Science, Service, Stewardship

2022 5-Year Review:
Summary & Evaluation of
Snake River Basin Steelhead

National Marine Fisheries Service
West Coast Region

5-Year Review: Snake River Basin Steelhead

Species Reviewed	Evolutionarily Significant Unit or Distinct Population Segment
Steelhead (*Oncorhynchus mykiss*)	*Snake River Basin Steelhead*

This page intentionally left blank

Table of Contents

List of Tables

List of Figures

This page intentionally left blank

Contributors
West Coast Region
(alphabetical)

Nora Berwick
1201 NE Lloyd Blvd, Suite 1100
Portland, OR 97232
503-231-6887
Nora.Berwick@noaa.gov

Diana Dishman
1201 NE Lloyd Blvd, Suite 1100
Portland, OR 97232
(503) 736-4466
diana.dishman@noaa.gov

Patty Dornbusch
1201 NE Lloyd Blvd, Suite 1100
Portland, OR 97232
503-230-5430
Patty.Dornbusch@noaa.gov

Chad Fealko
1205 South Challis Street
Salmon, ID 83467
208-753-5105
Chad.Fealko@noaa.gov

Sarah Fesenmeyer
800 E. Park Blvd, Plaza IV, Suite 220
Boise, ID, 83712
208-378-5660
Sarah.Fesenmeyer@noaa.gov

Ritchie Graves
1201 NE Lloyd Blvd, Suite 1100
Portland, OR 97232
503-231-6891
Ritchie.Graves@noaa.gov

Lynne Krasnow
1201 NE Lloyd Blvd, Suite 1100
Portland, OR 97232
503-231-2163
Lynne.Krasnow@noaa.gov

Aurele LaMontagne
800 Park Blvd, Suite 220
Boise, ID 83712
208-378-5686
Aurele.Lamontagne@noaa.gov

Nancy Munn
1201 NE Lloyd Blvd, Suite 1100
Portland, OR 97232
503-231-6269
Nancy.Munn@noaa.gov

Natasha Preston
1201 NE Lloyd Blvd, Suite 1100
Portland, OR 97232
503-231-2178
Natasha.Preston@noaa.gov

Anthony Siniscal
1201 NE Lloyd Blvd, Suite 1100
Portland, OR 97232
971-322-8407
Anthony.Simiscal@noaa.gov

Northwest Fisheries Science Center (alphabetical)

Chris Jordan, PhD
Newport Research Station, Bldg 955
2032 SE OSU Drive
Newport, Oregon 97365-5275
541-754-4629
Chris.Jordan@noaa.gov

Mari Williams
1201 NE Lloyd Blvd, Suite 1100
Portland, OR 97232
503-231-6880
Mari.Williams@noaa.gov

1. General Information

1.1 Introduction

Many West Coast salmon and steelhead (*Oncorhynchus sp.*) stocks have declined substantially from their historical numbers and now are at a fraction of their historical abundance. There are several factors that contribute to these declines, including overfishing, loss of freshwater and estuarine habitat, hydropower development, poor ocean conditions, and hatchery practices. These factors collectively led to the National Marine Fisheries Service's (NMFS) listing of 28 salmon and steelhead stocks in California, Idaho, Oregon, and Washington under the Federal Endangered Species Act (ESA).

The ESA, under section 4(c)(2), directs the Secretary of Commerce to review the listing classification of threatened and endangered species at least once every 5 years. A 5-year review is a periodic analysis of a species' status conducted to ensure that the listing classification of a species as threatened or endangered on the List of Endangered and Threatened Wildlife and Plants (List) (50 CFR 17.11 – 17.12; 50 CFR 223.102, 224.101) is accurate (USFWS and NMFS 2006; NMFS 2020c). After completing this review, the Secretary must determine if any species should be: (1) removed from the list; (2) have its status changed from endangered to threatened to endangered; or (3) have its status changed from threatened to endangered to threatened. If, in the 5-year review, a change in classification is recommended, the recommended change will be further considered in a separate rule-making process. The most recent listing reviews for salmon and steelhead occurred in 2016. This document describes the results of the 2022 5-year review for ESA-listed Snake River Basin (SRB) steelhead.

A 5-year review is:

- A summary and analysis of available information on a given species;
- The tracking of a species' progress toward recovery;
- The recording of the deliberative process used to make a recommendation on whether or not to reclassify a species; and
- A recommendation on whether reclassification of the species is indicated.

A 5-year review is not:

- A re-listing or justification of the original (or any subsequent) listing action;
- A process that requires acceleration of ongoing or planned surveys, research, or modeling;
- A petition process; and
- A rulemaking.

1.1.1 Background on salmonid listing determinations

The ESA defines species to include subspecies and distinct population segments (DPS) of vertebrate species. A species may be listed as threatened or endangered. To identify taxonomically recognized species of Pacific salmon, we apply the "Policy on Applying the Definition of Species under the ESA to Pacific Salmon" (56 FR 58612). Under this policy, we identify population groups that are "evolutionarily significant units" (ESUs) within taxonomically recognized species. We consider a group of populations to be an ESU if it is substantially reproductively isolated from other populations within the taxonomically recognized species and represents an important component in the evolutionary legacy of the species. We consider an ESU as constituting a DPS and therefore a "species" under the ESA.

Under this policy, a DPS of steelhead must be discrete from other populations, and it must be significant to its taxon.

Artificial propagation programs (hatcheries) are common throughout the range of ESA-listed West Coast salmon and steelhead. Prior to 2005, our policy was to include in the listed ESU or DPS only those hatchery fish deemed "essential for conservation" of a species. We revised that approach in response to a court decision and on June 28, 2005, announced a final policy addressing the role of artificially propagated Pacific salmon and steelhead in listing determinations under the ESA (70 FR 37204) (Hatchery Listing Policy). This policy establishes criteria for including hatchery stocks in ESUs and DPSs. In addition, it: (1) provides direction for considering hatchery fish in extinction risk assessments of ESUs and DPSs; (2) requires that hatchery fish determined to be part of an ESU or DPS be included in any listing of the ESU or DPS; (3) affirms our commitment to conserving natural salmon and steelhead populations and the ecosystems upon which they depend; and (4) affirms our commitment to fulfilling trust and treaty obligations with regard to the harvest of some Pacific salmon and steelhead populations, consistent with the conservation and recovery of listed salmon ESUs and steelhead DPSs.

To determine whether a hatchery program is part of an ESU or DPS and therefore must be included in the listing, we consider the origins of the hatchery stock, where the hatchery fish are released, and the extent to which the hatchery stock has diverged genetically from the donor stock. We include within the ESU or DPS (and therefore within the listing) hatchery fish that are derived from the population in the area where they are released and that are no more than moderately diverged from the local population.

Because the new Hatchery Listing Policy changed the way we considered hatchery fish in ESA listing determinations, we completed new status reviews and ESA listing determinations for West Coast salmon ESUs on June 28, 2005 (70 FR 37159), and for steelhead DPSs on January 5, 2006 (71 FR 834). On August 15, 2011, we published our 5-year reviews and listing determinations for 11 ESUs of Pacific salmon and 6 DPSs of steelhead from the Pacific Northwest (76 FR 50448). On May 26, 2016, we published our 5-year reviews and listing determinations for 17 ESUs of Pacific salmon, 10 DPSs of steelhead, and the southern DPS of eulachon (*Thaleichthys pacificus)* (81 FR 33468), including reaffirming threatened status for SRB steelhead.

1.2 Methodology Used to Complete the Review

On October 4, 2019, we announced the initiation of 5-year reviews for 17 ESUs of salmon and 11 DPSs of steelhead in Oregon, California, Idaho, and Washington (84 FR 53117). We requested that the public submit new information on these species that has become available since our 2015-2016 5-year reviews. In response to our request, we received information from federal and state agencies, Native American tribes, conservation groups, fishing groups, and individuals. We considered this information, as well as information routinely collected by our agency, to complete these 5-year reviews.

To complete the reviews, we first asked scientists from our Northwest and Southwest Fisheries Science Centers to collect and analyze new information about ESU and DPS viability. To evaluate viability, our scientists used the Viable Salmonid Population (VSP) concept developed by McElhany et al. (2000). The VSP concept evaluates four criteria – abundance, productivity, spatial structure, and diversity – to assess species viability. Through the application of this concept, the Science Centers considered new information on the four salmon and steelhead population viability criteria. They also considered new information on ESU and DPS composition. At the end of this process, the Science Centers prepared reports detailing the results of their analyses.

To further inform the reviews, we asked salmon management biologists from our West Coast Region familiar with hatchery programs to consider new information available since the previous listing determinations. Among other things, they considered hatchery programs that have ended, new hatchery programs that have started, changes in the operation of existing programs, and scientific data relevant to the degree of divergence of hatchery fish from naturally spawning fish in the same area. We also consulted salmon management biologists from the West Coast Region familiar with habitat conditions, hydropower operations, and harvest management. These biologists identified relevant information and provided their insights on the degree to which circumstances have changed for each listed entity. Finally, we solicited information on tributary habitat conditions and limiting factors from geographically based salmon conservation partners from federal agencies, state agencies, Tribes, and non-governmental organizations.

In preparing this report, we considered all relevant information, including the work of the Northwest Fisheries Science Center (Ford 2022); the report of the regional biologists regarding hatchery programs; recovery plans for the species in question; technical reports prepared in support of recovery plans for the species in question; the listing record (including the designation of critical habitat and adoption of protective regulations); recent biological opinions issued for SRB steelhead; information submitted by the public and other government agencies; and the information and views provided by geographically based salmon conservation partners. The present report describes the agency’s findings based on all of the information considered.

1.3 Background – Summary of Previous Reviews, Statutory and Regulatory Actions, and Recovery Planning

1.3.1 Federal register notice announcing Initiation of this review

84 FR 53117; October 4, 2019.

1.3.2 Listing history

In 1997, NMFS listed SRB steelhead as threatened (Table 1).

Table 1. Summary of the listing history under the Endangered Species Act for the SRB steelhead DPS.

Salmonid Species	ESU/DPS Name	Original Listing	Revised Listing(s)
Steelhead (*O. mykiss*)	Snake River Basin Steelhead	**FR Notice:** 62 FR 43937 **Date:** 8/18/1997 **Classification:** Threatened	**FR Notice:** 71 FR 834 **Date:** 1/5/2006 **Classification:** Threatened

1.3.3 Associated rulemakings

The ESA requires NMFS to designate critical habitat, to the maximum extent prudent and determinable, for species it lists under the ESA. Critical habitat is defined as: (1) specific areas within the geographical area occupied by the species at the time it is listed, on which are found those physical or biological features essential to the conservation of the species, and which may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by the species at the time it is listed, upon a determination by the Secretary that such areas are essential for the conservation of the species. We designated critical habitat for SRB steelhead in 2005.

Section 9 of the ESA prohibits the take of species listed as endangered. The ESA defines take to mean harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct. For threatened species, the ESA does not automatically prohibit take, but instead authorizes the agency to adopt regulations it deems necessary and advisable for species conservation and to apply the take prohibitions of Section 9(a)(1) through (ESA section 4(d)). In 2000, NMFS adopted 4(d) regulations for threatened salmonids that prohibit take except in specific circumstances. On July 10, 2000, we applied these 4(d) regulations to SRB steelhead (65 FR 42422).

Table 2. Summary of rulemaking for 4(d) protective regulations and critical habitat for SRB steelhead.

Salmonid Species	ESU/DPS Name	4(d) Protective Regulations	Critical Habitat Designations
Steelhead (*O. mykiss*)	Snake River Basin Steelhead	**FR Notice:** 65 FR 42422 **Date:** 7/10/2000 **Revised**: 6/28/2005 (70 FR 37159)	**FR notice:** 70 FR 52630 **Date:** 9/2/2005

1.3.4 Review history

Table 3 lists the numerous scientific assessments of the status of the SRB steelhead DPS. These assessments include reviews conducted by our Northwest Fisheries Science Center and technical reports prepared to support recovery planning for these species.

Table 3. Summary of previous scientific assessments for SRB steelhead.

Salmonid Species	ESU/DPS Name	Document Citation
Steelhead (*O. mykiss*)	Snake River Basin Steelhead	Ford 2022 NMFS 2016a NWFSC 2015 Ford et al. 2011 ICTRT 2007a ICTRT and Zabel 2007 Good et al. 2005 McClure et al. 2003 ICTRT 2003 NMFS 1997 Busby et al. 1996

1.3.5 Species' recovery priority number at start of 5-year review process

On April 30, 2019, NMFS issued new guidelines (84 FR 18243) for assigning listing and recovery priorities. Under these guidelines, we assign each species a recovery priority number ranging from 1 (high) to 11 (low). This priority number reflects the species demographic risk (based on the listing status and species' condition in terms of its productivity, spatial distribution, diversity, abundance, and trends) and recovery potential (major threats understood, management actions exist under U.S. authority or influence to abate major threats, and certainty that actions will be effective). Additionally, if the listed species is in conflict with construction or other development projects or other forms of economic activity, then they are assigned a 'C' and are given a higher priority over those species that are not in conflict. Table 4 lists the recovery priority number for the SRB steelhead DPS that was in effect at the time this 5-year review began (NMFS 2019a). In January 2022, NMFS issued a new report with updated recovery priority numbers. The number remained unchanged for SRB steelhead DPS (NMFS 2022).

1.3.6 Recovery plan or outline

Table 4. Recovery Priority Number (2019a) and Endangered Species Act Recovery Plan for SRB steelhead DPS.

Salmonid Species	ESU/DPS Name	Recovery Priority Number	Recovery Plan/Outline
Steelhead (*O. mykiss*)	Snake River Basin Steelhead	**3C**	Title: Recovery Plan for Snake River Spring/Summer Chinook Salmon and Snake River Basin Steelhead https://www.fisheries.noaa.gov/resource/document/recovery-plan-snake-river-spring-summer-chinook-salmon-and-snake-river-basin **Date:** 11/30/2017 **Type:** Final

2. Review Analysis

In this section, we review new information to determine whether the SRB steelhead delineation remains appropriate.

2.1 Delineation of Species under the Endangered Species Act

Is the species under review a vertebrate?

ESU/DPS Name	YES	NO
Snake River Basin Steelhead	X	

Is the species under review listed as an ESU/DPS?

ESU/DPS Name	YES	NO
Snake River Basin Steelhead	X	

Was the ESU/DPS listed prior to 1996?

ESU/DPS Name	YES	NO	Date Listed if Prior to 1996
Snake River Basin Steelhead		X	n/a

Prior to this 5-year review, was the ESU/DPS classification reviewed to ensure it meets the 1996 ESU/DPS policy standards?

In 1991, NMFS issued a policy explaining how the agency would apply the definition of "species" in evaluating Pacific salmon stocks for listing consideration under the Endangered Species Act (ESA) (56 FR 58612). Under this policy a group of Pacific salmon populations is considered a "species" under the ESA if it represents an "evolutionarily significant unit" (ESU) which meets the two criteria of: (1) being substantially reproductively isolated from other con-specific populations; and (2) representing an important component in the evolutionary legacy of the biological species. The 1996 joint NMFS-Fish and Wildlife Service (FWS) "distinct population segment" (DPS) policy (61 FR 4722) affirmed that a stock (or stocks) of Pacific salmon is considered a DPS if it represents an ESU of a biological species. Accordingly, in listing the SRB steelhead DPS under the DPS policy in 1997, we used the joint DPS policy to delineate the DPS under the ESA.

2.1.1 Summary of relevant new information regarding the delineation of the SRB steelhead DPS

DPS Delineation

This section provides a summary of information presented in the Northwest Fisheries Science Center's *Biological viability assessment update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest* (Ford 2022).

We found no new information that would justify a change in the delineation of the SRB steelhead DPS (Ford 2022).

Membership of Hatchery Programs

For West Coast salmon and steelhead, many of the ESU and DPS descriptions include fish originating from specific artificial propagation programs (e.g., hatcheries) that, along with their naturally produced counterparts, are included as part of the listed species. NMFS' Policy on the Consideration of Hatchery-Origin Fish in Endangered Species Act Listing Determinations for Pacific Salmon and Steelhead (70 FR 37204) guides our analysis of whether individual hatchery programs should be included as part of the listed species. The Hatchery Listing Policy states that hatchery programs will be considered part of an ESU/DPS if they exhibit a level of genetic divergence relative to the local natural population(s) that is not more than what occurs within the ESU/DPS.

In preparing this report, our hatchery management biologists reviewed the best available information regarding the hatchery membership of this DPS. They considered changes in hatchery programs that occurred since the last 5-year review (e.g., some have been terminated while others are new) and made recommendations about the inclusion or exclusion of specific programs. They also noted any errors and omissions in the existing descriptions of hatchery program membership. NMFS intends to address any needed changes and corrections via separate rulemaking subsequent to the completion of the 5-year review process prior to any official change in hatchery membership.

In the 2016 5-year review, the SRB steelhead DPS was defined as including all naturally spawned anadromous *O. mykiss* (steelhead) populations below natural and manmade impassable barriers in streams in the Snake River basin of southeast Washington, northeast Oregon, and Idaho, as well as six artificial production programs: the Tucannon River, Dworshak National Fish Hatchery, Lolo Creek, North Fork Clearwater River, East Fork Salmon River, and the Little Sheep Creek/Imnaha River Hatchery steelhead hatchery programs (71 FR 834).

Since 2016, we updated the SRB DPS listing to reflect the following six changes to hatchery programs (85 FR 81822). We: (1) added the Salmon River B-run Program because the existing release is now classified as a separate and distinct program; (2) added the South Fork Clearwater (Clearwater Hatchery) B-run program because the existing release is now classified as a separate and distinct program; (3) changed the name of the East Fork Salmon River Program to the East Fork Salmon River Natural Program; (4) removed the Lolo Creek Program because it is now considered part of the listed Dworshak National Fish Hatchery Program; (5) removed the North Fork Clearwater Program because it is now considered part of the listed Dworshak National Fish Hatchery Program, and; (6) changed the name of the Little Sheep Creek/Imnaha River Hatchery Program to the Little Sheep Creek/Imnaha Program.

The addition or removal of an artificial propagation program from a DPS does not necessarily affect the listing status of the DPS; however, it revises the DPS's composition to reflect the best available scientific information as considered under our Hatchery Listing Policy. The addition of an artificial propagation program to a DPS represents our determination that the artificially propagated stock is no more divergent relative to the local natural population(s) than what would be expected between closely related natural populations within the ESU (70 FR 37204). We relied on the Hatchery Listing Policy in our 2020 Final Rule on Revisions to Hatchery Programs as Part of Pacific Salmon and Steelhead Species Listed under the Endangered Species Act (85 FR 81822).

2.2 Recovery Criteria

The ESA requires that NMFS develop recovery plans for each listed species, unless the Secretary finds a recovery plan would not promote the conservation of the species. Recovery plans must contain, to the maximum extent practicable, objective measurable criteria for delisting the species, site-specific management actions necessary to recover the species, and time and cost estimates for implementing the recovery plans.

Evaluating a species for potential changes in ESA listing requires an explicit analysis of population or demographic parameters (the biological criteria) and also of threats under the five ESA listing factors in ESA section 4(a)(1) (listing factor [threats] criteria). Together these make up the objective, measurable criteria‖ required under section 4(f)(1)(B).

For Pacific salmon, NMFS appointed Technical Recovery Teams (TRTs) to define criteria to assess each listed Pacific salmonid species' biological viability. NMFS adopted the TRT's viability criteria as the biological criteria for Pacific salmonid recovery plans, based on the best available scientific information and other considerations as appropriate. NMFS also developed criteria to assess progress toward alleviating the relevant threats to Pacific salmonid species (listing factor [threats] criteria). For the Recovery Plan for Snake River Spring/Summer Chinook Salmon and Snake River Basin Steelhead (recovery plan), NMFS adopted the viability criteria metrics defined by the Interior Columbia Technical Recovery Team (ICTRT) (ICTRT 2007) as the biological recovery criteria for the ESA-listed SRB steelhead.

Biological review of the species continues as the recovery plan is implemented and additional information becomes available. This information, along with new scientific analyses, can increase certainty about whether the threats have been abated, whether improvements in population biological viability have occurred for the salmon and steelhead, and whether linkages between threats and changes in biological viability are understood. NMFS assesses these biological recovery criteria and the delisting criteria through the adaptive management program for the plan during the ESA 5-year review (USFWS and NMFS 2006; NMFS 2020a).

2.2.1 Approved recovery plan with objective, measurable criteria

Does the species have final, approved recovery plans containing objective, measurable criteria?

ESU/DPS Name	YES	NO
Snake River Basin Steelhead	X	

2.2.2 Adequacy of recovery criteria

Based on new information considered during this review, are the recovery criteria still appropriate?

ESU/DPS Name	YES	NO
Snake River Basin Steelhead	X	

Are all of the listing factors that are relevant to the species addressed in the recovery criteria?

ESU/DPS Name	YES	NO
Snake River Basin Steelhead	X	

2.2.3 The biological recovery criteria as they appear in the recovery plan

For the purposes of reproduction, salmon and steelhead typically exhibit a metapopulation structure (McElhany et al. 2000; Schtickzelle and Quinn 2007). Rather than interbreeding as one large aggregation, ESUs and DPSs function as a group of demographically independent populations separated by areas of unsuitable spawning habitat. For conservation and management purposes, it is important to identify the independent populations that make up an ESU or DPS.

McElhany et al. (2000) defined an independent population as: "…a group of fish of the same species that spawns in a particular lake or stream (or portion thereof) at a particular season and which, to a substantial degree, does not interbreed with fish from any other group spawning in a different place or in the same place at a different season." For our purposes, not interbreeding to a "substantial degree" means that two groups are considered to be independent populations if they are isolated to such an extent that exchanges of individuals among the populations do not substantially affect the population dynamics or extinction risk of the independent populations over a 100-year time frame. Independent populations exhibit different population attributes that influence their abundance, productivity, spatial structure, and diversity. Independent populations are the units that are combined to form alternative recovery scenarios for multiple similar population groupings and ESU viability.

NMFS used the viable salmonid population (VSP) concept (McElhany et al. 2000) to define the independent populations in an ESU or DPS. The VSP concept is based on the biological parameters of abundance, productivity, spatial structure, and diversity for an independent salmonid population to have a negligible risk of extinction over a 100-year time frame. The VSP concept identifies the attributes, provides guidance for determining the conservation status of populations and larger-scale groupings of Pacific salmonids, and describes a general framework for how many and which populations within an ESU/DPS should be at a particular status for the ESU/DPS to have an acceptably low risk of extinction. McElhany et al. (2007) developed combined VSP criteria metrics that describe the probability of population extinction risk in 100 years (Figure 1). NMFS color-coded the risk assessment to assist the readers to more easily distinguish the various risk categories.

VSP Criteria Metrics		**Spatial Structure/Diversity Risk**			
	Risk	Very Low	Low	Moderate	High
Abundance/Productivity Risk	Very Low (<1%)	Very Low Risk (Highly Viable)	Very Low Risk (Highly Viable)	Low Risk (Viable)	Moderate Risk
	Low (<5%)	Low Risk (Viable)	Low Risk (Viable)	Low Risk (Viable)	Moderate Risk
	Moderate (<25%)	Moderate Risk	Moderate Risk	Moderate Risk	High Risk
	High (>25%)	High Risk	High Risk	High Risk	High Risk

Figure 1. VSP Criteria Metrics.

For the purposes of recovery planning and the development of recovery criteria, the NMFS-appointed ICTRT identified independent populations for SRB steelhead, and then grouped them together into genetically similar major population groups (MPGs) (ICTRT 2003).

The ICTRT also developed species biological viability criteria for applications at the ESU/DPS, MPG, and independent population scales (ICTRT 2007). The viability criteria are based on the VSP concept described above. Recovery scenarios outlined in the ICTRT viability criteria report (ICTRT 2007) are targeted to achieve, at a minimum, the ICTRT's biological viability criteria for each major population grouping. Accordingly, the criteria are designed "[t]o have all major population groups at viable (low risk) status with representation of all the major life history strategies present historically, and with the abundance, productivity, spatial structure, and diversity attributes required for long-term persistence." Recovery criteria and strategies outlined in the Recovery Plan for Snake River Spring/Summer Chinook Salmon and Snake River Basin Steelhead are targeted on achieving, at a minimum, the ICTRT biological viability criteria for each major population grouping in the ESU/DPS (NMFS 2017a).

Recovery scenarios outlined in the ICTRT viability criteria report (ICTRT 2007b) are targeted to achieve, at a minimum, the ICTRT's biological viability criteria for each major population grouping. Accordingly, the criteria are designed "[t]o have all major population groups at viable (low risk) status with representation of all the major life history strategies present historically, and with the abundance, productivity, spatial structure, and diversity attributes required for long-term persistence." The Snake River management unit recovery plans (SRSRB 2011; NMFS 2017b, 2017c, 2017d) identify 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. The following describes the combination of population status most likely to achieve viability for each MPG.

The SRB steelhead DPS has six MPGs (five extant and one – Hells Canyon – with no associated independent populations) with 24 extant populations (Figure 2). The SRB steelhead DPS includes all naturally spawned anadromous *O. mykiss* (steelhead) originating below natural and manmade impassable barriers from the Snake River basin. Also, steelhead from six artificial production programs: Tucannon River, Salmon River B-run, South Fork Clearwater (Clearwater Hatchery) B-run, Dworshak National Fish Hatchery, East Fork Salmon River, and Little Sheep Creek/Imnaha River Hatchery (71 FR 834; 85 FR 81822).

The five extant SRB steelhead MPGs are described in the recovery plan (NMFS 2017b), with recovery scenarios identified for each MPG. The recovery plan recognizes that, at the MPG level, there may be several alternative combinations of populations and statuses and risk ratings that could satisfy the ICTRT viability criteria.

Lower Snake River MPG (two populations)

- The Tucannon River and Asotin Creek populations must achieve at least *Viable* status (low risk), with one of the populations at *Highly Viable* (very low risk) status.

Grande Ronde River MPG (four populations)

- At least two steelhead populations in the MPG must achieve at least *Viable* status (low risk), with at least one population at *Highly Viable* status (very low risk) status. The Upper Grande Ronde is the only large population in the MPG and must attain *Viable* status.
- All remaining populations should at least achieve *Maintained* status (moderate risk).

