficial for productivity in northern areas but detrimental in southern areas (Gargett 1997). Effects of climate change on the timing and intensity of ocean upwelling, which brings nutrient-rich waters to the surface in coastal areas of the California Current, are poorly understood with some climate models show upwelling will be delayed in the spring and become more intense in the summer, while others show it largely unchanged (Bakun et al. 2015; Rykaczewski et al. 2015). Our intent with this summary is not to provide an exhaustive review of what is known about current conditions contributing to current status delineations, but instead to provide an overview, with a particular emphasis on environmental factors that are important to anadromous fish productivity and survival. In many cases, current environmental conditions are outside the range of observations; therefore, their biological effects are difficult to predict. Only in hindsight will we be able to tell how these conditions affected survival and these effects are discussed here to ensure that it’s understood they are incorporated into status levels.

Climate Change and Pacific Northwest salmon

Climate change is predicted to cause a variety of impacts on Pacific salmon and their ecosystems (Mote et al. (2003); Crozier et al. (2008a); Martins et al. (2012); Wainwright and Weitkamp (2013)). During the last century, average regional air temperatures increased by 1.5°F, and increased up to 4°F in some areas. As the climate changes, air temperatures in the Pacific Northwest are expected to increase <1°C in the Columbia Basin by the 2020s and 2°C to 8°C by the 2080s (Mantua et al. 2010). Overall, about one-third of the current cold-water fish habitat in the Pacific Northwest is likely to exceed key water temperature thresholds by the end of this century (USGCRP 2009). While total precipitation changes are uncertain, increasing air temperature will result in more precipitation falling as rain rather than snow in watersheds across the basin (NMFS 2015).

The complex life cycles of anadromous fishes including salmon rely on productive freshwater, estuarine, and marine habitats for growth and survival, making them particularly vulnerable to environmental variation (Morrison et al. 2016). Ultimately, the effect of climate change on salmon and steelhead across the Pacific Northwest will be determined by the specific nature, level, and rate of change and the synergy between interconnected terrestrial/freshwater, estuarine, nearshore, and ocean environments.

The primary effects of climate change on Pacific Northwest salmon and steelhead are:

- direct effects of increased water temperatures on fish physiology
- temperature-induced changes to stream flow patterns
- alterations to freshwater, estuarine, and marine food webs
- changes in estuarine and ocean productivity

While all habitats used by Pacific salmon will be affected, the impacts and certainty of the change vary by habitat type. Some effects (e.g., increasing temperature) affect salmon at all life stages in all habitats, while others are habitat-specific, such as stream flow variation in freshwater, sea level rise in estuaries, and upwelling in the ocean. How climate change will affect each stock or population of salmon also varies widely depending on the level or extent of change and the rate of change and the unique life history characteristics of different natural populations (Crozier et al. 2008b). For example, a few weeks' difference in migration timing can have large differences in the thermal regime experienced by migrating fish (Martins et al. 2011).

Temperature Effects

Like most fishes, salmon are poikilotherms ("cold-blooded" animals), so increasing temperatures in all habitats can have pronounced effects on their physiology, growth, and development rates (see review by Whitney et al. (2016)). Increases in water temperatures beyond their thermal optima will likely be detrimental through a variety of processes including: increased metabolic rates (and therefore food demand), decreased disease resistance, increased physiological stress, and reduced reproductive success. All of these processes are likely to reduce survival (Beechie et al. 2013; Wainwright and Weitkamp 2013; Whitney et al. 2016). As examples of this, high mortality rates for adult sockeye salmon in the Columbia River and likewise in the Fraser River have recently been attributed to higher water temperatures, as increasing temperatures during adult upstream migration are expected to result in increased mortality of sockeye salmon adults by 9-16% by century's end (Martins et al. 2011). Juvenile parr-to-smolt survival of Snake River Chinook salmon are predicted to decrease by 31-47% due to increased summer temperatures (Crozier et al. 2008b).

By contrast, increased temperatures at ranges well below thermal optima (i.e., when the water is cold) can increase growth and development rates. Examples of this include accelerated emergence timing during egg incubation stages, or increased growth rates during fry stages (Crozier et al. 2008a; Martins et al. 2012). Temperature is also an important behavioral cue for migration (Sykes et al. 2009), and elevated temperatures may result in earlier-than-normal migration timing. While there are situations or stocks where this acceleration in processes or behaviors is beneficial, there are also others where it is detrimental (Martins et al. 2012; Whitney et al. 2016).

Freshwater Effects

As described previously, climate change is predicted to increase the intensity of storms, reduce winter snow pack at low and middle elevations, and increase snowpack at high elevations in northern areas. Middle and lower elevation streams will have larger fall/winter flood events and lower late summer flows, while higher elevations may have higher minimum flows. How these changes will affect salmon populations largely depends on their specific life history characteristics and location, which vary at fine spatial scales (Crozier et al. 2008b; Martins et al. 2012). Within a relatively small geographic area (Salmon River Basin, Idaho), survival of some Chinook salmon populations was shown to be determined largely by temperature, while survival of others was determined by flow (Crozier and Zabel 2006). Populations inhabiting regions that are already near or exceeding thermal maxima will be most affected by further increases in temperature and perhaps the rate of the increases while the effects of altered flow are less clear and likely to be basin-specific (Crozier et al. 2008b; Beechie et al. 2013). However, river flow is already becoming more variable in many Puget Sound rivers, and is believed to negatively affect Chinook salmon survival more than other environmental parameters (Ward et al. 2015). It is likely this increasingly variable flow is detrimental to multiple salmon and steelhead populations in the Columbia River Basin as well.

Stream ecosystems will likely change in response to climate change in ways that are difficult to predict (Lynch et al. 2016). Changes in stream temperature and flow regimes will likely lead to shifts in the distributions of native species and provide “invasion opportunities” for exotic species. This will result in novel species interactions including predator-prey dynamics, where juvenile salmon may be either predators or prey (Lynch et al. 2016; Rehage and Blanchard 2016). How juvenile salmon will fare as part of “hybrid food webs”, which are constructed from natives, native invaders, and exotic species, is difficult to predict (Naiman et al. 2012).

Uncertainty in climate predictions

In 2016, NMFS released their Guidance for Treatment of Climate Change in NMFS Endangered Species Act Decisions (Weiting 2016), which recommended use of the most current reports from the Intergovernmental Panel on Climate Change (IPCC) in evaluating effects of climate change in section 7(a)(2) biological opinions under the ESA. This guidance states that “NMFS will use climate indicator values projected under the IPCC's Representative Concentration Pathway 8.5 when data are available. When data specific to that pathway are not available, we will use the best available science that is as consistent as possible with RCP 8.5” (Weiting 2016). Global climate projections provided in the most recent IPCC reports (IPCC 2014) are informative and, in some cases, the only or the best scientific information available for use.

There is considerable uncertainty in the predicted effects of climate change on the globe as a whole, and on Pacific Northwest anadromous fish in particular, and there is also the question of indirect effects of climate change and whether human “climate refugees” will move into the range of salmon and steelhead, increasing stresses on their respective habitats (Dalton et al. 2013; Poesch et al. 2016).

Many of the effects of climate change (e.g., increased temperature, altered flow, coastal productivity, etc.) will have direct impacts on the food webs that salmon rely on in freshwater, estuarine, and marine habitats to grow and survive. Such ecological effects are extremely difficult to predict even in fairly simple systems, and minor differences in life history characteristics among stocks of salmon may lead to large differences in their response (e.g., Crozier et al. (2008b); Martins et al. (2011); Martins et al. (2012). This means it is likely that there will be “winners and losers,” meaning some salmon populations may enjoy different degrees or levels of benefit from climate change while others will suffer varying levels of harm.

Pacific anadromous fish are adapted to natural cycles of variation in freshwater and marine environments, and their resilience to future environmental conditions depends both on characteristics of each individual population and on the level and rate of change. They should be able to adapt to some changes, but others are beyond their adaptive capacity (Crozier et al. 2008a; Waples et al. 2009). With their complex life cycles, it is also unclear how conditions experienced in one life stage are carried over to subsequent life stages, including changes to the timing of migration between habitats. Systems already stressed due to human disturbance are less resilient to predicted changes than those that are less stressed, leading to additional uncertainty in predictions (Bottom et al. 2011; Naiman et al. 2012; Whitney et al. 2016).

Climate change is expected to impact Pacific Northwest anadromous fish during all stages of their complex life cycles. In addition to the direct effects of rising temperatures, indirect effects include alterations in stream flow patterns in freshwater and changes to food webs in freshwater, estuarine and marine habitats. There is high certainty that predicted physical and chemical changes will occur, however, the ability to predict bio-ecological changes to fish or food webs in response to these physical/chemical changes is extremely limited, leading to considerable uncertainty.

For ESA-listed MCR steelhead populations in the Touchet, Walla Walla, Umatilla, and Deschutes Rivers, as well as Snake River steelhead in the Tucannon River, water quality and water quantity are limiting factors (Section 2.2.1). As described above, climate change is expected to increase temperatures, alter flow regimes, and affect snow fall and rain patterns, all of these would be expected to have an effect on these summer steelhead populations which are dependent on having flows that are of enough volume and temperature to provide passage into these rivers in the fall, for migration to the spawning areas, and for juvenile rearing. The water in these basins have already been impacted by a number of factors including the removal of riparian vegetation; timber harvest; road construction; agricultural development; livestock grazing; urbanization; wetland draining; gravel mining; alteration of channel structure through stream relocation, channel confinement, and straightening; beaver removal; construction of dams for multiple purposes; and direct withdrawal of water for irrigation or human consumption. All of these factors in combination with reduced flows and higher temperatures due to climate change would be expected to reduce the overall productivity and abundance of summer steelhead populations in these basins.

In conclusion, the current literature supports previous concerns that natural climatic variability can amplify and exacerbate long-term climate change impacts. Recent estimates of rates of climate change are similar to those previously published. Anthropogenic climate change will likely to varying degrees effect all west coast anadromous fish species, including MCR and Snake River summer steelhead, especially when interacting factors are incorporated (e.g., existing threats to populations, water diversion, accelerated mobilization of contaminants, hypoxia, and invasive species). However, through historical selective processes anadromous fish have adapted their behavior and physiology to inhabit available habitat ranging from southern California up to the Alaskan western coastline. This process by which Pacific anadromous fish are adapted to natural cycles of variation in freshwater and marine environments required a certain degree of plasticity, and may show resilience to future environmental conditions that mimic this natural variation. While climate change effects will certainly result in changes, it is unlikely that specifics are possible to predict. Alternate life history types, such as those associated with extended lake or estuarine rearing, provide an important component of the species diversity with which to guard against an uncertain future. However, the life history types that will be successful in the future are neither static nor predictable, and therefore maintaining or promoting existing diversity that is found in the natural populations of Pacific anadromous fish is essential for continued existence of populations into the future (Schindler et al. 2010; Bottom et al. 2011).

2.6.3. Hatcheries

A more comprehensive discussion of hatchery programs in the Columbia Basin can be found in the 2017 opinion on Mitchell Act funded programs (NMFS 2017e). In summary, because most programs are ongoing, the past effects of each are reflected in the most recent status of the species, (NWFSC 2015) and were summarized in Section 2.2.1 of this opinion. Additionally, nearly all hatchery programs in the Columbia River basin have undergone ESA §7 consultation, either as part of the Mitchell Act funding action or in separate bundles. Therefore, nearly all ongoing hatchery effects in the Action Area from programs not included in the Proposed Action are considered part of the environmental baseline.

Generally speaking, in the past hatcheries have been used to compensate for factors that limit anadromous salmonid viability (e.g., harvest, human development) by maintaining fishable returns of adult salmon and steelhead. A new role for hatcheries emerged during the 1980s and 1990s as a tool to conserve the genetic resources of depressed natural populations and to reduce short-term extinction risk (e.g., Snake River sockeye salmon). Hatchery programs also can be used to help improve viability by supplementing natural population abundance and expanding spatial distribution. However, the long-term benefits and risks of hatchery supplementation remain untested (Christie et al. 2014). Therefore, fixing the factors limiting viability is essential for long-term viability.

The MCR steelhead recovery plan (NMFS 2009), identified hatchery fish that stray into Middle Columbia tributaries and spawn naturally as representing a serious threat to steelhead recovery. More than 100 hatchery programs operate in the Columbia Basin above Bonneville Dam, mostly for the purpose of providing fish for harvest to mitigate losses caused by the FCRPS. Some hatchery programs may provide conservation benefits; however, hatchery programs also pose threats to natural-origin steelhead in some Middle Columbia watersheds. Hatchery-influenced genetic change can reduce the fitness of both hatchery and natural-origin fish in the wild, and hatchery-influenced ecological effects (competition for food and space) can reduce population productivity and abundance (see Appendix A).

In particular, hatchery programs designed to return summer steelhead to upstream Columbia River tributaries result in substantial numbers of stray hatchery steelhead spawning naturally among several Middle Columbia populations (NMFS 2009). Concern exists regarding the continuing detrimental impact of these stray out-of-DPS hatchery fish in natural spawning areas on the genetic diversity and productivity of naturally produced MCR steelhead populations.

The Oregon Steelhead Recovery Plan identified hatchery practices and the effects of spawning stray hatchery fish as a key limiting factor and threat to the viability of the Deschutes River Eastside, Deschutes Westside, John Day, Umatilla, and Walla Walla populations. Out-of-DPS hatchery-origin spawners were estimated at 29 percent for Deschutes Eastside, 15.2 percent for Deschutes Westside, from 10 to 18 percent for Lower Mainstem John Day, and 5 percent for the Umatilla population (NMFS 2009).

Within the Action Area, both the Round Butte hatchery program on the Deschutes River and the Umatilla hatchery program on the Umatilla River use endemic summer steelhead for broodstock; however, the Deschutes River program discontinued use of natural-origin steelhead due to concerns with whirling disease and of incorporating out-of-basin strays in the broodstock. Out-of-basin hatchery smolts are released into the Walla Walla River as part of the LSRCP. WDFW operates the Lyons Ferry Hatchery, which is the only summer steelhead hatchery program in the Walla Walla basin in Oregon. This hatchery program has been modified over time to reduce the impacts of non-endemic hatchery smolts released into the lower Walla Walla River with the goal of reducing genetic risks to the endemic steelhead population. These changes have been found to have reduced risks to the Touchet and Walla Walla steelhead populations (NMFS 2017d).

The Touchet River Endemic summer steelhead program, also funded under by the LCRCP and part of the Proposed Action was designed in 2000 to determine the feasibility of using endemic summer steelhead as broodstock with the goal of replacing the release of LFH Wallowa stock summer steelhead. This program is being evaluated as part of this opinion.

2.6.4. Harvest

Fisheries of the Columbia River are established within the guidelines and constraints of the Pacific Salmon Treaty, the Endangered Species Act administered by NMFS, the Pacific Fishery Management Council, the states of Oregon and Washington, the Columbia River Compact, and management agreements negotiated between the parties to *U.S. v. Oregon*. Fisheries management through these various organizations has resulted in the decline of total exploitation rates for Columbia River salmon and steelhead, especially since the 1970s. Because of these changes, the ICTRT currently considers harvest a secondary limiting factor for Oregon MCR steelhead populations.

Ocean Fisheries

NMFS (2009) identified that steelhead are rarely caught in ocean fisheries because they tend to be distributed offshore of major fishing areas and are therefore not readily available. According to Rich (1942), Columbia River steelhead were historically taken along with Chinook and coho in ocean fisheries off the mouth of the Columbia River, but accounted for less than 0.1% of the catch and numbered only in the few hundreds of fish. Current ocean fisheries generally target Chinook and coho salmon, and interception of steelhead is believed to be rare. If caught, steelhead must be released. Creel surveys on recreational ocean fisheries recorded less than 100 steelhead (of any DPS) caught each year from 2003 to 2005. Of these, less than 10 were estimated to be released wild fish mortalities. Ocean fishing mortality on MCR steelhead is assumed to be zero.

Mainstem Columbia Fisheries

Harvest rates on the MCR Steelhead DPS in the past (e.g. prior to 1975) were estimated at 65 percent in fisheries occurring in the Columbia River. Current rates are much lower. There has been no direct freshwater non-tribal harvest on wild steelhead from the MCR DPS since 1992, when the last wild fish catch-and-release regulations on these populations became effective.

Therefore, all current non-tribal harvest impacts on MCR DPS steelhead are due to incidental bycatch in commercial or recreational fisheries that target hatchery steelhead or other species.

There are three stocks of summer steelhead used for management of treaty and non-treaty Columbia River mainstem fisheries, including the Skamania stock, upriver A-run stock, and upriver B-run stock. All MCR steelhead populations are designated as A-run, with two populations being winter run. In NOAA's Biological Opinion for the 2008-2017 *U.S. v. Oregon* Fisheries Agreement, the wild MCR steelhead DPS in the non-treaty winter, spring, and summer mainstem fisheries are subject to a 2% harvest rate limit (NMFS 2008d). Non-treaty fall fisheries are also limited to a 2% harvest rate limit for A-run summer steelhead. The total annual harvest rate limit for A-run steelhead in non-treaty fisheries is 4% and 2% for the summer-run and winter-run of the MCR steelhead DPS respectively. The actual harvest impacts from non-treaty fisheries have been less than the limits in the *U.S. v. Oregon* Fisheries Agreement. The yearly incidental catch of A-run summer steelhead in non-treaty fisheries has averaged 2.15% from 2008 to 2015 (Table 17) (NMFS 2008d).

Snake River steelhead populations are designated as either A-run or B-run. In NOAA's Biological Opinion for the 2008-2017 *U.S. v. Oregon* Fisheries Agreement, winter, spring, and summer fisheries are subject to a 2% harvest rate limit on wild steelhead from each steelhead DPS. Non-Treaty fall season fisheries are likewise subject to a 2% harvest rate limit for each steelhead DPS.

Table 17. Annual post season performance of fisheries managed under the 2008 *U.S. v. Oregon* Agreement.

ESU or DPS		Total impact annually achieved based on postseason reporting							
Combined Rates[1]		**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Snake River spring/ summer-run Chinook		9.1%	10.0%	9.1%	8.8%	10.6%	9.2%	12.5%	13.4%
UCR spring-run Chinook		9.1%	9.1%	10.8%	8.7%	10.5%	9.1%	12.4%	13.4%
UWR spring-run Chinook	In spring fisheries	5.9%	7.6%	16.4%	12.9%	10.0%	9.3%	8.9%	9.0%
LCR Chinook	Spring component[3]	yes	yes	yes	yes	yes	yes	yes	yes
	Fall tule component[2]	33.0%	37.0%	35.0%	40.8%	44.5%	32.9%	40.8%	34.90%
	Fall bright component[4]	5,485	6,283	9,294	8,205	8,143	15,197	20,809	2,149
Snake River fall-run Chinook		27.4%	37.9%	25.9%	33.0%	34.6%	31.3%	34.8%	31.3%
LCR Coho[2]		7.3%	18.7%	10.7%	13.5%	14.0%	13.7%	17.4%	24.4%
CR Chum		1.6%	1.6%	4.7%	0.1%	0.1%		0.8%	1.4%
Snake River Sockeye		4.6%	6.0%	6.8%	7.8%	9.7%	4.7%	5.0%	6.2%
Separate Rates									
Tribal only	Steelhead B-Run (in fall fisheries)	15.2%	16.8%	15.7%	21.1%	13.5%	14.0%	12.5%	12.1%
Non-tribal only									
Snake River Steelhead	Group A Index (in winter/spring/summer fisheries)	0.8%	0.7%	0.9%	0.9%	2.2%	0.8%	0.7%	0.5%
Snake River Steelhead	Group B Index (in winter/spring/summer fisheries)	0.1%	0.0%	0.1%	0.2%	0.2%	0.0%	0.0%	0.0%
Snake River Steelhead	Group A Index (in fall fisheries)	0.6%	1.0%	0.8%	1.6%	1.2%	1.6%	1.3%	1.1%
Snake River Steelhead	Group B Index (in fall fisheries)	1.1%	1.3%	1.8%	1.9%	1.8%	2.0%	1.6%	2.0%
UCR Steelhead	In winter/spring/summer fisheries	0.8%	0.7%	0.9%	1.5%	1.9%	0.9%	0.8%	0.5%
UCR Steelhead	In fall fisheries	1.0%	0.8%	0.8%	1.5%	1.2%	1.6%	1.3%	1.1%
MCR Steelhead	Summer component (in winter/spring/summer fisheries)	0.8%	0.7%	0.9%	0.9%	2.2%	0.8%	0.7%	0.5%
MCR Steelhead	Summer Component (in fall fisheries)	0.6%	1.0%	0.8%	1.6%	1.2%	1.6%	1.3%	1.1%
MCR Steelhead	Winter Component (winter fisheries)	0.3%	0.4%	0.7%	0.7%	0.8%	0.4%	0.7%	0.6%
LCR Steelhead	Summer component (in winter/spring/summer fisheries)	0.3%	0.4%	0.7%	0.7%	0.8%	0.4%	0.7%	0.6%
LCR Steelhead	Summer Component (in fall fisheries)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
LCR Steelhead	Winter Component (in winter fisheries)	0.3%	0.3%	0.7%	0.7%	0.8%	0.6%	0.6%	0.6%
UWR Steelhead	Winter Component (in winter fisheries)	--	--	--	0.3%	0.5%	0.6%	0.6%	0.6%

[1] Rate allocations are specified in 2008 *U.S. v. Oregon* Agreement, but can be added together for reporting purposes

[2] Rate set annually in coordination with PFMC for combined exploitation rate for ocean and Columbia River mainstem fisheries up to Bonneville Dam.