Imnaha River MPG (one population)

- The Imnaha River population must attain *Highly Viable* status (very low risk) for the MPG to achieve viable status and support delisting of the SRB steelhead DPS.

Clearwater River MPG (five extant and one extirpated population)

- At least three of the MPG's six populations must be *Viable*, and one of these populations must be *Highly Viable* for the MPG to meet the criteria.
- Because the North Fork Clearwater population is extirpated, the only Large-size population left is the Lower Mainstem Clearwater River, and it must achieve viability to meet this criterion. At least two of the three Intermediate-size populations must also attain V*iable* status (Selway, Lochsa [targeted for *Highly Viable*] SF Clearwater).
- All remaining populations should at least achieve *Maintained* status.

Salmon River MPG: (12 extant populations)

- Since there are 12 steelhead populations in the Salmon River MPG, at least six must be *Viable* (low risk) for the MPG to be viable. One of these populations must achieve *Highly Viable* (very low risk) status.
- At least four of the six viable populations must be Intermediate size.
- At least two of the six viable populations need to be populations with predominantly B-run fish so that all major life histories are represented. Also, because the geographic area of this MPG is so large, it is important that spatial distribution of the viable populations be considered.
- All remaining populations should at least achieve *Maintained* status.

Hells Canyon Tributaries MPG

This MPG historically contained three independent populations. However, all three populations were above Hells Canyon Dam (Powder River, Burnt River, and Weiser River) and are now extirpated. A small number of steelhead occupy some tributaries below Hells Canyon Dam; however, none of these tributaries (nor all combined) appear to be large enough to support an independent population. Based on the extirpated status of these populations, the MPG is not expected to contribute to the recovery of the DPS (NMFS 2017c).

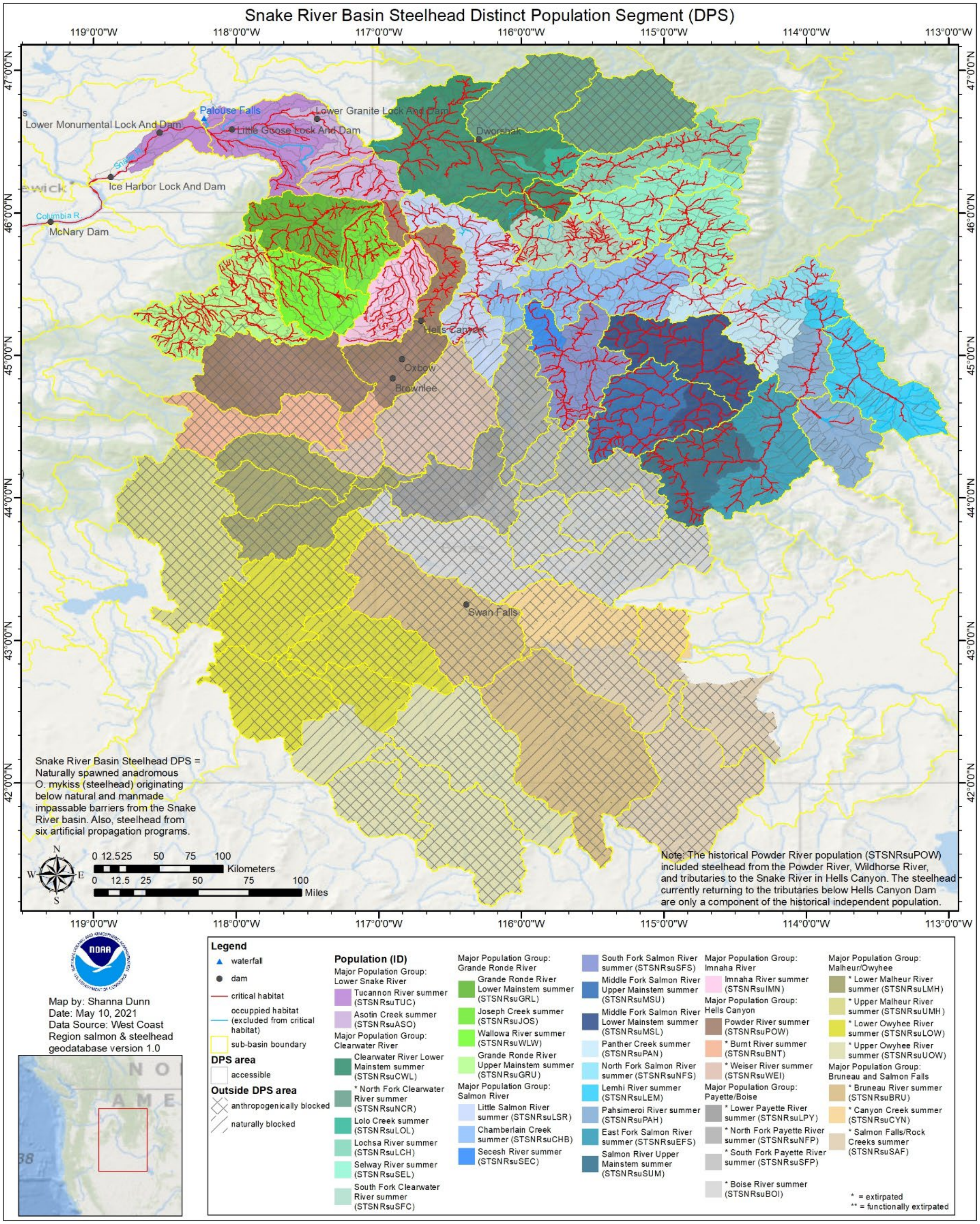

Figure 2. SRB steelhead DPS populations and major population groups.

2.3 Updated Information and Current Species' Status

Information provided in this section includes a summary from the *Biological viability assessment update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest* (Ford 2022) (Subsection 2.3.1) and our current listing factors analysis (Subsection 2.3.2).

2.3.1 Analysis of VSP criteria (including discussion of whether the VSP criteria have been met)

Updated Biological Risk Summary

Below are the Ford (2022) updated viability status summaries integrated across the four VSP parameters for the SRB steelhead populations and grouped by MPG.

The Lower Snake River MPG is not viable. It does not meet the recovery viability criteria of both populations meeting viable status, with one being highly viable (Figure 3). The Tucannon River population must achieve viable status, and either the Asotin population or Tucannon population must reach Highly Viable, for MPG viability.

Risk Rating for Abundance/Productivity	Risk Rating for Spatial Structure and Diversity			
	Very Low	Low	Moderate	High
Very Low (<1%)	Highly Viable	Highly Viable	Viable	Maintained
Low (1–5%)	Viable	Viable	Viable	Maintained
Moderate (6–25%)	Maintained	Maintained	Maintained ***Lwr Snake R. (Tucannon, Asotin)***	High Risk
High (>25%)	High Risk	High Risk	High Risk ***Tucannon R.***	High Risk

Figure 3. Lower Snake River MPG population risk ratings **integrated** across the four VSP parameters. Viability key: Dark Green = highly viable; Green = viable; Orange = maintained; and Red = high risk (does not meet viability criteria) (Ford 2022, Table 23, p. 104).

The Grande Ronde MPG is not viable. To meet viability criteria, this MPG must bring the high-risk populations to at least maintained status (Figure 4). Further, the upper Grande Ronde population must remain at least viable, and one of the populations must improve to highly viable. The Grande Ronde MPG is rated as maintained (not viable), but more specific data on spawning abundance and the relative contribution of hatchery spawners for the Lower Grande Ronde and Wallowa populations would improve future assessments.

Risk Rating for Abundance/Productivity	Risk Rating for Spatial Structure and Diversity			
	Very Low	Low	Moderate	High
Very Low (<1%)	Highly Viable	Highly Viable	Viable ***Upper Gr Ronde***	Maintained
Low (1–5%)	Viable	Viable ***Joseph Creek***	Viable	Maintained
Moderate (6–25%)	Maintained	Maintained	Maintained	High Risk
High (>25%)	High Risk	High Risk **Wallowa**	High Risk ***Lower Gr Ronde.***	High Risk

Figure 4. Grand Ronde River MPG population risk ratings **integrated** across the four VSP parameters. Viability key: Dark Green = highly viable; Green = viable; Orange = maintained; and Red = high risk (does not meet viability criteria) (Ford 2022, Table 23, p. 104).

The Imnaha MPG is not viable; however, the Imnaha MPG's single population moved from maintained to viable status in this review period (Figure 5). Still, the single population and MPG must achieve Highly Viable status to reach MPG viability.

Risk Rating for Abundance/Productivity	Risk Rating for Spatial Structure and Diversity			
	Very Low	Low	Moderate	High
Very Low (<1%)	Highly Viable	Highly Viable	Viable ***Imnaha***	Maintained
Low (1–5%)	Viable	Viable	Viable	Maintained
Moderate (6–25%)	Maintained	Maintained	Maintained	High Risk
High (>25%)	High Risk	High Risk	High Risk	High Risk

Figure 5. Imnaha River MPG population risk ratings integrated across the four VSP parameters. Viabilitykey: Dark Green = highly viable; Green = viable; Orange = maintained; and Red = high risk (does not meet viability criteria) (Ford 2022, Table 23, p. 104).

The Clearwater River MPG is not viable. The only large population (Lower Mainstem) is rated at highly viable. For the MPG to be viable, two additional populations must be viable and the remaining populations must be rated as at least maintained (Figure 6). The SF Clearwater population is rated as viable; however, the Lolo population is rated high risk, and the Lochsa and Selway populations are rated as maintained. The viability assessment (Ford 2022) reported Lolo, Lochsa, and Selway as a three-population aggregate, which was rated as maintained. We reviewed the data underlying that analysis and determined that the Lolo population, when treated individually, rates as high risk. The Lolo population is a small size ("basic") population expected to maintain a mean abundance of at least 500 adults for viability; however, this population apparently has had less than 200 adults in each of the last 5 years, through the 2020/21 return. For the individual Lolo population, recent abundance and productivity tend not to support a rating of maintained but instead indicate high risk. Future ratings of populations in the MPG would benefit from more specific data on spawning abundance and the relative contribution of hatchery spawners.

Risk Rating for Abundance/Productivity		Risk Rating for Spatial Structure and Diversity			
		Very Low	Low	Moderate	High
	Very Low (<1%)	Highly Viable	Highly Viable	Viable	Maintained
			Lower Main Clearwater R.	***SF Clearwater R.***	
	Low (1–5%)	Viable	Viable	Viable	Maintained
	Moderate (6–25%)	Maintained	Maintained	Maintained	High Risk
			Selway R. Lochsa R.		
	High (>25%)	High Risk	High Risk	High Risk	High Risk
				LoLo Creek	

Figure 6. Clearwater River MPG population risk ratings integrated across the four VSP parameters. The Lolo Creek population was disaggregated from the Selway and Lochsa populations (see explanation in the MPG discussion). Viabilitykey: Dark Green = highly viable; Green = viable; Orange = maintained; and Red = high risk (does not meet viability criteria) (Ford 2022, Table 23, p. 104) .

The Salmon River MPG is not viable. The MPG has several criteria for MPG viability but fails on the first criteria, which calls for half, or six out of 12, populations to be viable and one to be highly viable (Figure 7). The Little Salmon River population is the only population in the MPG with a viable rating.

Risk Rating for Abundance/Productivity	Risk Rating for Spatial Structure and Diversity			
	Very Low	Low	Moderate	High
Very Low (<1%)	Highly Viable	Highly Viable	Viable ***Little Salmon R.***	Maintained
Low (1–5%)	Viable	Viable	Viable	Maintained
Moderate (6–25%)	Maintained	Maintained ***SF Salmon R.*** ***Secesh R.*** ***Chamberlain Cr.*** ***Lwr MF Salmon R.*** ***Upr MF Salmon R.***	Maintained ***NF Salmon R.*** ***Lemhi R.*** ***Pahsimeroi R.*** ***EF Salmon R.*** ***Upr Main Salmon R.***	High Risk ***Panther Creek***
High (>25%)	High Risk	High Risk	High Risk	High Risk

Figure 7. Salmon River MPG population risk ratings integrated across the four VSP parameters. Viability key: Dark Green = highly viable; Green = viable; Orange = maintained; and Red = high risk (does not meet viability criteria) (Ford 2022, Table 23, p. 104).

Based on the updated viability information available for this review, none of the five MPGs meet the viability criteria set forth in the 2017 recovery plan, and the viability of many individual populations remains uncertain. Of particular note, the updated, population-level abundance estimates have made very clear the recent (last 5 years) sharp declines that are extremely worrisome, were they to continue. The most recent 5-year metric indicates that each population has decreased by about 50 percent. The viability metrics used in these analyses (standardized PNW-wide and ICTRT) are intentionally based on long-time periods (10-20 year geometric means) to buffer against the rapid swings in abundance that salmon and steelhead populations are known to exhibit. While these filtering approaches intentionally result in muted responses to rapid abundance change, they also can lag in raising concerns about a dramatic change in population status. Rapid response metrics, or metrics that are more keyed to system-wide synchronous behavior of population productivity, may be appropriate for raising concern for the status in these situations.

Based on 20-year geometric means, productivity for all populations remains above replacement. Cyclical spawner-to-spawner ratios, which reflect combined impacts of habitat, climate, and density dependence, have been strongly below replacement since 2010. Productivity is also expected to decline in the coming years due to recent declines in abundance.

Spatial structure risk ratings for all of the SRB steelhead populations were low or very low risk given the evidence of broad distribution of natural production within populations. The exception was Panther Creek, which was given a high-risk rating for spatial structure based on the lack of spawning in the upper sections. Based on extensive survey information from the Salmon River and Clearwater River MPGs, the spatial structure ratings for SRB steelhead populations were maintained at the levels assigned in the original ICTRT assessment. Diversity risk ratings were low to moderate and nearly unchanged from the previous 5-year review period.

DPS Summary

Population abundance declines since the 2016 5-year review are sharp and are expected to negatively affect productivity in the coming years corresponding with these declines. These declines in abundance, according to short-term metrics, are of greater concern if they continue through the next 5-year review period. However, spatial structure risk is very low as SRB steelhead are widely distributed throughout their accessible range, and the species exhibits resilience to rapid changes in abundance. Overall, the information analyzed for the 2022 viability assessment does not indicate a change in the biological risk status of the DPS, which remains in the moderate extinction risk category, as supported by the population risk ratings summarized by MPG in section 2.3.1 above.

2.3.2 ESA listing factor analysis

Section 4(a)(1) of the ESA directs us to determine whether any species is threatened or endangered because of any of the following factors: (A) the present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; or (E) other natural or man-made factors affecting its continued existence. Section 4(b)(1)(A) requires us to make listing determinations after conducting a review of the status of the species and taking into account efforts to protect such species. Below we discuss new information relating to each of the five factors as well as efforts being made to protect the species.

Listing Factor A: Present or threatened destruction, modification or curtailment of its habitat or range

Significant habitat restoration and protection actions at the federal, state, tribal, and local levels have been implemented to improve the degraded habitat conditions and fish passage issues described in the Snake River recovery plans. While these efforts have been substantial and are expected to benefit the survival and productivity of the targeted populations, we do not yet have evidence demonstrating that improvements in habitat conditions have led to improvements in population viability. The effectiveness of habitat restoration actions and progress toward meeting the viability criteria should continue to be monitored and evaluated with the aid of newly implemented monitoring and evaluation programs. Generally, it takes one to five decades to demonstrate increases in viability.

In the 2020 Columbia River System biological opinion (NMFS 2020a), NMFS concluded that tributary habitat conditions are likely improving in some areas as a result of habitat improvement actions. In addition, results from PACFISH/INFISH Biological Opinion (PIBO) monitoring have shown that mid-1990s changes in guidance for land management plans and actions on Pacific Northwest National Forest and Bureau of Land Management lands have led to measurable improvements in salmonid habitat over the past 20 years (Roper et al. 2019). These gains in habitat quality are likely from more conservative management standards in riparian areas and the implementation of best management practices to reduce sediment delivery to streams from roads. However, tributary habitat conditions are generally still degraded from ongoing development and land-use activities, which continue to negatively affect SRB steelhead abundance, productivity, spatial structure, and diversity. The potential exists to improve tributary habitat capacity and productivity in this DPS, although the potential is limited or uncertain in some areas (NMFS 2016a, 2017b). Strong density dependence in SRB steelhead populations (ISAB 2015) indicates that population abundance improvements through habitat restoration would best be achieved by targeting limiting life stages or habitat limiting factors. Additional improvements are needed in almost all populations to achieve recovery goals.

Current Status and Trends in Habitat

Below, we summarize information on the **current status and trends in tributary habitat** conditions by MPG since our last 2016 5-year review. We specifically address:

(1) population-specific key emergent or ongoing habitat concerns (threats or limiting factors) focusing on the top concerns that potentially have the biggest impact on independent population viability;

(2) population-specific geographic areas of habitat concern (e.g., independent population major/minor spawning areas) where key emergent or ongoing concerns about this habitat condition remain;

(3) population-specific key protective measures and major restoration actions taken since the 2016 5-year review toward achieving the recovery plan viability criteria established by the recovery plan (NMFS 2017a) as efforts that substantially address a key concern noted in **above #1 and # 2**, or that represent a noteworthy conservation strategy;

(4) key regulatory measures that are either adequate, or, inadequate and contributing substantially to the key tributary habitat concerns summarized above; and

(5) recommended future recovery actions over the next 5 years toward achieving population viability, including: key near-term restoration actions that would address the key concerns summarized above; projects to address monitoring and research gaps; fixes or initiatives to address inadequate regulatory mechanisms, and addressing priority habitat areas when sequencing priority habitat restoration actions.

The following section describes the tributary habitat for each MPG. Migration corridor habitat in the Salmon River, Snake River, and Columbia River is vitally important to this DPS. This migratory habitat is addressed under *Listing Factor C (Disease and Predation) and Listing*

Factor D (Inadequacy of Regulatory Mechanisms), and Listing Factor E (Other Natural or Manmade Factors).

Lower Snake River MPG

1) Population-Specific Key Emergent or Ongoing Habitat Concerns Since the 2016 5-year review

For the two independent SRB steelhead populations (Tucannon River and Asotin Creek) in the Lower Snake River MPG, the primary tributary habitat concerns since the 2016 5-year review continue. These concerns were identified in the 2011 South East Washington Snake River Recovery Plan (SRSRB 2011) and were reiterated by the SRSRB in 2020 (SRSRB 2020):

- lack of stream complexity;
- excess sediment;
- low stream flows;
- high stream temperatures;
- degraded riparian conditions;
- reduced floodplain connectivity; and
- passage barriers (Tucannon River population only).

2) Population-Specific Geographic Areas of Habitat Concern Since the 2016 5-year review

Both populations in the MPG are located in the geographic areas of tributary habitat concern (SRSRB 2011, 2020; NMFS 2017a).

3) Population-Specific Key Protective Measures and Major Restoration Actions Taken Since the 2016 5-year review

Population-specific key protective measures and major restoration actions taken since the 2016 5-year review and adoption of the 2017 Recovery Plan for Snake River Spring/summer Chinook Salmon and Snake River Basin Steelhead include:

- Tucannon River population. Addition of whole trees over 10 miles of Tucannon River habitat to reengage the river with its floodplain, increase side channels, lower summer water temperatures, and create more juvenile summer and winter rearing habitat (SRSRB 2020).
- Asotin Creek population. Installation of hundreds of low-cost post-assisted log structures in the headwaters of the Asotin Creek watershed to re-meander streams and reduce stream energy and hydrographic flashiness (SRSRB 2020).

- Asotin Creek population. Provision of natural fish passage to an additional 51 and 15 stream miles for Asotin Creek and Alpowa Creek fish passage barriers (Asotin Creek Headgate, Alpowa Creek County Culvert, Buford Creek Culvert), respectively (SRSRB 2020).

4) Key Regulatory Measures Since the 2016 5-year review

The recovery plan (NMFS 2017a) and previous 5-year review (NMFS 2016a) identified inadequate regulatory mechanisms as a priority issue affecting SRB steelhead recovery in all Snake River basin geographic areas with extant SRB steelhead populations and MPGs. Various federal, state, and county regulatory mechanisms are in place to minimize or avoid habitat degradation caused by human use and development. New information available since the last 5-year review indicates that the adequacy of several regulatory mechanisms has stayed the same on average, with some mechanisms showing the potential for some improvement, whereas others have made it more challenging to protect and recover our species. See *Listing Factor D: Inadequacy of Regulatory Mechanisms* in this document for details.

5) Recommended Future Actions Over the Next 5 years Toward Achieving Population Viability

The greatest opportunities toward achieving population viability and advancing recovery of SRB steelhead in the Lower Snake River MPG include:

- Tucannon River population. Improve and increase summer and winter juvenile rearing habitat, especially in high potential reaches of the Tucannon River and Pataha Creek, by restoring riparian areas, reducing temperatures and substrate embeddedness, and increasing recruitment of large wood (SRSRB 2011).
- Tucannon River population. Enhance overwinter rearing habitat for Tucannon River juvenile steelhead, increase rearing habitat complexity, and reconnect the river to its floodplain (SRSRB 2011; CCD 2021).
- Tucannon River population. Address the Tucannon Tumalum and Hixon culverts and Cottonwood Creek culvert passage barriers in the next 5 years (SRSRB 2020).

Grande Ronde River MPG

1) Population-Specific Key Emergent or Ongoing Habitat Concerns Since the 2016 5-year review

For the four independent SRB steelhead populations (Joseph Creek, Lower Grande Ronde River, Wallowa River, and the Upper Grande Ronde River) in the Grande Ronde River MPG, the primary tributary habitat concerns since the 2016 5-year review and identified in the 2017 recovery plan (NMFS 2017c) continue to be:

- Lack of large wood and large wood recruitment (all populations).

- Impaired riparian conditions, channelization, and loss of off-channel habitat and floodplain connectivity (all populations).
- High summer water temperatures (Upper Grande Ronde population).
- Ice flows increased by poor riparian conditions and altered floodplain/channel function (Upper Grande Ronde population).
- Low stream flows due to irrigation withdrawals (Upper Grande Ronde and Wallowa River populations).
- Loss of habitat complexity and connectivity sufficient to support summer and winter juvenile rearing steelhead (Upper Grande Ronde population) (USBR 2011).
- Timber management and grazing (Joseph Creek population).

2) Population-Specific Geographic Areas of Habitat Concern Since the 2016 5-year review

Population-specific geographic areas of habitat concern in the Grande Ronde River MPG are:

- Upper Grande Ronde River and Catherine Creek (Upper Grande Ronde population).
- Upper Grande Ronde and Joseph Creek (These two population areas host the majority of spawners for the MPG).
- Lostine and Wallowa River drainages (Wallowa River population).

3) Population-Specific Key Protective Measures and Major Restoration Actions Taken Since the 2016 5-year review

Partners have completed habitat restoration projects since 2016 through the Atlas Process for watershed planning (GRMW 2020), including:

- Wallowa River population. Four projects in the Lostine River increased instream flow through 12.5 miles of habitat.
- Upper Grande Ronde population. Nine projects increased summer stream flow to 10 miles of habitat in Catherine Creek.
- Upper Grande Ronde population. Conservation partners and the Wallowa-Whitman National Forest completed seven projects that added large wood to tributaries to the upper Grande Ronde River.
- Upper Grande Ronde population. Conservation partners completed a large-scale floodplain restoration project at Birdtrack Springs on the Grande Ronde River.

4) Key Regulatory Measures Since the 2016 5-year review

The recovery plan (NMFS 2017a) and previous 5-year review (NMFS 2016a) identified inadequate regulatory mechanisms as a priority issue affecting SRB steelhead recovery in all

Snake River basin geographic areas with extant SRB steelhead populations and MPGs. Various federal, state, and county regulatory mechanisms are in place to minimize or avoid habitat degradation caused by human use and development. New information available since the last 5-year review indicates that the adequacy of several regulatory mechanisms has stayed the same on average, with some mechanisms showing the potential for some improvement, whereas others have made it more challenging to protect and recover our species. See *Listing Factor D: Inadequacy of Regulatory Mechanisms* in this document for details.

5) Recommended Future Actions Over the Next 5 years Toward Achieving Population Viability

The greatest opportunities toward achieving population viability and advancing recovery of SRB steelhead in the Grand Ronde MPG are to:

- Upper Grande Ronde and Wallowa River populations. Continue support and development of the Atlas planning framework for the Upper Grande Ronde and the Wallowa basin to guide and prioritize habitat restoration actions (Tetra Tech, Inc. 2017).
- All non-wilderness populations. Complete restoration actions that reduce summer stream temperatures and mitigate for climate change. These projects include: protecting in-stream flows through lease and acquisition, increasing hyporheic exchange and floodplain storage, reestablishing robust native riparian vegetation, and implementing Stage 0 floodplain restoration techniques where appropriate (Justice et al. 2017; Powers, Helstab and Niezgoda 2018; Wondzell, Diabat and Haggerty 2019). Continue funding projects through the Columbia Basin Watershed Transactions Program.
- All non-wilderness populations. Reconnect streams to their floodplains and increase habitat complexity by creating sustainable beaver habitat that supports beaver populations (e.g., beaver dam analogs, ponds, riparian vegetation), enhances fish habitat, and mitigates climate change (Pollock et al. 2017; Dwire, Mellmann-Brown and Gurrieri 2018). Continue to increase habitat complexity, reconnect floodplains, and improve riparian conditions, particularly in the Upper Grande Ronde River and Wallowa River population areas.

Imnaha River MPG

1) Population-Specific Key Emergent or Ongoing Habitat Concerns Since the 2016 5-year review

The Imnaha MPG includes one population, the Imnaha population. NMFS' recovery plan (NMFS 2017c) identifies the following ongoing habitat concerns for the Imnaha MPG:

- High stream temperatures and low summer stream flows due to water withdrawals.
- Impaired riparian and channel conditions resulting from past livestock grazing, timber harvest, and road construction.

- Excessive fine sediment.
- Reduced large wood, low pool frequency and quality, water quality, and flow conditions.

2) Population-Specific Geographic Areas of Habitat Concern Since the 2016 5-year review

Geographic areas of habitat concern within the Imnaha River MPG include Big Sheep Creek, Little Sheep Creek, and the Imnaha River below Freezeout Creek (NMFS 2017c).

3) Population-Specific Key Protective Measures and Major Restoration Actions Taken Since the 2016 5-year review

- Lick Creek culvert replacement project was completed in 2017. Actions included adding boulder, large wood, and spawning gravel; replacing culverts, structures, and fords with bridges; and adding culverts at locations other than above stream crossings (OWRI 2020).
- Imnaha upland weed control project was completed in 2018 (OWRI 2020).

4) Key Regulatory Measures Since the 2016 5-year review

The NMFS recovery plan (NMFS 2017a) and previous 5-year review (NMFS 2016a) identified inadequate regulatory mechanisms as a priority issue affecting SRB steelhead recovery in all Snake River basin geographic areas with extant SRB steelhead populations and MPGs. Various federal, state, and county regulatory mechanisms are in place to minimize or avoid habitat degradation caused by human use and development. New information available since the last 5-year review indicates that the adequacy of several regulatory mechanisms has stayed the same on average, with some mechanisms showing the potential for some improvement, whereas others have made it more challenging to protect and recover our species. See *Listing Factor D: Inadequacy of Regulatory Mechanisms* in this document for details.

5) Recommended Future Actions Over the Next 5 years Toward Achieving Population Viability

NMFS’ recovery plan (NMFS 2017c) recommends the following habitat actions for the Imnaha MPG:

- Continue to support and develop the Atlas planning framework for the Imnaha population to guide and prioritize habitat restoration actions (Tetra Tech, Inc. 2017).
- Focus restoration actions in Big Sheep Creek, Little Sheep Creek, and the Imnaha River below Freezeout Creek to improve riparian conditions, help moderate summer temperatures, and reduce fine sediment.
- Restore tributary habitat conditions, especially for steelhead spawners and juvenile rearing.

- Maintain current wilderness protection to protect and conserve pristine tributary habitat.

Clearwater River MPG

1) Population-Specific Key Emergent or Ongoing Habitat Concerns Since the 2016 5-year review

Six populations are included in the Clearwater River MPG. The five extant populations include the Lower Mainstem Clearwater River, Selway River, Lochsa River, Lolo Creek, and SF Clearwater River. The North Fork Clearwater River population is extirpated. NMFS' recovery plan (NMFS 2017a) identifies the following ongoing habitat concerns for all populations in the Clearwater MPG:

- Migration barriers.
- Sediment.
- Riparian condition, shade, large wood recruitment.
- Habitat complexity.
- Stream temperature.
- Altered stream hydrology and channels from land management and levees (Lower Mainstem Clearwater River population).

2) Population-Specific Geographic Areas of Habitat Concern Since the 2016 5-year review

NMFS' recovery plan (NMFS 2017a) identifies the following geographic areas of habitat concern for each population in the Clearwater MPG:

- Lower Mainstem Clearwater River population. Watersheds with the highest priority for protection and restoration are streams with relatively high natural base flows and current high steelhead densities or high intrinsic potential for production.
- Selway River population. Tributaries to the lower Selway River.
- Lochsa River population. Stream reaches with high intrinsic potential steelhead habitat in the major spawning areas of Crooked Fork, Fish, Lake, and White Sands creeks.
- Lolo Creek population. Lolo Creek mainstem, Yoosa Creek, Musselshell Creek, and Yakus Creek.
- South Fork Clearwater River population. Major spawning areas include the Crooked River, Newsome Creek, Red River, American River, and Elk Creek watersheds.
- South Fork Salmon River Population. Several federal grazing allotments were permanently closed, reducing potential impacts to spawning and rearing habitat.

3) Population-Specific Key Protective Measures and Major Restoration Actions Taken Since the 2016 5-year review

- Lower Mainstem Clearwater River population. Various project proponents have completed more than two dozen habitat restoration projects reconnecting floodplains and meadows, installing LWD, and removing passage barriers. Since the last 5-year review, these actions have improved more than 20 miles of steelhead habitat in the Lapwai Creek and Potlatch River drainages. The Lewiston Orchards Irrigation District (LOID) wells project was completed in 2016, adding additional flow to Sweetwater and Lapwai creeks (PCSRF 2021).
- Selway River population. Six tributary culverts on the O'Hara Creek Road were replaced in 2016, eliminating chronic sediment delivery to steelhead spawning and rearing habitat in O'Hara Creek (NMFS 2015).
- Lochsa River population. The Waw'aalamnima Creek LWD placement project was completed in 2016 (PCSRF 2021).
- Lolo Creek population. Nez Perce Tribe Collette mine channel and floodplain restoration improved 0.6 miles, 15 acres of habitat (NPCNF 2016). The Nevada Creek culvert replacement opened passage to 4.7 miles of cold-water habitat (PCSRF 2021).
- South Fork Clearwater River population. Crooked River mine tailings habitat restoration is ongoing, restoring floodplain processes to a 2-mile legacy dredge mining site (USDA 2015). Leggett Creek culvert replacement provided steelhead passage to Leggett Creek (PCSRF 2021).

4) Key Regulatory Measures Since the 2016 5-year review

The NMFS' recovery plan (NMFS 2017a) and previous 5-year review (NMFS 2016a) identified inadequate regulatory mechanisms as a priority issue affecting SRB steelhead recovery in all Snake River basin geographic areas with extant SRB steelhead populations and MPGs. Various federal, state, and county regulatory mechanisms are in place to minimize or avoid habitat degradation caused by human use and development. New information available since the last 5-year review indicates that the adequacy of several regulatory mechanisms has stayed the same on average, with some mechanisms showing the potential for some improvement, whereas others have made it more challenging to protect and recover our species. See *Listing Factor D: Inadequacy of Regulatory Mechanisms* in this document for details.

5) Recommended Future Actions Over the Next 5 years Toward Achieving Population Viability

NMFS' recovery plan (NMFS 2017a) recommends the following habitat actions, for each population, over the next 5 years to achieve Clearwater MPG viability:

- Lower Mainstem Clearwater River population. Establish site-specific habitat restoration priorities using information the watershed plans developed from geomorphic stream assessments (also throughout the Clearwater basin) and updated information from fish population inventories in high priority watersheds. Habitat activities should be designed to preserve, restore, or rehabilitate natural habitat-forming processes (i.e., flood frequency and magnitude, sediment supply, and LWD recruitment).
- Selway River and Lochsa River populations. Prioritize habitat restoration projects to reduce road sediment and passage barriers in tributaries to the lower Selway River.
- Lolo Creek population. Eliminate migration barriers and chronic sediment sources from roads, and restore riparian conditions, large wood, and floodplain connectivity in the geographic areas of concern listed above to increase productivity and smolt production in the Lolo Creek population. Continue to support and develop the Atlas planning frameworks for the Lolo Creek and South Fork Clearwater River populations.
- South Fork Clearwater River population. Protect existing high-quality habitats, improve riparian conditions, eliminate chronic sediment and restore channel and floodplain function in historic mining sites by removing unnecessary bank stabilization structures. Support studies of juvenile rearing and migration to inform restoration of rearing habitat.

Salmon River MPG

1) Population-Specific Key Emergent or Ongoing Habitat Concerns Since the 2016 5-year review

The Salmon River MPG includes the following 12 populations: Little Salmon River, South Fork Salmon River, Secesh River, Chamberlin Creek, Lower Middle Fork Salmon River, Upper Middle Fork Salmon River, Panther Creek, North Fork Salmon River, Lemhi River, Pahsimeroi River, East Fork Salmon River, and the Upper Mainstem Salmon River. Habitat concerns reported in the 2016 5-year review (NMFS 2016a) and the ESA Recovery Plan for Idaho Snake River Spring/Summer Chinook Salmon and SRB Steelhead (NMFS 2017a) and reaffirmed in this review period (Biomark ABS et al. 2019; NPT 2020a) continue to exist:

- Low flows. The Lemhi River and Pahsimeroi River populations are particularly impacted by low flows caused by irrigation diversion.
- Degraded riparian conditions. The conditions affect the Lemhi River, Pahsimeroi River, East Fork Salmon River, and Upper Salmon Mainstem populations.
- Sediment. High sediment levels affect the Lemhi River, Pahsimeroi River, Upper Salmon Mainstem, and South Fork Salmon River populations.
- High summer water temperature. Temperatures affect rearing juveniles from all populations in the MPG, except in the Panther Creek and North Fork Salmon River populations.

- Passage barriers. Barriers restrict passage for the Secesh and South Fork Salmon River populations.
- Insufficient overwintering habitat. Insufficient overwintering habitat is limiting juvenile growth in the Lemhi River, Pahsimeroi River, and Upper Salmon Mainstem populations. A habitat concern identified since the 2016 5-year review, insufficient overwintering habitat is due in part to simplified stream channels and lack of floodplain complexity.
- Migration Corridor. Degraded habitat conditions in the Salmon River, Snake River, Columbia River, and Columbia River estuary continue to adversely affect juveniles and adults from all populations in this MPG.

2) Population-Specific Geographic Areas of Habitat Concern Since the 2016 5-year review

There are no additional population-specific geographic areas of habitat concern identified beyond the emergent and ongoing habitat concerns listed (all populations in the MPG) in the 2017 recovery plan (NMFS 2017a).

3) Population-Specific Key Protective Measures and Major Restoration Actions Taken Since the 2016 5-year review

The Tribes, U.S. Forest Service (USFS), and other partners have completed many habitat restoration projects in the Salmon River MPG since the 2016 5-year review:

- South Fork Salmon River population. The Nez Perce Tribe and the Payette National Forest decommissioned 42 miles of upland and 14 miles of riparian roads; improved 14 miles of road; and replanted several degraded riparian areas (NPT 2020a).
- Little Salmon River population. The Payette National Forest replaced six passage barrier culverts in the Boulder Creek subwatershed, reconnecting 6 miles of stream habitat (Payette National Forest 2020).
- Lower Middle Fork Salmon River population. The Nez Perce Tribe and the Payette National Forest decommissioned 3 miles of upland, and 3 miles of riparian roads eliminated 12 stream crossings; installed two bridges and improved 14 miles of road; and screened two water diversions (NPT 2020b).
- Lemhi River population. Conservation partners have improved summer instream flow, reconnected tributaries to the mainstem river, increased floodplain and habitat complexity, and altered grazing management to improve riparian habitat (Biomark ABS et al. 2019). The Hawley Creek project reconnected an important tributary to the Lemhi River after 100 years of agriculture-related disconnection. The Eagle Valley Ranch project, a large-scale floodplain restoration project, was implemented in an area critical to late summer/winter rearing juveniles. The Henry Project and the Lemhi Fayle Project also restored floodplain habitat, and the Big Timber 2 diversion created access to 8 miles

of tributary habitat. Overall, work in the Lemhi River basin between 2007 and 2019 has increased the summer rearing capacity for parr (Uthe et al. 2017; Haskell et al. 2019).

- Pahsimeroi River population. Since 2016, conservation partners have improved instream flow during the irrigation season, altered grazing management to improve riparian habitat, reconnected tributary flow to the mainstem river, and increased floodplain and habitat complexity (Biomark ABS et al. 2019). Installation of head gates, piping irrigation water, and closing ditches, coupled with the Idaho Department of Water Resources formally requiring compliance with existing water rights conditions (i.e., quantity diverted, timing of diversion, and usage of a measuring device), has resulted in the presence of perennial water in the Upper Pahsimeroi. Four additional restoration projects improved fish passage, habitat complexity, sediment transport, floodplain connectivity, and riparian health on three miles of habitat. Habitat restoration actions since 2008 effectively doubled the amount of spawning and rearing habitat available to salmon and steelhead (NMFS 2020b).
- Panther Creek population. Since 2016, the USFS and the Shoshone-Bannock Tribes have focused new efforts on stream habitat improvement in Panther Creek. The Panther Creek Riverscapes Conceptual Restoration Plan identifies mileages, reaches, and targeted restoration actions within the watershed (Hill et al. 2019). A 110-acre parcel adjacent to historically high-quality spawning habitat on Panther Creek was protected through the Land and Water Conservation Fund. Installation of a bridge on Musgrove Creek reconnected fish access to 7 miles of habitat.
- Multiple Populations – Instream Flow. Since 2016, the Idaho Water Transactions Program has remained an important means of ongoing habitat restoration and protection across the MPG. Mechanisms to improve instream flow during the irrigation season included minimum flow agreements, short-term or permanent water leases, and moving points of diversion from a flow-limited reach to a reach with adequate water for fish. From 2016 to 2019, the Idaho Water Transactions Program protected between 29 and 41 CFS per year (2,025 to 3,906 acre-feet per year) (IDWR 2020). These projects improved habitat for the Lemhi River, Pahsimeroi River, and Upper Mainstem Salmon River populations.
- Multiple Populations – Fish Screens. The Idaho Department of Fish and Game maintains fish screens on at least 264 water diversions across the MPG, including 124 in the Lemhi, 19 in the Pahsimeroi, and 23 in the Upper Salmon Mainstem rivers, preventing entrainment of the Lemhi, Pahsimeroi, and Upper Salmon Mainstem populations in irrigation diversions (NMFS 2020b). Additional screens exist in the East Fork Salmon River, North Fork, and Upper and Lower Mainstem Salmon River populations. Screens reduce diversion-related mortality for fish from every population in the MPG.
- Upper Mainstem Salmon River Population. Several miles of mainstem habitat historically degraded by dredge mining have been restored in the Yankee Fork since 2015.

Restoration improved floodplain connectivity, habitat complexity, increased quantity of habitat, and improved spawning substrate in key locations.

4) Key Regulatory Measures Since the 2016 5-year review

The NMFS' recovery plan (NMFS 2017a) and previous 5-year review (NMFS 2016a) identified inadequate regulatory mechanisms as a priority issue affecting SRB steelhead recovery in all Snake River basin geographic areas with extant SRB steelhead populations and MPGs. Various federal, state, and county regulatory mechanisms are in place to minimize or avoid habitat degradation caused by human use and development. New information available since the last 5-year review, including mainstem information, indicates that the adequacy of several regulatory mechanisms has stayed the same on average, with some mechanisms showing the potential for some improvement, whereas others have made it more challenging to protect and recover our species. See *Listing Factor D: Inadequacy of Regulatory Mechanisms* in this document for details.

5) Recommended Future Actions Over the Next 5 years Toward Achieving Population Viability

- All populations. Continue to conduct appropriate road maintenance, road obliteration, road relocation, and road resurfacing; improve riparian conditions in disturbed areas; eliminate passage barriers; and restore floodplains.
- South Fork Salmon and Secesh populations. Improve water quality by reclaiming abandoned mine sites, such as the Cinnabar mine (NPT 2020a). Improve planning for potential climate change effects by continuing to monitor stream temperature and validate fish distribution in modeled cold water refugia (Payette National Forest 2020).
- Lower Middle Fork Salmon River population. In Big Creek, reduce and prevent sediment delivery to streams by rehabilitating abandoned mine sites and roads, such as the Dewey Mine and associated roads in the Thunder Mountain Mining District. Reduce impacts of water diversions for domestic, irrigation, stockwater, and hydropower purposes on instream flows in upper Big Creek by administering special use permits for water diversions on National Forest lands (Payette National Forest 2020) (Big Creek).
- Lemhi River, Pahsimeroi River, and Salmon River Upper Mainstem populations. Increase winter juvenile rearing habitat by increasing floodplain connectivity and complex habitat structure, reducing width-to-depth ratios, increasing low- to zero-velocity pool habitat with cover, providing side channel habitat, and reducing fine sediment delivery to streams (Biomark ABS et al. 2019). As appropriate, replicate similar actions in other populations as new information identifies similar problems or is based on inference from data-rich populations. Complete Multiple Reach Assessment reports for the Upper Lemhi River basin, Lower Lemhi River basin, Lower Pahsimeroi River basin, and Upper Salmon River basin above Redfish Lake Creek to determine where habitat

restoration would be most effective at increasing population viability (Biomark ABS et al. 2019).

- East Fork Salmon, Lemhi, Pahsimeroi, and Upper Mainstem Salmon River populations. Reconnect tributaries to the mainstem Salmon River from the North Fork Salmon River to Valley Creek. This action will increase available spawning and rearing habitat in tributaries, provide temperature refugia for juveniles, and lower summer water temperatures for juvenile rearing in the mainstem Salmon River (NMFS 2017a; IDFG 2021).
- Increase instream flow through: (1) expanding and continuing the Idaho Water Transactions Program; (2) securing permanent water transactions for the lower Lemhi minimum flow needs, and continuing filling needs with shorter-term agreements until permanent agreements can be established; (3) seeking additional water transaction agreements throughout the MPG; and (4) limiting new water rights in the MPG. For aging fish screen infrastructure at water diversions, ensure ongoing funding sources to complete routine maintenance and necessary upgrades. Fund new fish screens when new habitat is opened up through tributary reconnection projects.
- Lemhi River population. In the lower mainstem Lemhi River (downstream of Hayden Creek), increase habitat complexity by increasing the sinuosity of the single-thread main channel while creating areas of island braiding with complex instream structure, hydraulic variability, and low-velocity areas with cover.
- Lemhi River population. In the upper mainstem Lemhi River, increase habitat complexity by creating multi-threaded channels, narrow width-to-depth ratios, stable banks, and willow-dominated riparian areas. Maintain and improve instream flow and tributary stream connections to the mainstem Lemhi River (Biomark ABS et al. 2019).
- For the Pahsimeroi River population. Maintain and improve instream flow. Increase habitat quantity by adding more channels within groundwater-influenced reaches that provide high-quality, complex habitat, including split flows, side channels, spring channels, and alcoves. Increase stream length by increasing sinuosity, which also increases hyporheic flow. Establish a robust, riparian community along the banks and floodplain, increasing shade, improving bank structure and habitat, and providing a buffer from upland and floodplain sediment sources (Biomark ABS et el. 2019).
- Upper Mainstem Salmon River population. Increase habitat complexity by creating or enhancing multi-threaded channels and increasing floodplain connection (Biomark ABS et al. 2019). Maintain and improve instream flow and tributary stream connections to the mainstem Upper Salmon River, particularly upstream of the Alturas Lake Creek confluence (Biomark ABS et al. 2019).
- Panther Creek population. Remove fish passage barriers at road-stream crossings, add large wood to streams, encourage beaver recolonization to restore floodplain connectivity, screen water diversions, and continue low-tech process-based stream habitat restoration efforts. Re-evaluate the role of the Panther Creek population in the MPG

recovery scenario in the recovery plan, considering the natural spawning that has occurred in this population since 2005 (Conley and Denny 2019).

Listing Factor A Conclusion

Conservation partners have implemented many tributary habitat restoration projects across the DPS since the last 5-year review. These projects have improved habitat conditions for SRB steelhead spawning, rearing, and migration in many reaches. In addition, PIBO landscape-scale monitoring has shown that habitat is improving on Pacific Northwest National Forests and Bureau of Land Management (BLM) lands. Still, habitat limiting factors remain the same since the last 5-year review. Widespread areas of degraded habitat persist, and further habitat degradation continues, across the basin, with a lack of habitat complexity, simplified stream channels, disconnected floodplains, impaired instream flow, loss of cold water refugia, and other limiting factors. We conclude that given the restoration, further degradation, and continuance of tributary habitat limiting factors, the overall habitat risks to the persistence of the SRB Steelhead DPS is moderate, remaining the same since the last 5-year review.

Recommended future actions

Future recommended habitat restoration actions will target habitat limiting factors found in the DPS recovery plan (NMFS 2017b), and limiting factors identified in large-scale restoration plans from watershed councils, Tribes, and state and federal agencies. Continued large-scale watershed and stream habitat restoration remains a key component of recovering this DPS, as described in the 2017 recovery plan (NMFS 2017a). Important considerations for tributary habitat restoration over the next 5 years include:

- Prioritize projects that improve habitat complexity and resiliency to climate change. Actions to restore channel complexity, passage, riparian vegetation, streamflow, and floodplain connectivity and re-aggrade incised stream channels can ameliorate temperature increases, base flow decreases, and peak flow increases, thereby improving population resilience to certain effects of climate change (Beechie et al. 2013).
- Prioritize projects that restore habitat where age classes of rearing juveniles are missing. Support geomorphic assessments and juvenile steelhead studies in the Clearwater basin to inform restoration plans that address missing age classes of rearing juveniles.
- Connect tributaries to mainstem migration corridors. Temperature refugia from tributaries is vital to successful migration and survival (Keefer et al. 2018; EPA 2021).
- Support and enhance local- to basin-scale frameworks to guide and prioritize habitat restoration actions and integrate a landscape perspective into decision making. Successful examples in the DPS include the Grande Ronde, Lolo Creek, and South Fork Clearwater Atlas process and the Integrated Rehabilitation Assessment in the Upper Salmon River (Tetra Tech Inc. 2017; Biomark ABS et al. 2019; White et al. 2021). White et al. (2021) suggest that these efforts would benefit from gaining broader public support and formalizing an adaptive management strategy.

- Implement habitat restoration at a watershed scale. Roni et al. (2010) found that, for a watershed, at least 20 percent of floodplain and in-channel habitat need to be restored to gain a 25 percent increase in salmon smolt production. Most watersheds occupied by this species have not yet reached that level of floodplain and habitat restoration.
- Reconnect stream channels with their floodplains. The reintroduction of beaver (Pollock et al. 2017) and use of low-tech process-based methods (Wheaton et al., eds. 2019) will facilitate widespread, low-cost floodplain restoration across the DPS, including in higher elevation spawning and rearing areas, to increase the productivity of freshwater habitat for steelhead.
- Ensure that habitat improvement actions are implemented consistent with best practices for watershed restoration (see, e.g., Beechie et al. 2010; Hillman et al. 2016; and Appendix A of NMFS 2020a).

Listing Factor B: Overutilization for commercial, recreational, scientific, or educational purposes

Harvest

Systematic improvements in fisheries management since the 2016 5-year review include implementation of a new *U.S. v. Oregon* Management Agreement for the years 2018-2027, which replaces the previous 10-year agreement. This new agreement maintains the limits and reductions in harvest impacts for the listed ESUs/DPSs that were secured in previous agreements (NMFS 2018a).

Steelhead encounters in the ocean are rare and incidental impacts to steelhead in ocean fisheries targeting other species are inconsequential (low hundreds of fish each year) to very rare (PFMC 2020). The majority of harvest-related impacts on SRB steelhead occurs in the mainstem Columbia River. Recreational fisheries targeting hatchery-run steelhead with incidental impacts on natural returns also occur in the mainstem Columbia River and sections of the Snake, Clearwater, and Salmon rivers (NWFSC 2015). Limits on harvest rates for SRB steelhead are established for treaty and non-treaty fisheries in the Columbia River. Treaty fisheries in the Columbia River are limited to an incidental take of 13 to 20 percent (depending on run size) of SRB steelhead returning to the Columbia River mouth (NMFS 2018a). For non-treaty fisheries, there are separate limits for A-Run and B-Run components during each of the management periods (management periods are: (1) winter, spring, and summer combined, and; (2) fall. The limit for non-treaty fisheries is two percent each for A and B-run steelhead during each management period (NMFS 2018a). Overall, impacts on SRB steelhead have declined since the last 5-year review. Impacts in treaty fisheries have declined from 13.8 percent in the last 5-year review period (NMFS 2016a) to an average of 8.7 percent during years 2014-2019 (TAC 2015, 2016, 2017, 2018, 2019, 2020). Impacts in non-treaty fisheries have averaged 0.58, 1.28, 0.08, and 1.52 percent for A-Run winter/spring/summer, A-Run fall, B-Run winter/spring/summer, and B-run fall, respectively during the years 2014-2019 (TAC 2015, 2016, 2017, 2018, 2019, 2020). Harvest rates have decreased since the 2016 5-year review. Impacts in treaty and non-treaty fisheries are limited by the 2018-2027 *U.S. v. Oregon* Management Agreement (NMFS 2018a). Therefore, harvest continues to pose a moderate risk to SRB steelhead.

Research and Monitoring

The quantity of take authorized under ESA sections 10(a)(1)(A) and 4(d) for scientific research and monitoring for these species remains low in comparison to their abundance. Much of the work is being conducted for the purpose of fulfilling state and federal agency obligations under the ESA to ascertain the species' status. Authorized mortality rates associated with scientific research and monitoring are generally capped at 0.5 percent across the West Coast Region for all listed salmonid ESUs and DPSs. As a result, the mortality levels that research causes are very low throughout the region. In addition, and as with all other listed salmonids, the effects research has on the Snake River salmonids are spread over various reaches, tributaries, and areas across all of their ranges. Thus no area or population is likely to experience a disproportionate amount of loss. Therefore, the research program, as a whole, has only a very small impact on overall population abundance, a similarly small impact on productivity, and no measurable effect on spatial structure or diversity for SRB steelhead.

Any time we seek to issue a permit for scientific research, we consult on the effects that the proposed work would have on each listed species' natural- and hatchery-origin components. However, because research has never been identified as a threat or a limiting factor for any listed species, and because most hatchery fish are considered excess to their species' recovery needs, examining the quantity of hatchery fish taken for scientific research would not inform our analysis of the threats to a species' recovery. Therefore, we only discuss the research-associated take of naturally-produced fish in these sections.

From 2015 through 2019, researchers were approved to take a yearly average of fewer than 683,200 SRB steelhead juveniles (<7,700 lethally). For adult salmonids during this same period, researchers were approved to take a yearly average of fewer than approximately 21,000 SRB steelhead (<260 lethally) per year (NMFS APPS database; https://apps.nmfs.noaa.gov/).

For the vast majority of scientific research actions, history has shown that researchers generally take far fewer salmonids than are authorized every year. Reporting from 2015 through 2019 indicates that over those 5 years, the average actual yearly total take for naturally-produced juveniles or adults was 12 percent of the amount authorized for SRB steelhead. The actual lethal take was also low over the same 5-year period: the average yearly lethal take of juveniles was only 7 percent of the average amount authorized per year, and the average yearly lethal take of adults was only 0.5 percent of the average amount authorized per year for SRB steelhead.