[3] Managed for hatchery escapement goals to the Cowlitz, Lewis and Sandy Rivers. If annual box is yes, then H.E. goal was met 100%.

[4] Managed for an escapement goal of 5,700 fish in the North Lewis River.

Tributary fisheries that affect MCR steelhead

Oregon and Washington have proposed regulations for tributary recreational fisheries in FMEPs submitted to NOAA Fisheries for approval under the limit 4 of the 4(d) rule. All tributary recreational fisheries require the release of all unmarked steelhead thus all impacts on MRC summer steelhead are due to catch and release mortality. WDFW estimates that the impacts on MCR steelhead from all fisheries was 7.5% for the Treaty Columbia River mainstem and tributary fisheries, < 4.0 % for the non-treaty Columbia River mainstem fisheries, and 0.3% in Washington tributaries for a total impact of less than 12% (WDFW 2008). Treaty fisheries do occur in the Umatilla River—Tribal members can retain natural-origin steelhead during fisheries targeting spring Chinook, fall Chinook, and coho salmon. Tribal fisheries are estimated to have harvested an average of 80 adult steelhead (hatchery and natural-origin combined) annually, between 2001 and 2009, and the harvest ranged from 32 to 129 over that period (Clarke et al. 2010). The annual average impact from the retention of natural-origin steelhead in this tribal fishery represents approximately 2.5% of the average adult returns to the Umatilla River.

Monitoring these impacts is complex. Information assessing catch-and-release mortality of adult steelhead is limited. However, available information suggests that hook-and-release mortality is low. Hooton (1987) found catch-and-release mortality of adults in winter steelhead fisheries to be, on average, less than 5 percent when using barbed and barbless hooks, bait and artificial lures; Hooton (1987) concluded that catch-and-release of adult steelhead was an effective mechanism for maintaining angling opportunity without negatively impacting stock recruitment. Reingold (1975) showed that adult steelhead hooked, played to exhaustion, and then released returned to their target spawning stream as well as steelhead not hooked and played to exhaustion. Similarly, Nelson et al. (2005) observed that the catch-and-release mortality for radio-tagged wild winter steelhead was 2.5 percent and that tagged steelhead survived to spawning even after being caught and released up to three times. Mongillo (1984) reported a strong correlation between water temperature and catch-and-release mortality with water temperatures below 50°F (10°C) providing optimal survival, while temperatures above 60°F (15.5°C) increase the mortality rate.

ODFW performed a number of Population Viability Assessment model runs for 27 steelhead populations to assess the impact of fisheries mortality on the status and recovery of steelhead in Oregon (Chilcote 2001). The model looked at a range of fisheries mortalities from 0% to 75%. The results were stated in terms of the probability of the population becoming extinct in 50 years at each fisheries mortality rate. For most populations, the modeling suggested that the probability of extinction was essentially zero as long as fisheries mortality rates remained lower than 30%. As mortality rates became greater than 40%, the probability of extinction increased dramatically. Furthermore, once the probability of extinction increased beyond 0.05, the transition to an extinction probability of 1.00 was very rapid. In other words, once mortality rates increase sufficiently to cause the probability of extinction to exceed 0.05, any additional mortality would cause a rapid increase in the likelihood of extinction. Because the transition from low to high risk happens so rapidly, there is little room for error (in the model or the measurements of mortality rates). To address this concern, ODFW will manage steelhead fisheries not to exceed a maximum fisheries mortality limit to 20%. This conservative approach was used to provide a buffer for errors, even though the model results suggested that management under a 40% limit was unlikely to cause extinction.

Combining all of the expected impacts on MCR steelhead from Columbia River mainstem and tributary fisheries is expected to be well below the 20% mortality rate management goal and supports the ICTRT's determination that fisheries are a secondary limiting factor for MCR steelhead (ICTRT 2008).

Tributary Fisheries that affect Snake River steelhead

Spring Chinook salmon fisheries also occur within the Columbia River tributary subbasins in northeast Oregon that affects Snake River steelhead. 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 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 2013a). 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 2013a). There is a small tribal spring Chinook salmon fishery in the Tucannon River that operates intermittently. From 2007-2009, this fishery did not occur. (https://www.fws.gov/lsnakecomplan/Reports/NPTreports.html).

Sport harvest for steelhead in the Snake River Basin is restricted to adipose clipped, hatchery-origin fish. Estimates of maximum incidental mortality rates for listed populations associated with steelhead and trout fisheries are based on estimates of hooking rates and hooking-related mortality estimated at 5 percent for adult steelhead caught and released in steelhead fisheries (Hooton 1987), and 10 percent for spring chinook adults caught and released during trout fisheries (Lindsay et al. 2001). For the individual populations where fisheries occur to selectively harvest hatchery fish in terminal areas, incidental mortality of natural steelhead is usually less than 5 percent of the population. Catch-and-release mortality of steelhead is likely to be higher if the fishery occurs during warm water conditions (Mongillo 1984). However, most of the steelhead harvest occurs between October and March when average water temperature in the Snake River is around 8-9°C, (WDOE – River and Stream Water Quality Monitoring Program – Station#35A150). In the Snake River mainstem, where effects are likely distributed among populations, mortality is less than one percent across the DPS (Copeland et al. 2013; 2014; Copeland et al. 2015; Stark et al. 2016).

2.7. 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 in Appendix A and application of the methodology and analysis of the Proposed Action is in Section 2.7.2. 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.

2.7.1. Factors That Are Considered When Analyzing Hatchery Effects

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

"Because of the potential for circumventing the high rates of early mortality typically experienced in the wild, artificial propagation may be useful in the recovery of listed salmon species. However, artificial propagation entails risks as well as opportunities for salmon conservation" (Hard et al. 1992). A Proposed Action is analyzed for effects, positive and negative, on the attributes that define population viability: abundance, productivity, spatial structure, and diversity. The effects of a hatchery program on the status of an ESU or steelhead DPS and designated critical habitat "will depend on which of the four key attributes are currently limiting the ESU, and how the hatchery fish within the ESU affect each of the attributes" (70 FR 37204, 37215, June 28, 2005). The presence of hatchery fish within the ESU can positively affect the overall status of the ESU by increasing the number of natural spawners, by serving as a source population for repopulating unoccupied habitat and increasing spatial distribution, and by conserving genetic resources. "Conversely, a hatchery program managed without adequate consideration can affect a listing determination by reducing adaptive genetic diversity of the ESU, and by reducing the reproductive fitness and productivity of the ESU".

NMFS' analysis of the Proposed Action is in terms of effects it would be expected to have on ESA-listed species and on designated critical habitat, based on the best scientific information available. This allows for quantification (wherever possible) of the effects of the six factors of hatchery operation on each listed species at the population level (in Section 2.7.2), 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 2.17).

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

Action for its effects on ESA-listed species and on designated critical habitat depends on six factors. These factors are:

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

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

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

(4) RM&E that is associated with the hatchery program

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

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

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

2.7.2. Effects of the Proposed Action

This section discusses the effects of the Proposed Action on the ESA-listed species in the Action Area. Most of the effects here focus on MCR steelhead because the facilities operate and releases occur in the MCR region. The effects analysis of returning adults (Section 2.9, Factor 2) looks at the effects on MCR steelhead and Snake River steelhead. The effects analysis of juvenile outmigration (Section 2.10, Factor 3) looks at the effects on other ESA-listed salmonids, such as the Upper Columbia and Lower Columbia species, and determined that all effects in the migration corridor is discountable; MCR steelhead may be affected by fish that residualize.

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

The Touchet and Umatilla steelhead programs will use listed natural-origin summer steelhead in their broodstocks, as discussed below. The Walla Walla spring Chinook salmon hatchery program and the Round Butte Hatchery spring Chinook salmon program may incorporate unlisted natural-origin spring Chinook salmon in the broodstock. Similarly, the Touchet Spring Chinook salmon program may also incorporate natural-origin spring Chinook salmon into the broodstock when collection begins in the Touchet River. These programs would not affect ESA-listed spring Chinook salmon populations.

The Touchet program originally proposed using broodstock consisting of up to 100% natural-origin steelhead adults in their integrated component of the hatchery program, meaning they may collect a maximum of 36 natural-origin adult summer steelhead from the Touchet River population for a release size of 50,000 smolt (Section 2.4). For a current study being conducted in that program, they are utilizing 25% hatchery-origin fish (F1 Touchet Endemic Stock) in the broodstock. Moreover, the most recent five year (2011 to 2015) mean abundance of natural-origin summer steelhead returns to the Touchet River is 331 (Section 2.9). This does not meet the minimum abundance threshold for the Touchet River population of 1,000 individuals, as outlined in the Recovery Plan for Mid-Columbia Steelhead (NMFS 2009). Even though this population does not meet minimum abundance thresholds, the population does not show a clear decreasing trend in recent years, and is generally believed to be at and/or near the replacement level. Moreover, this population is not being targeted for viability in the recovery scenarios (NMFS 2009), and is targeted as a “maintained” population. The removal of up to 36 adults would have an adverse effect on the population by reducing the overall abundance of natural-origin steelhead spawning naturally. However, these effects would be ameliorated by the resulting increase in naturally spawning hatchery endemic steelhead. The naturally spawning hatchery summer steelhead would be expected to increase the overall abundance and productivity of the population even though the hatchery steelhead may not be as productive as the natural-origin summer steelhead (Christie et al. 2014). In addition, there are no genetic concerns with removing natural-origin steelhead from the Touchet River population for this program, since the program operation still allows for PNI targets, as outlined in Factor 2 (Section 2.9).

The Umatilla program is proposing to use broodstock consisting of up to 70 natural-origin adults and 40 Umatilla Hatchery steelhead in their integrated component of the hatchery program, meaning they would collect a maximum of 110 natural-origin adult summer steelhead in the future from the Umatilla River population to meet a release size of 150,000 smolts. The most recent five year (2011 to 2015) mean abundance of natural-origin steelhead returns to the Umatilla River is 3,134 (Section 2.4). The minimum abundance threshold for the Umatilla River population is 1,500 natural-origin spawners according to the Recovery Plan for Mid-Columbia Steelhead (NMFS 2009). Because the natural-origin returns for this population are well above this abundance target (between ~900 and ~3,400 fish over in recent years), abundance concerns are minimal to negligible in the current state of the population, and the removal of up to 110 adults would not alter this status. Furthermore, the naturally spawning hatchery summer steelhead would be expected to increase the overall abundance and productivity of the population even though the hatchery steelhead may not be as productive as the natural-origin summer steelhead (Christie et al. 2014). Thus, the removal of natural-origin summer steelhead to meet proposed hatchery broodstock needs is not considered to be negative on the abundance of this population. In addition, there are no genetic concerns with removing natural-origin steelhead from the Umatilla River population for this program, since the program operation still allows for PNI targets, as outlined in Factor 2 (Section 2.9).

The removal of broodstock for the Touchet and Umatilla programs is not considered to be excessive, and the abundance and genetic impacts on the populations are not considered a substantial risk (Section 2.9). Furthermore, the reduction in abundance from the removal of natural-origin adults from the naturally spawning populations for broodstock can be ameliorated by the naturally-spawning hatchery adults that were derived from those populations.

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

The proposed hatchery programs pose both genetic and ecological risks, and although there is some benefit to the species from the integrated programs designed to supplement the natural populations, the net effect on steelhead is negative.

2.9.1. Genetic Effects

Evaluation of Proposed Adult Management

For each program, NMFS considers three major areas of genetic effects: within-population diversity, outbreeding effects, and hatchery-influenced selection. The within-population diversity area covers such topics as effective size and mating protocols. We see no concerns with respect to within-population diversity in any of the programs comprising the Proposed Action. Assessment of the other two categories occurs simultaneously using the pHOS/PNI metrics as surrogates because the outbreeding effects and hatchery-influenced selection cannot be direct measured. As explained in Appendix A, the Hatchery Scientific Review Group (HSRG) has developed guidelines for allowable pHOS levels in populations, scaled by the population's conservation importance, recommending a maximum of 5% in "primary" populations, 10% for "contributing" populations, and at a level required to maintain "sustaining" populations (e.g., HSRG 2014). Listed salmonid populations in the interior Columbia River are classified by recovery expectation (ICTRT 2007b) rather than by the HSRG classification scheme, but "viable" and "highly viable" equate to "primary", and "maintain" equates to "contributing" and "sustaining."

NMFS has not adopted HSRG gene flow (i.e., pHOS, pNOB, PNI) standards per se. However, at present the HSRG standards and the 5% (or 0.05) stray standard (from segregated programs) from Grant (1997) are the only acknowledged quantitative standards available, so NMFS considers them a useful screening tool. For a particular program, NMFS may, based on specifics of the program, broodstock composition, and environment, consider a pHOS or PNI level to be a lower risk than the HSRG would but, generally, if a program meets HSRG standards, NMFS will typically consider the risk levels to be acceptable[3].

The Walla Walla, Touchet, and Round Butte spring Chinook salmon programs are using non-listed fish and are releasing fish into populations that are also not listed, therefore, genetic analyses for potential genetic effects resulting from operation of these spring Chinook salmon in this Opinion are not needed in this analysis.

The Touchet and Umatilla River steelhead programs use natural-origin adults in the broodstock sourced from the local populations. Therefore, the potential negative genetic effects from this program are considered along with the demographic benefit of increasing abundance. To perform our analysis, we will use models that consider the best available information for the target population to determine the

[3] The only exception to date is the case of steelhead programs using highly domesticated broodstocks, where NMFS has imposed more stringent guidelines e.g.,NMFS (2016a).

likely PNI of the population based on the applicants' proposed proportion of natural-origin broodstock (pNOB) and the pHOS in natural spawning areas. A PNI of > 0.5 indicates that natural selection outweighs hatchery-influenced selection (HSRG 2014).

Gene Flow Assessment for the Touchet River Steelhead Population

Best available data suggests that the Touchet Endemic program is likely to obtain a PNI of > 0.5. For example, data from 2011-2015 indicates that PNI ranged from 0.28-0.61, with an average of 0.492 based on the multi-population model tool analysis developed by Busack (2015) (Table 18). We calculated the proportional increase in smolt numbers from the Lyons Ferry Hatchery release of Wallowa stock into the Touchet River (from 85,000 to 100,000) and applied this proportional increase to returning adult Lyons Ferry Hatchery hatchery-origin steelhead. This allowed us to estimate what pHOS and pNOS would have been for years 2011-2015 if 100,000 smolts had been released for this non-endemic hatchery program, under the assumption that the natural-origin return numbers are the same.

In the future, NMFS expects a phase out of the Wallowa stock hatchery-origin steelhead releases in the Touchet, and subsequently an increase in the size of the Touchet endemic steelhead program. As this transition occurs, NMFS anticipates that the applicants will develop a sliding scale that specifies pHOS and pNOB targets for the larger Touchet hatchery steelhead program.

Table 18. Proportionate Natural Influence (PNI) for the Touchet Salmon River Natural Population. pNOS = proportion of natural-origin spawners; pHOSi = proportion of integrated hatchery-origin spawners; pHOSs = proportion of segregated hatchery-origin spawners; pNOB = proportion natural-origin broodstock; pHOBi = proportion of integrated hatchery-origin broodstock; pHOBs = proportion of segregated hatchery-origin broodstock.

Return Year	Natural-origin Returns	pNOS	Total pHOS	Touchet Hatchery steelhead			Lyons Ferry Hatchery steelhead			PNI
				pHOSi	pNOB	pHOBi	pHOSs	pNOB	pHOBs	
Current Conditions (50,000 release)										
2011	468	0.86	0.14	0.11	1.0	0	0.03	0	1	0.60
2012	294	0.76	0.24	0.18	1.0	0	0.05	0	1	0.47
2013	501	0.71	0.29	0.25	1.0	0	0.04	0	1	0.50
2014	163	0.78	0.22	0.10	0.72	0.28	0.13	0	1	0.28
2015	228	0.92	0.08	0.05	0.71	0.29	0.03	0	1	0.61
Average	331	0.81	0.19	0.14	0.88	0.11	0.06	0	1	**0.49**

Sources: Bumgarner (2017d); 2017f); Reynolds (2017a); Turner (2017)

Because estimated natural-origin returns for this population vary, NMFS expects that at this time, the demographic concerns outweigh genetic risks for the population. This is because the minimum abundance threshold for the Touchet River population is 1,000 natural-origin spawners (NMFS 2009); abundance over the last five years has ranged from 16–50 percent of this value (Table 15). In addition, in the current recovery scenario, this population is not targeted for viability or high viability, but for maintained status. NMFS believes a PNI of 0.5 calculated as a 5-year running average is adequate for maintaining the population, and a PNI of < 0.5 is acceptable when natural-origin abundance is low (i.e. < 250 fish), to ensure enough fish are available to spawn regardless of fish origin. Thus, under current operations a pNOB of 0.75 and a pHOS from the endemic steelhead program of < 30% are likely to ensure gene flow guidelines are met.

A comparison of the 2014 and 2015 lines in Table 18 shows the importance of impacts from the Lyons Ferry program. Were fish from this program (or this stock) not on the spawning grounds, high PNIs could be achieved with a less aggressive program in terms of pNOB. For example, if pNOB was 25%, a PNI of 50% could be achieved with a pHOS of 25%; a PNI of 67% could be achieved with a pHOS of about 13%.

Gene Flow Assessment for the Umatilla River Steelhead Population

Best available data suggests that the Umatilla River Natural steelhead program is likely to obtain a PNI of > 0.67. For example, data from 2011-2015 indicates that PNI ranged from 0.73-0.94, with an average of 0.844 based on the multi-population model tool analysis developed by Busack (2015) (Table 19). The program has a current release of 150,000 fish, and there are no plans to change this program nor the other hatchery programs that contribute to non-endemic hatchery steelhead proportions.

Table 19. Proportionate Natural Influence (PNI) for the Umatilla Salmon River Natural Population. pNOS = proportion of natural-origin spawners; pHOSi = proportion of integrated hatchery-origin spawners; pHOSs = proportion of segregated hatchery-origin spawners; pNOB = proportion natural-origin broodstock; pHOBi = proportion of integrated hatchery-origin broodstock; pHOBs = proportion of segregated hatchery-origin broodstock.

Return Year	Natural-origin Returns	PNOS	Total pHOS	Umatilla Hatchery steelhead			Out of Basin Hatchery steelhead			PNI
				pHOSi	pNOB	pHOBi	pHOSs	pNOB	pHOBs	
Current Conditions (150,000 release)										
2011	3,122	0.80	0.20	0.19	1	0	0.01	0	1	0.73
2012	2,407	0.81	0.19	0.18	1	0	0	0	1	0.85
2013	2,583	0.93	0.07	0.07	1	0	0	0	1	0.94
2014	4,915	0.89	0.11	0.10	0.67	0.33	0	0	1	0.88
2015	3,543	0.85	0.15	0.15	0.63	0.37	0	0	1	0.82
Average	3,134	0.86	0.14	0.14	0.86	0.14	0	0	1	**0.84**

Sources: Clarke (2017c); 2017b); Reynolds (2017b)

However, because estimated natural-origin returns for this population vary, we believe that at this time, demographic concerns outweigh genetic concerns for this population. This is because the minimum abundance threshold for the Umatilla Salmon River population is 1,500 natural-origin spawners (NMFS 2009); abundance over the last five years surpassed this threshold by a minimum of ~900 fish to as many as ~3,400 fish (Table 15). In addition, in the current recovery scenario, this population is targeted for viable. Thus, NMFS believes a PNI of 0.67 calculated as a 5-year running average is adequate for a viable population, and this program currently exceeds this value. Thus, NMFS believes maintaining a pNOB of 70 percent and a pHOS at current levels ensures that the program is within acceptable gene flow recommendations.