The majority of the requested take for naturally produced SRB steelhead juveniles has primarily been (and is expected to continue to be) capture via screw traps, electrofishing units, and beach seines. Smaller numbers are collected as a result of hand or dip netting, minnow traps, weirs, other seines, trawling, hook and line sampling, and those intentionally sacrificed. Adult take for the species has primarily been (and is expected to continue to be) capture via weirs or fish ladders, with smaller numbers getting unintentionally captured by, hook and line angling, and hand or dip nets screw traps, seining, and other methods that target juveniles (NMFS APPS database; https://apps.nmfs.noaa.gov/). Our records indicate that mortality rates for screw traps are typically less than one percent and backpack electrofishing are typically less than three percent. Unintentional mortality rates from seining, dip netting, minnow traps, weirs, and hook and line methods are also limited to no more than three percent.

The quantity of take authorized over the past 5 years has remained relatively stable for SRB steelhead compared to the prior 5 years. The total amount of take authorized for naturally-produced fish increased by 27 percent, and the amount of authorized lethal take increased by 32 percent from 2015 through 2019 when compared to 2010 through 2014. However, increases in take requested and authorized have not resulted in similar increases in the take actually occurring. From 2015 through 2019, the total take reported decreased by almost six percent compared to 2010 through 2014, and the lethal take that actually occurred increased by 25 percent when comparing the same two time periods.

Overall, research impacts remain minimal due to the low mortality rates authorized under research permits and that research is spread out geographically throughout the Snake River basin. Therefore, the overall effect on listed populations has not changed substantially since the last 5-year review (NMFS 2016a). We conclude that the risk to the species' persistence because of utilization related to scientific studies remains low.

Listing Factor B Conclusion

The majority of harvest-related impacts on SRB steelhead occurs in the mainstem Columbia River. New information available since the last ESA 5-year review indicates harvest impacts have declined (TAC 2015-2020). The overall risk to the species' persistence because of harvest since the 2016 5-year review continues to pose a moderate risk.

Since the last 5-year review, scientific research impacts on listed SRB steelhead have remained relatively stable compared to the past 5 years (NMFS APPS database; https://apps.nmfs.noaa.gov/). The risk to SRB steelhead persistence from overutilization emanating from scientific research since the previous 2016 5-year review remains low. Accounting for harvest and research impacts, the overall risk from overutilization is remains at moderate.

Recommended future actions

- Continue all research, monitoring, and evaluation activities.

Listing Factor C: Disease and Predation

Disease

Disease rates over the past 5 years are believed to be consistent with the previous review period. Climate change impacts, such as increasing temperature, likely increase susceptibility to diseases. For the 2016 5-year review (NMFS 2016a), we reported that the spread of a new strain (i.e., M clade) of infectious hematopoietic necrosis virus (IHNV) along the Pacific coast may increase disease-related concerns for Snake River salmon and steelhead in the future. Since then, the M clade of IHNV has not appeared in SRB steelhead and does not appear to pose an additional risk to the DPS (Linda Rhodes, NWFSC, email sent to C. Fealko, NMFS, April 5, 2021, regarding IHNV status). SRB steelhead continue to be affected by the U clade of IHNV, but this risk has not changed since the prior 5-year review.

The handling and transport of juveniles result in them being held at much higher densities than are observed in the wild, increasing the risk of disease transmission. Juvenile transport continues through the Columbia River, and the lower smolt to adult returns (SARs) produced by transported fish may be due, in part, to increased disease. Transport rates or methods have not materially changed since the prior 5-year review, so this risk appears relatively static across the period evaluated for this current review.

Overall, projections for increasing water temperatures across the species range, increased disease prevalence, and associated salmonid susceptibility to disease in warmer water present a substantial and increasing risk to the species since the prior review period.

Avian Predation

Avian predation in the lower Columbia River estuary

Piscivorous colonial water birds, especially terns, cormorants, and gulls, have significantly impacted the survival of juvenile salmonids in the Columbia River. Caspian terns on Rice Island, an artificial dredged-material disposal island in the estuary, consumed about 5.4 to 14.2 million juveniles per year in 1997 and 1998 (up to 15 percent of all the smolts reaching the estuary; Roby et al. 2017). Efforts to move the tern colony closer to the ocean at East Sand Island, where they would diversify their diet to include marine forage fish, began in 1999. During the next 15 years, smolt consumption was about 59 percent less than when the colony was on Rice Island. The U.S. Army Corps of Engineers (Corps) has further reduced smolt consumption by reducing the bare sand available on East Sand Island for nesting from 6 acres to 1 acre. Combined with harassment (kleptoparasitism) by bald eagles, and egg and chick predation by gulls, the number of nesting pairs has dropped from more than 10,000 in 2008 to fewer than 5,000 in 2018 and 2019 (Roby et al. 2021).

Hostetter et al. (2012) found that body size and behavior affect susceptibility to tern predation. Steelhead smolts are more susceptible to predation than other out-migrating salmonids due to their larger body size. Hatchery steelhead are also more susceptible to tern predation (surface predation) because hatchery steelhead swim closer to the surface of the water than wild steelhead smolts. Hostetter et al. (2012) reiterates that avian predation is a limiting factor to species survival and recovery.

The Corps has also reduced the size of the double-crested cormorant colony on East Sand Island, although efforts to reduce predation rates have not been successful. The pressures of lethal take and non-lethal hazing under the Corps' management plan (USACE 2015), combined with harassment by bald eagles, moved thousands of nesting pairs from the island to the Astoria-Megler Bridge. Because the colony on the bridge is 9 miles further up-river than East Sand Island, these birds are likely to be consuming more juvenile salmonids per capita than when they were foraging further downstream with access to plentiful marine forage fish (Evans et al. 2020; Lawes et al. 2021). Researchers cannot estimate predation rates for birds nesting on the bridge because PIT tags cannot be detected or recovered if they fall into the water. Although predation rates for East Sand Island cormorants on SRB steelhead decreased from 6.3 percent to 0.5 percent when birds moved to the bridge, cormorant predation may have increased in the estuary as a whole.

Avian predation in the mainstem Columbia and Snake rivers

Juvenile SRB steelhead also have been vulnerable to predation by terns nesting in the interior Columbia plateau, including islands in McNary Reservoir and in the Hanford Reach. The Corps has successfully prevented terns from nesting on Crescent Island since 2015. To improve survival for this and other salmonids, the Corps raised the elevation of John Day Reservoir during the spring smolt migration in 2020, inundating the Blalock Islands to prevent its use by terns. This operation will continue under the proposed action identified in the 2020 biological opinion for the Columbia River System (CRS) (BPA et al. 2020).

The 2008 FCRPS biological opinion first required that the CRS Action Agencies (Corps, U.S. Bureau of Reclamation, and Bonneville Power Administration) implement avian predation control measures at mainstem dams in the lower Snake and Columbia rivers. Since then, each of the CRS projects has used hazing and passive deterrence, including wire arrays across tailrace areas, spike strips along the edge of the concrete, water sprinklers at juvenile bypass outfalls, pyrotechnics, propane cannons, and limited amounts of lethal take. These measures have reduced the number of smolts consumed by birds at the dams and will continue to be implemented, with improvements as new techniques become available.

Avian predation on SRB steelhead is substantial. Evans et al. (2021) evaluated 11 years (2008-2018) of data on cumulative avian predation on SRB steelhead by all birds from major nesting locations from Lower Granite Dam to the Pacific Ocean. Cumulative predation probability is the percent of available out-migrating smolts consumed by birds and ranges from 18 to 46 percent annually (Evans et al. 2021). Data (Evans et al. 2021) averaged from 2016-2018 (2020 review period) show a 27 percent decline in avian predation mortality compared to the 5-year average for the 2015 review period. Evans et al. (2021) also demonstrated that avian predation for SRB steelhead is slightly lower above Bonneville Dam than below.

Overall, during this 5-year review period, avian predation rates on SRB steelhead in the Columbia and Snake River migration corridors and estuary are lower than the predation rates reported in our previous 2016 5-year review. Ongoing management practices, such as water elevation adjustments and avian predation control/hazing measures, have helped drive this change. However, for SRB steelhead, avian predation is the leading cause of smolt mortality in the Snake and Columbia River migration corridors and estuary, and is a limiting factor for SRB steelhead survival and recovery.

Marine Mammal Predation

Recent research over the past 5 years suggests that predation pressure on ESA-listed salmon and steelhead from seals, sea lions, and killer whales has been increasing in the northeastern Pacific over the past few decades (Chasco et al. 2017a, 2017b). Models developed by Chasco et al. (2017a) estimate that consumption of Chinook salmon in the eastern Pacific Ocean by three species of seals and sea lions and fish-eating (Resident) killer whales may have increased from 5 to 31.5 million individual salmon of varying ages since the 1970s, even as fishery harvest of Chinook salmon has declined during the same time period (Marshal et al. 2016; Chasco et al. 2017a; Ohlberger 2019). This same modeling suggests these increasing trends have continued across all regions of the northeastern Pacific over the past 5 years. The potential predation impacts of specific marine mammal predators of ESA-listed salmonids on the West Coast are discussed individually below.

Pinniped Predation (Seals and Sea Lions)

Numbers of pinnipeds that are predators of adult salmonids have increased considerably in the Pacific Northwest since the Marine Mammal Protection Act (MMPA) was enacted in 1972 (Carretta et al. 2013). California sea lions *(Zalophus californianus)*, Steller sea lions *(Eumetopias jubatus)*, and harbor seals *(Phoca vitulina)* all consume salmonids from the mouth of the Columbia River and its tributaries up to the tailrace of Bonneville Dam.

The current population size of California sea lions (CSL) is 257,606 (Carretta et al. 2019). The stock is estimated to be approximately 40 percent above its maximum net productivity level (183,481 animals), and it is therefore considered within the range of its optimum sustainable population (OSP) size (Carretta et al. 2019). The Oregon Department of Fish and Wildlife counted the number of individual California sea lions hauling out in the Columbia River mouth at the East Mooring Basin in Astoria, Oregon, from 1997 through 2017. Pinniped counts at the East Mooring Basin during September and October, when SRB steelhead are migrating, have generally increased and doubled from 2014 to 2016 (Wright 2018). Numbers at East Moring Bay peaked in 2016 and declined from 2017-2020, approaching 2014 numbers[1]. California sea lion predation as a percentage of the run averaged 1.0 percent from 2017-2019 (Tidwell and van der Leeuw 2020).

The current population size of Steller sea lions (SSL) is 71,562 (52,139 non-pups and 19,423 pups) (Muto et al. 2019). Muto et al. (2017) concluded that the eastern stock of SSL is likely within its OSP range; however, NMFS has not determined its status relative to OSP.

[1] E-mail to Robert Anderson, NMFS, from Bryan Wright, ODFW, November 17, 2020.

Excluder gates and FOGs along the face of Powerhouse 2 at Bonneville Dam successfully prevent pinnipeds from entering the adult fish ladders, and thus minimize opportunities to prey on SRB steelhead. The number of Steller sea lions at Bonneville Dam over the past 5 years has been less on average than the previous 5-years, with a high of 66 animals in 2018 and a low of 50 animals in 2019, compared to a high of 89 animals in 2011 and a low 65 animals in 2014. In addition, peak numbers of Steller sea lions occur in the spring at Bonneville Dam, therefore not overlapping SRB steelhead peak migration in the fall. However, predation as a percentage of the run on Pacific salmon and steelhead stocks by Steller sea lions has been steadily increasing and was higher than that by California sea lions. Steller sea lion predation as a percentage of the run averaged 2.7 percent from 2017-2019.

The current population size of the Oregon and Washington Coast stock of harbor seals[2] is 15,533 (Pearson and Jeffries 2018). This stock's status relative to OSP is unknown. Harbor seals are seen only occasionally at Bonneville Dam, with 0-3 individuals sited annually from 2002-2020, or 0.5 percent of annual pinnipeds counted (Tidwell and van der Leeuw 2021). When compared to sea lion numbers and predation percents, harbor seals at Bonneville Dam are an insignificant source of pinniped predation.

New information since the last 5-year review suggests that the risk to the DPS from pinniped predation is significant and increasing, particularly from Steller Sea lions feeding immediately below Bonneville Dam, although predation in the lower Columbia River may be higher than previously understood. Pinniped counts at the East Mooring Basin during September and October, when SRB steelhead are migrating, have generally increased from 2014. Numbers at East Moring Bay peaked in 2016 and declined from 2017-2020, approaching 2014 numbers[3]. California sea lion predation as a percentage of the run averaged 1.0 percent from 2017-2019. For Steller sea lions, despite declines in numbers at Bonneville Dam due to exclusion measures, predation as a percentage of the run on Pacific salmon and steelhead stocks by Steller sea lions has been steadily increasing and was higher than that by California sea lions. Steller sea lion predation as a percentage of the run averaged 2.7 percent from 2017-2019. New management actions authorized under the Endangered Salmon Predation Prevention Act to lethally remove sea lions (see Listing Factor D for details) are expected to reduce pinniped predation on adult SRB steelhead in the lower Columbia River. However, given the logistical challenges of removing sea lions and other uncertainties, the magnitude of this expected reduction in pinniped predation is uncertain.

Although exclusion efforts have reduced the numbers of sea lions at East Mooring Basin and Bonneville Dam, with their increasing population numbers and expanded geographical range, marine mammals are consuming more Pacific salmon and steelhead since the 2016 5-year review. Because of the fall timing, SRB steelhead have less overlap with peak spring and summer pinniped presence and thus are less affected than other Pacific salmon. However, sea

[2] For a complete stock status, definition and geographic range see Carretta et al. 2019.
[3] E-mail to Robert Anderson, NMFS, from Bryan Wright, ODFW, November 17, 2020.

lion predation currently accounts for 3.7 percent of the annual SRB adult steelhead run. This consumption of Pacific salmon is having an adverse impact on some ESA-listed species (Marshall et al. 2016; Thomas et al. 2016; Chasco et al. 2017a).

Northern Pikeminnow Predation

A sport fishing reward program was implemented in 1990 to reduce the numbers of Northern pikeminnow in the Columbia River basin (NMFS 2010). The program continues to meet expected targets, which may reduce predation on smolts of all salmon and steelhead species in the mainstem Columbia River. The sport reward fishery removed an average of 188,708 piscivorous pikeminnow per year during 2015 to 2019 in the Columbia and Snake rivers (Williams et al. 2015, 2016, 2017, 2018; Winter et al. 2019). Northern pikeminnow predation can increase when avian predation (for all fish species) is reduced (ISAB 2019). Northern pike minnow predation on juvenile ESA-listed salmonids in the Columbia River was estimated to be 8 percent in 1996 and reduced to an estimated 5 percent due to the ongoing sport fishing removal program for northern pikeminnow (ISAB 2019).

Aquatic Invasive Species

Non-indigenous fishes affect salmon and their ecosystems through many mechanisms.

The Independent Scientific Review Board (ISAB 2019) reported on non-indigenous fish predators. Of all the non-indigenous fish predators in the Columbia River system (rivers not lakes), the two major threats to native listed salmonids are smallmouth bass and walleye. When compared to northern pikeminnow predation in the John Day reservoir, the proportion of predation was northern pikeminnow (78 percent), walleye (13 percent), and smallmouth bass (9 percent). However, smallmouth bass are far more widespread than walleye in the Columbia River, are considered a larger and increasing threat, and increase predation when pikeminnow numbers are reduced. Threats are not restricted to direct predation; non-indigenous species compete directly and indirectly for resources, significantly altering food webs and trophic structure, and potentially altering evolutionary trajectories (Sanderson et al. 2009; NMFS 2010). ISAB (2019) reports that the range of warm-water non-indigenous species is expanding and may include the headwater tributaries of the Columbia River basin by 2080.

Listing Factor C Conclusion

Disease rates over the past 5 years are believed to pose a low risk to the persistence of SRB steelhead and are consistent with the previous review period.

The extinction risk posed to the DPS by predation from avian, pinniped, and other fish species has remained largely the same, at moderate levels, since the last 5-year review. Avian predation rates are much higher than predation rates from predatory fish or marine mammals. In the mainstem Snake and Columbia rivers, and Columbia River estuary, efforts by the Corps to reduce or relocate predatory birds has reduced or increased avian predation depending on location resulting in no overall change in avian predation impacts since the last 5-year review.

Pinniped predation during this review period averaged 3.7 percent of adult return to East Mooring Bay and Bonneville Dam. Moderate predation from all sources is similar to the last 5-year review, and poses a moderate risk to the persistence of SRB steelhead.

Recommended future actions

- Pacific salmon and steelhead recovery partners[4] are encouraged to develop and implement a long-term management strategy to reduce pinniped predation on Pacific salmon and steelhead in the Columbia River basin and Puget Sound by removing, reducing, and-or minimizing the use of manmade haul outs used by pinnipeds in select areas (e.g., river mouths/migratory pinch points).
- Pacific salmon and steelhead recovery partners[5] are encouraged to expand, develop, and implement monitoring efforts in the Columbia River basin, Puget Sound, and California to identify pinniped predation interactions in select areas (e.g., river mouths/migratory pinch points), and quantitatively assess predation impacts by pinnipeds on Pacific salmon and steelhead stocks.
- Continue current avian and predatory fish predation reduction programs.

Listing Factor D: Inadequacy of Regulatory Mechanisms

Various federal, state, county and tribal regulatory mechanisms are in place to reduce habitat loss and degradation caused by human use and development, such as the hydrosystem and harvest. For this review, we focus our analysis on regulatory mechanisms for habitat and harvest that have either improved for SRB steelhead, or are still causing the most concern in terms of providing adequate protection for SRB steelhead.

Habitat

Habitat concerns are described throughout Listing Factor A as having either a system-wide influence, or more localized influence, on the populations and MPGs that comprise the species. The habitat conditions across all habitat components (tributaries, mainstems, estuary, and marine) necessary to recover listed SRB steelhead are influenced by a wide array of federal, state, and local regulatory mechanisms. The influence of regulatory mechanisms on listed salmonids and their habitat resources is based in large degree by the underlying ownership of the land and water resources as Federal, state, or private holdings. Most of the land in the Snake River basin is managed by the Federal government (about 64 percent), including the U.S. Forest Service, U.S. Bureau of Land Management, and the U.S. Department of Energy. The U.S. Bureau of Reclamation works with other state and federal agencies and private groups to manage the basin’s water resources for the many, and sometimes competing, uses.

---

[4] Federal and state agencies, tribes, landowners, watershed councils, private organizations, etc.
[5] Federal and state agencies, tribes, landowners, watershed councils, private organizations, etc.

One factor affecting habitat conditions across all land or water ownerships is climate change, the effects of which are discussed under Section 2.3.2 (*Listing Factor E: Other natural or manmade factors affecting its continued existence).* We reviewed summaries of national and international regulations and agreements governing greenhouse gas emissions. These documents indicate that, while the number and efficacy of such mechanisms have increased in recent years, there has not yet been a substantial deviation in global emissions from the past trend, and upscaling and acceleration of far-reaching, multilevel, and cross-sectoral climate mitigation will be needed to reduce future climate-related risks (IPCC 2014, 2018). These findings suggest that current regulatory mechanisms, both in the U.S. and internationally, are not adequate to address the rate at which climate change negatively impacts habitat conditions for many ESA-listed salmon and steelhead.

Regulatory Mechanisms Resulting in Adequate or Improved Protection

New information available since the last 5-year review indicates that the adequacy of some regulatory mechanisms has improved (or has the potential to improve) and has increased the protection of SRB steelhead. These include:

1. The Endangered Species Act Section 7 Biological Opinions

- <u>Mainstem hydrosystem improvements</u>. NMFS completed two biological opinions, one in 2019 (NMFS 2019b) and the second in 2020 (a), for the Columbia River System (CRS). The 2020 opinion increased the amount of spring spill to improve passage conditions for juvenile salmon. The Action Agencies hypothesize that spring spill improvements may increase downstream migration survival, which is expected to increase population productivity by delivering more smolts to the ocean, resulting in more adults returning. Additional improvements in survival are possible from a revised juvenile transport program and more estuary restoration. Since the last 5-year review, increased spring spill rates have and will continue to decrease the proportion of juveniles from the Snake River that are transported. This is anticipated to improve adult SRB steelhead survival through the CRS since fish transported as juveniles survive at roughly half the rate of non-transported fish (Crozier et al. 2020) during their upstream migrations.
- <u>Estuary Habitat Improvements</u>. The CRS Action Agencies are implementing an estuary habitat improvement program (the Columbia Estuary Ecosystem Restoration Program, CEERP), reconnecting the historical floodplain below Bonneville to the mainstem Columbia River. From 2007 through 2019, the Action Agencies implemented 64 projects, including dike and levee breaching or lowering, tide-gate removal, and tide-gate upgrades that reconnected over 6,100 acres of historical tidal floodplain habitat to the mainstem and another 2,000 acres of floodplain lakes (Karnezis 2019; BPA et al. 2020). This represents more than a 2.5 percent net increase in the connectivity of habitats that produce prey used by juvenile Snake River salmon and steelhead (Johnson et al. 2018). In addition to this extensive reconnection effort, about 2,500 acres of currently functioning floodplain habitat have been acquired for conservation.

Floodplain habitat restoration can affect the performance of juvenile salmonids whether they move onto the floodplain or stay in the mainstem. Wetland food production supports foraging and growth within the wetland (Johnson et al. 2018), but these prey items (primarily chironomid insects) (PNNL and NMFS 2018, 2020) are also exported to the mainstem and off-channel habitats behind islands and other landforms, where they become available to salmon and steelhead migrating in these locations. Thus, for any smolts that do not enter a tidal wetland channel, they still derive benefits from wetland habitats. Continuing to grow during estuary transit may be part of a strategy to escape predation during the ocean life stage through larger body size. The CEERP strategy includes a robust monitoring program that provides the basis for adaptive management. This includes action effectiveness monitoring at each restoration site. Monitoring will continue at completed sites and will be initiated for sites constructed during the period of the proposed action. Johnson et al. (2018) found that the action effectiveness monitoring data collected since 2012 generally indicated that the restoration of physical and biological processes was underway at these sites. Continued evaluation of these monitoring data will confirm that these floodplain reconnections are enhancing conditions for juvenile salmonids as they migrate through the mainstem or provide sufficient information to better inform site selection or project design.

As part of the adaptive management framework, the Action Agencies will continue to discuss relevant climate change science with their independent science panel, the Expert Regional Technical Group, and regional partners in an effort to understand how their planned estuary projects can be more resilient to sea-level rise, increasing temperatures, and changes in seasonal mainstem flows. The Action Agencies' annual update of their CEERP restoration and monitoring plans will document any adjustments in design, location, or other project elements to address climate change impacts, both during the implementation of the proposed actions and beyond.

- Tributary Habitat Improvements. Since 2008, under the biological opinions for the CRS (NMFS 2008a, 2014a, 2019, 2020), the Action Agencies have implemented a tributary habitat program as mitigation for the effects of the CRS. Implementation of the program has focused primarily on Upper Columbia spring Chinook salmon and steelhead and SR spring/summer Chinook salmon and SRB steelhead. Some actions have also been targeted to address Mid-Columbia steelhead. The level of investment in the program has remained relatively constant since the last 5-year review, as have the specific populations on which the Action Agencies have focused their efforts.

  The main changes in the program since the last 5-year review include a shift from having local expert panels evaluate benefits of actions using a method developed as part of the 2008 biological opinion to the use of life-cycle models, where available, to evaluate benefits of tributary habitat improvement actions (along with other considerations described in Appendix A of NMFS 2020a). In addition, a Tributary Habitat Steering Committee was formally convened under the 2019 biological opinion, and under the

2020 biological opinion, a Tributary Technical Team will be formed to provide scientific input on the implementation of the program to help ensure that program goals and objectives are achieved. The Action Agencies have remained committed to ensuring that the program is informed by recovery plans and other best available information and science, builds adaptively on science-based strategies and research and monitoring information, and maintains the extensive network of collaboration with local experts and implementing partners that was developed under previous CRS biological opinions. NMFS views these changes and commitments as positive and appropriate adaptations of the program to evolving science on both the prioritization and implementation of tributary habitat improvement actions and the evaluation of action and program benefits. Still, degraded habitat conditions continue to negatively affect abundance, productivity, spatial structure, and diversity. Additional improvement is needed to restore habitat to levels consistent with achieving the ESA recovery goals.

- Fish Population and Habitat Research, Monitoring and Evaluation. The CRS Action Agencies are implementing a comprehensive fish population and habitat research, monitoring, and evaluation (RME) program that began under the 2008 FCRPS biological opinion and its 2010 Supplement (NMFS 2008a, 2010) and continues under the 2020 CRS biological opinion. The habitat RME program is structured to include compliance, implementation, effectiveness, and status and trends monitoring and research. The Action Agencies' RME efforts are intended to work in concert with similar efforts funded by other federal, state, tribal, utility, and private parties that, when combined, will contribute to basinwide RME data and analyses. Under the 2020 CRS biological opinion, the Action Agencies will continue to implement a tributary habitat RME program to assist in regional efforts to assess tributary habitat conditions, limiting factors, and habitat-improvement effectiveness and to address critical uncertainties associated with offsite habitat mitigation actions.
- Federally Authorized Water Diversions. Examples of Federal authorities include The Federal Land Policy and Management Act of 1976, as amended (USDI 1976), the 1986 Ditch Bill Act (PL 99-545, HR 2921), and special-use authorizations. In Idaho, the USFS has recently completed jeopardy (NMFS 2012a, 2016b, 2016c, 2020b) or initiated (i.e., Sawtooth National Forest) ESA section 7 consultations on the use of Federal land to convey water to private irrigation water users. Future implementation of these consultations, including the associated voluntary conservation measures, is likely to provide minor improvements, relative to baseline conditions, to water quantity and water temperature within the migratory corridor for SRB steelhead.

2. Federal Land Policy and Management Act of 1976, as amended. Vital regional Federal land management strategies should continue, including PACFISH (USDA/USDI 1995), to maintain or improve the quality of aquatic systems for salmonids, and the Interior Columbia Basin Strategy (ICBEMP 2014), a science and ecosystem-based strategy for land management and actions. Equally important is continuance of the PACFISH/INFISH Biological Opinion Monitoring

Program (PIBO; Roper et al. 2019) which provides unique long-term regional-scale monitoring of the effects of federal land management on riparian and stream habitat in the Pacific Northwest. Current PIBO monitoring shows a measurable improvement in Columbia River basin anadromous fish habitat on National Forest and BLM lands since the last 5-year review.