Straying

NMFS considers the straying of hatchery fish into other populations a risk when in occurs at unnatural levels or from unnatural sources (see Appendix A – Factor 2 for discussion on straying).

For this analysis we used a combination of available PIT-tag and coded-wire tag data to determine where fish from each of the four hatchery programs could potentially stray and interact with ESA-listed fish. For this analysis, we excluded fish caught in mainstem and terminal fisheries because both species hold in freshwater for a period of time (up to ~ 4 months for spring Chinook salmon and up to ~7 months for steelhead) before spawning, making them more likely to wander into areas where they are not intending to spawn.

Although Chinook are not ESA-listed in the MCR, they have the potential to stray into other listed areas (e.g., LCR, Snake River, UCR). The data for both Chinook programs suggests that straying into listed areas is a relatively rare occurrence; an average of ≤ 1 fish per year for all terminal area where fish were detected at either a hatchery or on the spawning grounds (Table 20), a number unlikely to have a detectable effect on the listed populations where spring Chinook salmon from the Round Butte or Walla Walla are recovered/detected. The Touchet Spring program is a new program and no straying data is available, however, based on the broodstock source and release location it is expected that stray rates would be similar to those observed for the Walla Walla spring Chinook salmon program.

For the steelhead programs, straying is relatively low and occurs into areas outside of the MCR. For the Umatilla program, over the course of ten years of CWT recoveries, only an estimated seven fish were detected in terminal areas (Table 20). For the Touchet endemic steelhead program, PIT-tag detections were highest in the Tucannon River (about 4 fish per year on average) and less than one per year in other areas where Touchet River fish were detected.

Although straying into the Tucannon River with Touchet River fish appears to be elevated, the natural-origin fish from the Touchet River appear to have a similar behavior, and are straying into the Tucannon River at the similar rate at 8.8 and 12.5 percent, respectively (Table 21). This suggests that straying of Touchet River fish into the Tucannon River is not a hatchery phenomenon, but an environmental one, possibly due to warmer temperatures in the Walla Walla Subbasin or hydrosystem operations in this reach of the mainstem Columbia River. In addition, the applicants have proposed to acclimate juvenile steelhead from 2-3 week at the Dayton

Acclimation Pond as opposed to the current direct stream release strategy, which would be expected to improve homing back to the Touchet River. Once the program is expanded to 150,000 smolts to replace the Wallowa stock releases, a portion, if not all of these fish will be ad-clipped, making them vulnerable to mark-selective steelhead fisheries throughout the area. Thus, we do not anticipate more than 15 percent of the Touchet hatchery-origin returns detected at McNary Dam to stray into the Tucannon River, even with an increase in release size when measured as a 5-year running average.

Table 20. Program fish detected in non-target terminal areas where ESA-listed populations exist; CWT = coded-wire tag; PIT = passive integrated transponder tag.

Program	Data Type and Years	Non-target Terminal Recovery Location	Estimated Number summed over all years
Round Butte Spring Chinook Salmon	CWT; Recovery years 2004-2013	Hood River	7
		Little White Salmon	5
		White Salmon	11
		Entiat River	1
		Willamette River	11
		Wallowa River	1
Walla Walla Spring Chinook Salmon	CWT; Brood years 2004-2006	None	0
	PIT; Detection years 2010-2017	Methow River	1 (unexpanded)
Umatilla Steelhead	CWT; Recovery years 2004-2013	Pataha Creek	2
		Alpowa Creek	3
		Clearwater River	2
Touchet Endemic Steelhead	PIT; Detection years 2004-2013	Tucannon River	37 (unexpanded)
		Yakima River	1 (unexpanded)
		Entiat River	1 (unexpanded)
		Tributaries between Tucannon and Lower Granite Dam	10 (unexpanded)
		Asotin Creek	3 (unexpanded)
		Potlatch River	1 (unexpanded)
		Tributaries between Touchet River and Ice Harbor Dam	1 (unexpanded)
Touchet Spring Chinook Salmon	New Program		

Sources: (Bumgarner 2017b; Clarke 2017b; Seals 2017; Zimmerman 2017a; 2017b)

Table 21. The number of hatchery and natural-origin steelhead originating from the Touchet River detected at McNary Dam and in the Tucannon River.

	Touchet Natural-Origin Steelhead			Touchet Hatchery-origin Steelhead		
Run Year	Number Return to McNary	Number Return to Tucannon	% of McNary returns to Tucannon	Number Return to McNary	Number Return to Tucannon	% of McNary returns to Tucannon
2011[1]	225	7	3.1	251	39	15.5
2012	257	19	7.4	193	14	7.3
2013	284	34	12.0	56	7	12.5
2014	511	10	2.0	185	8	4.3
2015	464	92	19.8	290	47	16.2
2016[2]	100	0	0.0	336	49	14.6
Average	**307**	**27**	**8.8**	**219**	**27**	**12.5**

Source: (Bumgarner 2017b); Bumgarner (2017a)

[1]This was the first year of tagging for natural-origin fish in the Touchet River, and return numbers were lower than expected.

[2]This was a lower natural-origin return year and the screw trap location was moved, resulting in a drop in efficiency of tagging natural-origin juvenile outmigrants.

2.9.2. Ecological Effects

Hatchery fish and the progeny of naturally spawning hatchery fish may increase risks to ESA-listed fish on the spawning grounds through competition on the spawning grounds and when natural-origin adults are encountered at adult collection facilities (see Appendix A). Hatchery adults may also provide marine-derived nutrients to the naturally spawning habitat within the Action Area (see Appendix A).

Adult nutrient contribution

Returning hatchery adults would be expected to contribute marine-derived nutrients to the ecosystem from both naturally spawning adults and carcass outplants. The hatchery fish carcasses can 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 (see Appendix A). Such transport by anadromous fish of nutrients from the marine environment to freshwater is important because temperate freshwater environments like that of the Action Area are typically low in available nutrients and relatively unproductive (Cederholm et al. 2000). The contribution of marine-derived nutrients would be expected to increase the productivity of the habitat for the rearing of juvenile salmonids.

Competition with natural-origin listed salmon and steelhead

Competition between adult hatchery spring Chinook salmon and listed, natural-original steelhead is likely negligible due to differences in run, holding and spawn timing (Table 22). Because of these temporal differences, competition for spawning sites is unlikely to occur. Likewise, steelhead egg incubation is largely complete by the end of June, well before spring Chinook salmon spawn and could potentially superimpose steelhead redds (NMFS 2009). In addition, because both species have coexisted throughout the Action Area for a long time, it is likely they developed different habitat niches that further reduce the likelihood of competition and redd superimposition low.

Because of similar run, holding, and spawn timing, hatchery steelhead that spawn naturally have an increased likelihood of competing and superimposing redds of natural-origin steelhead. However, the degree to which this occurs is informed by pHOS/straying levels. In our genetic analysis above (Section 2.9.1), we found that pHOS within the target population for the Touchet Endemic and Umatilla steelhead programs has been less than 30 percent annually over the last five years (Table 18 and Table 19). Out-of-basin straying of steelhead originating from these two programs also has been low (Table 20), which limits their ability to compete and superimpose redds on those of other ESA-listed DPSs. The only exception may be for natural-origin fish in the Tucannon River because straying into this population is higher than in other locations. However, the proposal to acclimate juvenile hatchery steelhead before release in the Touchet River is expected to improve homing and consequently reduce straying into the Tucannon River.

Table 22. Run-timing, holding, and spawn timing of adult salmon and steelhead (NMFS 2009; ODFW 2011).

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

2.9.2.1. Adult Collection

The operation of traps for broodstock collection would result in the capture and handling of ESA-listed steelhead see Table 3, Table 4, and Table 7. In the Touchet River the operation of the Dayton Adult Trap (DAT) is expected to handle up to 800 natural-origin steelhead with fewer than 16 incidentally lost due to trapping and handling (Table 3). The facility will also trap up to 150 unmarked Touchet Endemic hatchery steelhead that cannot visibly be distinguish from natural-origin adults, but can be identified by examining for a CWT, and by examining the dorsal fin. A proportion of these will be retained for broodstock and the rest released upstream after sampling. The actual number of adults collected ranged from 118 to 221 natural-origin adults and 23 to 85 endemic summer steelhead (Table 23). Since the trap has been remodeled mortalities during trapping has averaged less than one per year.

Table 23. Natural-origin and Touchet Endemic summer steelhead trapped at the Dayton Adult Trap.

Return Year	Natural Trapped	Hatchery Endemic Trapped
2010-11	143	57
2011-12	163	23
2012-13	118	39
2013-14	175	85
2014-15	221	49

The operation of the Three Mile Falls Dam trap is expected to handle up to 3,500 natural-origin adults during broodstock collection and adult monitoring activities and with fewer than 35 lost due to trapping and handling (Table 4). The TMFD trap is annually operated from September through mid-April. The trap can be operated to trap all steelhead passing the facility but to limit handling impacts, beginning in December, the trap is operated for five days then salmon and steelhead are allowed to volitionally migrate for nine days. Monitoring is done with a video system. The actual number of adults that have been trap at the TMFD, has been substantially less than the proposed maximum (Table 24) with an average of less than one mortality annually. Three of the mortalities were due to fish jumping out the trap and one died in the pond.

Table 24. Natural-origin summer steelhead trapped at Three Mile Falls Dam trap, and associated mortalities.

Return Year	Trapped	Mortalities
2012-13	1,193	0
2013-14	2,266	2
2014-15	1,978	2
2015-16	1,296	0
2016-17	767	0

When the Walla Walla River spring Chinook salmon program begins to collect broodstock at the Nursery Bridge Dam fishway (NBDF), trapping will occur from May through June. The operators estimated that up to 250 natural-origin summer steelhead could be handled annually with a loss of fewer than 5 adults due to trapping and handling (Table 7). During the past five years, an average of 27 adult steelhead have been enumerated at Nursery Bridge Dam during May (range of 8 to 51), an average of 4.7% of the run. No steelhead have been enumerated in June over that period.

Broodstock for the Round Butte Hatchery spring Chinook salmon program will be collected in the Buckley Type Fish Trap at the Pelton Reregulating Dam (Pelton Trap). The trap is operated year around but spring Chinook salmon return to the basin from May through late August. Steelhead can overlap with spring Chinook salmon collection during the month of August, but, for return years 2013-2017, no natural-origin steelhead have been encountered at the Pelton Trap in August.

The traps that are used to collect broodstock are located at man-made barriers that have been modified to trap migrating adult salmon and steelhead. The operation of the traps to collect broodstock may affect natural-origin steelhead by delaying migration and changing the spawning distribution within the basin. To limit the effects of delay, the traps are checked daily during the peak migration periods. During the low migration periods the traps would be check less frequently. As described above the TMFD trap is operated intermittently December through April reducing the potential for delay. Spawning distribution would not be expected to be affected because most if not all of the spawning habitat is located above the trap sites.

Broodstock will be collected for the Touchet Spring program will occur at the Dayton Adult Trap in coordination with the collection and sampling of summer steelhead. Collection of broodstock could also take place at the NBDF and would occur in conjunction with the broodstock collection activities for the Walla Walla Spring Chinook program. The collection of broodstock for the Touchet Spring program would not be expected to increase the number of ESA-listed steelhead handled as identified in Table 3 and Table 7.

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

The Action Area includes the mainstem Columbia River down to the Bonneville Dam because of this factor (see section 2.5), since juvenile hatchery fish are likely to compete and prey on natural-origin fish wherever they co-occur. More detailed discussion of the effects of hatchery fish in the estuary and plume occurs in NMFS (2017a) and is incorporated by reference.

2.10.1.1. Hatchery release competition and predation effects

NMFS used the PCD Risk model developed by Pearsons and Busack (2012) to evaluate predation and competition interactions between natural-origin fish and hatchery fish released as part of the Proposed Action. The original version of the model suffered from operating system conflicts that prevented completion of model runs and was suspected of also having coding errors. As a result, the program was modified by Busack in 2017 into a considerably simpler version to increase supportability and reliability. At present, the program does not include disease effects and probabilistic output. Our model also does not account for the beneficial effects of juvenile hatchery-origin fish releases, mainly in the form of prey for natural-origin salmon and steelhead, or growth that likely occurs post-release. Parameter values used across multiple model runs are shown in Table 25 and Table 26. Hatchery program specific parameter values are detailed in Table 27.

Table 25. Parameters and values for model runs.

Parameter	Value
Habitat complexity	0.1
Population overlap	1.0
Habitat segregation	0.3 for intraspecific interactions, 0.6 for interspecific interactions[1]
Dominance mode	3
Piscivory	0.002 for Chinook salmon, 0.0023 for steelhead[1]
Maximum encounters per day	3
Average temperature	9.0°C[2]
Predator:prey length ratio for predation	0.25[3]

[1] HETT (2014)
[2] DART website: http://www.cbr.washington.edu/dart/query/river_graph_text
[3] Daly et al. (2014)

There are a number of key assumptions/caveats that allowed us to run the model, but that can affect the final results. For our model runs, we assumed a 100 percent population overlap between hatchery-origin fish and all natural-origin listed species present. Releases of hatchery-origin juveniles may overlap with natural-origin chum, coho, sockeye, Chinook salmon, and steelhead in the Action Area. However, our analysis is focused on assessing effects on listed species, limiting overlap of those species in areas where listed species are present. To address this, we modified residence/travel times for hatchery juveniles if they did not overlap completely with certain listed natural-origin species and/or age classes. For example, Snake River fall Chinook salmon do not inhabit the tributaries of the MC. Thus, effects on Snake River fall Chinook salmon from hatchery releases would not occur until they comingled in the mainstem Columbia River below the MCR tributary confluence. We believed it was better to address overlap by adjusting residence time rather than by adjusting population overlap because the population overlap parameter represents microhabitat overlap, not basinwide-scale overlap. We acknowledge that a 100 percent population overlap in microhabitats is likely an overestimation of effects.

A second assumption/caveat is that "competition" is depicted in the model as the number of natural-origin fish lost to competitive interactions assuming that all competitive interactions that result in body weight loss are applied to each fish until death occurs (i.e., when a fish loses 50% of its body weight). This method is not meant to represent the actual mechanism, but instead is meant to provide a maximum mortality estimate using these parameter values.

The model also does not include age-0 steelhead because steelhead spawn from March to June with a peak from April to May in the Action Area (Busby et al. 1996). Thus, it is unlikely that any age-0 steelhead would have emerged in time to interact with the hatchery spring Chinook salmon or steelhead smolts as they migrate downstream.

We also conducted model runs with natural-origin fish numbers at the point where all possible hatchery-origin fish interactions are exhausted at the end of each day. It is possible that in doing this, we ran the models with natural-origin juvenile abundances that exceed actual numbers available. Using natural-origin juvenile numbers at the point where all possible hatchery-origin fish interactions are exhausted at the end of each day allows us to estimate worst-case impacts on listed natural-origin fish. The exception to this is for sockeye salmon because we have data for natural-origin abundance for the one population that composes the entire Snake River Sockeye ESU that demonstrates that, from 2006-2016, the maximum number of natural-origin sockeye salmon produced was ~61,000 (Kozfkay 2017), which make up approximately 2% of the estimated 2.9 million sockeye salmon juveniles in the lower Columbia River (Zabel 2015; 2017). Thus, we used 3,050,000 (61,000/0.02) as the natural-origin sockeye salmon abundance within the Action Area in the model, along with the proportions of each age-class (87 percent age-1, and 13 percent age-2) available from Kozfkay (2017). To ensure the effects due to competition and predation are within our model estimates, we will use travel times as a surrogate for these effects and continue to monitor median travel times from release to encounter at the first dam on an annual basis (using a 5-year rolling median) compared to the values used in our analyses (Table 27).

Table 26. Age and size of listed natural-origin salmon and steelhead encountered by juvenile hatchery fish after release; CV = coefficient of variation.

Species	Age	Length in mm (CV)	Source
Chinook salmon	0	62 (0.15)	(Simpson 2017)
	1	89 (0.15)	(Simpson 2017)
Steelhead	1	96 (0.22)	(Simpson 2017)
	2	178 (0.10)	(Simpson 2017)
Coho salmon	1	74 (0.22)	(Simpson 2017)
	2	90 (0.22)	(Simpson 2017)
Sockeye salmon	1	86 (0.08)	(HETT 2014)
	2	128 (0.11)	(HETT 2014)
Chum Salmon	0	40 (0.08)	(Hillson et al. 2017)

Table 27. Hatchery fish parameter values for the PCDrisk model.

Program	Release Site[1]	Release Number	Size in mm (CV)	Mean of mean Survival			Travel (Residence) Time (mean of mean days)		
				Release to tributary mouth[3]	Tributary mouth to mainstem Dam[3]	Mainstem Dam to Bonneville Dam[4]	Release to tributary mouth[3]	Tributary mouth to mainstem Dam[3]	Mainstem Dam to Bonneville Dam[4]
Touchet Endemic Steelhead	Touchet River RM 53	150,000	161 (20)	0.45	0.80 (McNary)	0.84	35	10 (McNary)	4
Umatilla Steelhead	Umatilla River RM 64	150,000	145 (20)	0.71	0.68 (John Day)	0.95	10	12 (John Day)	1
Walla Walla Spring Chinook	Touchet River RM 55	500,000	154 (20)	0.36	0.75 (McNary)	0.73	26	7 (McNary)	5
Touchet Spring Chinook	Touchet River RM 55	250,000	154 (20)	0.36	0.75 (McNary)	0.73	26	7 (McNary)	5
Round Butte Spring Chinook	Deschutes River RM 100	401,294[2]	103 (20)	0.66	0.78 (Bonneville)	Not applicable	4	3 (Bonneville)	Not applicable

[1] If releases occurred a multiple sites, we used data from the site furthest upstream for a maximum estimate of travel time.
[2] Fry are released above the Pelton trap at RM 100, which is impassable and contains no listed species. Therefore, we used an average survival to the trap from fry and smolts released above from 2011-2015, and added those numbers to our values of smolts released at Pelton trap (PGE and CTWS 2016).
[3] Sources:(Bumgarner 2017c; Clarke 2017a; Shrader 2017)
[4] Sources:(Faulkner et al. 2012; Faulkner et al. 2013; Faulkner et al. 2015; Faulkner et al. 2016; Faulkner et al. 2017)

The analysis from the 2017 biological opinion modeled all 500,000 spring Chinook salmon smolts from the Walla Walla Spring Chinook salmon program as being released into the Touchet River at River mile 55 (Table 27) even though only 100,000 from that program would be released into the Touchet River annually under the Proposed Action. The reason for modeling it this way was to reduce the total number of model runs needed for the evaluation, but also to still capture the maximum effect by using the greatest distance fish could travel allowing for the maximum number of potential interactions. Because of this adjustment, actual impacts would be expected to be less than those modeled.

The model results for the release of 500,000 hatchery spring Chinook salmon smolts into the Touchet River to account for the Walla Walla Spring Chinook Salmon Hatchery Program, estimated that the equivalent of 9 Chinook salmon, 23 steelhead, 1 sockeye salmon, 2 coho salmon, and 0 chum salmon adults would be lost. The release of 250,000 hatchery spring Chinook salmon smolts under the proposed Touchet Spring program represents a 50% increase in the total number of spring Chinook salmon smolts released, and thus impacts would be expected to increase proportionally (i.e., increase by 50%). The 250,000 smolt increase would result in an additional loss of 5 Chinook salmon, 12 steelhead, 1 sockeye salmon, 0 coho salmon, and 1 chum salmon adults. These additional adults are included in Table 28.