3. Federal Energy Regulatory Commission. As part of the re-authorization process for the Hells Canyon Complex (HCC) of dams (i.e., Brownlee, Oxbow, and Hells Canyon dams), the Federal Energy Regulatory Commission (FERC) has issued annual operation licenses for each project since the original 50-year licenses expired in 2005. In 2019, Oregon DEQ and Idaho DEQ issued 401 certifications for the project, an important component of a complete license application. Most notably, the 401 certifications require a substantial commitment to reduce the temperature of water exiting Hells Canyon Dam in the late summer and fall and to improve water quality in the Snake River. If and when implemented, this is expected to be accomplished primarily through habitat restoration activities upstream of the Hells Canyon Complex (both in the mainstem Snake River and in several tributaries) which will address return flows from irrigation projects, narrow the channel width, and restore more normative river processes between Swan Falls Dam and the upper end of Brownlee reservoir. The Idaho Power Company amended their license application and provided FERC with a biological evaluation, assessing the impacts of the project, in 2020. As of March 2021, FERC has not indicated how they intend to proceed with the relicensing of the Hells Canyon project.

4. Marine Mammal Protection Act.

The United States Congress (Congress) amended the MMPA in 1994 to include a new section, section 120 – Pinniped Removal Authority. This section provides an exception to the MMPA “take” moratorium and authorizes the Secretary of Commerce to authorize the intentional lethal taking of individually identifiable pinnipeds that are having a significant negative impact on the decline or recovery of salmonid fishery stocks. In 2018, Congress amended section 120(f) of the MMPA, which expanded the removal authority for removing predatory sea lions in the Columbia River and tributaries.

To address the severity of pinniped predation in the Columbia River Basin, NMFS has issued six MMPA section 120 authorizations (2008, 2011, 2012, 2016, 2018, and 2019) and one section 120(f) permit (2020). Under these authorizations, as of May 13, 2022, the states have removed (transferred and killed) 278 California sea lions and 52 Steller sea lions. Removal of sea lions in the Columbia River has protected (fish escaping sea lion predation) an estimated 62,284 to 83,414 adult salmon and steelhead in the Columbia River Basin.

Continued management action under the MMPA is expected to reduce sea lion predation on adult salmon and steelhead in the Columbia River. Given the logistical challenges of removing sea lions and other uncertainties, the magnitude of this expected reduction in sea lion predation is uncertain.

Consistent with the Congressional intent of the Endangered Salmon Predation Prevention Act, under the MMPA section 120(f) permit, we encourage Eligible Entities to develop and implement a long-term management strategy to deter the future recruitment of sea lions into the MMPA 120(f) geographic area.

5. Clean Water Act. The Federal Clean Water Act (CWA) addresses the development and implementation of water quality standards, the development of Total Maximum Daily Loads (TMDLs), filling of wetlands, point source permitting, the regulation of stormwater, the discharge of dredge and fill material, and other provisions related to the protection of U.S. waters. The CWA has retained authorities, and delegated authorities administered by the states of Idaho, Oregon, and Washington with oversight by the U.S. Environmental Protection Agency (EPA). State water quality standards are set to protect beneficial uses, which include several categories of salmonid use. Together the state and federal clean water acts regulate the level of pollution within streams and rivers in Idaho, Oregon, and Washington.

- In December 2016, Congress amended the CWA by adding Section 123, which requires EPA and Office and Management and Budget to take actions related to restoration efforts in the basin. The U.S. Government Accountability Office (GAO) was asked to review restoration efforts in the Columbia River basin, and in 2018 the GAO presented its report to the Committee on Transportation and Infrastructure, House of Representatives: Columbia River basin, Additional Federal Actions Would Benefit Restoration Efforts. The report reveals that while multiple agencies had a variety of programs by which they engaged in restoration activities between 2010 and 2016, since 2016, the EPA had not yet taken steps to establish the Columbia River Basin Restoration Program, as required by the Clean Water Act Section 123. EPA stated it had not received dedicated funding appropriated for this purpose; however, EPA actually has not yet requested funding to implement the program or identified needed resources. Also, the GAO reports that an interagency crosscut budget has not been submitted. According to OMB officials, they have had internal conversations on the approach to develop the budget but have not requested information from agencies. EPA did develop a grants program in 2019, and in September of 2020 announced the award of $2 million in 14 grants to tribal, state and local governments, non-profits, and community groups throughout the Columbia River basin.
- In December 2019, the Ninth Circuit Court of Appeals issued an opinion that the EPA must identify a temperature TMDL for the Columbia River as neither the State of Washington nor Oregon has provided a temperature TMDL. On May 18, 2020, EPA issued for public review and comment the TMDL for temperature on the Columbia and Lower Snake rivers. The TMDL addresses portions of the Columbia and lower Snake rivers that have been identified by the states of Washington and Oregon as impaired due to temperatures that exceed those states' water quality standards. After considering comments, EPA may make modifications, as appropriate, and then transmit the TMDL to Oregon and Washington for incorporation into their current water quality management plans. Implementation of the TMDL will likely benefit SRB steelhead through improved thermal conditions in the migratory corridor.

- EPA released its final Columbia River Cold Water Refuges Plan on January 7, 2021. The plan focuses on the lower 325 miles of the Columbia River from the Snake River to the ocean. Cold water refuges serve an increasingly important role to some salmon and steelhead species as the lower Columbia River has warmed over the past 50 years and will likely continue to warm in the future due to climate change. The Columbia River Cold Water Refuges Plan is a scientific document with recommendations to protect and restore cold water refuges. EPA issued this plan in response to consultation under section 7 of the ESA associated with its approval of Oregon's temperature standards for the Columbia River. This plan also serves as a reference for EPA's Columbia and Snake Rivers Temperature TMDL.

6. CWA Delegated Authority:

- In 2015, jeopardy biological opinions were issued for Idaho and Oregon for water quality standards for toxic substances (NMFS 2012b, 2014b). These consultations called for the adoption of new water quality criteria for a number of toxic substances. Since the issuance of the biological opinions, Idaho has adopted new criteria for copper and selenium. Oregon has adopted new criteria for ammonia, copper, and cadmium, and EPA has promulgated new criteria for aluminum. Implementation of the RPA for the jeopardy consultations will result in greater protections for our listed salmonid and their habitats.
- In December 2016, EPA approved IDEQ's *Upper Salmon River Subbasin Assessment and TMDL: 2016 Addendum and 5-year Review* (IDEQ 2016). The TMDL addendum identified shade targets needed for the impaired streams to achieve compliance with temperature criteria. This document establishes the shade levels that land managers (i.e., private, state, and federal) should strive for through future implementation plans and actions.
- The Oregon Department of Environmental Quality submitted its 2018/2020 Integrated Report in April 2020 to the EPA. The current EPA assessment characterizes assessed rivers and streams in Oregon that support fish and aquatic life. In Oregon, there are roughly 19,000 miles of good habitat and roughly 113,000 miles of impaired habitat. Impaired waters have increased 33 percent since the 2012 integrated report, generally from non-attainment of water temperature criteria. These reports indicate that in general, water quality is declining: https://mywaterway.epa.gov/state/OR/water-quality-overview; https://www.oregon.gov/deq/wq/Documents/irFS1820.pdf ; https://www.oregon.gov/deq/wq/pages/2018-integrated-report.aspx
- Washington State relies on use-based (e.g., aquatic life use) Surface Water Quality Standards, found in Washington Administrative Code (WAC) 173-201A. The EPA approved the Washington State's updated Water Quality Assessment 305(b) report and 303(d) list in 2012. It has not been updated since that date. (http://www.ecy.wa.gov/programs/Wq/303d/index.html).

7. 90.94 RCW Streamflow Restoration.

In January 2018, the Washington State legislature passed the Streamflow Restoration law that helps restore streamflows to levels necessary to support robust, healthy, and sustainable salmon populations while providing water for homes in rural Washington. The State law requires that enough water is kept in streams and rivers to protect and preserve instream resources and values such as fish, wildlife, recreation, aesthetics, water quality, and navigation. One of the most effective tools for protecting streamflows is to set instream flows, which are flow levels adopted into rule. Instream flows cover nearly half of the state's watersheds and the Columbia River. In Washington, and especially on the east side of the state, out-of-stream uses, especially irrigation, exacerbate seasonally low flows, leading to passage and temperature problems, and the loss of instream habitat. Other water uses also play a contributing role, as well as land use (lack of recharge arising from impervious surfaces). The Washington State Department of Ecology has a list of 16 critical watersheds where instream flows are thought to be a contributing factor to "critical" or "depressed" fish status, as identified by the Washington Department of Fish and Wildlife. Some of these protected critical watersheds can be found in the following five counties which intersect the Snake River basin: Asotin, Garfield, Whitman, Columbia, and Walla Walla.

8. Idaho Forest Practices Act.

The Idaho Department of Lands administers the Idaho Forest Practices Act, a law created in 1974. The agency is currently considering revisions of the Idaho Forest Practices Act to improve shade and large woody debris delivery on private forest lands. The proposed revision to the 2014 Shade Rule provides a methodology crafted to provide the maximum amount of flexibility to landowners while ensuring protective levels of shade remain. The proposed revisions to the tree retention rule would simplify the methodology to calculate retention. Under the Idaho Forest Practices Act, stream protection zones generally have a width of 75 feet and, therefore, may not protect all riparian functions at some sites (Sweeney and Newbold 2014; Reeves et al. 2016).

- In 2015, the Washington legislature created the Fish Passage Barrier Removal Board to establish a new statewide strategy for fish barrier removal and administering grant funding available for that purpose.
- In 2018, the Oregon legislation placed restrictions on motorized in-stream placer mining. In order to protect indigenous anadromous salmonids and habitat essential to the recovery and conservation of Pacific lamprey, motorized in-stream placer mining is not permitted to occur below the ordinary high-water line in any river in Oregon containing essential indigenous anadromous salmonid habitat. Oregon DEQ has an online interactive map that shows areas where motorized in-stream placer mining is prohibited.[6] This restriction reduces potential sedimentation of instream anadromous habitat from placer mining.

[6] http://geo.maps.arcgis.com/apps/webappviewer/index.html?id=1fedde6ecbff46feb7c41524f21d42d7

Harvest

1. Columbia River Harvest Management: U.S. v. Oregon.

Pursuant to a September 1, 1983, Order of the U.S. District Court, the allocation of harvest in the Columbia River was established under the "Columbia River Fish Management Plan" and implemented in 1988 by the parties of *U.S. v. Oregon*. Since 2008, 10-year management agreements have been negotiated through *U.S. v. Oregon* (NMFS 2008c and 2018a). Harvest impacts on ESA–listed species in Columbia River commercial, recreational, and treaty fisheries continue to be managed under the 2018-2027 *U.S. v. Oregon* Management Agreement (NMFS 2018a). The parties to the agreement are the United States, the states of Oregon, Washington, and Idaho, and the Columbia River Treaty Tribes: Warm Springs, Yakama, Nez Perce, Umatilla, and Shoshone-Bannock. The agreement sets harvest rate limits on fisheries impacting ESA-listed species, and these harvest limits continue to be annually managed by the fisheries co-managers (TAC 2015, 2016, 2017, 2018, 2019, 2020). The current *U.S. v. Oregon* Management Agreement (2018-2027) has, on average, maintained reduced impacts of fisheries on the Snake River species (TAC 2015, 2016, 2017, 2018, 2019, 2020), and we expect that to continue with the abundance-based framework incorporated into the current regulatory regime.

Regulatory Mechanisms Resulting in Inadequate or Decreased Protection

We remain concerned about the adequacy of existing habitat regulatory mechanisms with regard to water rights allocation, instream flow rules, and residential wells – each of which reduces available stream volume, flows, limits habitat connectivity, and increases the temperature regime; floodplain management and levees – which constrain floodplain connectivity, riparian conditions, and habitat complexity and habitat-forming processes; and the extensive federal land forest road networks, grazing, and recreation – which erode river banks, introduce sediment load, and impair riparian vegetation and large wood contribution. These concerns, which are key threats for SRB steelhead, fall within the control of federal and state land and water mechanisms, described below.

1. Clean Water Act. The current Clean Water Act (CWA) Navigable Waters Protection Rule: Definition of Waters of the United States, which went into effect on June 22, 2020, will have deleterious effects on SRB steelhead salmon as the regulatory nexus to consult on potentially harmful actions has been reduced and redefined. Redefined language and increased exemptions reduce the ability to utilize ESA and EFH to avoid, minimize and mitigate effects that impact listed species and their designated critical habitats. However, on December 7, 2021, the EPA and U.S. Army Corps of Engineers published a proposed rule to revise the definition of “Waters of the United States” (86 FR 69372). The agencies propose to put back into place the pre-2015 definition of “Waters of the United States,” updated to reflect consideration of Supreme Court decisions. This familiar approach would support a stable implementation of “Water of the United States” while the agencies continue to consult with states, tribes, local governments, and a broad array of stakeholders in implementing the Waters of the United States rule and future regulatory actions.

Additionally, in 2021, the U.S. Army Corps of Engineers finalized the re-issuance of existing Nation Wide Permits with modifications (86 FR 2744; 86 FR 73522). The modifications will allow an increase in the amount of fill and destruction of habitat for frequently used nationwide permits throughout the range of SRB steelhead. Although regional conditions may address some of these issues, there has not been any indication that regional conditions will be developed to address the impacts to listed species and their designated critical habitat.

2. CWA Delegated Authority. Implementation of the 2016 addendum to the Upper Salmon River subbasin assessment and TMDL (IDEQ 2016) rests with the land managers and is voluntary. As such, there is uncertainty relative to the extent to which land management changes and restoration activities will occur along the corridors of impaired streams.

3. 1872 Mining Law. Increased mining and mineral extraction activities. In Idaho, mining still takes place under the 1872 Mining Law, giving agencies limited discretion in how they regulate it. In addition, out-of-state miners are attracted to Idaho as Idaho is the only state in the west that allows suction dredging in streams with anadromous fish. Issues related to mining threats in the Snake River basin have expanded since the last 5-year review.

- Salmon River Basin. A key mining threat is present in the Upper Salmon and East Fork South Fork Salmon rivers where proposals exist for large-scale open pit mine expansion and mineral lease applications for suction dredge mining in the Salmon River. This includes proposing diversion of flows in areas with salmon and steelhead spawning habitats important for recovery. In addition, there is potential for other large-scale gold mining in the headwaters of the Middle Fork Salmon River based on the results of current exploration in the Big Creek drainage. The Thompson Creek Mine in the Upper Salmon River is approved for expansion and ten more years of operation, but is currently in a storage phase until molybdenum prices improve. For some populations, mining remains a threat because of past contamination issues, such as in Panther Creek, and there remains the potential to degrade water quality in large reaches of a stream, decreasing population viability.
- Clearwater River Basin. After completing consultations with NMFS, the USFS/BLM began permitting small suction dredge mining programs in 2013 for Lolo Creek and in 2016 for the South Fork Clearwater River (SFCR). Both programs are limited to mainstem reaches during summer and by the amount of disturbance or number of dredges allowed. The EPA also consulted on and established a general permit program (NPDES) for small suction dredging in 2014 and renewed it in 2019 (EPA 2018). The programs align with EPA’s 2003 TMDL for sediment in the SFCR, which included load/activity limits for 15 suction dredges. Idaho Department of Water Resources (IDWR) also permits the SFCR recreational dredging program; and beginning in 2020 Idaho Department of Environmental Quality (IDEQ) assumed EPA’s suction dredge permitting, as part of the NPDES program transfer from EPA to Idaho. Efforts to coordinate the Federal and State permitting have had mixed results but have improved. For instance, in 2018, IDWR issued substantially more permits for the SFCR than the Federal program

allows, which led to levels of the activity and its effects beyond what NMFS and USFWS had authorized. However, by 2021 the State re-aligned the number of permitted dredges with the Federal SFCR program. Nevertheless, some unpermitted dredging continues to occur. Also, with this activity closed in several other states, requests of Federal and State agencies for dredging and placer mining in the SFCR, its tributaries, and nearby drainages continue to increase.

4. National Environmental Policy Act. The National Environmental Policy Act (NEPA) ensures that agencies consider the significant environmental consequences of their proposed actions and inform the public about their decision making. The NEPA final rule, November 19, 2020, includes new and revised categorical exclusions and a Determination of NEPA Adequacy provision that has the potential to accelerate timber management and road construction projects with reduced public input and effects analyses (85 FR 73620). However, ESA section 7 consultation requirements will still apply. In addition, beaver restoration and management is recommended as a recovery action for this species (see Listing Factor A). There is a corresponding need to evaluate management authorities within this DPS to determine whether changes could be made to support recolonization and/or reintroduction of beaver.

5. Federal Emergency Management Agency. <u>National Flood Insurance Program (NFIP).</u> The NFIP is a Federal benefit program that extends access to Federal monies or other benefits, such as flood disaster funds and subsidized flood insurance, in exchange for communities adopting local land use and development criteria consistent with federally established minimum standards. Under this program, development within floodplains continues to be a concern because it facilitates development in floodplains without mitigation for impacts on natural habitat values.

All West Coast salmon species, including 27 of the 28 species listed under the ESA, are negatively affected by an overall loss of floodplain habitat connectivity and complex channel habitat. Over decades, the reduction and degradation of habitat have progressed as flood control and wetland filling occurred to support agriculture, silviculture, or conversion of natural floodplains to urbanizing uses (e.g., residential and commercial development). Loss of habitat through conversion was identified among the factors for decline for most ESA-listed salmonids. NMFS has found that altering and hardening stream banks, removing riparian vegetation, constricting channels and floodplains, and regulating flows are primary causes of anadromous fish declines (65 FR 42450). Activities affecting this habitat include wetland and floodplain alteration (64 FR 50414).

Development proceeding in compliance with NFIP minimum standards ultimately results in impacts to floodplain connectivity, flood storage/inundation, hydrology, and to habitat-forming processes. Development consequences of levees, stream bank armoring, stream channel alteration projects, and floodplain fill, combine to prevent streams from functioning properly and result in degraded habitat. Most communities (counties, towns, cities) in Washington, Idaho, and Oregon, are NFIP participating communities, applying the NFIP minimum standards. For this reason, it is important to note that, where it has been analyzed for effects on salmonids, floodplain development that occurs consistent with the NFIP's minimum criteria has been found to jeopardize 18 listed species of salmon and steelhead (Chinook salmon, steelhead, chum salmon, coho salmon, sockeye salmon) (NMFS 2008b, 2016d). The Reasonable and Prudent Alternative provided in NMFS 2016d (Columbia River basin species, Oregon Coast coho salmon, Southern Oregon/Northern California Coast coho salmon) has not yet been implemented.

FEMA No-Rise Analysis. Region X previously adopted a limited exception to the hydraulic and hydrologic (H&H, also known as "no rise") analysis, for habitat restoration actions within floodways - the Policy on Fish Enhancement Structures in the Floodway (1999). The original intent of Region X's policy was to assist NFIP participating communities in their support of habitat restoration projects that benefit salmon species listed under the ESA. However, Region X found that the policy was being applied incorrectly both in terms of the projects to which it should apply and the consequences of the exception.

- Upon further consideration, in August 2020, FEMA Region X rescinded the policy because it was inconsistent with the requirements at 44 CFR 60.3(d)(3) and (4). The regulation requires communities that participate in the NFIP to review all "development" in mapped special flood hazard areas and issue permits as appropriate. Development is broadly defined to include any man-made alteration, and so would also cover in-stream habitat restoration projects. Essential to this permitting responsibility is the requirement that any proposal for development in the regulatory floodway be accompanied by an H&H analysis.
- The consequence of this policy rescission is that habitat restoration projects in the floodway must now include in their budgets the time and resources required for the H&H analysis needed by the local community, and if necessary, the additional time and resources needed to obtain a Letter of Map Revision (LOMR) if floodway and flood elevations are altered by the habitat structures. Such costs and permitting timeframes can make it more difficult to complete vital restoration projects.

Listing Factor D Conclusion

There have been improvements in the adequacy of some regulatory mechanisms affecting the SRB steelhead DPS since the 2016 5-year review (see above list of Regulatory Mechanisms Resulting in Adequate or Improved Protection). In addition, there have also been regulatory changes resulting in inadequate or decreased protection of ESA-listed SRB steelhead, some at the DPS and national scales (e.g., CWA, FEMA NFIP and H&H analysis, NEPA). Based on the information noted above for regulations in the Snake River basin and the Columbia River migratory corridor, we conclude that the overall risk to the species' persistence because of the adequacy of some existing regulatory mechanisms has improved slightly since our prior review. However, some landscape-scale regulations affecting floodplain connectivity continue to increase the risk to the persistence of SRB steelhead.

Recommended Future Actions

- Restrict development of floodplains to reduce impacts to floodplain connectivity and habitat-forming processes.
- Allow funding for levee setbacks when rebuilding levees.

Listing Factor E: Other natural or manmade factors affecting its continued existence

Climate Change

One factor affecting the rangewide status of SRB steelhead and aquatic habitat is climate change. Major ecological realignments are already occurring in response to climate change (Crozier et al. 2019). As observed by Siegel and Crozier in 2019, long-term trends in warming have continued at global, national, and regional scales. The five warmest years in the 1880 to 2019 record have all occurred since 2015, while 9 of the 10 warmest years have occurred since 2005 (Lindsey and Dahlman 2020). The year 2020 was another hot year in national and global temperatures; it was the second hottest year in the 141-year record of global land and sea measurements and capped off the warmest decade on record (http://www.ncdc.noaa.gov/sotc/global202013). Events such as the 2013-2016 marine heatwave (Jacox et al. 2018) have been attributed directly to anthropogenic warming in the annual special issue of Bulletin of the American Meteorological Society on extreme events (Herring et al. 2018). Global warming and anthropogenic loss of biodiversity represent profound threats to ecosystem functionality. These two factors are often examined in isolation, but likely have interacting effects on ecosystem function (Siegel and Crozier 2019). Conservation strategies now need to account for geographical patterns in traits sensitive to climate change, as well as climate threats to species-level diversity.

Climate change has negative implications for SRB steelhead survival and recovery, and for their designated critical habitat (Climate Impacts Group 2004; Zabel et al. 2006; ISAB 2007), characterized by the ISAB as follows:

- Warmer air temperatures will result in diminished snowpack and a shift to more winter/spring rain and runoff, rather than snow that is stored until the spring/summer melt season.
- With a smaller snowpack, watersheds will see their runoff diminished earlier in the season, resulting in lower stream flows in June through September. Peak river flows, and river flows in general, are likely to increase during the winter due to more precipitation falling as rain rather than snow.
- Water temperatures are expected to rise, especially during the summer months when lower stream flows co-occur with warmer air temperatures. Islam et al. (2019) found that air temperature accounted for about 80 percent of the variation in stream temperatures in the Fraser River, thus tightening the link between increased air and water temperatures.

These changes will not be spatially homogenous 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, earlier emergence of fry, and increased competition among species.

Impacts on Salmon and Steelhead

Range of effects caused by a changing climate

Climate change is predicted to cause a variety of impacts to Pacific salmon and their ecosystems (Mote et al. 2003; Crozier et al. 2008a; Martins et al. 2012; Wainwright and Weitkamp 2013). 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. Ultimately, the effects of climate change on salmon and steelhead across the Columbia River basin will be determined by the specific nature, level, and rate of change and the synergy among interconnected terrestrial/freshwater, estuarine, nearshore, and ocean environments.

Synchrony between terrestrial and marine environmental conditions (e.g., coastal upwelling, precipitation and river discharge) has increased in spatial scale causing the highest levels of synchrony in the last 250 years (Black et al. 2018). A more synchronized climate combined with simplified habitats and reduced genetic diversity may be leading to more synchrony in the productivity of populations across the range of salmon (Braun et al. 2016). Climate change and anthropogenic factors continue to reduce the adaptive capacity in Pacific salmon. They also alter life history characteristics and simplify population structure.

The primary effects of climate change on Pacific Northwest salmon and steelhead are (Crozier 2016):

- Direct effects of increased water temperatures alter fish physiology and increase susceptibility to disease.
- Temperature-induced changes to stream flow patterns can block fish migration, trap fish in dewatered sections, dewater redds, introduce non-native fish, and degrade water quality.
- Alterations to freshwater, estuarine, and marine food webs alter the availability and timing of food resources.
- Changes in estuarine and ocean productivity change the abundance and productivity of fish resources.

The 2017 recovery plan (NMFS 2017a) identified the following potential effects of climate change on SR spring/summer Chinook salmon and SRB steelhead in freshwater areas:

- Winter flooding in transient and rainfall-dominated watersheds may scour redds, reducing egg survival.

- Water temperatures during incubation may accelerate the rate of egg development and result in earlier fry emergence and dispersal, which could be either beneficial or detrimental, depending on location and prey availability.
- Reduced summer and fall flows may reduce the quality and quantity of juvenile rearing habitat, strand fish, or make fish more susceptible to predation and disease.
- Reduced flows and higher temperatures in late summer and fall may decrease parr-to-smolt survival.
- Warmer temperatures will increase metabolism, which may increase or decrease juvenile growth rates and survival, depending on the availability of food.
- Overwintering survival may be reduced if increased flooding reduces suitable habitat.
- Timing of smolt migration may be altered due to a modified timing of the spring freshet, such that there is a mismatch with ocean conditions and predators.
- Higher temperatures while adults are holding in tributaries and migrating to spawning grounds may lead to increased prespawning mortality or reduced spawning success as a result of delay or increased susceptibility to disease and pathogens.
- Increases in water temperatures in Snake and Columbia River reservoirs could increase consumption rates and growth rates of predators and, hence, predation-related mortality on juvenile spring/summer Chinook salmon and steelhead.
- Lethal water temperatures (temperatures that kill fish) may occur in the mainstem migration corridor or in holding tributaries, resulting in higher mortality rates.
- If water temperatures in the lower Snake River (especially Lower Granite Dam and reservoir) warm during late summer and fall sufficiently that they cannot be maintained at a suitable level by cold-water releases from Dworshak Reservoir, then migrating adult Snake River summer Chinook salmon and steelhead could have higher rates of mortality and disease.