The results of the model runs from point of release to Bonneville Dam are summarized in Table 29. We expressed the loss of natural-origin juveniles as adult equivalents based on smolt-to-adult-survival rates (SARs) averaged across hatchery programs for each species throughout the basin. This assumes that hatchery SARs are a reasonable proxy for natural-fish survival, an assumption that NMFS recommends validating where possible. Although we have done our best to modify our model runs to eliminate those areas where only non-listed fish exist (e.g., Chinook salmon in the MCR), we cannot completely eliminate effects on non-listed fish (i.e., MCR spring Chinook salmon and MCR fall Chinook salmon) from our model at this time. Thus, our assumption that all Chinook salmon lost are listed likely overestimates the impact on each ESU. We also assume that the effects on each population within each ESU are proportional to their ESU composition. For example, if a single population represents 5 percent of the natural-origin adults, then the loss our model predicts would be some percentage of the 5 percent contribution of that population to the ESU, under an assumption of proportional distribution of impacts across the populations in that ESU. Where the violation of such an assumption might occur—that is, where available data are insufficient to describe an observed typical distribution of populations when the impact may be occurring—applying the effect of all such impacts to the weakest population may, for example, be used to delineate an extreme effect, one that is unlikely to represent the actual effect.

A total of 24 natural-origin Chinook salmon (unlisted MCR spring Chinook and MCR fall Chinook salmon) adult equivalents are estimated be lost to competition and predation with hatchery-origin juveniles between the point of release downstream to Bonneville Dam (Table 28). To obtain a better idea of what the effect of this loss could be at the ESU level, we first need to determine the proportions of subyearlings versus yearlings. At Bonneville Dam, 40 percent of listed, wild, Chinook salmon juveniles are likely to be yearlings, while 60 percent of listed Chinook salmon juveniles are likely to be subyearlings (Table 7a in Zabel 2013; Zabel 2014a; 2014b; 2015; 2017). This equates to 10 adult equivalents from ESUs with listed yearlings and 14 adult equivalents from ESUs with listed subyearlings (Table 29). We then used estimates of the proportion of each listed ESU present in juvenile outmigrants captured at Bonneville Dam, and applied these values to the adult equivalents we calculated based on SAR. In addition, we applied the ratio of UCR spring Chinook salmon returns compared to the UCR summer/fall Chinook salmon returns (0.24) to the UCR Chinook salmon adult equivalent (6) to better estimate the effect on UCR Spring Chinook Salmon ESU. The estimated effect on each listed ESU is negligible at < 0.1 percent of natural-origin adult returns to the Columbia River Basin.

Regarding steelhead, we estimate that up to 70 natural-origin adults could be lost annually as a result of competition and predation with hatchery juveniles, all of which are from listed DPSs (Table 29). To parse out the impact for each listed DPS, we took a similar approach for steelhead as we did for Chinook salmon: we used the proportions of each DPS at Bonneville Dam to determine loss attributable to each DPS (average from 2012 through 2016; Table 9 in Zabel 2013; 2014a; 2014b; 2015; 2017). The UCR and MCR steelhead DPSs had the highest percentage loss at 0.2 percent, and we assume this loss would not occur to any one population, but would be divided proportionally among the extant populations within the DPS. Thus, even this conservative estimate of the maximum possible effects of competition and predation on listed, natural-origin steelhead demonstrates that the impacts are expected to be negligible.

The model estimates that up to 1,659 juvenile sockeye salmon could be lost annually as a result of competition and predation with hatchery juveniles, which equates to about eight sockeye salmon adults (Table 29). Assuming that all of the impacts accrue to Snake River sockeye salmon, the 8 potential adults that could be lost represents 0.5% of the average annual return to the Columbia River (Table 29).

For both chum and coho salmon, there is only a single ESU in the Columbia River Basin (i.e., Columbia River Chum Salmon ESU and Lower Columbia River Coho Salmon ESU). The < 0.1 percent of chum and coho salmon adult equivalents lost to ecological interactions (Table 29) with hatchery-origin juveniles is negligible. Furthermore, we assume this impact would be divided proportionally among the 17 chum and 24 coho salmon populations within the ESUs. For example, even if this effect disproportionally accrued to a single population, a loss of 1 adult non-ESA listed chum salmon would not equate to a meaningful reduction in spawners returning to that population, nor to any effect on the ESU as a whole.

Table 28. Maximum number of juvenile natural-origin salmon and steelhead lost within the Action Area due to predation and competition with hatchery fish released under Proposed Action.

Species	Total	SAR[1]	Adult Equivalents
Chinook Salmon	4,842	0.005	24
Steelhead	7,986	0.0088	70
Coho Salmon	275	0.0198	5
Sockeye Salmon	1,659	0.005	8
Chum Salmon	387	0.0039	2

[1] Sources: Chinook salmon (ODFW 2013a; USFWS 2015); Steelhead (WDFW 2015; ODFW 2017a; ODFW and CTUIR 2017); Coho salmon (ODFW 2013b); sockeye salmon (IDFG 2012); chum salmon (Hillson 2015)

Table 29. Maximum natural-origin adult equivalents lost due to competition and predation with hatchery-origin juveniles by ESU/DPS compared to returning adults from 2011-2015 of the same ESU/DPS: AE = adult equivalents.

Species (ESU/DPS)		Percent Yearlings at Bonneville Dam	Lost Yearling (Smolt) AEs	Percent Subyearlings at Bonneville Dam	Lost Subyearling AEs	Total Lost AEs[1]	Natural-origin Adults at Mouth of Columbia River	Percent of Natural-origin Adults Returning at Mouth
Chinook Salmon	**Total**	100	10	100	14	24	141,728	< 0.1
	Snake River Spring/Summer	28	3	0	0	3	32,823[2]	< 0.1
	Snake River Fall	0	0	1	0	1	23,198[3]	< 0.1
	Upper Columbia River Spring	70	7	0	0	7	5,064[4]	< 0.1
	Lower Columbia River	2	0	99	14	14	38,464[5]	< 0.1
	Upper Willamette River Spring	0	0	0	0	0	9,356[6]	0.0
Steelhead	**Total**	100	70	0	0	70	115,833	< 0.1
	Snake River	4	3	0	0	3	54,414[7]	< 0.1
	Upper Columbia River	21	15	0	0	15	6,929[7]	0.2
	Mid-Columbia River	68	48	0	0	48	22,300[7]	0.2
	Lower Columbia River	7	5	0	0	5	22,031[7]	< 0.1
	Upper Willamette River	0	0	0	0	0	10,159[7]	0.0
Snake River Sockeye Salmon		2	<1	2	<1	<1	1,623[8]	~0[9]
Columbia River Chum Salmon		0	0	100	1	1	18,498[10]	< 0.1
Lower Columbia River Coho Salmon		100	5	0	0	5	267,060[11]	< 0.1

[1] We accounted for effects to the listed UCR spring Chinook ESU from our model by applying the total Chinook adult equivalents to McNary from the UCR by the ratio of UCR spring Chinook salmon to UCR River summer Chinook salmon. This was calculated by summing the average total return (hatchery and natural) of UCR spring Chinook salmon (Table 8 of ODFW and WDFW 2016) and the total return of summer Chinook salmon (Table 10 of ODFW and WDFW 2016) from 2011-2015, and then dividing the total UCR spring Chinook return into this sum. We then applied this average proportion (0.24) of UCR spring Chinook to the total number of UCR Chinook salmon adult equivalents estimated to be lost from our model analysis (6).

[2] Average number of wild adult returns to the Columbia River; Table 9 in ODFW and WDFW (2016).

[3] Average number of wild adult returns to the Columbia River; Table 5 in WDFW and ODFW (2017).

[4] Average number of wild adult returns to the Columbia River; Table 8 in ODFW and WDFW (2016).

[5] Average of the sum of Lower Columbia River fall bright Chinook salmon, fall tule Chinook salmon, and spring/summer Chinook salmon. The fall bright Chinook salmon numbers were a sum of the total natural spawner abundance estimates of each population from Tables 2.1.12-2.1.14 in TAC (2017) minus harvest impacts from the respective years (Tables 9, 12, 16-18 in TAC 2017). The fall tule Chinook salmon numbers were obtained from Table 4 in WDFW and ODFW (2017) by using the 2011 to 2015 actual

return numbers for the Lower River Wild stock. The spring/summer Chinook salmon numbers were obtained by summing the total natural spawner abundance estimates of each population from Tables 2.1.10 and 2.1.11 of TAC (2017) minus the total impact of the Upper Willamette River spring-run Chinook salmon fishery (Table 88; NMFS 2017e).

[6] Average number of natural-origin returns to the Columbia River mouth. For each year, the natural-origin return number was estimated by multiplying the projected spring Chinook run size by the percent of unmarked fish obtained from http://www.dfw.state.or.us/fish/fish_counts/willamette/archives.asp, last accessed on October 30, 2017.

[7] The average sum of the total wild summer steelhead returns (Table 6; WDFW and ODFW 2017) and total wild winter steelhead returns (Table 11; ODFW and WDFW 2016) multiplied by the proportions of each DPS described above at Tongue Point.

[8] Average number of Snake River sockeye returns to the Columbia River from 2011 to 2015; Table 18 in ODFW and WDFW (2016).

[9] The total adult equivalents lost for Snake River sockeye is 0.16 (8x0.02); using 0.16, percent of natural-origin adults returning at mouth for the Snake River sockeye salmon is 0.01 percent.

[10] Average number of total Columbia River chum abundance; Table 12 in WDFW and ODFW (2017).

[11] Average number of total coho salmon returns minus hatchery coho returns; Table 8 in WDFW and ODFW (2017).

Residualism

A proportion of the smolts released from a hatchery may not migrate to the ocean but rather reside for a period of time in the vicinity of the release point. These non-migratory smolts (residuals) may directly compete for food and space with natural-origin juvenile salmonids of similar age. 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. As described in Appendix A under Factor 3, hatchery programs can take a number of actions to reduce the potential for hatchery salmon and steelhead from residualizing including:

- releasing hatchery smolts that are physiologically ready to migrate
- operating the hatcheries such that hatchery fish are reared to sufficient size that smoltification occurs in nearly the entire population
- releasing hatchery smolts below areas used by natural-origin 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

Evaluations of residualized spring Chinook salmon in the Yakima River from the release of 810,000 smolts, found that the number of residual hatchery Chinook salmon ranged from 2 to 423 from 2009 to 2011 (Temple et al. 2012). Johnson et al. (2012) estimate that the number of residualized hatchery spring Chinook salmon found on the spawning grounds ranged from 0 to 78 from 1999 to 2011, and were fewer in number than natural-origin residuals (0-92). Both of these estimates show that only a small fraction, less than 0.1 percent, of the hatchery juvenile releases tended to residualize. Assuming that residualism rates would be similar in tributaries of the MCR, then very few would be expected to residualize (<250). Due to the low abundance of residualized hatchery salmon, and the tendency for co-occurring species to minimize habitat overlap, impacts from interactions leading to completion with and predation on natural-origin steelhead below the release locations are expected to be negligible.

2.10.1.2. Naturally-produced progeny competition

Naturally spawning hatchery spring Chinook salmon and summer steelhead originating from the Proposed Action are likely to be less efficient at reproduction than their natural-origin counterparts (Christie et al. 2014), but the progeny of such hatchery spawners are likely to make up a sizable portion of the juvenile fish population. If the current rearing habitat is limited, the added abundance of hatchery progeny could result in a density-dependent response by natural-origin juveniles of decreasing growth/mortality, earlier migration due to high densities, and potential exceedance of habitat capacity. These density-dependent effects on both listed Chinook salmon and steelhead would be expected to increase in the future if the ESA-listed steelhead populations grow.

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. In the short-term, we do not believe current densities are limiting natural-origin salmon and steelhead production. NMFS expects that the monitoring efforts would detect negative impacts before they reach problematic levels, and we include language in the ITS (Section 2.18) to ensure that appropriate monitoring takes place.

2.10.1.3. Disease

The co-managers closely monitor for disease during all aspects of the production program. Section 7.7 of the HGMPs describe the fish health actions associated with broodstock holding and spawning. For example, all the spawned spring Chinook salmon female broodstock are sampled for IHN, BKD and other pathogens as appropriate. Each egg batch associated with individual fish are discarded upon the detection of IHN Type 2 or BKD greater than "low-level" detections.

Sections 9 in the HGMPs describes the fish health maintenance and monitoring actions and risk aversion measures during incubation and rearing. For example, fish are monitored daily for elevated levels of mortality, and a subset of fish are tested monthly for a variety of possible pathogens.

ODFW Fish Health staff perform fish health inspections prior to any transfer and smolt releases. All fish are examined to detect the presence of "reportable pathogens" as defined in the PNFHPC disease control guidelines, within 3 weeks prior to release. Fish are also inspected prior to each transfer from one facility to the next, as per ODFW Fish Health Management Policy. Only certified fish are released. All of these actions are implemented to prevent the amplification and transmission of infectious diseases in the naturally spawning populations within the MCR.

2.11. Factor 4. Research, monitoring, and evaluation that is associated with the hatchery program

The HGMPs for the Proposed Action address the five factors that NMFS takes into account when it analyzes and weighs the beneficial and negative effects of hatchery RM&E (Section 5, Appendix A). The Proposed Action includes RM&E activities that will continue to monitor the Performance Indicators identified in Section 1.10 of the HGMPs, ensure compliance with this opinion, and inform future decisions over how the hatchery programs can be adjusted to meet their goals while further reducing impacts on ESA-listed steelhead. The activities will also monitor the status of the reintroduced and non-listed Chinook salmon populations.

As described in the Proposed Action there are two types of RM&E, one that focuses on the evaluation of the hatchery programs and one the focuses on the natural-origin populations. The activities to monitor the hatchery program occur within the hatchery environment and thus would not directly impact natural-origin salmon and steelhead. These activities include monitoring within hatchery survival and growth, fish health, and smoltification prior to release. Other activities associated with the hatchery evaluation include reviewing data on fish migration, catch records to estimated hatchery contribution to fisheries, and the recovery of CWTs. All of these activities would not involve the take of ESA-listed species.

RM&E activities outside the hatchery focus primarily on the contribution of the hatchery fish to the naturally spawning populations and the status of the populations in the Walla Walla River and Umatilla River Basins. NMFS has developed general guidelines to reduce impacts when collecting listed adult and juvenile salmonids (NMFS 2000b; 2008a), which have been incorporated as terms and conditions into section 10 and section 7 permits for research and enhancement activities (e.g., NMFS 2007). Though necessary to monitor and evaluate impacts on listed populations from hatchery programs, monitoring and evaluation programs should be designed and coordinated with other plans to maximize the data collection while minimizing take of listed fish. The RM&E activities in the Proposed Action will maximize the data collection by using natural-origin juveniles that are collected and tagged for more than one project. The RM&E guidelines are currently being followed during RM&E activities and will be included as terms and conditions.

The proposed RM&E activities will directly and incidentally take ESA-listed steelhead adults and juveniles as described in Proposed Action (Section 1.3), which will negatively affect the populations encountered. The level of take and its impact on ESA-listed steelhead depends on the activity.

Touchet River and Walla Walla River

Dayton Pond Trapping

During steelhead and spring Chinook salmon broodstock collection and monitoring activities, the Dayton Adult Trap is expected to encounter up to 800 natural-origin steelhead adults; an estimated 16 adults could die annually as a result of handling. The expected loss of 16 adults represents approximately 5% of the recent mean annual escapement of 331 natural-origin adults (Table 15). The estimated loss of 16 adults assumes a handling mortality of 2% and the maximum number of encounters. However, the actual number of natural-origin steelhead trapped at this facility has ranged from 119 to 601 for the period 2006 to 2015 and annual mortalities have been very low, averaging less than 1 adult/year since the new facility was installed. Consequently, while up to 16 adults could be lost in a single year, this is a very conservative estimate and the average annual losses would likely be substantially lower.

The proposed weirs on Coppei, Patit, and Dry Creeks will not be used to collect broodstock, but will be used to monitor escapement and remove stray hatchery adults. The weir in Coppei Creek is expected to encounter up to 200 natural-origin steelhead while the weir on Patit Creek is expected to encounter up to 50 adults (Table 3). The weir on Dry Creek has been proposed but has never been installed; if installed, the WDFW estimates that up to 100 natural-origin adults could be handled annually at this weir. The WDFW estimates that up to 7 adults, total, could be lost due to trapping and handling at these weirs. The 7 adults represents approximately 2% of the average annual return to the Touchet. The actual number of adults handled at these weirs have ranged from 9 to 122 in Coppei Creek and 2 to 60 in Patit Creek (Table 30). Mortalities due to handling have averaged less than one per year.

Table 30. Natural-origin steelhead and Touchet Endemic summer steelhead trapped at the Coppei Creek weir and the Patit Creek weir and associated mortalities. Natural passed downstream are natural-origin steelhead that were not trapped and sample at the weir during their upstream migration (Trump 2017a).

Return Year	Natural passed upstream	Mortalities	Natural passed downstream	Endemic passed upstream
Coppei Creek Weir				
2010	122	0	3	1
2011	33	0	4	2
2012	32	0	5	0
2013	57	1	2	6
2014	27	3	4	0
2015	34	0	47	1
2016	58	1	1	0
2017	9	0	2	0
Patit Creek Weir				
2014	2	0	0	0
2015	60	1	18	1
2016	33	0	20	1
2017	0	0	0	0

RSTs Touchet and Walla Walla

The RST has been operated in a number of locations in the Touchet River below Dayton; beginning in the 2014-15 migration year, the trap was operated 10 miles below the town of Prescott, Washington. This is the lower-most site in the Touchet River and is the location that is expected to be used into the future. The proposed RST in the Touchet River is expected to handle up to 12,000 juvenile *O. mykiss* with an associated loss of 360 juveniles or 3% (Table 3). Handling of juveniles at these trapping facilities can lead to injury and cause stress, however, trained personnel and established operating protocols can reduce the likelihood of any impacts (see Appendix A). The handling of 12,000 juvenile *O. mykiss* would represent over 21% of the average juvenile outmigration from the Touchet River. This is assumes that all of the fish handled are outmigration smolts, however, a large proportion of the fish PIT-tagged are parr not outmigrating smolts. The parr would be part of the larger population of juvenile *O. mykiss* within the Touchet River and thus the actual impacts would be expected to be less.

The actual numbers are much lower in than what was estimated by the operators. The recent average annual catch and handling of 3,390 juvenile steelhead is much less than 1/3 the operator's estimated level of handling and varies due to river flows and weir efficiencies. Actual mortalities have averaged 81. The 3,390 average catch represents approximately 6% of the Age-1 juvenile steelhead abundance above the Dayton trap. The estimated maximum mortality of 447 juveniles represents between 4 and 16 adults depending on the smolt-to-adults survival and the recent average number of actual juveniles lost represents between less than one adult and 3 adults. The loss at the maximum rate, if it occurred annually, would reduce the abundance of the natural-origin population in the short term, but the loss of 4 to 16 adults would be expected to be mitigated by Touchet Endemic hatchery steelhead spawning naturally. Because the Touchet Endemic summer steelhead incorporate natural-origin adults their contribution to the naturally spawning population would be expected to increase abundance and potentially contribute to productivity.

Table 31. Catch and associated mortality of juvenile *O. mykiss* during rotary screw trap operations in the Touchet River.

Year	Catch	Mortality
2011-12	3,721	65
2012-13	6,525	219
2013-14	2,781	103
2014-15	1,101	11
2015-16	4,685	58
2016-17	1,526	30
Average	3,390	81

CTUIR will operate three existing rotary screw traps to sample out migrating summer steelhead and spring Chinook salmon in the Walla Walla River and Mill Creek (Section 1.3). The traps will be operated continuously during fall through spring as stream conditions allow. Steelhead will be scanned for PIT-tags and healthy summer steelhead (> 125 mm FL) will be manually PIT-tagged and released on site. These tagging efforts will supplement those conducted by project collaborator WDFW in the Touchet River. The estimated mortality would be 160 juvenile MCR steelhead out of the 8,000 juveniles collected. Actual mortalities have been less with an average of 52, and a range of 1 to 152 (Table 32).

Table 32. The combined catch and associated mortality of juvenile *O. mykiss* during the operation of the Walla Walla and Mill Creek RSTs (Olson 2017).

Year	Total Handled	Mortalities
2010	3,833	94
2011	3,751	152
2012	1,671	16
2013	880	53
2014	1,247	5
2015	1,046	1
2016	244	83
2017	1,177	12
Average	1,731	52

Juvenile abundance and distribution

A number of methods have been proposed to estimate juvenile abundance and distribution in the Touchet River if it occurs in the future. The use of electrofishing, hook and line, and beach seines for collect juveniles is proposed to collect up to 3,650 juveniles annually with an associate loss of 87 juveniles. Handling of juveniles during these activities can lead to injury and cause stress, however, trained personnel and established operating protocols can reduce the likelihood of any impacts (see Appendix A). Hook and line and beach seining methods have not been used in the past only electrofishing has been used to qualitatively determine abundance and distribution. When the sampling occurred in the past, an average 5,578 juveniles were collected annually (Table 33). It should be noted that if these methods are used in the future to PIT tag juvenile *O. mykiss*, then larger age-1 juveniles would be targeted substantially reducing the total number of *O. mykiss* handled annually.

Table 33. Juvenile *O. mykiss* collected during electrofishing activities in the Touchet River Basin, note that Age-1 fish may include age-2 and age-3 fish (Bumgarner 2017e).

Year	Total	Age-0	Age-1
2001	4,069	2,901	1,168
2002	5,785	4,871	914
2003	11,840	9,382	2,458
2004	3,144	2,023	1,121
2005	3,267	2,248	1,019
2006	5,361	4,408	953
Average	5,578	4,306	1,272

Fish Salvage

The co-managers will salvage stranded fish from irrigation facilities and other locations throughout the Walla Walla River Basin. Seines and backpack electro-fishing gear are used to collect fish from isolated pools or reaches in dewatered areas. Rescued fish are either returned directly to the river above or below the affected area or trucked several miles upstream depending on the suitability of stream conditions. The maximum expected take for this activity is 200 adult natural-origin steelhead and up to 500 juvenile *O. mykiss*. From 2010 to 2016, a total of 8 salvage actions have occurred with a total of 90 juvenile *O. mykiss* and 1 Chinook juvenile handled, with no observed mortalities (Trump 2017b). It is expected that all of the fish collected would have been lost otherwise, making this a reduction of mortality of 89 fish.

Redd Surveys

Adult salmon and steelhead observed during spawning ground surveys would not be negatively impacted because any effects due to the presence of the surveyors would be negligible as the adults temporarily move away as the surveyors pass by.

Pacific Lamprey Research

CTUIR will conduct presence/absence electro-fishing surveys for lamprey annually throughout the Walla Walla River basin to better understand current abundance and distribution of lamprey. Up to 500 juvenile *O. mykiss* may be encountered during this sampling with a potential mortality of 8 juveniles. Surveys for spawning lamprey will also be conducted and may encounter and juvenile steelhead, but the effects are expected to be negligible as the adults and juveniles temporarily move away from the observers.

Freshwater Mussel Research in Touchet and Walla Walla River

During freshwater mussel surveys adult and juvenile steelhead may be encountered but the effects are expected to be negligible as the adults and juveniles temporarily move away from the observers. Up to 100 juvenile *O. mykiss* may be encountered during the collection of non-salmonid host fish with the potential loss of up to 2 juveniles. This activity would only occur if the non-salmonid host fish could not be collected at the RSTs.

Umatilla River

Three Mile Falls Dam Adult Monitoring

The TMDF adult collection facility is operated on a daily basis from August 16 until December 1st. Beginning on December 1st, the trapping facility is generally operated for five days and is then closed for nine days. Returning adults are allowed to volitionally migrate upstream when the trap is not being operated and adult returns are video-enumerated. During trapping operations, it is expected that up to 3,500 natural-origin summer steelhead could be handled annually, with an estimated 35 that would incidentally die as a result of handling. These numbers are the anticipated maximum impacts, due to variability in adult returns and survival. The actual number of adults collected has averaged 1,500 adults and ranged from 767 to 2,266 and mortalities have averaged less than one annually (Table 24).

Juvenile outmigration and natural production

Smolt outmigration will be monitored using RST operated at the mouth of Birch Creek and an inclined plane trap in the juvenile bypass facility within the West Extension Canal at TMD. Trapping at the West Extension Canal will occur between March and June, and the RST at Birch Creek will be operated from December through June, depending on river conditions. Fish will be examined for marks and tags and unmarked summer steelhead will be given a PIT tag. Up to 9,000 juvenile natural-origin steelhead will be PIT-tagged annually. These two traps are expected to handle up to 12,000 juvenile *O. mykiss* with an expected mortality of 150.

The CTUIR will capture and PIT tag steelhead emigrating from Meacham Creek and the Umatilla River above the mouth of Meacham Creek using RSTs. The monitoring will provide abundance estimates of steelhead leaving those watersheds. The goal is to PIT tag up to 7,000 steelhead juveniles. The traps will be operated from March 1 through May and possibly into June if flows allow. These efforts resume in August, September or October if flows allow. Low flows may stop or delay trapping before the end of May and the resumption of trapping in August. The RST expect to collect up to 14,000 juvenile *O. mykiss* with an estimated 90 mortalities.

The combined total for the maximum number of *O. mykiss* collected annually at all of the juvenile monitoring facilities is 26,155 (Table 7). The actual of *O. mykiss* handled at these RSTs is substantially less than proposed averaging 16,465 juveniles (see Table 34). Mortalities have been low averaging approximately 2.2% at the Upper Umatilla RST and less than one percent at the other traps (Table 34). Handling of juveniles at these trapping facilities can lead to injury and cause stress, however, trained personnel and established operating protocols can reduce the likelihood of any impacts (see Appendix A). Hanson (2017) estimated that for the last 25 years the abundance of outmigrating smolts at TMFD has averaged 43,540. If the juvenile *O. mykiss* captured were all smolts, the trapping would capture approximately 38% of all the outmigrants. But the 16,465 juveniles trapped is made up of both migrating and non-migrating *O. mykiss*, so the impacts on the natural-origin population would be only a portion of that total, and the average number of juveniles lost annually represents between 2 and 6 adults depending on the smolt-to-adult survival. The maximum proposed loss of 255 juveniles represents between 2 and 9 adults which would not be expected to have any noticeable effect on the current abundance of the Umatilla summer steelhead population (Table 15).

Lamprey Research

To monitor the outmigration of larval and metamorphosed lampreys, an RST will be operated from October through May (CTUIR 2017c). The trap will be located at RM 1.9 on the lower mainstem Umatilla River. The trap will be operated 24-hours per day and checked twice a day by CTUIR personnel. The number of ESA-listed steelhead that could be encountered is expected to be up to 100 juvenile *O. mykiss* with an associated mortality of 10 juveniles. In addition, up to an additional 10 adult steelhead (most likely kelts) could be encountered (Table 4).

To monitor larval abundance and distribution annual electro-fishing surveys will be conducted and up to 1,000 juveniles could be encountered and of these 10 could be lost. Spawning ground surveys will be conducted to monitor lamprey spawning and may encounter adult and juvenile steelhead, but the effects are expected to be negligible as the adults and juveniles temporarily move away from the observers.

Freshwater Mussel Research

Freshwater mussel research activities in the Umatilla River include surveys to identify remaining freshwater mussel populations in the Umatilla River, the potential collection of freshwater mussels as broodstock or for genetic analysis, the potential experimental rearing of freshwater mussels in the Umatilla River, and survey, salvage, and translocation efforts associated with in-channel stream restoration work. These activities may encounter adult and juvenile steelhead (CTUIR 2017b), though no physical handling of ESA-listed summer steelhead would be expected to occur; but the effects are expected to be negligible as the adults and juveniles temporarily move away from the observers (Table 4).

Table 34. Natural-origin juvenile *O. mykiss* captured at ODFW and CTUIR downstream migrant traps in the Umatilla River Basin (Hanson 2017). Note the Lower Umatilla RST has not initiated operation.

Year	**Upper Umatilla RST**		**Meacham RST**		**Birch Creek RST**		**Three Mile Bypass Trap**		**Lower Umatilla RST**	
	Trapped	Mortality	Trapped	Mortality	Trapped	Mortality	Trapped	Mortality	Trapped	Mortality
2012	1,900	40	2,919	57	748	0	2,743	13	0	0
2013	5,220	88	6,364	14	4,659	23	3,554	15	0	0
2014	4,508	33	5,233	33	5,071	21	3,066	5	0	0
2015	6,682	170	2,754	16	7,569	55	2,119	3	0	0
2016	5,466	198	5,044	19	4,067	11	2,654	16	0	0
Average	4,755	106	4,463	28	4,423	22	2,827	10	0	0

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

Best available information indicates that these hatchery facility operations have no effect on ESA-listed species. There is only one program that is proposed to include construction, which is for the Walla Walla spring Chinook salmon program to upgrade the AHSF to the Walla Walla Hatchery. Facility operations effects considered here are effects of the intake pipe, water withdrawal, and effluent.

Touchet Endemic Steelhead Program

The facilities that could affect ESA-listed salmonids in this program are Lyons Ferry Hatchery and the Dayton Acclimation Facility. The production of hatchery steelhead under the Proposed Action at these facilities occurs at the same time as other programs analyzed in (NMFS 2017d) and would not increase impacts on ESA-listed salmon and steelhead beyond those already analyzed in previous consultations (NMFS 2017d). These impacts include the effects of water withdrawals, which reduce available rearing and migration habitat and a threat of entrainment on natural-origin juveniles through the facility intake. Overall NMFS (2017d) found that these effects were negligible, with intake screens meeting NMFS criteria to reduce the potential for entrainment, and reduce flow occurring over a short distance, and for a short period in the spring. Overall, the effects of operating the facility on steelhead are insignificant.

Walla Walla spring Chinook Salmon Program

The Proposed Action includes operation of AHSF, which was analyzed in NMFS (2016b). The Proposed Action also includes the construction, operation, and maintenance of the Walla Walla Hatchery, located on South Fork Walla Walla River. The construction of this hatchery will be achieved by expanding the AHSF.

Additionally, the operation of the Walla Walla Wet Lab for the rearing of freshwater mussels under the Proposed Action would have no effect on ESA-listed species because the facility is isolated from the natural environment.

Construction of the Walla Walla Hatchery

The construction includes land-based activities that would not affect ESA-listed salmonids. The one construction activity that may affect listed salmonids is the installation of a pumpback system, which would require a new discharge pipe. There may potentially be a second construction activity associated with the juvenile bypass system, as discussed below.

The new discharge pipe will be placed immediately downstream of the intake pipe—the outfall is separated by a concrete wall from the intake pipe; the distance between the two is less than 1 foot. Construction would require a small amount of construction work in or adjacent to the South Fork Walla Walla. Any in-water work would take place during the July 1 to August 15 work window as specified by ODFW. Juvenile MCR steelhead (*O. mykiss*)[4] likely would be present and would be small enough to enter the intake forebay during summer, so the Proposed Action includes measures to minimize effects on those juvenile fish. Before in-water construction begins, the work areas would be isolated using cofferdams. To minimize exposure to suction dredging, risk of impingement, and asphyxiation, fish would be removed using either nets or electrofishing. Catching fish using nets or electrofishing may cause stress to the fish, but is not expected to lead to mortality.

The disturbance of *O. mykiss* juveniles at these facilities during the proposed construction activities is expected to be minimal. The in-water work would affect only an insubstantial area of rearing habitat, relative to the rearing habitat immediately available to the juvenile *O. mykiss*, thus limiting impacts on juvenile *O. mykiss* that may be rearing in the area. Some juvenile *O. mykiss* may swim away from the disturbance to avoid impacts, and any juvenile *O. mykiss* that would be displaced would be expected to return to their previous location as soon as the work is completed, and no long-lasting impacts are expected.

The effect of the construction activities on *O. mykiss* is likely to be similar to the effect of maintenance activity to remove silt at AHSF, which was analyzed in NMFS (2016b) because the location and juvenile fish salvage/exclusion method are similar between the two activities. During the silt removal during past intake bay clean-outs, very few juvenile *O. mykiss* have been encountered, with only two juvenile *O. mykiss* being salvaged in 2014 and none in 2013, with no mortalities. Effects of the capture and removal of juvenile *O. mykiss* to install the discharge pipe are expected to be minor, though slightly greater than that of silt removal because the installation of the discharge pipe occurs in summer (compared to the silt removal in winter), when the fish could experience more stress from higher water temperature. We do not anticipate the number of encounters to be more than 50 fish to install the discharge pipe, with limited mortality associated with handling (5 percent), which accounts for a change in abundance and distribution of juveniles when this construction may take place compared to the juvenile abundance and distribution during the past intake bay clean-outs.

Operation of the Walla Walla Hatchery

The newly constructed Walla Walla Hatchery will be operated year-round, providing for adult holding, spawning, incubation, rearing, and release of 500,000 spring Chinook salmon. The facility already has an intake screen that meets NMFS screening criteria, which minimizes the risk of fish impingement or entrainment. The Walla Walla Hatchery would use stream water for two reasons, for hatchery withdrawal and for the juvenile bypass, which could reduce the instream flow.

The proposed hatchery operation would withdraw 20 cfs from the South Fork Walla Walla River. Of this 20 cfs, 15 cfs would be returned immediately below the intake (less than 1 foot apart). The remaining 5 cfs is routed to the abatement pond, which is either returned to the river through the new discharge pipe through the pumpback system or through the current abatement pond outfall 500 feet downstream of the intake. There will be daily monitoring for instream flow

[4] Because juvenile steelhead cannot be distinguished from its resident counterpart, juvenile fish of these species will collectively referred to as *O. mykiss*.

near Harris Park (3 miles upstream of the hatchery); when monitoring indicates that OWRD's minimum instream flow requirements would not be met due to hatchery withdrawals, water that must pass through the abatement pond will be returned to the river near the intake so that minimum instream flows are maintained.

The juvenile bypass system uses 4 to 6 cfs of water (in addition to the 20 cfs described above), which is returned to the river 250 feet downstream from the intake. The removal of 4 to 6 cfs over the bypass reach would not be expected to have any discernable effect on rearing and migration habitat. The withdrawal represents less than 5% of the minimum instream flow requirements during the peak migration periods in the spring and up to 11% during the low flow period in the fall (Table 35). Average daily instream flows during the summer has averaged over 90cfs (BPA et al. 2014), thus overall reduction is less than 7% of the instream flow in the bypass section. Instream flows that exceed the minimum flow requirements are expected to provide sufficient instream rearing habitat as well as provide for migration of both juveniles and adult salmonids.

Table 35. Oregon Water Resources Department's instream flow requirement (cfs).

Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
100	136	136	136	136	100	70	70	70	54	54	100

BPA and the CTUIR have determined that during specific months of the year, the operation of the existing bypass system would potentially reduce the flows below the minimum state mandated flow requirement within the bypass reach (Table 35). To address these impacts, BPA proposes that the hatchery operators close the juvenile bypass system when daily monitoring shows the potential for the operation of the juvenile bypass system to reduce instream flows below the minimum flow requirement for that time of year (Table 6). During the winter months (December through March) air temperatures can reach well below freezing at night, which can lead to conditions where flows in the South Fork Walla Walla River are reduced due to freezing. This is usually temporary with flows increasing during the day as frozen river water melts. Due to these reductions in flows during the winter months BPA has estimated that the removal of 4-6cfs to operate the juvenile bypass system would reduce flows below the instream minimum. The number of days in each month varies with 5 days in December, 4 days in January and March, and up to 10 days in February (Table 6). Not operating the bypass system on those days might cause delay because fish entering the intake could not exit though the bypass. However, juvenile fish would still be able to migrate back to the river through the intake.

Impacts on steelhead juveniles from the closing the bypass on those days is expected to be minimal, because the closures would not generally occur on consecutive days, would likely not last for the whole day, and juvenile fish would be able hold and rear in the intake until the bypass in reopened. Furthermore, juveniles would not necessarily be delayed because juvenile fish do not tend to migrate during this period due to the cold water temperatures, or migrating fish have already moved downstream. Mahoney et al. (2015) found that the juvenile migration period for smolts in the Walla Walla River began in March and peaked in April and May, with smaller juveniles migrating to the lower Walla Walla River from October through December.

For the purpose of this opinion, we assume that the Walla Walla Hatchery (when it produces 500,000 spring Chinook salmon[5]) will be operated under a NPDES permit that would allow for the hatchery to meet the instream water quality standards, with no interim discharge limits, and that the facility effluent is monitored to ensure compliance with permit requirements. Though compliance with NPDES permit conditions is not an assurance that effects on ESA-listed salmonids will not occur, the facilities use the water specifically for the purposes of rearing hatchery salmonids, which have a low mortality during hatchery residence compared to survival in the natural-environment (~70 percent compared to 7 percent (Bradford 1995)). This suggests that the effects of effluent, which is further diluted once discharged, will have a minimal impact on ESA-listed salmonids in the area, as discussed below. Whether a NPDES permit is in place and complied with or not, if the effluent produced is similar to the type and amount considered here, the effects are expected to be no greater than described here.

The total facility discharges proportionally small volumes of water with waste (predominantly biological waste) into a larger water body, which results in temporary, very low or undetectable levels of contaminants. These contaminants contained in biological waste (e.g., suspended solids, ammonia, chlorophyll-a, phosphorus) could negatively affect listed species directly (e.g., increased ammonia interfering with fish's ion regulations) and indirectly (e.g., increased phosphorus increases pH, which in turn, creates sublethal effects on fish); the general effects of various biological waste in hatchery effluent are summarized in NMFS (2004a). While these effects can occur at high levels of contaminants, the biological waste from the Proposed Action is not likely to have a detectable effect on listed species because of the use of an abatement pond at the hatchery.

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

Maintenance of the Walla Walla Hatchery

The routine maintenance of Walla Walla Hatchery would not be different than the routine maintenance of the existing facility at the site, the South Fork Walla Wall AHSF, which was analyzed in NMFS (2016b).

[5] Current level of production at AHSF does not require a NPDES permit because it rears less than 20,000 pounds of fish. Until the production level increases to 500,000 smolts, we do not anticipate that the water quality effects would change from that analyzed in NMFS (2016b), which concluded that there is not adverse effect on listed species from the effluent.

Umatilla River Summer Steelhead Program

With the exception of Minthorn adult holding facility, all facility effects for this program were analyzed in NMFS (2011c) and in NMFS (2016b), which found that water withdrawals and facilities maintenance activities can adversely affect ESA-listed species, but such effects are not likely to jeopardize the continued existence of ESA-listed species.

The Minthorn adult holding facility withdraws about 1 to 5 cfs of water from the Minthorn Springs Creek from mid-September to late May. Minthorn Springs Creek is not identified as having any spawning, rearing, or migration Primary Constituent Elements (PCEs) (Table J1 of NMFS 2017c), meaning that the creek is not a suitable habitat for MCR steelhead. In addition, Minthorn Springs Creek was also not designated as a critical habitat (Map J6 of NMFS 2017c), further supporting that Minthorn Springs Creek is not a suitable habitat for MCR steelhead. Therefore, we assume that no listed MCR steelhead are present in Minthorn Springs Creek, and the Minthorn adult holding facility would not affect listed steelhead.

Round Butte Hatchery Spring Chinook Salmon Program

There are two facilities used for this program that could affect ESA-listed salmonids: Wizard Falls Hatchery and Round Butte Hatchery. The Wizard Falls Hatchery is located on the Metolius River, above Round Butte Dam, which is not passable to anadromous fish. While an experimental population of reintroduced steelhead exist in this area, it is not considered as part of the DPS. Because no ESA-listed fish are present in the area of the Wizard Falls Hatchery, there is no adverse effect on ESA-listed salmonids.

At the Round Butte Hatchery, water is withdrawn from the west bank grout tunnel drilled into the canyon wall immediately west of the hatchery. Because hatchery water is not withdrawn from a live stream, there is no possibility of effect on listed fishes from hatchery water withdrawal, including dewatering, impingement, and entrainment.

The Round Butte Hatchery is operated under NPDES permit (General Permit 300J) and discharges into Lake Simtustus. Because Lake Simtustus is not an anadromous water and no MCR steelhead are present, the Round Butte Hatchery effluent would not affect listed species.

Touchet Spring Chinook Salmon Program

Broodstock for the Touchet Spring program will be collected at the Carson NFH until enough adults return to the Touchet River for broodstock to be collected at the DAT. Effects from the collection of broodstock and the operation of Carson NFH were previously evaluated in (NMFS 2007; 2016c). Green eggs and milt would be transported to Lyons Ferry Hatchery for incubation and rearing to release. The production of spring Chinook salmon under the Proposed Action at these facilities occurs at the same time as other programs analyzed in (NMFS 2017d) and would not increase impacts on ESA-listed salmon and steelhead beyond those already analyzed in previous consultations (NMFS 2017d). These impacts include the effects of water withdrawals, which reduce available rearing and migration habitat and a threat of entrainment on natural-origin juveniles through the facility intake. Overall NMFS (2017d) found that these effects were negligible, with intake screens meeting NMFS criteria to reduce the potential for entrainment, and reduce flow occurring over a short distance, and for a short period in the spring. Overall, the effects of operating the facilities on steelhead are insignificant.