Effects caused by changing flows and temperatures

While all habitats used by Pacific salmon and steelhead will be affected, the impacts and certainty of the change vary by habitat type. Some effects (e.g., increasing temperature) affect all life stages in all habitats. In contrast, 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 and steelhead also varies widely depending on the level or extent of change, 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). This difference between run times and survival is illustrated by comparing runs of SR sockeye and SRB steelhead. During 2015, the Columbia River experienced a combination of continued high summer temperatures and lower than average flows (due to the lower snowpack from the previous winter and drought conditions exacerbated due to increased occurrences of warm weather patterns) In 2015, about 475,000 adult sockeye salmon (all ESUs) passed Bonneville Dam in the Columbia River, but only 2 to 15 percent of these adult sockeye salmon, depending upon the population, survived to their spawning grounds. (NMFS 2016a). In contrast, the survival of SRB steelhead in 2015 exceeded that of SR sockeye salmon. SRB steelhead are a summer-run steelhead with a late summer and early fall mainstem migration time, and also express several behaviors for avoiding high water temperatures during adult migration.

Siegel et al. (2021) found different population groups of summer-run steelhead have variable temperature thresholds for delaying migration and variable delay times. SRB steelhead arrive in the Columbia River from August through September, with A-run steelhead arriving early and encountering higher water temperatures and B-run steelhead arriving about a month later (Siegel et al. 2021). Some steelhead go directly to spawning areas while others delay migration in the cooler refugia in the mainstem or tributaries, or overwinter in the mainstem rivers. This behavioral flexibility – which is not exhibited by other Columbia River salmon species to the same extent – may help steelhead respond to anticipated increases in river temperatures with climate change, assuming that temperature refuge habitats continue to be accessible (Siegel et al. 2021).

Like most fishes, salmon and steelhead are poikilotherms (cold-blooded animals); therefore, 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 the fitness of salmonids, including SRB steelhead (Beechie et al. 2013; Wainwright and Weitkamp 2013; Whitney et al. 2016).

By contrast, temperatures at ranges in 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. 2011). 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 others where it is detrimental (Sykes et al. 2009; Whitney et al. 2016).

Climate change is predicted to increase the intensity of storms, reduce winter snowpack 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 freshwater ecosystems largely depends on their specific characteristics and location (Crozier et al. 2008b; Martins et al. 2012). For example, within a relatively small geographic area (the Salmon River basin in Idaho), survival of some Chinook salmon populations was shown to be determined largely by temperature, while for others, it was determined by flow (Crozier and Zabel 2006). Certain salmon 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 likely to become more variable in many rivers and is believed to negatively affect anadromous fish survival more than other environmental parameters (Ward et al. 2015). This increasingly variable flow will likely be detrimental to salmon and steelhead populations in the Columbia River basin.

Changes in stream temperature and flow regimes are likely to lead to shifts in the distributions of native species and facilitate the establishment of exotic species. This will result in novel species interactions, including predator-prey dynamics, where juvenile native species may be either predators or prey (Lynch et al. 2016; Rehage and Blanchard 2016). How juvenile native species will fare as part of "hybrid food webs," which are constructed from native, native invaders, and exotic species, is difficult to predict (Naiman et al. 2012).

New Climate Change Information

The last 5-year review (NMFS 2016a) summarized the best available science on how climate change is predicted to impact freshwater environments, estuarine and plume environments, marine conditions and marine survival, the consequences of marine conditions, and drought management. The current best available science supports that previous analysis. The discussion below updates new information as it relates to how climate change is currently impacting and predicted to impact SRB steelhead in the future.

Marine Effects and Survival

Siegel and Crozier (2020) summarized new science published in 2019, with a number of publications describing the anomalous conditions of the marine heatwave that led to an onshore and northward movement of warm stratified waters into the California Current ecosystem off of the west coast of the U.S. Brodeur et al. (2019) described the community response of the plankton community composition and structure, suggesting that forage fish diets had to shift in response to food resources that are considerably less nutritionally dense. This was supported by the work of Morgan et al. (2019), who stated that it was unclear whether these observations represented an anomaly or were a permanent change in the Northern California Current.

Crozier et al. (2019) asserted in their vulnerability analysis (see below) that sea surface temperature and ocean acidification (as well as freshwater stream temperatures) were the most broadly identified climate-related stressors likely to impact populations.

Variation in marine productivity and prey quality can greatly impact the marine survival of salmon and steelhead populations. The specific ocean habitat use of different salmon populations is poorly defined. Recent work by Espinasse et al. (2019) used carbon and nitrogen stable isotopes derived from an extensive time-series of salmon scales to examine aspects of the marine environment used by Rivers Inlet (British Columbia) sockeye salmon. The authors were able to identify likely rearing areas before sampling. This work and other research cited in Siegel and Crozier (2020) are improving our understanding of how marine productivity impacts salmon and steelhead growth and survival, particularly during the early marine period.

While we understand that sea surface temperature is tightly linked to marine survival, we do not yet understand the mechanism involved. The work described above are important steps in our understanding.

Siegel and Crozier (2019) observe that changes in marine temperature are likely to have a number of physiological consequences on fishes themselves. For example, in a study of small planktivorous fish, Gliwicz et al. (2018) found that higher ambient temperatures increased the distance at which fish reacted to prey. Numerous fish species (including many tuna and sharks) demonstrate regional endothermy, which in many cases augments eyesight by warming the retinas. However, Gliwicz et al. 2018 suggest that ambient temperatures can have a similar effect on fish that do not demonstrate this trait. Climate change is likely to reduce the availability of biologically essential omega-3 fatty acids produced by phytoplankton in marine ecosystems. Loss of these lipids may induce cascading trophic effects, with distinct impacts on different species depending on compensatory mechanisms (Gourtay et al. 2018). Reproduction rates of many marine fish species are also likely to be altered with temperature (Veilleux et al. 2018). The ecological consequences of these effects and their interactions add complexity to predictions of climate change impacts in marine ecosystems.

Migration and Rearing Corridor Habitat

The lower Columbia River estuary provides important migratory habitat for juvenile SRB steelhead. Since the late 1800s, about 70 percent of the vegetated tidal wetlands of the Columbia River estuary have been lost to diking, filling, and bank hardening, combined with flow regulation and other modifications (Kukulka and Jay 2003; Bottom et al. 2005; Marcoe and Pilson 2017; Brophy et al. 2019). This disconnection of tidal wetlands and floodplains has reduced the production of wetland macrodetritus supporting the food web (Simenstad et al. 1990; Maier and Simenstad 2009), both for small Chinook and chum salmon that rear in shallow water and for larger juveniles, such as yearling SRB steelhead, which migrate in the mainstem (PNNL and NMFS 2020).

Restoration actions in the estuary have improved habitat quality and fish access to floodplain forests and wetlands. From 2007 through 2019, the Bonneville Power Administration the Corps implemented 64 projects that included dike and levee breaching or lowering, tide-gate removal, and tide-gate upgrades. These projects have reconnected over 6,100 acres of the historical floodplain to the mainstem Columbia River and another 2,000 acres of floodplain lakes (Karnezis 2019; BPA et al. 2020). This represents more than a 2.5 percent net increase in the connectivity of habitats that produce prey used by yearling steelhead (Johnson et al. 2018). In addition to this extensive reconnection effort, the Bonneville Power Administration and Corps have acquired conservation easements to protect about 2,500 acres of currently functioning floodplain habitat from development. Numerous other project sponsors have completed floodplain protection and restoration projects in the lower Columbia River.

Forests

Climate change will impact forests of the western U.S., which dominate the landscape of many watersheds in the region. Forests are already showing evidence of increased drought severity, forest fire, and insect outbreak. Forest fires affect salmon streams by altering sediment load, channel structure, and stream temperature through the removal of canopy. Holden et al. (2018) found strong correlations between the number of dry-season rainy days and the annual extent of forest fires, as well as a significant decline in the number of dry-season rainy days over the study period (1984-2015). Consequently, predicted decreases in dry-season precipitation, combined with increases in air temperature, will likely contribute to the existing trend of more extensive and severe forest fires.

Beyond environmental factors, many decades of fire suppression management practices have left forests more dense and less diverse, which increases vulnerability to greater fire damage. Attempts to restore forest composition to a state more similar to historical conditions will likely increase fire resiliency, although some restoration methods, including timber harvest and prescribed fire, are often contentious (Johnston et al. 2018).

Groundwater Effects

The effect of climate change on groundwater availability is likely to be uneven. Sridhar et al. (2018) coupled a surface-flow model with a ground-flow model to improve predictions of surface water availability with climate change in the Snake River basin. Combining the VIC and MODFLOW models (VIC-MF), they predicted flow for 1986-2042. Comparisons with historical data show improved performance of the combined model over the VIC model alone. Projections using RCP 4.5 and 8.5 emission scenarios suggested an increase in water table heights in downstream areas of the basin and a decrease in upstream areas. Such assessments will help stakeholders manage water supplies more sustainably, but ultimately will likely make it more challenging for adult salmon returning to spawn in late summer and early fall. In support of that idea, Leach and Moore (2019) found that groundwater may only make streams resistant to change in the short term since groundwater sources will be impacted on longer time scales.

Freshwater Effects

As cited in Siegel and Crozier (2019), Isaak et al. (2018) examined recent trends in stream temperature across the western United States using a large regional dataset. Stream warming trends paralleled changes in air temperature and were pervasive during the low-water warm seasons of 1996-2015 (0.18-0.35°C/decade) and 1976-2015 (0.14-0.27°C/decade). Isaak et al. (2018) concluded that most stream habitats will likely remain suitable for salmonids in the near future, with some becoming too warm.

The following is excerpted from Siegel and Crozier (2019), who present a review of recent scientific literature evaluating effects of climate change, describing the projected impacts of climate change on instream flows:

- Cooper et al. (2018) examined whether the magnitude of low river flows in the western U.S., which generally occur in September or October, are driven more by summer conditions or the prior winter's precipitation. They found that while low flows were more sensitive to summer evaporative demand than to winter precipitation, interannual variability in winter precipitation was greater. Sridhar et al. (2018), predicted that summer evapotranspiration is likely to increase in conjunction with declines in snowpack and increased variability in winter precipitation. Their results suggest that low summer flows are likely to become lower, more variable, and less predictable.

Streams with intact riparian corridors that lie in mountainous terrain are likely to be more resilient to changes in air temperature. These areas may provide refuge from climate change for a number of species, including Pacific salmon. Krosby et al. (2018) identified potential stream refugia throughout the Pacific Northwest based on a suite of features thought to reflect the ability of streams to serve as such refuges. Analyzed features include large temperature gradients, high canopy cover, large relative stream width, low exposure to solar radiation, and low levels of human modification. They created an index of refuge potential for all streams in the region, with mountain area streams scoring the highest. Flat lowland areas, which commonly contain migration corridors, were generally scored with the lowest refuge potential, and thus were prioritized for conservation and restoration. However, forest fires can increase stream temperatures dramatically in short time-spans by removing riparian cover (Koontz et al. 2018), and streams that lose their snowpack with climate change may see the largest increases in stream temperature due to the removal of temperature buffering (Yan et al. 2021). These processes may threaten some habitats that are currently considered refugia.

Siegel and Crozier (2019) point out concern that, for some salmon populations, climate change may drive mismatches between juvenile arrival timing and prey availability in the marine environment. However, phenological diversity can contribute to metapopulation-level resilience by reducing the risk of a complete mismatch. Carr-Harris et al. (2018) explored phenological diversity of marine migration timing in relation to zooplankton prey for sockeye salmon from the Skeena River of Canada. They found that sockeye salmon migrated over a period of more than 50 days. Populations from higher elevations and further inland streams arrived in the estuary later, and different populations encountered distinct prey fields. They recommended that managers maintain and augment such life-history diversity.

Climate Vulnerability Assessment

Crozier et al. (2019) recently completed a climate vulnerability assessment for Pacific salmon and steelhead, including SRB steelhead. The assessment was based on three components of vulnerability: (1) biological sensitivity, which is a function of individual species characteristics; (2) climate exposure, which is a function of geographical location and projected future climate conditions; and (3) adaptive capacity, which describes the ability of a DPS to adapt to rapidly changing environmental conditions. Objectives were to characterize the relative degree of threat posed by each component of vulnerability across DPSs and to describe landscape-level patterns in specific threats and cumulative vulnerability at the DPS level. Crozier et al. (2019) provides more information on the methodology they used to calculate climate vulnerability for each DPS.

Crozier et al. (2019) concluded that SRB steelhead has a high risk of overall climate vulnerability based on its high biological sensitivity, high risk for climate exposure, and moderate capacity to adapt. Increases in synchrony between climate and steelhead response to climate change across the DPS populations indicates that the DPS is losing its adaptability to climate change (Crozier et al. 2019). Ocean survival is well predicted by environmental climate indices, particularly upwelling and the Pacific Northwest Index (Williams et al. 2014). However, the impact of climate change specifically on marine survival is uncertain, leading to a high cumulative climate vulnerability score for the marine stage (Crozier et al. 2019).

Crozier et al. (2019) describes high vulnerability to climate change as a combination of high sensitivity to climate change and high exposure to changing environmental conditions at a given life stage. Crozier et al. (2019) assigns a moderate rating in adaptive capacity for SRB steelhead. This moderate rating reflects vulnerabilities in access to historic habitat both through blockage by dams and reduced access to floodplains. Reductions in vulnerability to climate change can be gained quickly by restoring access to historical and floodplain habitats, which in turn restores more natural ecological and physical processes. Juveniles are especially vulnerable to reduced summer flow and high stream water temperatures. However, their adaptive capacity is bolstered by heat tolerance and behavioral flexibility in the juvenile life stage. In addition, SRB steelhead are spring spawners with greater mobility and are able to use smaller higher elevation steams, making them less vulnerable to variations in fall and winter precipitation. This mobility during migration and staging also affords them greater access to temperature refugia in smaller cooler tributary streams.

Hatchery Effects

The effects of hatchery fish on the status of a DPS depends upon which of the four key attributes – abundance, productivity, spatial structure, and diversity – are currently limiting the DPS, and how the hatchery fish within the DPS affect each of the attributes (70 FR 37204). Hatchery programs can provide short-term demographic benefits, such as increases in abundance during periods of low natural abundance. They also can help preserve genetic resources until limiting factors can be addressed. However, the long-term use of artificial propagation may pose risks to natural productivity and diversity. The magnitude and type of the risk depends on the status of affected populations and on specific practices in the hatchery program.

Currently, there are 13 steelhead hatchery programs in the Snake River basin (6 of which are included in the SRB DPS), plus one kelt reconditioning program. The hatchery programs that are considered to be part of the DPS are: Tucannon River, Salmon River B-run, South Fork

Clearwater (Clearwater Hatchery) B-run, Dworshak National Fish Hatchery, East Fork Salmon River, and Little Sheep Creek/Imnaha River Hatchery.

The kelt reconditioning program consists of the collection of post-spawned steelhead more than 60 centimeters in length and the administration of disease-preventative medications and feed to improve survival over what would be expected without intervention. (Typically kelts are in fairly poor condition after spawning and may have low chances of surviving downstream migration.) Upon release, these fish are intended to return to natal populations, thereby increasing spawner escapement and productivity if reconditioned individuals successfully spawn (NMFS 2016b, 2017d, 2017e, 2017f, 2019b).

Evidence indicates that several B-Index steelhead populations targeted by the kelt reconditioning program have likely benefited from this program. Since 2008, the Snake River kelt reconditioning program has been operating at a research scale. While the facility has been reported to be too small to reach the program's goal of increasing the Lower Granite Reservoir ladder count of B-Index steelhead by 6 percent (Hatch et al. 2018), the program has demonstrated the feasibility of reaching the goal. In 2013, 69 reconditioned B-Index steelhead were released (approximately 40 percent of the program's goal). In 2015, 24 reconditioned B-Index steelhead were released below Lower Granite Dam, and an additional 21 fish were determined to be skip spawners and retained for release in 2016. In 2016, 22 fish were released, and 98 fish were released in 2017. The 2017 release of 98 premature fish was composed of 77 skip spawners, with fecundities approximately 1.51 times those of maiden fish, and 21 consecutive spawners, with fecundities about 1.27 times those of maiden fish (Hatch et al. 2018). BPA funds the Snake River Kelt Reconditioning Program as mitigation for the CRS, but it is not a steelhead production program.

Hatchery programs for some SRB steelhead populations serve the dual purpose of providing fish for fisheries and providing supplemental spawners to help rebuild depressed natural populations.

Most hatchery production for SRB steelhead was initiated under the Lower Snake River Compensation Plan (LSRCP) as part of the Water Resources Development Act of 1976 (90 Stat. 2917). The LSRCP included a program to design and construct fish hatcheries to compensate for some of the losses of salmon and steelhead adult returns incurred as a result of the construction and operation of the four lower Snake River hydroelectric dams. Mitigation goals for the LSRCP program include 55,100 adult steelhead. The program is administered by the USFWS. Production under the LSRCP began in the mid-1980s.

The Dworshak Dam mitigation program provides hatchery production of steelhead as compensation for the loss of access to the North Fork Clearwater River (NMFS 2017b). Dworshak National Fish Hatchery, completed in 1969, is the focus for that production. Hatchery fish are also produced as mitigation for fish losses caused by construction of the Hells Canyon Complex in the Snake River Hells Canyon area. None of the Hells Canyon Complex dams, which are owned and operated by the Idaho Power Company, have fish passage facilities. The Idaho Power Company built four hatcheries to mitigate the Hells Canyon Complex's effects on native fish populations: Oxbow, Rapid River, Niagara Springs, and Pahsimeroi Hatcheries. The four hatchery facilities are managed by the Idaho Department of Fish and Game.

Several uncertainties exist regarding the effects of hatchery programs on natural-origin SRB steelhead populations. One of the main areas of uncertainty is the relative proportion and distribution of hatchery-origin spawners in natural spawning areas at the population level, particularly for SRB steelhead (Ford 2022). Because of this lack of information, the diversity status of most of the populations in the DPS remains uncertain (Table 5). Information is needed to determine where and to what extent unaccounted for hatchery steelhead are interacting with ESA-listed populations, particularly in Idaho (Ford 2022). Co-managers have continued to install PIT tag arrays throughout the Snake River basin that are likely to provide new information on population abundance and productivity, and hatchery fish proportions and distribution throughout the Snake River basin. In addition, NMFS, hatchery-funding agencies, and the state and tribal co-managers participate in a Snake River Steelhead Workgroup to continue to collaborate on addressing these uncertainties.

Table 5. ESA Status of hatchery programs within the SRB Steelhead DPS; NFH = National Fish Hatchery; HGMP = Hatchery and Genetic Management Plan; C = Review under the ESA is complete; U = undergoing ESA review; M = HGMP has not been submitted or is being modified by the applicant.

Program Stock Origin	Program	Run	Watershed Location of Release (State)	Currently Listed?	HGMP Status
Tucannon	Tucannon River	Summer	Tucannon River (WA)	Yes	C
Imnaha	Little Sheep Creek/Imnaha River Hatchery	Summer	Imnaha River (OR)	Yes	C
EF Salmon	EF Salmon River	A	EF Salmon River (ID)	Yes	C
NF Clearwater/ Dworshak stock	Dworshak NFH	B	Clearwater River (ID)	Yes	C
	Salmon River B-run	B	Pahsimeroi River, Yankee Fork, Little Salmon River (ID)	Yes	C
SF Clearwater	SF Clearwater (Clearwater Hatchery) B-run	B	SF Clearwater River (ID)	Yes	C
Wallowa stock	Lyons Ferry NFH	Summer	Tucannon River (WA), Cottonwood Creek (OR)	No	C
	Wallowa Hatchery	Summer	Wallowa River (OR)	No	C

Program Stock Origin	Program	Run	Watershed Location of Release (State)	Currently Listed?	HGMP Status
Hells Canyon/Oxbow	Hells Canyon Snake River	A	Snake River (ID)	No	C
Sawtooth/ Pahsimeroi	Pahsimeroi Hatchery	A	Pahsimeroi River (ID)	No	C
	Upper Salmon River	A	Upper Salmon River (ID)	No	C
	Streamside Incubator Project	A	Upper Salmon River (ID)	No	C
	Little Salmon River	A	Little Salmon River (ID)	No	C

Listing Factor E Conclusion

Climate Change

Climate change affects the rangewide status of SRB steelhead and aquatic habitat. Crozier et al. (2019) published a climate vulnerability analysis for Pacific salmon and steelhead based on species sensitivity, exposure, and adaptive capability. For SRB steelhead, the life stage that appears to be the most vulnerable to climate change is juvenile rearing. Summer habitats may have reduced flow, or restricted tributary access, particularly in areas impacted by irrigation withdrawals. High summer water temperatures are also prevalent. Climate change has and will cause earlier snow melt timing, reduced summer flows, and higher air temperatures; all of which will exacerbate the low flows and high water temperatures for juvenile SRB steelhead. This DPS is also considered to have only moderate capacity to adapt to climate change impacts. Given the extrinsic factors currently increasing the vulnerability of many populations to climate change impacts, it is unclear whether their adaptability would be sufficient to mitigate the risk climate change poses to the persistence of this DPS. The risk to SRB steelhead persistence from climate change has increased since the previous 2016 5-year review.

Terrestrial and Ocean Conditions, and Marine Survival

An anomalous marine heatwave led to an onshore and northward movement of warm stratified waters into the California Current ecosystem off of the west coast of the U.S. It is unknown at this time whether this warming is an anomaly or permanent. The coastal ocean warming caused changes in the plankton community composition and structure, suggesting that forage fish diets are considerably less nutritional. In addition, Crozier et al. (2019) asserted in their vulnerability analysis that sea surface temperature and ocean acidification (as well as freshwater stream temperatures) were the most broadly identified climate-related stressors likely to impact populations. The risk to SRB steelhead persistence from the climate change effects of sea surface temperature, ocean acidification, and freshwater stream temperatures has increased since the previous 2016 5-year review.

Hatchery Effects

In general, hatchery programs can provide short-term demographic benefits to salmon and steelhead, such as increases in abundance during periods of low natural abundance. They also can help preserve genetic resources until limiting factors can be addressed. However, the long-term use of artificial propagation may pose risks to natural productivity and diversity. The magnitude and type of risk depend on the affected populations' status and on specific practices in the hatchery program. Hatchery programs can affect naturally produced populations of salmon and steelhead in a variety of ways, including competition (for spawning sites and food) and predation effects, disease effects, genetic effects (e.g., outbreeding depression, hatchery-influenced selection), broodstock collection effects (e.g., to population diversity), and facility effects (e.g., water withdrawals, effluent discharge) (NMFS 2018b).

Hatchery practices for SRB steelhead have evolved as the status of natural populations has changed, and new plans are being implemented and evaluated as a result of recent ESA consultations on Hatchery and Genetic Management Plans for every steelhead hatchery program in the Snake River basin. These consultations concluded that hatchery programs in the Snake River basin are not likely to appreciably reduce the likelihood of survival and recovery of the Snake River Steelhead DPS (NMFS 2017b). The consultations also included terms and conditions for continued monitoring of the hatchery programs and their effects on listed species.

Several uncertainties exist regarding the effects of hatchery programs on natural-origin SRB steelhead populations. One of the main areas of uncertainty is the relative proportion and distribution of hatchery-origin spawners in natural spawning areas at the population level, particularly for SRB steelhead (Ford 2022). Because of this lack of information, the diversity status of most of the populations in the DPS remains uncertain. Information is needed to determine where, and to what extent, unaccounted for hatchery steelhead are interacting with ESA-listed populations, particularly in Idaho (Ford 2022). Co-managers have continued to install PIT tag arrays throughout the Snake River basin that are likely to provide new information on population abundance and productivity and hatchery fish proportions and distribution throughout the Snake River basin. In addition, NMFS, hatchery funding agencies, and the state and tribal co-managers participate in a Snake River Steelhead Workgroup to continue to collaborate on addressing these uncertainties. Information about the proportion and distribution of hatchery-origin spawners in natural spawning areas remains uncertain and similar to the previous 5-year review period. The risk to SRB steelhead persistence from hatcheries remains uncertain and at moderate to high risk, and has not changed since the last review period.

Recommended Future Actions

At this time, we are unable to mitigate for the effects of reduced ocean survival within the marine environment. Efforts to mitigate carryover effects from freshwater could affect marine survival in these populations and increase the resilience of populations during all life stages. These include:

- Improve and expand access to historical rearing habitats.This should increase smolt abundance and body condition, resulting in improved population viability. Intrinsic habitat potential is negatively correlated with present levels of disturbance, so restoring all critical habitat could yield substantial benefits. Specifically, efforts should aim to restore the lower elevation historically highly productive habitat that has been lost and higher elevation rearing habitats that are prone low flow and high water temperatures.
- Improve individual fish growth by reducing contaminant loads, increasing floodplain habitat, and increasing habitat complexity. These actions, in general, could boost population productivity.

2.4 Synthesis

The ESA defines an endangered species as one that is in danger of extinction throughout all or a significant portion of its range, and a threatened species as one that is likely to become an endangered species in the foreseeable future throughout all or a significant portion of its range. Under ESA section 4(c)(2), we must review the listing classification of all listed species at least once every 5 years. While conducting these reviews, we apply the provisions of ESA section 4(a)(1) and NMFS' implementing regulations at 50 CFR part 424.

To determine if a reclassification is warranted, we review the status of the species and evaluate the five risk factors, as identified in ESA section 4(a)(1): (1) the present or threatened destruction, modification, or curtailment of its habitat or range; (2) overutilization for commercial, recreational, scientific, or educational purposes; (3) disease or predation; (4) inadequacy of existing regulatory mechanisms; and (5) other natural or man-made factors affecting a species' continued existence. We then make a determination based solely on the best available scientific and commercial information, taking into account efforts by states and foreign governments to protect the species.