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

No fisheries are part of the Proposed Action. The description of other fisheries in the Action Area and the effects of the fisheries on listed species are described in Section 2.6.4, Fisheries in the Environmental Baseline because those fisheries are ongoing.

2.14. Effects of the Action on Critical Habitat

Operation of the hatchery programs would have a minor effect on designated critical habitat PBFs in the Action Area.

The existing hatchery facilities (i.e., Lyons Ferry Hatchery, Umatilla Hatchery, Carson NFH, Round Butte Hatchery) have not led to altered channel morphology and stability, reduced and degraded floodplain connectivity, excessive sediment input, or the loss of habitat diversity. Hatchery maintenance activities are expected to retain existing conditions, and would have minimal adverse effects on designated critical habitat. In addition, no new instream structures are proposed that would permanently affect designated critical habitat.

The operation of the Dayton Acclimation Pond occurs at the same time as other programs analyzed in (NMFS 2017d) and would not increase impacts on designated critical habitat beyond those already analyzed in the previous consultations (NMFS 2017d). These impacts would include the reduction in available rearing and migration habitat between the facility intake and the outfall. The impacts are expected to be negligible because the reduction in flow would be minor, less than 11% of the flow, occur over a relatively short distance, and would occur during a brief period in the spring.

The installation of the new outfall structure at the Walla Walla Hatchery, as described above, may impact a small section of stream shore, but these impacts would be expected to be transitory and would have no long-term effect on critical habitat.

Critical habitat for MCR steelhead that may be adversely affected is in South Fork Walla Walla River. The AHSF is proposed to be expanded to the Walla Walla Hatchery, which will require in-water work in the South Fork Walla Walla River to install a discharge pipe during the July 1 to August 15 work window. Before in-water construction begins, the work areas would be isolated using cofferdams. To minimize exposure to suction dredging, risk of impingement, and asphyxiation, fish would be removed using either nets or electrofishing. This work would block a small portion of the South Fork Walla Walla River for a short period of time, but would not permanently alter the habitat in the river. Therefore, it is likely to only have a minor effect on the designed critical habitat PBFs for juvenile rearing.

The Walla Walla Hatchery would use surface water diversions to return a majority of that water to the river a short distance (less than a foot) from the diversion point (Section 2.12). In addition, the hatchery would be operated to maintain OWRD’s instream flow requirement (Table 35). Our analysis determined that because the diversion distance is very short (<1 foot), the withdrawal of instream flow will not be expected to violate the minimum instream flow established by OWRD, therefore these water withdrawals would not affect adult spawning and juvenile rearing critical habitat of ESA-listed MCR steelhead. The juvenile bypass system at the Walla Walla Hatchery used 4-6cfs to operate and reduces flow in a 250 ft section of the South Fork River from the intake to the outfall. The removal of the bypass flow would be expected to have only a minimal effect on migration and rearing habitat, because the average daily flows would only be reduced by under 6% and would only affect a 250 ft section of the river. The facility operators will monitor instream flows and if the operation of the bypass causes the flow in the bypass section to be less than the instream flow minimum, the bypass would be closed allowing the 4-6cfs to remain in the river, ensuring no effect on the instream critical habitat.

Another potential effect on critical habitat is the use of chemicals for cleaning or treating pathogens that are present in the hatchery effluent from the Walla Walla Hatchery on South Fork Walla Walla River. At this time, no information exists to suggest the use of the chemicals and their subsequent dilution to manufacturer’s instructions would cause adverse effects on listed fish. Furthermore, the use of abatement ponds to allow chemical degradation into less toxic components, and the mixing of effluent with the remaining water in the creek or river lead to an expectation that there would not be a detectable change in water quality. Thus, the effects on water quality in spawning and rearing critical habitat are negligible.

2.15. 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 2.5. To the extent ongoing activities have occurred in the past and are currently occurring, their effects are included in the baseline (whether they are Federal, state, tribal or private). To the extent those same activities are reasonably certain to occur in the future (and are tribal, state or private), their future effects are included in the cumulative effects analysis. This is the case even if the ongoing tribal, state or private activities may become the subject of section 10(a)(1)(B) incidental take permits in the future until an opinion for the take permit has been issued.

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

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

More detailed discussion of cumulative effects for the Columbia River basin can be found in our biological opinion on the funding of Mitchell Act hatchery programs (NMFS 2017e). In summary, it is likely that the type and extent of salmon and steelhead hatchery programs and the numbers of fish released in the analysis area and throughout the Columbia Basin generally will change over time. Although adverse effects will continue, these changes are likely to reduce effects such as competition and predation on natural-origin salmon and steelhead compared to current levels, especially for those species that are listed under the ESA. This is because all salmon and steelhead hatchery and harvest programs funded and operated by non-federal agencies and tribes in the Columbia Basin have to undergo review under the ESA to ensure that listed species are not jeopardized and that "take" under the ESA from salmon and steelhead hatchery programs is minimized or avoided. Where needed, reductions in effects on listed salmon and steelhead are likely to occur through:

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

The cumulative impacts of climate change on ESA-listed salmon and steelhead are difficult to predict, but are discussed under in the Environmental Baseline Section 2.6.2. The Proposed Action addresses climate change effects by aligning future hatchery operations with recovery, primarily by ensuring that natural populations are capable of improving in productivity, abundance, and diversity, which will allow them to adapt to changing environments. Pacific anadromous fish are adapted to natural cycles of variation in freshwater and marine environments, and their resilience to future environmental conditions depends both on characteristics of individual populations and on the level and rate of change. However, the life history types that will be successful in the future are neither static nor predictable, therefore maintaining or promoting existing diversity that is found in the natural populations of Pacific anadromous fish is the wisest strategy for continued existence of populations.

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

2.16. 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 2.7.2) to the environmental baseline (Section 2.6) and to cumulative effects (Section 2.15) taking into account the status of the species and critical habitat (Section 2.2) to formulate the agency's biological opinion as to whether the Proposed Action is likely to: (1) Reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated or proposed critical habitat for the conservation of the species.

In assessing the overall risk of the Proposed Action on each species, NMFS considers the risks of each factor discussed in Section 2.7.2., 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.

2.16.1. Middle Columbia River Steelhead DPS

Best available information indicates that the MCR Steelhead DPS remains at threatened status (NWFSC 2015). Although there have been improvements in the viability of some populations, and out-of-basin stray rates have been reduced, natural-origin abundances are still highly variable compared to previous status reviews.

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

The majority of the effects of the Proposed Action on this DPS are genetic and ecological in nature. This is a factor in the abundance (ecological), productivity (ecological), and diversity (genetic) parameters. Effects from facility operation and broodstock collection are small and localized, and, while RM&E requires handling of a substantial portion of the juvenile population, less than 3% are expected to die as a result of handling. The take pathway associated with these operations are represented as maximum total fish handled and killed as described in Table 3 (Touchet River), Table 4 (Umatilla River), and Table 7 (Walla Walla River). The information gained from conducting the RM&E work is essential for understanding the effects of the hatchery program on natural-origin steelhead populations. In addition, the construction activity to expand the AHSF to the Walla Walla Hatchery may encounter up to 50 fish, with a five percent mortality associated with handling. The take pathway for these fish are represented as these encounters.

The ecological and genetic effects on the adult life stage are limited by the proportion of hatchery-origin fish spawning naturally. The take pathway for these effects are measured as the proportion of hatchery-origin fish on natural spawning grounds measured as pHOS and through CWT/PIT detections. Both integrated steelhead programs have contributed less than 30 percent of the fish spawning in the Touchet and Umatilla River steelhead populations. This, combined with their high pNOB levels in the hatchery-origin broodstock has resulted in PNI values that favor natural selection. In addition, straying by fish originating from these programs within the DPS is low. Moreover, these releases are subject to high direct harvest rates from tribal and non-tribal fisheries. Therefore, it is unlikely that hatchery-origin returns from these releases will constitute a substantial amount of the total returns to natural spawning areas.

Effects of adult hatchery-origin spring Chinook salmon on steelhead are limited to those that are ecological in nature. The take pathway for these effects are also measured as the proportion of hatchery-origin fish on natural spawning grounds measured as pHOS and through CWT/PIT detections. Our analyses identified low levels of straying of fish from these programs into any recipient population (< 1 CWT recovered annually—after expansion for tagging rate, still very few fish of these programs show up as strays). In addition, the run-timing, holding, and spawning of these species does not overlap, suggesting there is unlikely to be any competition for spawning sites or redd superimposition.

Ecological effects on natural-origin juvenile steelhead associated with the releases from the hatchery programs represent a loss of about 0.2 percent from this DPS—based on average smolt-to-adult survival rates, this loss during outmigration is equivalent to approximately 40 fewer adults of the MCR steelhead DPS returning to the Columbia River. Based on current information, this is likely to be a maximum loss because of the assumptions and simplicity inherent in the model, and while it does indicate a decrease in adult abundance, this decrease is at a level that is likely insignificant to the DPS. As we continue to improve the model, these estimates will become more refined in the future, and will likely decrease the percentage of adults that are estimated to be lost from this worst-case scenario. The take pathway for these effects are measured as travel time for outmigrants as well as precocial maturation in hatchery juveniles prior to release (to represent residualism). Overall, this relatively small loss is unlikely to have an effect on the abundance and productivity of this DPS.

Added to the Species' Status, Environmental Baseline, and effects of the Proposed Action are the effects of future state, private, or tribal activities, not involving Federal activities, within the Action Area. The recovery plan for this DPS describes the on-going and proposed state, tribal, and local government actions that are targeted to reduce known threats to ESA-listed steelhead. Such actions are improving habitat conditions, and hatchery and harvest practices to protect listed steelhead DPSs, and NMFS expects this trend to continue.

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

2.16.2. Snake River Steelhead DPS

Best available information indicates that the Snake River Steelhead DPS is at high risk and remains at threatened status (NWFSC 2015). Ford et al. (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 et al. 2011).

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

The majority of the effects of the Proposed Action on this DPS are genetic and ecological in nature; primarily, this DPS was included in the analysis because of the straying of Touchet endemic hatchery-origin steelhead into the Tucannon River. The level of straying was high compared to straying into other steelhead populations for this program, and may result in some adverse effects on the Tucannon population if all of the fish detected spawned successfully. However, NMFS believes that acclimating fish in the Touchet River prior to release is likely to improve homing to the Touchet River and as a result reduce straying into the Tucannon River steelhead population. In addition to this, there were some small negative effects from hatchery-origin fish on natural-origin steelhead from this DPS that equaled two adult equivalent fish. This equates to a loss of much less than one percent of the adult natural-origin steelhead in this DPS. Overall, these relatively small losses are unlikely to have an effect on the diversity, abundance, or productivity of the steelhead DPS in the Snake River. NMFS will monitor whether decreased productivity, diversity, or abundance of natural-origin fish may necessitate more aggressive adult management, and/or reconsideration of hatchery program size in the future to limit impacts to these VSP parameters in this DPS (Appendix A).

Added to the Species' Status, Environmental Baseline, and effects of the Proposed Action are the effects of future state, private, or tribal activities, not involving Federal activities, within the Action Area. The recovery plan for this DPS describes the on-going and proposed state, tribal, and local government actions that are targeted to reduce known threats to ESA-listed steelhead. Such actions include improving habitat conditions, and hatchery and harvest practices to protect listed steelhead DPSs, and NMFS expects this trend to continue, and could lead to increases in abundance, productivity, spatial structure and diversity. Moreover, the natural-origin fish from the Walla Walla and Touchet Rivers also stray into the Tucannon River at the same rate as hatchery fish. Until adult passage problems at the Snake River dams can be addressed/improved, it's unlikely these strays will be decreased.

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

2.16.3. Critical Habitat

The Walla Walla Hatchery and the Dayton Acclimation Pond water diversions and discharges pose a negligible effect on designated critical habitat in the Action Area (Section 2.14). Existing hatchery facilities have not contributed to altered channel morphology and stability, reduced and degraded floodplain connectivity, excessive sediment input, or the loss of habitat diversity. The construction at the Walla Walla Hatchery may impact rearing PBFs because of inaccessibility to areas blocked off during construction. However, the number of natural-origin juveniles displaced is expected to be small, and the inaccessibility would be for only a short period. Thus, the impact on the spawning, rearing, and migration PBFs will be small in scale, and will not appreciably diminish the capability of the critical habitat to satisfy the essential requirements of the species.

The weirs on Coppei Creek, Patit Creek, and possibly on Dry Creek may impact migration PBFs. Habitat impacts from the installation and operation of the weirs are expected to be limited to the weir location, and to be of a short duration. Habitat will be temporarily impacted by the placement of the weirs. Each weir is designed to be installed and removed annually, eliminating the requirement for permanent structures in the river. When the weirs are operational, they would affect PBFs for migration for steelhead that would potentially be delayed at the weirs. Impacts may be reduced during periods of high flows, when the weirs would not operate continuously, which would allow for passage over or around the weir. Primarily, delay will be reduced by monitoring the weirs and processing the fish daily to limit the time in the trap.

Climate change may have some effects on critical habitat as discussed in Section 2.6.2. With continued losses in snowpack and increasing water temperatures during migration periods, it is possible that increases in the density and residence time of fish using cold-water refugia could result in increases in ecological interactions between hatchery and natural-origin fish of all life stages. However, the continued restoration of habitat should alleviate some of this potential pressure for suitable rearing and spawning habitat. After reviewing the Proposed Action and conducting the effects analysis, NMFS has determined that the Proposed Action will not impair PBFs designated as essential for spawning, rearing, juvenile migration, and adult migration purposes.

2.17. Conclusion

After reviewing the current status of the listed species, the environmental baseline within the Action Area, the effects of the Proposed Action, including effects of the Proposed Action that are likely to persist following expiration of the Proposed Action, and cumulative effects, it is NMFS' biological opinion that the Proposed Action is not likely to jeopardize the continued existence of the MCR Steelhead DPS, the continued existence of Snake River Steelhead DPS, or destroy or adversely modify its designated critical habitat.

2.18. 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 (16 USC 1532). 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 (50 CFR 17.3). 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.[6] 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.

2.18.1. Amount or Extent of Take

NMFS expects incidental take of ESA-listed steelhead is reasonably certain to occur as a result of the Proposed Action for the following factors.

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

The Touchet and Umatilla steelhead programs will both use listed natural-origin summer steelhead in their broodstocks. The maximum number of natural-origin summer steelhead that may be retained for broodstock is listed in Table 36 and Table 37, and the effects of the removal and the collection of adult broodstock are described below in Factor 2.

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

There is take for this factor due to three forms of harm: genetic effects, ecological effects, and adult handling/tagging and incidental mortality at adult collection facilities.

Specifically, take occurs for genetic effects through a reduction in genetic diversity, outbreeding depression, and hatchery-influenced selection. Additionally, take occurs through ecological effects of hatchery adults on the spawning grounds such as competition for spawning sites and redd superimposition. Take due to these two pathways (genetic and ecological effects) cannot be directly measured because it is not practical to quantify and track gene flow or interbreeding

[6] 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 USFWS interpretation of the term.

between hatchery- and natural-origin fish in a reliable way (genetic effects), or to quantify spawning site competition or redd superimposition (ecological effects). There are separate surrogates for the take occurring within the basin where hatchery fish are released and outside of it.

For the genetic and ecological effects take pathway for impacts within basin where the hatchery steelhead are released, NMFS will rely on a take surrogate that indicates the proportion of hatchery-origin steelhead in the natural spawning population as defined here:

> A five-year running average[7] pHOS of ≤ 0.3 measured at dams or weirs, or extrapolated from PIT-tag detections or CWT recoveries for the Umatilla and Touchet Steelhead programs beginning with return year 2019.

For the genetic and ecological effects take pathway for impacts from hatchery fish released under the Proposed Action on salmon and steelhead populations outside the basin were the fish are released, NMFS will rely on a take surrogate that indicates the proportion of hatchery-origin salmon and steelhead that stray into out-of-basin natural-origin populations as defined here:

> For all programs, straying is expected to equate to ≤ 5 CWT recoveries/PIT tag detections annually into any listed receiving population, measured as a five-year running average beginning in 2019 assuming marking proportions remain the same. If marking proportions increased in the future, this surrogate would need to be revisited. The exception is for Touchet Endemic steelhead into the Tucannon River, where we anticipate up to 15 percent of the Touchet Endemic steelhead detected at McNary Dam to return to the Tucannon River, as estimated from expanded PIT tag detections measured as a five-year running average beginning in 2019.

This set of take surrogate measurements is logically related to both the genetic and ecological take pathways through assessment of hatchery-origin fish on the spawning grounds. These metrics are rationally connected to incidental take in the form of genetic or ecological effects, because those effects only happen when and to the extent that both hatchery- and natural-origin fish occur simultaneously on the spawning grounds, and limiting the extent of hatchery fish on the spawning grounds reduces take by genetic or ecological effects. The take associated with these effects will be considered to have been exceeded with the above mentioned pHOS and CWT/PIT recovery or detection levels have been exceeded. These numbers are reasonable to use because exceedance of them will indicate conditions to be worse than current conditions. If these fish spawn, they can cause both ecological and genetic effects on natural-origin spawners. Moreover, through dam/weir collections, CWT, and PIT tag arrays, the take surrogate can be reliably measured and monitored.

The third take pathway for this factor is the handling/tagging of listed hatchery and natural-origin steelhead at adult collection facilities to facilitate broodstock collection, and sampling of fish for monitoring and evaluation. The extent of incidental take of ESA-listed steelhead expected to

[7] However, if it is apparent, from numbers observed in years prior to the fifth year that the average is certain to be exceeded, operators will contact NMFS in the year the likely exceedance is discovered.

occur as a result of the Proposed Action by this pathway is contained in Table 3, Table 4, and Table 7 (as reproduced below in Table 36, Table 37, and Table 38, respectively).

Table 36. The number of natural-origin Middle Columbia River summer steelhead adults and juvenile *O. mykiss*[8] encountered, sampled, tagged, and associated mortality during broodstock collection and monitoring and evaluation activities in the Touchet River Basin.

	Adult Steelhead				**Juvenile *O. mykiss***				
Activity	Encountered	Sampled	Tagged	Mortality	Encountered	Sampled	Tagged	Mortality	Notes
Dayton Adult Trapping	800	800	800	16					
Retained for Broodstock		28	28	4					
Touchet Endemic Adults	150	150							
Retained for Broodstock		15	15	3					
Coppei Creek Trapping	200	200	200	4					
Patit Creek Trapping	50	50	50	1					
Dry Creek Trapping	100	100	100	2					
Rotary Screw Trapping									
Touchet River	20	20	0	1	12,000	12,000	8,000	360	
Juvenile Abundance									
Electrofishing					2,500	2,500	2,500	75	
Hook and Line					150	150	150	2	
Beach Seine					1,000	1,000	1,000	10	
Redd Surveys (observed)	200			0					
Freshwater Mussel Research					50	0	0	1	
Totals	1,370	1,170	1,150	28	15,650	15,650	9,650	448	

[8] Juvenile rainbow trout and anadromous juvenile steelhead cannot be easily distinguished, so the genius and species name (*O. mykiss*) is used.

Table 37. Number of natural-origin adult steelhead and juvenile *O. mykiss* expected to be encountered, sampled, and tagged, and anticipated mortality during broodstock collection, and monitoring and evaluation activities in the Umatilla River Basin.

	Adult Steelhead				**Juvenile *O. mykiss***			
Activity	Encountered	Sampled	Tagged	Mortality	Encountered	Sampled	Tagged	Mortality
Three Mile Dam trapping								
Broodstock	70	70		≤70				
Adult Monitoring	3,500	3,500		35				
Juvenile Outmigration								
Rotary Screw Traps	5			1				
Three Mile Falls Dam	35			5	4,000	4,000	3,000	50
Birch Creek					8,000	8,000	6,000	100
Spawning Ground Surveys	400	0	0	0				
Natural Production Monitoring								
Rotary Screw Traps								
Meacham Creek	5			1	7,000	7,000	3,500	45
Upper Umatilla	5			1	7,000	7,000	3,500	45
Pacific Lamprey								
Rotary Screw Trap	10	0	0	1	100	0	0	2
Electrofishing	10	0	0	1	1,000	1,000	0	15
Lamprey Spawning	10	0	0	0	1,000	0	0	0
Freshwater Mussel Research					55	0	0	0
	3,580	3,500		45	28,155	27,000	11,400	257

Table 38. The number of natural-origin Middle Columbia River summer steelhead adults and juvenile *O. mykiss* expected to be encountered, sampled, tagged, and associated mortality during broodstock collection and monitoring and evaluation activities in the Walla Walla River Basin conducted by the CTUIR (see Touchet Endemic Summer Steelhead Program for other M&E activities in the Walla Walla Basin).