We conclude:

Updated Biological Risk Summary: Our Northwest Fisheries Science Center completed an updated viability assessment for the DPS (Ford 2022). They concluded that population abundance declines in this review period warrant close monitoring of population abundance over the next 5-year review period to determine the need for an elevated biological risk status for this DPS at the conclusion of the next 5-year assessment period.

- Listing Factor A (Habitat): Conservation partners have implemented many tributary habitat restoration projects across the DPS since the last 5-year review, improving habitat conditions for SRB steelhead spawning, rearing, and migration in many reaches. In addition, PIBO landscape-scale monitoring has shown that habitat is improving on Pacific Northwest National Forests and BLM lands. However, habitat limiting factors remain the same since the last 5-year review. Widespread areas of degraded habitat persist, and further habitat degradation continues across the basin, with a lack of habitat complexity, simplified stream channels, disconnected floodplains, impaired instream flow, loss of cold water refugia, and other limiting factors. We conclude that given the restoration, further degradation, and continuance of tributary habitat limiting factors, the overall habitat risk to the persistence of SRB Steelhead DPS is moderate, remaining the same since the last 5-year review.

- Listing Factor B (Overutilization): The risk to the species' persistence because of overutilization remains essentially unchanged since the 2016 5-year review and remains at a moderate level. Although total exploitation rates on the species have declined since the last 5-year review, harvest continues to pose a moderate risk to the persistence of SRB steelhead. Since the last 5-year review, scientific research impacts on listed SRB steelhead have remained low and relatively stable The overall risk to SRB steelhead persistence from overutilization since the previous 5-year review remains moderate.
- Listing Factor C (Disease and Predation): Disease rates over the past 5 years are believed to pose a low risk to the persistence of SRB steelhead and are consistent with the previous review period. The extinction risk posed to the DPS by predation from avian, pinniped, and other fish species has remained largely the same, at a moderate level, since the last 5-year review. Avian predation rates are much higher than predation rates from predatory fish or marine mammals. In the mainstem Snake and Columbia rivers, and Columbia River estuary, efforts by the Corps to reduce or relocate predatory birds have reduced or increased avian predation, depending on location, resulting in no overall change in avian predation impacts since the last 5-year review. Pinniped predation during this review period averaged 3.7 percent of adult return to East Mooring Bay and Bonneville Dam. Moderate predation from all sources is similar to the last 5-year review and poses a moderate risk to the persistence of SRB steelhead.
- Listing Factor D (Inadequacy of Regulatory Mechanisms): There have been improvements in the adequacy of some regulatory mechanisms within the Snake River Basin Steelhead DPS since the 2016 5-year review (see above list of Regulatory Mechanisms Resulting in Adequate or Improved Protection). There have also been regulatory changes resulting in inadequate or decreased protection of SRB steelhead, some at the DPS and national scales (e.g., CWA, FEMA NFIP and H&H analysis, NEPA). Based on the information noted above for regulations in the Snake River basin and the Columbia River migratory corridor, we conclude that the overall risk to the species' persistence because of the adequacy of some existing regulatory mechanisms has improved slightly since our prior review. However, some landscape-scale regulations affecting floodplain connectivity continue to increase the risk to the persistence of SRB steelhead.
- Listing Factor E (Other Natural and Manmade Factors):
    - Climate change affects the rangewide status of SRB steelhead and aquatic habitat. Crozier et al. (2019) published a climate vulnerability analysis for Pacific salmon and steelhead based on species sensitivity, exposure, and adaptive capability. For

SRB steelhead, the life stage that appears to be the most vulnerable to climate change is juvenile rearing. Summer habitats may have reduced flow, or loss of tributary access, from irrigation withdrawals. High summer water temperatures are also prevalent. Climate change has and will cause earlier snow melt timing, reduced summer flows, and higher air temperatures; all of which will exacerbate the low flows and high water temperatures for juvenile SRB steelhead. This DPS is also considered to have only moderate capacity to adapt to climate change impacts. Given the extrinsic factors currently increasing the vulnerability of many populations to climate change impacts, it is unclear whether their adaptability would be sufficient to mitigate the risk climate change poses to the persistence of this DPS. The risk to SRB steelhead persistence from climate change has increased since the previous 2016 5-year review.

- An anomalous marine heatwave led to an onshore and northward movement of warm stratified waters into the California Current ecosystem, causing changes in the plankton community composition and structure, suggesting that forage fish diets are considerably less nutritional. In addition, Crozier et al. (2019) asserted in their vulnerability analysis that sea surface temperature and ocean acidification (as well as freshwater stream temperatures) were the most broadly identified climate-related stressors likely to impact populations. The risk to SRB steelhead persistence from the climate change effects of sea surface temperature, ocean acidification, and freshwater stream temperatures has increased since the previous 2016 5-year review.
- In general, hatchery programs can provide short-term demographic benefits to salmon and steelhead, such as increases in abundance during periods of low natural abundance. They also can help preserve genetic resources until limiting factors can be addressed. However, the long-term use of artificial propagation may pose risks, including increased competition, predation, disease, genetic, broodstock collection, and facility effects (NMFS 2018b). Recent ESA consultations on Hatchery and Genetic Management Plans for every steelhead hatchery program in the Snake River basin concluded that hatchery programs in the Snake River basin are not likely to appreciably reduce the likelihood of survival and recovery of the Snake River Basin Steelhead DPS (NMFS 2017b). The main area of uncertainty regarding hatchery effects is the relative proportion and distribution of hatchery-origin spawners in natural spawning areas at the population level, particularly for SRB steelhead (Ford 2022). Information is needed to determine where, and to what extent, unaccounted-for hatchery steelhead are interacting with ESA-listed populations, particularly in Idaho (Ford 2022). The proportion and distribution of hatchery-origin spawners in natural spawning areas remain uncertain and similar to the previous 5-year review period. The risk to SRB steelhead persistence from hatcheries remains uncertain and at moderate to high risk, and has not changed since the last review period.

2.4.1 Snake River Basin steelhead DPS delineation and hatchery membership

The Northwest Fisheries Science Center's review (Ford 2022) found that no new information had become available that would justify a change in the delineation of the SRB steelhead DPS.

The West Coast Regional Office's review of new information since the previous 2016 5-year review regarding the DPS membership status of various hatchery programs indicates no changes in the SRB steelhead DPS membership are warranted.

2.4.2 ESU/DPS viability and statutory listing factors

The Northwest Fisheries Science Center's review of updated information (Ford 2022) does not indicate a change in the biological risk category of moderate for the SRB steelhead DPS since the time of the last 5-year review (NMFS 2016a). However, Ford (2022) notes that the updated population-level abundance estimates have made very clear the recent (last 5 years) sharp declines that are extremely worrisome, were they to continue.

Our analysis of the ESA section 4(a)(1) factors indicates that the collective risk to the SRB steelhead's persistence is moderate to high and is increasing because of climate change.

3. Results

3.1 Classification

Listing status

Based on the information provided above, we determine that no reclassification for the SRB steelhead SRB is warranted. Therefore, the SRB steelhead DPS should remain listed as threatened.

ESU/DPS Delineation

The Northwest Fisheries Science Center's viability assessment (Ford 2022) found that no new information has become available that would justify a change in delineation for the SRB steelhead DPS.

Hatchery Membership

For the SRB steelhead DPS, we do not recommend any changes to the hatchery program membership.

3.2 New Recovery Priority Number

Since the previous 2016 5-year review, NMFS revised the recovery priority number guidelines and twice evaluated the numbers (NMFS 2019a, 2022). Table 4 indicates the number in place for the SRB steelhead DPS at the beginning of the current review (3C). In January 2022, the number remained unchanged.

As part of this 5-year review, we re-evaluated the number based on the best available information, including the new viability assessment (Ford 2022). We concluded that the current recovery priority number remains 3C.

This page intentionally left blank.

4. Recommendations for Future Actions

In our review of the listing factors, we identified several actions critical to improving the status of the SRB steelhead DPS. These include implementing the 2017 recovery plan (NMFS 2017b), the *U.S. v. Oregon* (in-river harvest) Management Agreement for 2018-2027, the 2020 Columbia River System biological opinion (NMFS 2020a), and biological opinion on hatchery operations within the DPS (NMFS 2017d).

Some of the greatest opportunities to advance recovery are to:

- Implement habitat restoration at a watershed scale. Implement habitat improvement actions consistent with best practices for watershed restoration (see, e.g., Beechie et al. 2010; Hillman et al. 2016; and Appendix A of NMFS 2020a). Prioritize projects that improve habitat resilience to climate change; specifically, projects that restore natural flow regimes, reduce water temperatures, and reconnect tributaries and floodplains in juvenile rearing areas (Beechie et al. 2013).
- Develop, support, and enhance local- to basin-scale frameworks to guide and prioritize habitat restoration actions and integrate a landscape perspective into decision making. Successful examples of these Atlas and other watershed-scale assessments and plans can be found in Section 2.3.2 Listing factor A.
- Reconnect stream channels with their floodplains in steelhead habitat (Beechie et al. 2013). Use low-tech process-based methods (Wheaton et al., eds. 2019), including reintroducing beaver (Pollock et al. 2017) to facilitate widespread, low-cost floodplain restoration across the DPS.
- Connect tributaries to mainstem migration corridors. Temperature refugia from tributaries is vital to successful migration and survival (Keefer et al. 2018; EPA 2021).
- Monitor impacts from research programs, pinniped predation, hatcheries, and habitat restoration.
- Monitor population VSP metrics where data are lacking for populations that must reach viable status for MPG and DPS recovery.

This page intentionally left blank

5. References

5.1 Federal Register Notices

November 20, 1991 (56 FR 58612). Notice of Policy: Policy on Applying the Definition of Species Under the Endangered Species Act to Pacific Salmon.

February 7, 1996 (61 FR 4722). Notice of Policy: Policy Regarding the Recognition of Distinct Vertebrate Population Segments Under the Endangered Species Act.

August 18, 1997 (62 FR 43937). Final Rule: Endangered and Threatened Species: Listing of Several Evolutionary Significant Units (ESUs) of West Coast Steelhead.

September 16, 1999 (64 FR 50414). Endangered and Threatened Species; Threatened Status for Two Chinook Salmon Evolutionarily Significant Units (ESUs) in California

July 10, 2000 (65 FR 42422). Final Rule: Endangered and Threatened Species; Final Rule Governing Take of 14 Threatened Salmon and Steelhead Evolutionarily Significant Units (ESUs).

July 10, 2000 (65 FR 42450). Endangered and Threatened Species; Final Rule Governing Take of 14 Threatened Salmon and Steelhead Evolutionarily Significant Units (ESUs).

June 28, 2005 (70 FR 37159). Final Rule: Endangered and Threatened Species: Final Listing Determinations for 16 ESUs of West Coast Salmon, and Final 4(d) Protective Regulations for Threatened Salmonid ESUs.

June 28, 2005 (70 FR 37204). Final Policy: Policy on the Consideration of Hatchery-Origin Fish in Endangered Species Act Listing Determinations for Pacific Salmon and Steelhead.

September 2, 2005 (70 FR 52630). Final Rule: Endangered and Threatened Species; Designation of Critical Habitat for 12 Evolutionarily Significant Units of West Coast Salmon and Steelhead in Washington, Oregon, and Idaho.

January 5, 2006 (71 FR 834). Final Rule: Endangered and Threatened Species: Final Listing Determinations for 10 Distinct Population Segments of West Coast Steelhead.

August 15, 2011 (76 FR 50448). Notice of availability of 5-year reviews: Endangered and Threatened Species; 5-Year Reviews for 17 Evolutionarily Significant Units and Distinct Population Segments of Pacific Salmon and Steelhead.

May 26, 2016 (81 FR 33468). Notice of Availability of 5-year Reviews Endangered and Threatened Species; 5-Year Reviews for 28 Listed Species of Pacific Salmon, Steelhead, and Eulachon.

April 30, 2019 (84 FR 18243). Notice of Final Guidelines: Endangered and Threatened Species; Listing and Recovery Priority Guidelines.

October 4, 2019 (84 FR 53117). Notice of Initiation of 5-year Reviews: Endangered and Threatened Species; Initiation of 5-Year Reviews for 28 Listed Species of Pacific Salmon and Steelhead.

November 19, 2020 (85 FR 73620). Final Rule: U.S. Department of Agriculture, Forest Service (Agency) is adopting a final rule amending its National Environmental Policy Act (NEPA) regulations.

December 17, 2020 (85 FR 81822). Revisions to Hatchery Programs Included as Part of Pacific Salmon and Steelhead Species Listed Under the Endangered Species Act.

January 13, 2021 (86 FR 2744). Final Rule: Reissuance and Modification of Nationwide Permits.

December 7, 2021 (86 FR 69372). Revised Definition of "Waters of the United States".

December 27, 2021 (86 FR 73522). Reissuance and Modification of Nationwide Permits.

5.2 Literature Cited

Beechie, T. J., D. A. Sear, J. D. Olden, G. R. Pess, J. M. Buffington, H. Moir, P. Roni, and M. M. Pollock. 2010. Process-based principles for restoring river ecosystems. BioScience. 60(3):209–222.

Beechie, T., H. Imaki, J. Greene, et al. 2013. Restoring Salmon Habitat for a Changing Climate. River Research and Applications. v.29(8). 939-960pp.

Biomark, Applied Science and Engineering, U.S. Department of Interior Bureau of Reclamation, Idaho Governor's Office of Species Conservation, Trout Unlimited, and The Nature Conservancy. 2019. Upper Salmon Subbasin Habitat Integrated Rehabilitation, Assessment, June 2019. 297 pp.

Black, B. A., P. van der Sleen, E. Di Lorenzo, D. Griffin, W. J. Sydeman, J. B. Dunham, R. R. Rykaczewski, M. García-Reyes, M. Safeeq, I. Arismendi, and S. J. Bograd. 2018. Rising synchrony controls western North American ecosystems. Global change biology, 24(6), pp. 2305-2314.

Bottom, D. L., C. A. Simenstad, J. Burke, A. M. Baptista, D. A. Jay, K. K. Jones, et al. 2005. Salmon at river's end: The role of the estuary in the decline and recovery of Columbia River salmon. US Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-68, 8/1/2005.

BPA (Bonneville Power Administration), USBR (U.S. Bureau of Reclamation), and USACE (U.S. Army Corps of Engineers). 2020. Biological Assessment of Effects of the Operations and Maintenance of the Federal Columbia River System on ESA-Listed Species. Bonneville Power Administration, Portland, Oregon, 1/1/2020.

Braun, D. C., J. W. Moore, J. Candy, and R. E. Bailey. 2016. Population diversity in salmon: linkages among response, genetic and life history diversity. Ecography, 39(3), pp.317-328.

Brodeur, R. D., T. D. Auth, and A. J. Phillips. 2019. Major Shifts in Pelagic Micronekton and Macrozooplankton Community Structure in an Upwelling Ecosystem Related to an Unprecedented Marine Heatwave. Front. Mar. Sci. 6:212. doi: 10.3389/fmars.2019.00212.

Brophy L. S., C. M. Greene, V. C. Hare, B. Holycross, A. Lanier, W. N. Heady, et al. 2019. Insights into estuary habitat loss in the western United States using a new method for mapping maximum extent of tidal wetlands. PLoS ONE 14(8): e0218558.

Busby, P. J., T. C. Wainwright, G. J. Bryant, L. J. Lierheimer, R. S. Waples, F. W. Waknitz, and I. V. Lagomarsino. 1996. Status Review of West Coast Steelhead from Washington, Idaho, Oregon, and California. U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC-27, 261 p.

Carretta, J. V., E. Oleson, D. W. Weller, et al. 2013. U.S. Pacific Marine Mammal Stock Assessments: 2013. NOAA Technical Memorandum NMFS, NOAA-TM-NMFSSWFSC-504, U.S. Department of Commerce, NOAA, NMFS, Southwest Fisheries Science Center, LaJolla, California, 1/1/2013.

Carretta, J. V., K. A. Forney, E. M. Oleson, D. W. Weller, A. R. Lang, J. Baker, M. M. Muto, B. Hanson, A. J. Orr, H. Huber, M. S. Lowry, J. Barlow, J. E. Moore, D. Lynch, L. Carswell, and R. L. Brownell Jr. 2019. U.S. Pacific Marine Mammal Stock Assessments: 2018. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-617.

Carr-Harris, C. N., J. W Moore, A. S. Gottesfeld, J. A. Gordon, W. M. Shepert, J. D. J. Henry Jr., H. J. Russell, W. N. B. Helin, D. J. Doolan, and T. D. Beacham. 2018. Phenological diversity of salmon smolt migration timing within a large watershed. Transactions of the American Fisheries Society 147(5):775-790.

CCD (Columbia Conservation District). 2021. Habitat Restoration Prioritization and Conceptual Restoration Plans. Prepared by Anchor QEA, LLC. 112 pp.

Chasco, B. E., I. C. Kaplan, A. C. Thomas, A. Acevedo-Gutiérrez, D. P. Noren, M. J. Ford, M. B. Hanson, J. J. Scordino, S. J. Jeffries, K. N. Marshall, A. O. Shelton, C. Matkin, B. J. Burke, and E. J. Ward. 2017a. Competing tradeoffs between increasing marine mammal predation and fisheries harvest of Chinook salmon. Scientific Reports 7:15439. DOI:10.1038/s41598-017-14984-8

Chasco, B., I. C. Kaplan, A. Thomas, A. Acvedo-Gutierrez, D. Noren, M. J. Ford, M. B. Hansen, J Scordino, S. Jeffries, S. Pearson, K. N. Marshall, and E.J. Ward. 2017b. Estimates of Chinook salmon consumption in Washington State inland waters by four marine mammal predators from 1970 – 2015. Canadian Journal of Fisheries and Aquatic Sciences. 74: 1173–1194. http://dx.doi.org/10.1139/cjfas-2016-0203

Climate Impacts Group. 2004. Overview of climate change impacts in the U.S. Pacific Northwest. University of Washington, Seattle, Washington, 7/29/2004.

Conley, K. R. and L. P. Denny. 2019. Annual report on monitoring and evaluation of the Panther Creek Chinook Salmon Project – 2018. Shoshone Bannock Tribes, Fort Hall, Idaho. Available from: https://www.cbfish.org/Document.mvc/Viewer/P167789

Copeland, T., J. D. Bumgarner, A. Byrne, P. Cleary, L. Denny, J. L. Hebdon, C. A. Peery, S. Rosenberger, E. R. Sedell, G. E. Shippentower, C. Warren, and S. P. Yundt. 2015. Reconstruction of the 2012/2013 steelhead spawning run into the Snake River basin. Report to Bonneville Power Administration, Portland, Oregon.

Crozier, L. G. and R. W. Zabel. 2006. Climate impacts at multiple scales: evidence for differential population responses in juvenile Chinook salmon. Journal of Animal Ecology. 75:1100-1109.

Crozier, L. G., A. P. Hendry, P. W. Lawson, T. P. Quinn, N. J. Mantua, J. Battin, R. G. Shaw, and R. B. Huey. 2008a. Potential responses to climate change in organisms with complex life histories: evolution and plasticity in Pacific salmon. Evol Appl 1:252-270.

Crozier, L. G., R. W. Zabel, and A. F. Hamlett. 2008b. Predicting differential effects of climate change at the population level with life-cycle models of spring Chinook salmon. Global Change Biol 14:236-249.

Crozier, L. 2016. Impacts of Climate Change on Salmon of the Pacific Northwest, A review of the scientific literature published in 2015. Fish Ecology Division, Northwest Fisheries Science Center, NMFS, Seattle, WA. 42 pgs.

Crozier, L. G., M. M. McClure, T. Beechie, S. J. Bograd, D. A. Boughton, M. Carr, et al. 2019. Climate vulnerability assessment for Pacific salmon and steelhead in the California Current Large Marine Ecosystem. PLoS ONE 14(7): e0217711. https://doi.org/10.1371/journal.pone.0217711

Crozier, L. G., J. E. Siegel, L. E. Wiesebron, E. M. Trujillo, B. J. Burke, B. P. Sandford, and D. L. Widener. 2020. Snake River sockeye and Chinook salmon in a changing climate: Implications for upstream migration survival during recent extreme and future climates. PLoS One. 2020 Sep 30;15(9).

Dwire, K. A., S. Mellmann-Brown, and J. T. Gurrieri. 2018. Potential effects of climate change on riparian areas, wetlands, and groundwater-dependent ecosystems in the Blue Mountains, Oregon, USA. Climate Services. pp. 44-52.

EPA (U.S. Environmental Protection Agency). 2018. Authorization To Discharge Under the National Pollutant Discharge Eliminatino System (NPDES) for Small Suction Dredge Miners in Idaho. General Permit No.: IDG370000.

EPA (U. S. Environmental Protection Agency). 2021. Columbia River Cold Water Refuges Plan. EPA-910-R-21-001. U.S. Environmental Protection Agency Region 10. 216 pp.

Espinasse, B., B. P. V. Hunt, Y. D. Coll, and E. A. Pakhomov. 2019. Investigating high seas foraging conditions for salmon in the North Pacific: insights from a 100-year scale archive for Rivers Inlet sockeye salmon. Canadian Journal of Fisheries and Aquatic Sciences 76(6):918-927.

Evans, M. L., A. E. Kohler, R. G. Griswold, K. A. Tardy, K. R. Eaton, and J. D. Ebel. 2020. Salmon-mediated nutrient flux in Snake River sockeye salmon nursery lakes: the influence of depressed population size and hatchery supplementation, Lake and Reservoir Management, 36:1, 75-86, DOI: 10.1080/10402381.2019.1654571.

Evans, A. F., Q. Payton, K. Collis, B. Cramer, A. Turecek, N. J. Hostetter, and D. D. Roby. 2021. Chapter 7: Cumulative effects of avian predation on juvenile salmonids in the Columbia River basin in D. D. Roby, A. F. Evans, and K. Collis (editors). Avian Predation on Salmonids in the Columbia River Basin: A Synopsis of Ecology and Management. A synthesis report submitted to the U.S Army Corps of Engineers, Walla Walla, Washington; the Bonneville Power Administration, Portland, Oregon; the Grant County Public Utility District/Priest Rapids Coordinating Committee, Ephrata, Washington; and the Oregon Department of Fish and Wildlife, Salem, Oregon. 788 pp.

Ford, M. J., editor. 2022. Biological Viability Assessment Update for Pacific Salmon and Steelhead Listed Under the Endangered Species Act: Pacific Northwest. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-171.

Ford, M. J. (Ed.), T. Cooney, P. McElhany, N. Sands, L. Weitkamp, J. Hard, M. McClure, R. Kope, J. Myers, A. Albaugh, K. Barnas, D. Teel, P. Moran and J. Cowen. 2011. Status Review Update for Pacific Salmon and Steelhead Listed Under the Endangered Species Act: Pacific Northwest. U.S. Department of Commerce, NOAA Technical Memorandum NOAA-TM-NWFSC-113. November 2011.

Gliwicz, Z. M., E. Babkiewicz, R. Kumar, S. Kunjiappan, and K. Leniowski. 2018. Warming increases the number of apparent prey in reaction field volume of zooplanktivorous fish. Limnology and Oceanography 63:S30-S43.

Good, T. P., R. S. Waples, and P. Adams (Editors). 2005. Updated Status of Federally Listed ESUs of West Coast Salmon and Steelhead. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-NWFSC-66, 598 p.

Gourtay, C., D. Chabot, C. Audet, H. Le Delliou, P. Quazuguel, G. Claireaux, and J. L. Zambonino-Infante. 2018. Will global warming affect the functional need for essential fatty acids in juvenile sea bass (Dicentrarchus labrax)? A first overview of the consequences of lower availability of nutritional fatty acids on growth performance. Marine Biology 165(9):165:143.

GRMW (Grande Ronde Model Watershed). 2020. NOAA Fisheries requesting habitat trend information for salmon and steelhead from local partners: Response from Grande Ronde Model Watershed, April 2020. Grande Ronde Model Watershed, Enterprise, Oregon. 3 pp.

Haskell, C. A., K. Griswold, and A. L. Puls. 2019. Key findings and lessons learned from Pacific Northwest intensively monitored watersheds. Pacific Northwest Aquatic Monitoring Partnership. U.S. Geological Survey, Cook, Washington, 98605. Prepared by Pacific States Marine Fisheries Commission, Portland, Oregon, December 2019.

Hatch, D., Branstetter R., Stephenson J., Pierce A., Lessard R., Newell J., Matala, A., Bosch W., Everett S., Graham N., Medeiros, L., Jenkins L., Hoffman, B., Hoffman, N., Cavileer T., Nagler, J., Fiander M., Frederickson C., Blodgett J., Fast D., and Johnson R. 2018. Kelt Reconditioning and Reproductive Success Evaluation Research. 1/1/2018 - 12/31/2018 Bonneville Power Administration Annual Report, 2007-401-00.

Herring, S. C., N. Christidis, A. Hoell, M. P. Hoerling, and P. A. Stott, eds. 2018. Explaining extreme events of 2016 from a climate perspective. Bulletin of the American Meteorological Society 99.

Hill, A., S. Bennett, B. Bouwes, and S. Shahverdian. 2019. Panther Creek Riverscapes Conceptual Restoration Plan: Process-Based Restoration to Improve Chinook, Steelhead, and Bull Trout Habitat, February 28, 2019. Prepared for the Shoshone-Bannock Tribes. 74 pp.

Hillman, T., P. Roni, C. Jordan, and J. O’Neal. 2016. Effects of tributary habitat enhancement projects. Report to Bonneville Power Administration, Portland, Oregon.

Holden, Z. A., A. Swanson, C. H. Lucec, W. M. Jollyd, M. Manetae, J. W. Oylerf, D. A. Warren, R. Parsons, and D. Affleck. 2018. Decreasing fire season precipitation increased recent western US forest wildfire activity. Proceedings of the National Academy of Sciences of the United States of America 115(36):E8349-E8357.

Hostetter, N. J., A. F. Evans, D. D. Roby, and K. Collis. 2012. Susceptibility of Juvenile Steelhead to Avian Predation: the Influence of Individual Fish Characteristics and River Conditions. Transactions of the American Fisheries Society. 141:1586-1599.