	Adult Steelhead				**Juvenile *O. mykiss***			
Activity	Encountered	Sampled	Tagged	Mortality	Encountered	Sampled	Tagged	Mortality
Nursery Bridge Dam Adult Trapping	250	250	250	5				
Rotary Screw Trapping					8,000	8,000	8,000	160
Fish Salvage (seines and electro-fishing)	250	0	0	5	1,500	0	0	20
Redd Surveys (observed)	0	0	0	0				
Pacific Lamprey								
Surveys	100	0	0	0				
Electro-fishing					500	0	0	8
Freshwater Mussel Research								
Surveys	10	0	0	0				
Electro-fishing					100	0	0	2
	610	250	250	10	9,100	8,000	8,000	190

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

Predation, competition, or pathogen transmission, collectively referred to as ecological interactions, between natural-origin juvenile and hatchery-origin juvenile Chinook salmon and steelhead could result in take of natural-origin steelhead. Take by means of ecological interactions occurs as a result of, and in proportion to, the co-occurrence of hatchery- and natural-origin juvenile fish in the juvenile rearing areas and having the opportunity to compete for resources or prey on each other. This interaction can often be represented through outmigrating travel time as well as residualism in juvenile fish. However, it is difficult to quantify this take because ecological interactions cannot be directly or reliably measured and/or observed. Thus, we will rely on a take surrogate for outmigrants, represented in travel time of outmigrating fish, and for potential non-migrants, represented as the percentage of steelhead that are observed to be precociously mature prior to release.

For outmigrants, NMFS will rely on a take surrogate that measures the median travel time for hatchery-origin spring/summer Chinook to reach Bonneville Dam after release. Specifically, the extent of take from interactions between hatchery and natural-origin juvenile salmonids released in “viable” and “maintain” populations above LGD will be the take that occurs when the travel time[9] for emigrating juvenile hatchery-origin fish is more than five days longer than the median travel time value (which equates to 50% of the fish) following hatchery release (Table 27) for each program. Take will be considered to have been exceeded if travel times exceed the five-year median by five or more days in at least three of the five years used to establish the median. NMFS will begin calculating running medians of up to five years, beginning in 2018 with all available data, which will become five-year medians when data from 2018 to 2022 or later is available. This is rationally connected to the actual incidental take because if travel rate is five days more than previous estimates, it is a sign that fish are not migrating as quickly as expected, and therefore the expected take from interactions has likely been exceeded as a result of greater overlap between hatchery and natural-origin fish. This threshold will be monitored using emigration estimates from PIT tags, screw traps, or other juvenile monitoring techniques developed by the operators and approved by NMFS.

For both forms of take associated with residualism (mortality associated with competition and predation from residual hatchery-origin fish on natural fish and genetic effects caused by residual hatchery-origin fish spawning naturally), NMFS will rely on a take surrogate that consists of the percentage of steelhead from each year’s smolt release that are observed to be either parr, precociously maturing, or precociously mature immediately prior to release. This surrogate has a rational connection to the amount of take expected from residualism because precocious steelhead and parr may residualize after release from the hatchery at higher rates than normal and, because they do not outmigrate as quickly as non-precocious fish, their potential for adverse interactions with rearing juvenile steelhead is increased. We are able to use one single take surrogate because measuring precocious maturation is a reasonable representation of residualism,

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

and the two types of take associated with residualism can be accounted for by measuring precocious maturation prior to release. These observations would be sufficient to detect a trend of increasing residualism potential. Incidental take as described by this surrogate will be considered exceeded when more than five percent of program fish observed from each release group are precociously mature or parr (based on visual observation), using a running five-year average beginning with the 2018 release[10]. Between 2017 and 2022, the annual rate shall not exceed five percent. The take surrogate can be reliably measured and monitored through visual assessment of the hatchery population prior to release. This assessment relies on visual observation at pre-release sampling with a reasonable sample size determined by hatchery staff.

Factor 4: Research, monitoring, and evaluation that is associated with the hatchery program

The take pathway for this factor is the handling/tagging of listed natural-origin steelhead at adult collection facilities to facilitate broodstock collection, and sampling of fish for monitoring and evaluation. The collection, sampling, and tagging of ESA-listed species by the CTUIR, WDFW, and ODFW are not to exceed those levels provided above in Table 3 (Touchet River), Table 4 (Umatilla River), and Table 7 (Walla Walla River). Consequently, these numbers represent the expected maximum incidental take associated with RM&E.

Factor 5: Construction and operations of facilities that exist because of the hatchery program

Dayton Acclimation Pond
The operation of the Dayton Pond Acclimation facility would reduce flows in a 300 ft section of the Touchet River from the intake to the pond outfall (see Section 2.12) potentially causing take due to a temporary reduction in rearing and migration habitat in the bypass reach. Take cannot be quantified because these habitat changes and their associated harm cannot be reliably observed. Therefore, NMFS will use a take surrogate that measures the amount of flow being removed from the bypass reach. Specifically, the take expected to occur is that which accompanies removal of no more than 6 cfs of surface water during the operation of the facility. This surrogate is rationally connected to the amount or extent of take, since take increases as more water is diverted from the bypass reach. This surrogate can be reliably measured and monitored via the flow gage at the facility intake structure.

Walla Walla Hatchery
The construction activity to expand the AHSF to the Walla Walla Hatchery has the potential to incidentally encounter juvenile MCR steelhead when the new discharge pipe will be installed. The maximum anticipated encounters are 50 fish, with 5 percent mortality associated with handling.

There is also the potential for incidental take associated with the delay of migration due to closure of the juvenile bypass structure at the Walla Walla Hatchery. It is not practical to quantify the take expected to occur, therefore we will rely on a take surrogate in the form of

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

number of days the bypass is closed. This surrogate has a rational connection to the amount of take, since the length of the closure increases the number of fish affected. In periods of low flow, the days that the bypass system will be closed each month will not exceed those proved in Table 6. This surrogate will be reliably monitored by counting the number of days the bypass is closed, which will be confirmed daily. When the bypass is closed, juveniles that enter the intake have only one option for egress and that is back out through the intake and thus their migration maybe delayed during the period that the bypass is closed. This surrogate will limit the potential for delay.

Furthermore, the operation of the juvenile bypass will not exceed the 4-6 cfs currently used to operate in order to limit the small impact on habitat between the intake and the bypass outfall.

Table 39. Average number of days per month that the juvenile bypass at the Walla Walla Hatchery would close to meet instream minimum flows in the South Fork Walla Walla River.

Month	Days Bypass Closed
December	5
January	4
February	10
March	4
May	1
June	1

2.19.1. Effect of the Take

In Section 2.16, 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 MCR or Snake River Basin Steelhead DPSs or result in the destruction or adverse modification of their designated critical habitat.

2.19.2. Reasonable and Prudent Measures

"Reasonable and prudent measures" are measures to minimize the amount or extent of incidental take (50 CFR 402.02). These measures are nondiscretionary. NMFS concludes that the following reasonable and prudent measures are necessary and appropriate to minimize incidental take.

1. The USFWS LSRCP shall ensure that the applicants' activities as described for the Touchet Endemic Steelhead Program and the Touchet River Spring Chinook Salmon Program are consistent with the funder's portion of the Proposed Action.
2. The NMFS shall ensure that the applicants follow all conditions specified in each authorization issued as well as guidelines specified in this opinion for their respective programs.
3. The NMFS shall ensure that the applicants provide reports to SFD annually for all hatchery programs and associated RM&E.
4. The BPA shall review and approve ODFW, CTUIR, and WDFW activities as described in the annual statements of work for the Umatilla Steelhead and Walla Walla Spring Chinook

Salmon programs including associated RM&E, to ensure they are consistent with the BPA-funded portion of the Proposed Action.

2.19.3. Terms and Conditions

The terms and conditions described below are non-discretionary, and the federal action agencies must comply with them in order to implement the reasonable and prudent measures (50 CFR 402.14(i)). 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(i)). If the entity to whom a term and condition is directed does not comply, protective coverage for the Proposed Action would likely lapse.

1. The USFWS LSRCP shall ensure for their program that the applicants implement the hatchery programs as described in the Proposed Action (Section 1.3), the submitted HGMPs, and the Annual Operating Procedures to ensure they are consistent with the funder's portion of the Proposed Action including:
    a. Providing 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. Providing notice if monitoring reveals an increase in the amount or extent of take, or discovers an effect of the Proposed Action not considered in this opinion.
    c. Notifying NMFS SFD within 48 hours after knowledge of exceeding any authorized take. The applicants shall submit a written report, and/or convene a discussion with NMFS to discuss why the authorized take was exceeded within two weeks of the event.
    d. Developing a Gene Flow Management Plan with applicable parties and approved by NMFS prior to increasing the size of the Touchet steelhead program above the current production of 50,000 smolts.
2. The NMFS shall ensure that the applicants follow all conditions specified in each authorization issued as well as guidelines specified in this opinion for their respective programs.
3. NMFS shall ensure the applicants provide reports to SFD annually for all hatchery programs, and associated RM&E as follows:
    a. An annual RM&E report(s) is submitted by applicants no later than March 31st of the year following release (e.g., brood year 2016, release year 2017, report due March 2018).
    b. Annual reports should include:
        i. A calculation of quantifiable encounter and mortality take for each species across all program activities
        ii. *Hatchery Environment Monitoring Reporting*
            - Number and composition of broodstock, and dates of collection
            - Numbers, pounds, dates, locations, and tag/mark information of released fish

- Coefficient of variation around the average release size immediately prior to release
- Survival rates of all life stages (i.e., egg-to-smolt; smolt-to-adult)
- Disease occurrence at hatcheries and the acclimation sites
- Potential residual rates prior to release
- Any problems that may have arisen during hatchery activities
- Any unforeseen effects on listed fish

iii. *Natural Environment Monitoring Reporting*

- The number of returning hatchery and natural-origin adults
- The number and species of listed fish encountered at each adult collection location, and the number that die
- Distribution of hatchery- and listed natural-origin spawners
- The contribution of fish from these programs into ESA-listed populations
- Post-release out-of-basin migration timing of juvenile hatchery-origin fish to first mainstem dam
- Mean length, coefficient of variation, number, and age of natural-origin juveniles during RM&E activities
- Number and species of listed juveniles and adults encountered and the number that die during RM&E activities

c. All reports and other required notifications should be submitted electronically to the NMFS point of contact for this opinion: Rich Turner (503-736-4737, *rich.turner@noaa.gov).*

4. The BPA shall review and approve ODFW, CTUIR, and WDFW activities as described in the annual statements of work for the Umatilla Steelhead and Walla Walla Spring Chinook Salmon programs and associated RM&E to ensure they are consistent with the BPA-funded portion of the Proposed Action, including:

   a. Providing 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. Providing notice if monitoring reveals an increase in the amount or extent of take, or discovers an effect of the Proposed Action not considered in this opinion.

   c. Notifying NMFS SFD within 48 hours after knowledge of exceeding any authorized take. The applicants shall submit a written report, and/or convene a discussion with NMFS to discuss why the authorized take was exceeded within two weeks of the event.

2.20. Conservation Recommendations

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

1. Obtain a NPDES permit before increasing production at ASFH/Walla Walla Hatchery to 500,000 spring Chinook salmon and notify NMFS if the permit has interim limit(s).

2.21. 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.

2.22. "Not Likely to Adversely Affect" Determinations

2.22.1. Snake River Sockeye Salmon

The salmon and steelhead released under the Proposed Action has the potential to interact with ESA-listed Snake River Sockeye Salmon through interactions in the migration corridor.

On April 5, 1991, NMFS listed the Snake River Sockeye Salmon ESU as an endangered species (56 FR 14055) under the Endangered Species Act (ESA). This listing was affirmed in 2005 (70 FR 37160), and again on April 14, 2014 (79 FR 20802) (Table 10). Critical habitat was designated on December 28, 1993 (58 FR 68543) and reaffirmed on September 2, 2005 (Table 10). The ESU includes naturally spawned anadromous and residual sockeye salmon originating from the Snake River Basin in Idaho, as well as artificially propagated sockeye salmon from the Redfish Lake captive propagation program (Jones Jr. 2015) (Table 40).

Table 40. Snake River Sockeye Salmon ESU description and MPG (Jones Jr. 2015; NMFS 2015).

ESU Description	
Threatened	Listed under ESA in 1991; updated in 2014 (Table 10)
1 major population group	5 historical populations (4 extirpated)
Major Population Group	***Population***
Sawtooth Valley Sockeye	Redfish Lake
Artificial production	
Hatchery programs included in ESU (1)	Redfish Lake Captive Broodstock
Hatchery programs not included in ESU (0)	n/a

The ICTRT treats Sawtooth Valley Sockeye salmon as the single MPG within the Snake River Sockeye Salmon ESU. The MPG contains one extant population (Redfish Lake) and two to four historical populations (Alturas, Pettit, Stanley, and Yellowbelly Lakes) (NMFS 2015) (Figure 6). At the time of listing in 1991, the only confirmed extant population included in this ESU was the beach-spawning population of sockeye salmon from Redfish Lake, with about 10 fish returning per year (NMFS 2015). Historical records indicate that sockeye salmon once occurred in several other lakes in the Stanley Basin, but no adults were observed in these lakes for many decades; once residual sockeye salmon were observed, their relationship to the Redfish Lake population was uncertain (McClure et al. 2005). Since ESA-listing, progeny of the Redfish Lake sockeye salmon population have been outplanted to Pettit and Alturas Lakes within the Sawtooth Valley for recolonization purposes (NMFS 2011a).

Lakes in the Stanley Basin and Sawtooth Valley are relatively small compared to the other lake systems that historically supported sockeye salmon production in the Columbia Basin. The average abundance targets recommended by the Snake River Recovery Team (Bevan et al. 1994) were incorporated as minimum abundance thresholds into a sockeye salmon viability curve. The viability curve was generated using historical age structure estimates from Redfish Lake sampling in the 1950s to the 1960s, and year –to -year variations in brood -year replacement rates generated from abundance series for Lake Wenatchee sockeye salmon. The minimum spawning abundance threshold is set at 1,000 for the Redfish and Alturas Lake populations (intermediate category for lake size), and at 500 for populations in the smallest historical size category for lakes (i.e., Alturas and Pettit Lakes). Because space in the lakes is limited, the available spawning capacity may also be limited based on available habitat. The ICTRT recommended that long-term recovery objectives should include restoring at least three of the lake populations in this ESU to viable or highly viable status.

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

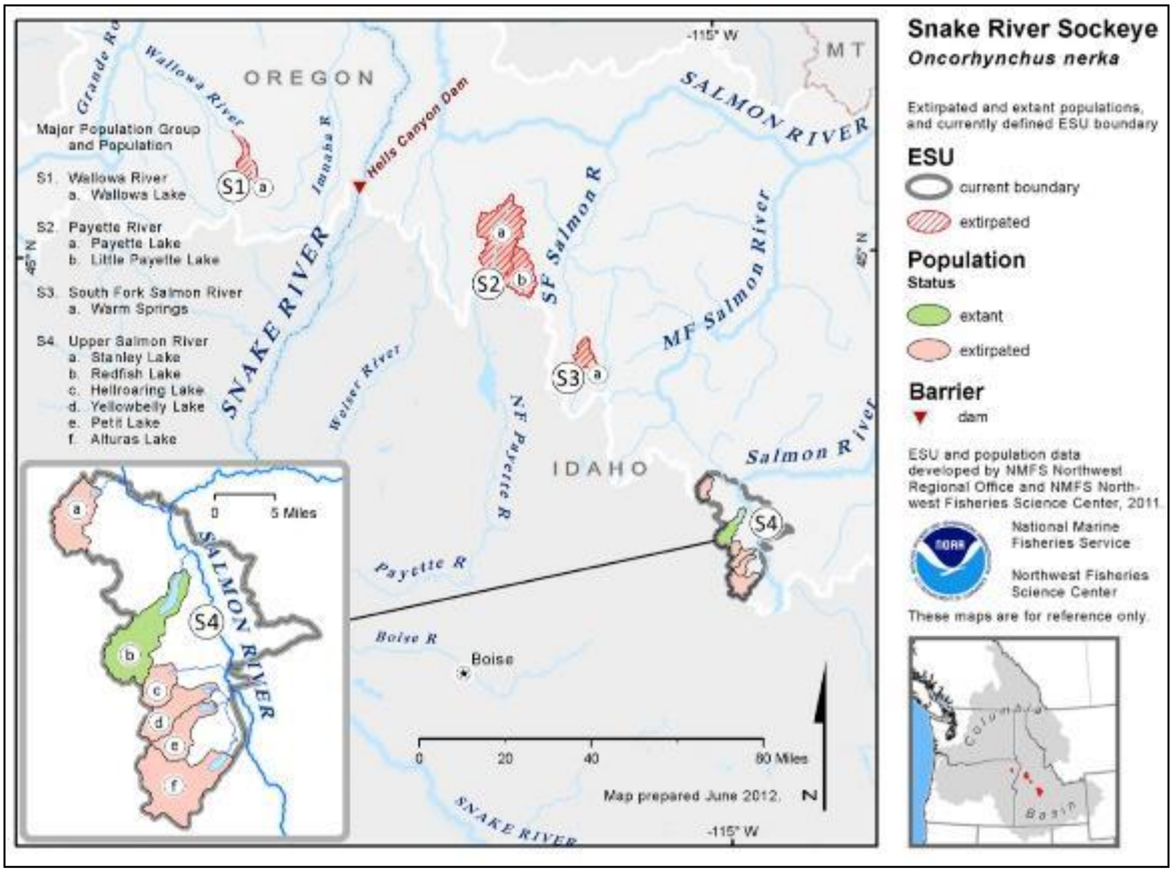

Figure 6. Map of the Snake River Sockeye Salmon ESU's spawning and rearing areas, illustrating populations and MPGs (NWFSC 2015).

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 Snake River Sockeye Salmon ESU is at high risk and remains at endangered status. Although the endangered Snake River Sockeye Salmon ESU has a long way to go before it will meet the biological viability criteria, annual returns of sockeye salmon through 2013 show that more fish are returning than before initiation of the captive broodstock program which began soon after the initial ESA listing (Table 10). Between 1999 and 2007, more than 355 adults returned from the ocean from captive brood releases – almost 20 times the number of natural-origin fish that returned in the 1990s, though this total is primarily due to large returns in the year 2000 (Table 41). Adult returns in the last six years have ranged from a high of 1,579 fish in 2014 (including

453 natural-origin fish) to a low of 257 adults in 2012 (including 52 natural-origin fish). Sockeye salmon returns to Alturas Lake ranged from one fish in 2002 to 14 fish in 2010 (Table 41). No fish returned to Alturas Lake in 2012, 2013, or 2014 (NMFS 2015).

Table 41. Hatchery- and natural-origin sockeye salmon returns to the Sawtooth Valley, 1999-2014 (IDFG, in prep.; NMFS 2015).

Return Year	Total Return	Natural Return	Hatchery Return	Alturas Returns*	Observed Not Trapped
1999	7	0	7	0	0
2000	257	10	233	0	14
2001	26	4	19	0	3
2002	22	6	9	1	7
2003	3	0	2	0	1
2004	27	4	20	0	3
2005	6	2	4	0	0
2006	3	1	2	0	0
2007	4	3	1	0	0
2008	646	140	456	1	50
2009	832	86	730	2	16
2010	1,355	178	1,144	14	33
2011	1,117	145	954	2	18
2012	257	52	190	0	15
2013	272	79	191	0	2
2014	1,579	453	1,062	0	63

*These fish were assigned as sockeye salmon returns to Alturas Lake and are included in the natural return numbers.

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

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

Limiting Factors

There are many factors that affect the abundance, productivity, spatial structure, and diversity of the Snake River Sockeye Salmon ESU. Factors that limit the ESU have been, and continue to be, the result of impaired mainstream and tributary passage, historical commercial fisheries, chemical treatment of Sawtooth Valley lakes in the 1950s and 1960s, poor ocean conditions, Snake and Columbia River hydropower system, and reduced tributary stream flows and high temperatures. These combined factors reduced the number of sockeye salmon that make it back to spawning areas in the Sawtooth Valley to the single digits, and, in some years, zero. The decline in abundance itself has become a major limiting factor, making the remaining population vulnerable to catastrophic loss and posing significant risks to genetic diversity (NMFS 2015; NWFSC 2015).

The most recent recovery plan (NMFS 2015) provides a detailed discussion of limiting factors and threats and describes strategies and actions for addressing each of them. Rather than repeating this extensive discussion from the recovery plan, it is incorporated here by reference. Overall, the recovery strategy aims to reintroduce and support adaptation of naturally self-sustaining sockeye salmon populations in the Sawtooth Valley lakes. An important first step towards that objective has been the successful establishment of anadromous returns from natural-origin Redfish Lake resident stock gained through a captive broodstock program. The long-term strategy is for the naturally produced population to achieve escapement goals in a manner that is self-sustaining and without the reproductive contribution of hatchery spawners (NMFS 2015).

In terms of natural production, the Snake River Sockeye Salmon ESU remains at extremely high risk although there has been substantial progress on the first phase of the proposed recovery approach – developing a hatchery based program to amplify and conserve the stock to facilitate reintroductions. At this stage of the recovery program there is no basis for changing the ESU ratings assigned in prior reviews, but the trend in status appears to be positive (NWFSC 2015).

Determination

In general, no fish from the Snake River Sockeye salmon ESU are present in the Action Area during any other stages of hatchery operations whereby the Proposed Action could result in effects on the species. The lone factor where the ESU could encounter effects associated with the Proposed Action is the interaction between hatchery juvenile salmonids in the Columbia River migration corridor, where they could be subject to predation and competition.

As described above in Section 2.10.1.1, hatchery salmon and steelhead released under the Proposed Action may encounter Snake River sockeye salmon juveniles within the mainstem

Columbia River below the mouth of the Snake River. The PCD risk model estimated that up to 1,555 juvenile sockeye salmon could be lost due to competition and predation effects. The 1,555 juveniles equate to approximately 8 returning adults (Table 29). If it is assumed that all of the impacts were only on Snake River sockeye salmon then the 8 adults lost would represent 0.5% of the average annual adult return of Snake River sockeye salmon (Table 29).

However, the assumption that model makes that impacts would only accrue to ESA-listed Snake River sockeye salmon is to identify the maximum possible impact on the ESA-listed species. In reality ESA-listed natural-origin juvenile Snake River sockeye, which have averaged approximately 61,000 (Kozfkay 2017) out of the Snake River, represent approximately 2% of the estimated 2.9 million sockeye salmon juveniles in the Columbia River as measured at McNary Dam (Zabel 2015; 2017). Thus, 2% of 1,555 juvenile sockeye salmon are likely to be from the Snake River Sockeye Salmon ESU, while the remaining 98% are likely to be from the non-listed populations from the Upper Columbia River. The Snake River sockeye salmon represent only 2% of the potential loss of 1,555 juvenile sockeye salmon, or 31 juveniles (1,555 times 2%). This is equivalent to a fraction of one adult (0.16 fish). As described above, there is a high level of variability with these model assumptions, such that the possibility of any measurable impact on ESA-listed sockeye salmon is likely to be zero, with the result being that the Proposed Action is not likely to adversely affect the ESA-listed Snake River Sockeye Salmon ESU due to predation and competition.

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 four steelhead hatchery programs, as described in Section 1.3. The Action Area (Figure 5) of the Proposed Action includes habitat described as EFH for Chinook and coho salmon (PFMC 2003) within the Columbia and Snake River Basins. Because EFH has not been described for steelhead, the analysis is restricted to the effects of the Proposed Action on EFH for Chinook and coho salmon.

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

3.2. Adverse Effects on Essential Fish Habitat

The Proposed Action has small effects on the major components of EFH. As described in Section 2.7.2, in-water construction at the Walla Walla Hatchery on South Fork Walla Walla River could temporarily remove access to a proportion of the salmon habitat. Water withdrawal for hatchery operations can adversely affect salmon by reducing streamflow, impeding migration, or reducing other stream-dwelling organisms that could serve as prey for juvenile salmonids. Water withdrawals can also kill or injure juvenile salmonids through impingement upon inadequately designed intake screens or by entrainment of juvenile fish into the water diversion structures. The proposed hatchery programs include designs to minimize each of these effects. In general, water withdrawals are small enough in scale that changes in flow would be undetectable, and impacts would not occur.

The PFMC (2003) recognized concerns regarding the "genetic and ecological interactions of hatchery and wild fish… [which have] been identified as risk factors for wild populations." The biological opinion describes in considerable detail the impacts hatchery programs might have on natural populations of Chinook salmon (Section 5, Appendix A); the effects on coho salmon are typically much smaller, due to the species-specific nature of many of the interactions and relatively small overlap in habitat usage by the two species. Ecological effects of juvenile and adult hatchery-origin fish on natural-origin fish are discussed in Sections 2.9 and 2.10. Hatchery fish returning to the Walla Walla River, Umatilla River, and Deschutes River Subbasins are expected to largely spawn and rear near the hatchery and not compete for space with spring Chinook or coho salmon. Some steelhead 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 steelhead on juvenile natural-origin Chinook or coho salmon is unlikely due to timing differences and because adult salmon typically stop feeding by the time they reach spawning areas (Groot and Margolis 1991). Predation and competition by juvenile hatchery steelhead 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 2.18) includes the best approaches to avoid or minimize those adverse effects in most areas. Thus, NMFS has no conservation recommendations specifically for Chinook and coho salmon EFH. However, the Reasonable and Prudent Measures, and Terms and Conditions included in the ITS are likely to address potential EFH effects.

3.4. Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, the Federal 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 an alternative time frame for the Federal agency response. The response must include a description of measures proposed by the agency for avoiding, mitigating, or offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with NMFS Conservation Recommendations, the Federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(k)(1)).

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

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 four spring Chinook salmon and steelhead 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 Round Butte, Touchet, Umatilla, and Walla Walla Rivers, and through the collection of data indicating the potential effects of the operation on the viability of natural populations of Snake River steelhead and MCR Steelhead. 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. The format and naming adheres to conventional standards for style.

4.2. Integrity

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

4.3. Objectivity

Information Product Category: Natural Resource Plan

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

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

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

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

5. APPENDIX A: FACTORS CONSIDERED WHEN ANALYZING HATCHERY EFFECTS

NMFS' analysis of the Proposed Action is in terms of effects the Proposed Action would be expected to have on ESA-listed species and on designated critical habitat, based on the best scientific information available. The effects, positive and negative, for the two categories of hatchery programs are summarized in Table 42. Generally speaking, effects range from beneficial to negative when programs use local fish[11] for hatchery broodstock, and from negligible to negative when programs do not use local fish for broodstock[12]. Hatchery programs can benefit population viability, but only if they use genetic resources that represent the ecological and genetic diversity of the target or affected natural population(s). When hatchery programs use genetic resources that do not represent the ecological and genetic diversity of the target or affected natural population(s), NMFS is particularly interested in how effective the program will be at isolating hatchery fish and at avoiding co-occurrence and effects that

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

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

potentially disadvantage fish from natural populations. NMFS applies available scientific information, identifies the types of circumstances and conditions that are unique to individual hatchery programs, then refines the range in effects for a specific hatchery program. Analysis of a Proposed Action for its effects on ESA-listed species and on designated critical habitat depends on six factors. These factors are:

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

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

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

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

Table 42. An overview of the range of effects on natural population viability parameters from the two categories of hatchery programs.

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

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

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

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

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

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

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

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

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

5.2.1. Genetic effects

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

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

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

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

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

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

The proportion of hatchery fish (pHOS)[13] among natural spawners is often used as a surrogate measure of gene flow. Appropriate cautions and qualifications should be considered when using this proportion to analyze outbreeding effects. Adult salmon may wander on their return migration, entering and then leaving tributary streams before spawning (Pastor 2004). These "dip-in" fish may be detected and counted as strays, but may eventually spawn in other areas, resulting in an overestimate of the number of strays that potentially interbreed with the natural population (Keefer et al. 2008). Caution must also be taken in assuming that strays contribute genetically in proportion to their abundance. Several studies demonstrate little genetic impact from straying despite a considerable presence of strays in the spawning population (Saisa et al. 2003; Blankenship et al. 2007). The causative factors for poorer breeding success of strays are likely similar to those identified as responsible for reduced productivity of hatchery-origin fish in general, e.g., differences in run and spawn timing, spawning in less productive habitats, and reduced survival of their progeny (Reisenbichler and McIntyre 1977; Leider et al. 1990; Williamson et al. 2010).

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

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

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

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

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

Critical information for analysis of hatchery-induced selection includes the number, location, and timing of naturally spawning hatchery fish, the estimated level of gene flow between hatchery-origin and natural-origin fish, the origin of the hatchery stock (the more distant the origin compared to the affected natural population, the greater the threat), the level and intensity of hatchery selection and the number of years the operation has been run in this way. Efforts to control and evaluate the risk of hatchery-influenced selection are currently largely focused on gene flow between natural-origin and hatchery-origin fish[14]. The Interior Columbia Technical Recovery Team (ICTRT) developed guidelines based on the proportion of spawners in the wild consisting of hatchery-origin fish (pHOS)(Figure 7).

More recently, the Hatchery Scientific Review Group (HSRG) developed gene-flow guidelines based on mathematical models developed by (Ford 2002) and by(Lynch and O'Hely 2001). Guidelines for isolated programs are based on pHOS, but guidelines for integrated programs are based also on a metric called proportionate natural influence (PNI), which is a function of pHOS and the proportion of natural-origin fish in the broodstock (pNOB)[15]. PNI is, in theory, a reflection of the relative strength of selection in the hatchery and natural environments; a PNI value greater than 0.5 indicates dominance of natural selective forces. The HSRG guidelines vary according to type of program and conservation importance of the population. When the underlying natural population is of high conservation importance, the guidelines are a pHOS of no greater than 5 percent for isolated programs. For integrated programs, the guidelines are a pHOS no greater than 30 percent and PNI of at least 67 percent for integrated programs (HSRG 2009). Higher levels of hatchery influence are acceptable, however, when a population is at high risk or very high risk of extinction due to low abundance and the hatchery program is being used to conserve the population and reduce extinction risk in the short-term. (HSRG 2004)offered additional guidance regarding isolated programs, stating that risk increases dramatically as the level of divergence increases, especially if the hatchery stock has been selected directly or indirectly for characteristics that differ from the natural population. The HSRG recently produced an update report (HSRG 2014) that stated that the guidelines for isolated programs may not provide as much protection from fitness loss as the corresponding guidelines for integrated programs.

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

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

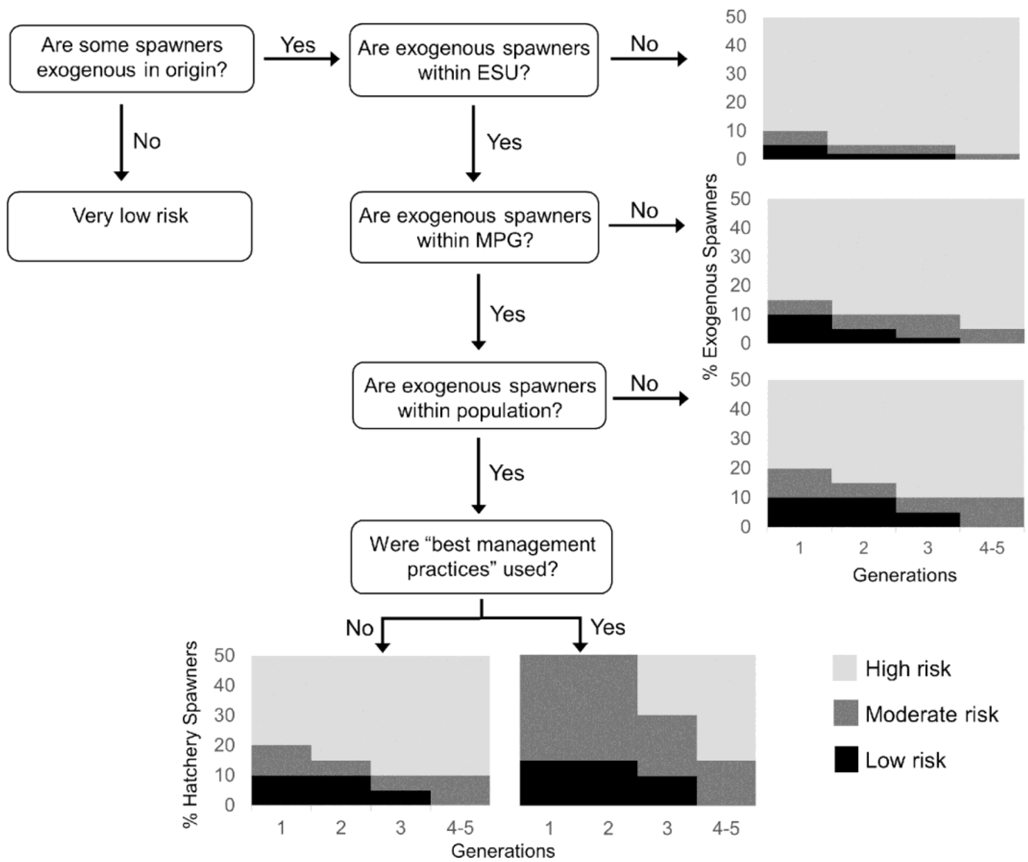

Figure 7. ICTRT (2007a) risk criteria associated with spawner composition for viability assessment of exogenous spawners on maintaining natural patterns of gene flow. Exogenous fish are considered to be all fish hatchery-origin, and non-normative strays of natural-origin.

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

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

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

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

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

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

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

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

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

Additional perspective on pHOS that is independent of HSRG modelling is provided by a simple analysis of the expected proportions of mating types. Figure 8 shows the expected proportion of mating types in a mixed population of natural-origin (N) and hatchery-origin (H) fish as a function of the census pHOS, assuming that N and H adults mate randomly[16]. For example, at a census pHOS level of 10 percent, 81 percent of the matings will be NxN, 18 percent will be NxH, and 1 percent will be HxH. This diagram can also be interpreted as probability of parentage of naturally produced progeny, assuming random mating and equal reproductive success of all mating types. Under this interpretation, progeny produced by a parental group with a pHOS level of 10 percent will have an 81 percent chance of having two natural-origin parents, etc.

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

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

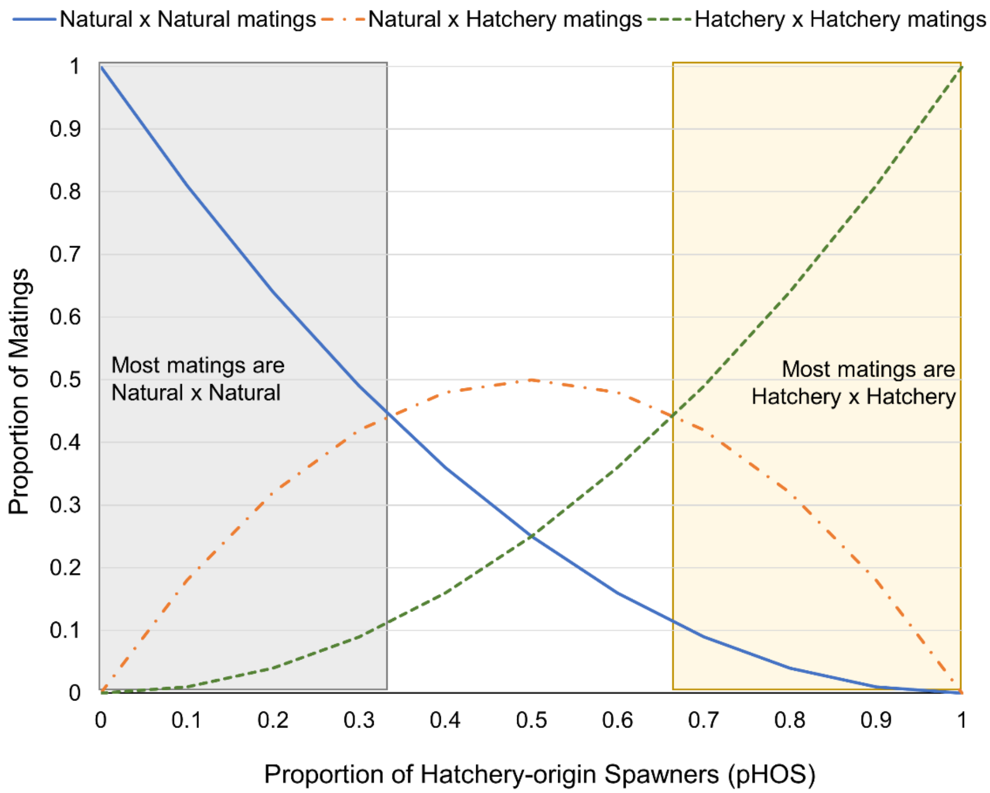

Figure 8. Relative proportions of types of matings as a function of proportion of hatchery-origin fish on the spawning grounds (pHOS).

5.2.2. Ecological effects

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

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

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

5.2.3. Adult Collection Facilities

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

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

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

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

5.3.1. Competition

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

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

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

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

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

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

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

Critical to analyzing competition risk is information on the quality and quantity of spawning and rearing habitat in the Action Area,[17] including the distribution of spawning and rearing habitat by quality and best estimates for spawning and rearing habitat capacity. Additional important information includes the abundance, distribution, and timing for naturally spawning hatchery fish and natural-origin fish; the timing of emergence; the distribution and estimated abundance for progeny from both hatchery and natural-origin natural spawners; the abundance, size, distribution, and timing for juvenile hatchery fish in the Action Area; and the size of hatchery fish relative to co-occurring natural-origin fish.

5.3.2. Predation

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

[17] "Action area" means all areas to be affected directly or indirectly by the action in which the effects of the action can be meaningfully detected and evaluated.

predation is greatest when natural populations of salmon and steelhead are at low abundance, when spatial structure is already reduced, when habitat, particularly refuge habitat, is limited, and when environmental conditions favor high visibility.

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

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

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

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

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

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

5.3.3. Disease

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

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

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

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

Adherence to a number of state, federal, and tribal fish health policies limits the disease risks associated with hatchery programs (IHOT 1995; ODFW 2003b; USFWS 2004; NWIFC and WDFW 2006). Specifically, the policies govern the transfer of fish, eggs, carcasses, and water to prevent the spread of exotic and endemic reportable pathogens. For all pathogens, both reportable and non-reportable, pathogen spread and amplification are minimized through regular monitoring (typically monthly) removing mortalities, and disinfecting all eggs. Vaccines may provide additional protection from certain pathogens when available (e.g., *Vibrio anguillarum*).

If a pathogen is determined to be the cause of fish mortality, treatments (e.g., antibiotics) will be used to limit further pathogen transmission and amplification. Some pathogens, such as *infectious hematopoietic necrosis virus* (IHNV), have no known treatment. Thus, if an epizootic occurs for those pathogens, the only way to control pathogen amplification is to cull infected individuals or terminate all susceptible fish. In addition, current hatchery operations often rear hatchery fish on a timeline that mimics their natural life history, which limits the presence of fish susceptible to pathogen infection and prevents hatchery fish from becoming a pathogen reservoir when no natural fish hosts are present.

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

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

5.3.4. Acclimation

One factor the can affect hatchery fish distribution and the potential to spatially overlap with natural-origin spawners, and thus the potential for genetic and ecological impacts, is the acclimation (the process of allowing fish to adjust to the environment in which they will be released) of hatchery juveniles before release. Acclimation of hatchery juvenile before release increases the probability that hatchery adults will home back to the release location, reducing their potential to stray into natural spawning areas. Acclimating fish for a period of time also allows them to recover from the stress caused by the transportation of the fish to the release location and by handling. (Dittman and Quinn 2008) provide an extensive literature review and introduction to homing of Pacific salmon. They note that, as early as the 19th century, marking studies had shown that salmonids would home to the stream, or even the specific reach, where they originated. The ability to home to their home or "natal" stream is thought to be due to odors to which the juvenile salmonids were exposed while living in the stream (olfactory imprinting) and migrating from it years earlier (Dittman and Quinn 2008; Keefer and Caudill 2013). Fisheries managers use this innate ability of salmon and steelhead to home to specific streams by using acclimation ponds to support the reintroduction of species into newly accessible habitat or into areas where they have been extirpated (Quinn 1997; Dunnigan 1999; YKFP 2008).

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

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

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

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

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

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

- Observation during surveying

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

5.4.1. Observing/Harassing

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

5.4.2. Capturing/handling

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

5.4.3. Fin clipping and tagging

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

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

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

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

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

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

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

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

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

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

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

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

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

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