ICBEMP (Interior Columbia Basin Ecosystem Management Project). 2014. Updated Interior Columbia Basin Strategy: A Strategy for Applying the Knowledge Gained by the Interior Columbia Basin Ecosystem Management Project to the Revision of Land Use Plans and Project Implementation. BLM/FS/FWS/EPA/NOAA Fisheries-Memorandum. April 18, 2014. https://www.fs.fed.us/r6/icbemp/html/ICBEMP_Frameworkmemorandum-and-strategy_2014.pdf.

ICTRT (Interior Columbia Technical Recovery Team). 2003. Independent Populations of Chinook, Steelhead, and Sockeye for Listed Evolutionarily Significant Units within the Interior Columbia Domain.

ICTRT (Interior Columbia Technical Recovery Team). 2007a. Required Survival Rate Changes to meet Technical Recovery Team Abundance and Productivity Viability Criteria for Interior Columbia River Basin Salmon and Steelhead Populations.

ICTRT (Interior Columbia Technical Recovery Team). 2007b. Viability Criteria for Application to Interior Columbia Basin Salmonid ESUs. Interior Columbia Basin Technical Recovery Team Technical Review Draft. March 2007. 91 p. + Appendices and Attachments.

ICTRT (Interior Columbia Technical Recovery Team) and R. W. Zabel. 2007. Assessing the Impact of Environmental Conditions and Hydropower on Population Productivity for Interior Columbia River Stream-type Chinook and Steelhead Populations.

IDEQ (Idaho Department of Environmental Quality). 2016. Upper Salmon River Subbasin Assessment and TMDL, 2016 Addendum and Five-Year Review, Hydrologic Unit Code 17060201. State of Idaho Department of Environmental Quality. https://www.deq.idaho.gov/water-quality/surface-water/total-maximum-daily-loads/salmon-river-upper-subbasin.

IDFG (Idaho Department of Fish and Game). 2021. Unpublished weir trap data 2015 to 2018 for tributaries to the Salmon River. February 12, 2021.

IDWR (Idaho Department of Water Resources). 2020. Idaho Water Transactions 2015-2020, unpublished. Spreadsheet provided to NOAA Fisheries in April 2020 by Amy Cassel, Idaho Department of Water Resources.

IPCC (Intergovernmental Panel on Climate Change). 2014. Summary for Policymakers. In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

IPCC (Intergovernmental Panel on Climate Change). 2018. Summary for Policymakers. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. In Press.

Isaak, D. J., C. H. Luce, D. L. Horan, G. L. Chandler, S. P. Wollrab, and D. E. Nagel. 2018. Global warming of salmon and trout rivers in the northwestern U.S.: Road to ruin or path through purgatory? Transactions of the American Fisheries Society 147:566-587.

ISAB (Independent Scientific Advisory Board). 2007. Climate change impacts on Columbia River Basin fish and wildlife. In: Climate Change Report, ISAB 2007-2. Independent Scientific Advisory Board, Northwest Power and Conservation Council, Portland, Oregon, 5/11/2007.

ISAB (Independent Science Advisory Board). 2015. Density dependence and its implications for fish management and restoration programs in the Columbia River basin. ISAB Report 2015-1, Portland, Oregon, 2/25/2015.

ISAB (Independent Science Advisory Board). 2019. Predation Metrics Report. A Review of Predation Impacts and Management Effectiveness for the Columbia River Basin. ISAB Report 2019-1. May 3, 2019. 169 pp.

Jacox, M. G., M. A. Alexander, C. A. Stock, and G. Hervieux. 2019. On the skill of seasonal sea surface temperature forecasts in the California Current System and its connection to ENSO variability. Climate Dynamics 53(12):7519-7533.

Johnson. G. E., K. L. Fresh, and N. K. Sather, eds. 2018. Columbia estuary ecosystem restoration program: 2018 Synthesis memorandum. Final Report. submitted by Pacific Northwest National Laboratory to U.S. Army Corps of Engineers, Portland District, Portland, Oregon, 6/1/2018.

Justice, C., S. M. White, D. A. McCullough, D. S. Graves, and M. R. Blanchard. 2017. Can stream and riparian restoration offset climate change impacts to salmon populations? Journal of Environmental Management, 212-227.

Karnezis, J. 2019. FW: [EXTERNAL] Re: FW: [Non-DoD Source] Re: checking with you re. edits to env baseline Communication to L. Krasnow (NMFS) from J. Karnezis (BPA), 12/19/2019.

Keefer, M. L., T. S. Clabough, M. A. Jepson, E. L. Johnson, C. A. Peery, and C. C. Caudill. 2018. Thermal exposure of adult Chinook salmon and steelhead: Diverse behavioral strategies in a large and warming river system. PLoS ONE 13(9): e0204274.

Koontz, E.D., E.A. Steel, and J.D. Olden. 2018. Stream thermal responses to wildfire in the Pacific Northwest. Freshwater Science, 37, 731 - 746.

Krosby, M., D. M. Theobald, R. Norheim, and B. H. McRae. 2018. Identifying riparian climate corridors to inform climate adaptation planning. Plos One 13(11):e0205156.

Kukulka, T. and D. A. Jay. 2003. Impacts of Columbia River discharge on salmonid habitat: 2. Changes in shallow-water habitat. Journal of Geophysical Research 108(C9): 3294. DOI: 10.1029/2003JC001829.

Lawes, T. J., K. S. Bixler, D. D. Roby, D. E. Lyons, K. Collis, A. F. Evans, A. Peck-Richardson, B. Cramer, Y. Suzuki, J. Y. Adkins, K. Courtot, and Q. Payton. 2021. Chapter 4: Double-crested cormorant management in the Columbia River estuary in D. D. Roby, A. F. Evans, and K. Collis (editors). Avian Predation on Salmonids in the Columbia River Basin: A Synopsis of Ecology and Management. A synthesis report submitted to the U.S. Army Corps of Engineers, Walla Walla, Washington; the Bonneville Power Administration, Portland, Oregon; the Grant County Public Utility District/Priest Rapids Coordinating Committee, Ephrata, Washington; and the Oregon Department of Fish and Wildlife, Salem, Oregon. 788 pp.

Leach, J. A. and R. D. Moore. 2019. Empirical Stream Thermal Sensitivities May Underestimate Stream Temperature Response to Climate Warming. Water Resources Research 55(7):5453-5467.

Lindsey, R. and L. Dahlman. 2020. Climate Change: Global Temperature. January 16. https://www.climate.gov/news-features/understanding-climate/climate-change-global-temperature.

Lynch, A. J., B. J. E. Myers, C. Chu, L. A. Eby, J. A. Falke, R. P. Kovach, T. J. Krabbenhoft, T. J. Kwak, J. Lyons, C. P. Paukert, and J. E. Whitney. 2016. Climate Change Effects on North American Inland Fish Populations and Assemblages. Fisheries 41(7):346-361. DOI: 10.1080/03632415.2016.1186016, 7/1/2016.

Maier, G. O. and C. A. Simenstad. 2009. The role of marsh-derived macrodetritus to the food webs of juvenile Chinook salmon in a large altered estuary. Estuaries and Coasts 32:984-998. DOI: 10.1007/s12237-009-9197-1.

Marcoe, K. and S. Pilson. 2017. Habitat change in the lower Columbia River estuary, 1870-2009. Journal of Coastal Conservation 21:505-525. DOI: 10.1007/s11852-017-0523-7.

Marshall, K. N., A. C. Stier, J. F. Samhouri, R. P. Kelly, and E. J. Ward. 2015. Conservation challenges of predator recovery. Conserv. Lett.

Martins, E. G., S. G. Hinch, D. A. Patterson, M. J. Hague, S. J. Cooke, K. M. Miller, M. F. Lapointe, K. K. English, and A. P. Farrell. 2011. Effects of river temperature and climate warming on stock-specific survival of adult migrating Fraser River sockeye salmon (Oncorhynchus nerka). Global Change Biology 17(1):99–114. DOI:10.1111/j.1365-2486.2010.02241.x.

Martins, E. G., S. G. Hinch, D. A. Patterson, M. J. Hague, S. J. Cooke, K. M. Miller, D. Robichaud, K. K. English, and A. P. Farrell. 2012. High river temperature reduces survival of sockeye salmon (Oncorhynchus nerka) approaching spawning grounds and exacerbates female mortality. Canadian Journal of Fisheries and Aquatic 69:330–342. DOI: 10.1139/F2011-154.

McClure, M. M., E. E. Holmes, B. L. Sanderson, and C. E. Jordan. 2003. A Large-Scale, Multispecies Status Assessment: Anadromous Salmonids in the Columbia River Basin, Ecological Applications, 13(4): 964-989.

McElhany, P., M. Ruckleshaus, M. J. Ford, T. Wainwright and E. Bjorkstedt. 2000. Viable Salmon Populations and the Recovery of Evolutionarily Significant Units. U. S. Department of Commerce, National Marine Fisheries Service, Northwest Fisheries Science Center, NOAA Technical Memorandum NMFS-NWFSC-42. 156 p. http://www.nwfsc.noaa.gov/publications/techmemos/tm42/tm42.pdf

McElhany, P., M. Chilcote, J. Myers, and R. Beamesderfer. 2007. Viability status of Oregon salmon and steelhead populations in the Willamette and lower Columbia basins. Prepared for Oregon Department of Fish and Wildlife and National Marine Fisheries Service by the National Marine Fisheries Service, Northwest Fisheries Science Center, 9/1/2007.McElhany et al. 2007

Morgan, C. A., B. R. Beckman, L. A. Weitkamp, and K. L. Fresh. 2019. Recent Ecosystem Disturbance in the Northern California Current. 2019 American Fisheries Society.

Mote, P. W., E. A. Parson, A. F. Hamlet, W. S. Keeton, D. Lettenmaier, N. Mantua, et al. 2003. Preparing for climatic change: The water, salmon, and forests of the Pacific Northwest. Climatic Change 61:45-88.

Muto, M. M. et al. 2017. Alaska Marine Mammal Stock Assessments: 2017. Government Reports Announcements and Index. Issue 03, 2005. doi: 10.7289/V5/TM-AFSC-378.

Muto, M. M., et al. 2019. U.S. Pacific Marine Mammal Stock Assessments: 2019. NOAA Technical memorandum NMFS-AFSC-393. P. 399.

Naiman, R. J., J. Richard Alldredge, D. A. Beauchamp, P. A. Bisson, J. Congleton, C. J. Henny, N. Huntly, R. Lamberson, C. Levings, E. N. Merrill, W. G. Pearcy, B. E. Rieman, G. T. Ruggerone, D. Scarnecchia, P. E. Smouse, and C. C. Wood. 2012. River restoration and food webs.Proceedings of the National Academy of Sciences Dec 2012, 109 (52) 21201-21207; DOI: 10.1073/pnas.1213408109

NMFS (National Marine Fisheries Service). 1997. Status Review Update for West Coast Steelhead from Washington, Idaho, Oregon, and California. July 7, 1997, NMFS-NWFSC/SWFSC Status Review Update Memo.

NMFS (National Marine Fisheries Service). 2008a. Endangered Species Act - Section 7 Consultation Biological Opinion. Consultation on Remand for Operation of the Federal Columbia River Power System, 11 Bureau of Reclamation Projects in the Columbia Basin, and ESA Section 10(a)(I)(A) Permit for Juvenile Fish Transportation Program. NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2008b. Endangered Species Act – Section 7 Consultation Final Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation Implementation of the National Flood Insurance Program in the State of Washington Phase One Document – Puget Sound Region. NMFS Tracking No.: 2006-00472

NMFS (National Marine Fisheries Service). 2008c. Endangered Species Act section 7(a)(2) Consultation Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation. Consultation on Treaty Indian and Non-Indian Fisheries in the Columbia River Basin Subject to the 2008-2017 U.S. v. Oregon Management Agreement. May 5, 2008. NMFS, Portland, Oregon. NMFS Consultation No.: NWR-2008-02406. 685p.

NMFS (National Marine Fisheries Service). 2010. Endangered Species Act - Section 7 Consultation Supplemental Biological Opinion. Supplemental Consultation on Remand for Operation of the Federal Columbia River Power System, 11 Bureau of Reclamation Projects in the Columbia Basin, and ESA Section 10(a)(I)(A) Permit for Juvenile Fish Transportation Program. NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2012a. Endangered Species Act Section 7 Formal Consultation and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for Diversions located on the Salmon-Challis National Forest in the Lemhi River Watershed, HUC 17060204, Lemhi County, Idaho. (multiple actions). NMFS Consultation No.: 2005/00061. 162pp.

NMFS (National Marine Fisheries Service). 2012b. National Marine Fisheries Service Endangered Species Act Section 7 Jeopardy and Adverse Modification of Critical Habitat Biological Opinion for the Environmental Protection Agency's Proposed Approval of Certain Oregon Administrative Rules Related to Revised Water Quality Criteria for Toxic Pollutants. NMFS Tracking Number WCR-2008-00148.

NMFS (National Marine Fisheries Service). 2014a. Endangered Species Act Section 7(a)(2) Supplemental Biological Opinion – Consultation on Remand for Operation of the Federal Columbia River Power System, Northwest Region. Available at: http://www.westcoast.fisheries.noaa.gov/publications/hydropower/fcrps/2014_supplemental_fcrps_biop_final.pdf

NMFS (National Marine Fisheries Service). 2014b. Endangered Species Act Section 7 and Magnuson-Stevens Fishery Conservation Act Essential Fish Habitat Consultation for Water Quality Toxics Standards for Idaho. NMFS Tracking Number WCR 2000-1484.

NMFS (National Marine Fisheries Service). 2015. Endangered Species Act Section 7 Formal Consultation and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for the Johnson Bar Salvage Project, Lower Selway (HUC 17060302) and Middle Fork Clearwater (HUC 17060304) (46.088432, -115.585645), Idaho County, Idaho. 99 pp.

NMFS (National Marine Fisheries Service). 2016a. 5-Year Review: Summary & Evaluation of Snake River Sockeye, Snake River Spring-Summer Chinook, Snake River Fall-Run Chinook, Snake River Basin Steelhead. National Marine Fisheries Service, West Coast Region, Portland, OR. 127 pp.

NMFS (National Marine Fisheries Service). 2016b. Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation Six Lower Snake River Spring/Summer Chinook Salmon Hatchery Programs. June 24, 2016. NMFS Consultation No.: WCR-2013-21. 142pp.

NMFS (National Marine Fisheries Service). 2016c. Endangered Species Act Section 7 Formal Consultation and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for the Authorization of Operation and Maintenance of Existing Water Diversions on the Middle Salmon River Watershed of the Salmon-Challis National Forest, HUCs 1706020301, 1706020302, 1706020303, 1706020304 and 1706020305, Lemhi County, Idaho. NMFS Consultation No.: WCR-2016-4505. 201pp.

NMFS (National Marine Fisheries Service). 2016d. Endangered Species Act (ESA) Section 7(a)(2) Jeopardy and Destruction or Adverse Modification of Critical Habitat Biological Opinion and Section 7(a)(2) “Not Likely to Adversely Affect” Determination for the Implementation of the National Flood Insurance Program in the State of Oregon

NMFS (National Marine Fisheries Service). 2017a. ESA Recovery plan for Idaho Snake River Spring/Summer Chinook salmon and Snake River Basin Steelhead. Idaho Management Unit. Chapter 6. NMFS West Coast Region, Portland, Oregon. November 2017. 349 pp. Available from https://www.fisheries.noaa.gov/resource/document/recovery-plan-snake-river-spring-summer-chinook-salmon-and-snake-river-basin

NMFS (National Marine Fisheries Service). 2017b. ESA recovery plan for Snake River spring/summer Chinook salmon (Oncorhynchus tshawytscha) & Snake River basin steelhead (Oncorhynchus mykiss). National Marine Fisheries Service, West Coast Region, November 1, 2017. 284 pp.

NMFS (National Marine Fisheries Service). 2017c. ESA Recovery Plan for Northeast Oregon Snake River Spring and Summer Chinook Salmon and Snake River Steelhead Populations. November 2017. 567 pp. Available from https://www.fisheries.noaa.gov/resource/document/recovery-plan-snake-river-spring-summer-chinook-salmon-and-snake-river-basin

NMFS (National Marine Fisheries Service). 2017d. Final Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. December 12, 2017. Nine Snake River Steelhead Hatchery Programs and one Kelt Reconditioning Program in Idaho. NMFS Consultation No.: WCR-2017-7286. 139p.

NMFS (National Marine Fisheries Service). 2017e. Endangered Species Act Section 7 Consultation Biological Opinion. Four Salmon River Basin Spring/Summer Chinook Salmon Hatchery Programs in the Upper Salmon River Basin. NMFS Consultation No.: WCR 2017-7432.

NMFS (National Marine Fisheries Service). 2017f. Final Endangered Species Act Section 7 Consultation Biological Opinion. December 12, 2017. Five Clearwater River Basin Spring/Summer Chinook Salmon and Coho Salmon Hatchery Programs. NMFS Consultation No.: WCR-2017-7303. 145p.

NMFS (National Marine Fisheries Service). 2018a. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response. Consultation on effects of the 2018-2027 U.S. v. Oregon Management Agreement, NMFS Consultation No.:WCR-2017-7164, NMFS, Lacey, Washington, 2/23/2018.

NMFS (National Marine Fisheries Service). 2018b. Endangered Species Act (ESA) Section 7(a)(2) biological opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) consultation. Snake River fall Chinook salmon hatchery programs, ESA section 10(a)(1)(A) permits, numbers 16607–2R and 16615–2R. NMFS Consultation Numbers: WCR-2018-9988. National Marine Fisheries Service, West Coast Region, 8/13/2018.

NMFS (National Marine Fisheries Service). 2019a. Recovering Threatened and Endangered Species, FY 2017-2018 Report to Congress. National Marine Fisheries Service. Silver Spring, MD.

NMFS (National Marine Fisheries Service). 2019b. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. Five Snake River Basin Spring/Summer Chinook Salmon Hatchery Programs (Reinitiation 2018). February 8, 2019. NMFS Consultation No.: WCR-2017-7319. 155p.

NMFS (National Marine Fisheries Service). 2020a. Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Continued Operation and Maintenance of the Columbia River System. July 24. WCRO 2020-00113.

NMFS (National Marine Fisheries Service). 2020b. Shapefile of fish screens maintained by Idaho Department of Fish and Game at water diversions in the upper Salmon River, vector data. National Marine Fisheries Service, Boise, Idaho.

NMFS (National Marine Fisheries Service). 2020c. Recovery Planning Handbook. Version 1.0. U.S. Department of Commerce, NOAA National Marine Fisheries Service. October 29, 2020.

NMFS (National Marine Fisheries Service). 2022. Recovering Threatened and Endangered Species, FY 2019–2020 Report to Congress. National Marine Fisheries Service. Silver Spring, MD. Report available online at: https://www.fisheries.noaa.gov/resource/document recovering-threatened-and-endangered-species-report-congress-fy-2019-2020.

NPCNF (Nez Perce Clearwater National Forest). 2016. Project Completion Form for the Collette Mine Stream Restoration Project. Programmatic Biological Opinion for Habitat Restoration Projects in Idaho. National Marine Fisheries Service (NMFS No: WCR-2014-832). July 27, 2016. 5 pp.

NPT (Nez Perce Tribe). 2020a. Nez Perce Tribe NOAA 5-Year Review Answers. Nez Perce Tribe, McCall Watershed Program, April 2, 2020.

NPT (Nez Perce Tribe). 2020b. Nez Perce Tribe NOAA 5-Year Review Answers for Big Creek. Nez Perce Tribe, McCall Watershed Program, April 2, 2020.

NWFSC (Northwest Fisheries Science Center). 2015. Status Review Update for Pacific Salmon and Steelhead Listed under the Endangered Species Act: Pacific Northwest. December 21, 2015.

Ohlberger, J., D. E. Schindlera, E. J. Ward, T. E. Walsworth, and T. E. Essington. 2019. Resurgence of an apex marine predator and the decline in prey body size. Proceedings of the National Academy of Sciences Dec 2019, 116 (52) 26682-26689; DOI: 10.1073/pnas.1910930116.

OWRI (Oregon Watershed Restoration Inventory). 2020. Online database accessed August, 2020. https://www.oregon.gov/oweb/data-reporting/Pages/owri.aspx.

Payette National Forest. 2020. Request for salmon and steelhead habitat information from local partners: responses from the Payette National Forest. Payette National Forest, McCall, Idaho, April 8, 2020.

PCSRF (Pacific Coastal Salmon Recovery Fund). 2021. Project and Performance Metrics Database. Accessed February 9, 2021. https://www.webapps.nwfsc.noaa.gov/apex/f?p=309:15

Pearson, S. F. and S. J. Jeffries. 2018. Estimating Washington's coastal and inland harbor seal populations.

PFMC (Pacific Fishery Management Council). 2020. Review of 2019 Ocean Salmon Fisheries: Stock Assessment and Fishery Evaluation Document for the Pacific Coast Salmon Fishery Management Plan. PFMC, Portland, OR. 337 p.

PNNL (Pacific Northwest National Laboratory) and NMFS (National Marine Fisheries Service). 2018. Restoration action effectiveness monitoring and research in the lower Columbia River and estuary, 2016-2017. Draft progress report prepared for the U.S. Army Corps of Engineers, Portland District, Portland, Oregon, 9/14/2018.

PNNL (Pacific Northwest National Laboratory) and NMFS (National Marine Fisheries Service). 2020. Restoration Action Effectiveness Monitoring and Research in the Lower Columbia River and Estuary, 2016-2017. Final technical report submitted by PNNL and NMFS to the U.S. Army Corps of Engineers, Portland District, Portland, Oregon. 6/1/2020.

Pollock, M. M., G. M. Lewallen, K. Woodruff, and C. E. Jordan. 2017. The Beaver Restoration Guidebook: Working with Beaver to Restore Streams, Wetlands, and Floodplains. Version 2.0. Portland: United States Fish and Wildlife Service.

Powers, P. D., M. Helstab, and S. L. Niezgoda. 2018. A process-based approach to restoring depositional river valleys to Stage 0, an anastomosing channel network. River Research and Applications, 1-11.

Reeves, G. H., B. R. Pickard, and K. N Johnson. 2016. An initial evaluation of potential options for managing riparian reserves of the Aquatic Conservation Strategy of the Northwest Forest Plan. Gen. Tech. Rep. PNW-GTR-937. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 97 p.

Rehage, J. S. and J. R. Blanchard. 2016. What can we expect from climate change for species invasions? Fisheries 41(7): 405-407.

Roby, D. D., K. Collis, P. J. Loschl, Y. Suzuki, D. Lyons, T. J. Lawes, et al. 2017. Avian predation on juvenile salmonids: Evaluation of the Caspian Tern Management Plan in the Columbia River estuary, 2016 Final annual report. U.S. Geological Survey, Oregon State University, Corvallis, Oregon, 3/21/2017.

Roby, D. D., T. J. Lawes, D. E. Lyons, K. Collis, A. F. Evans, K. S. Bixler, S. Collar, O. A. Bailey, Y. Suzuki, Q. Payton, and P. J. Loschl. 2021. Avian Predation on Salmonids in the Columbia River Basin: A Synopsis of Ecology and Management. A synthesis report submitted to the U.S Army Corps of Engineers, Walla Walla, Washington; the Bonneville Power Administration, Portland, Oregon; the Grant County Public Utility District/Priest Rapids Coordinating Committee, Ephrata, Washington; and the Oregon Department of Fish and Wildlife, Salem, Oregon. 788 pp.

Roni, P., G. Pess, T. Beechie, and S. Morley. 2010. Estimating Changes in Coho Salmon and Steelhead Abundance from Watershed Restoration: How Much Restoration Is Needed to Measurably Increase Smolt Production? North American Journal of Fisheries Management 30(6):1469-1484.

Roper, B. B., W. C. Saunders, and J. V. Ojala. 2019. Did changes in western federal land management policies improve salmonid habitat in streams on public lands within the Interior Columbia River Basin?. Environ Monit Assess (2019) 191: 574. 18pp.

Sanderson, B. L., K. A. Barnas, and A. M. W. Rub. 2009. Non-indigenous Species of the Pacific Northwest: An Overlooked Risk to Endangered Salmon? Bioscience. 59:245-256.

Schtickzelle, N. and T. P. Quinn. 2007. A Metapopulation Perspective for Salmon and Other Anadromous Fish. Fish and Fisheries. 8: 297-314.

Siegel, J. and L. Crozier. 2019. Impacts of Climate Change on Salmon of the Pacific Northwest: A review of the scientific literature published in 2018. Fish Ecology Division, Northwest Fisheries Science Center, National Marine Fisheries Service, NOAA. December.

Siegel, J. and L. Crozier. 2020. Impacts of Climate Change on Salmon of the Pacific Northwest: A Review of the Scientific Literature Published in 2019. Fish Ecology Division, Northwest Fisheries Science Center, National Marine Fisheries Service, NOAA.

Siegel, J. E., L. G. Crozier, L. E. Wiesebron, and D. L. Widener. 2021. Environmentally triggered shifts in steelhead migration behavior and consequences for survival in the mid-Columbia River. Plos One 16(5):e0250831.

Simenstad, C. A., L. F. Small, and C. D. McIntyre. 1990. Consumption processes and food web structure in the Columbia river estuary. Progress in Oceanography 25:271-298.

Sridhar, V., M. M. Billah, and J. W. Hildreth. 2018. Coupled surface and groundwater hydrological modeling in a changing climate. Groundwater 56(4):618-635.

SRSRB (Snake River Salmon Review Board). 2011. Snake River Salmon Recovery Plan for South East Washington. Prepared by the Snake River Recovery Board for the Washington Governor's Salmon Recovery Office. Available from https://www.fisheries.noaa.gov/resource/document/recovery-plan-snake-river-spring-summer-chinook-salmon-and-snake-river-basin

SRSRB (Snake River Salmon Review Board). 2020. Response to NOAA Fisheries requesting habitat trend information for salmon and steelhead from local partners. 14 pp.

Sweeney, B. W. and Newbold, J. D. (2014): Streamside Forest Buffer Width Needed to Protect Stream Water Quality, Habitat, and Organisms: A Literature Review. Journal of the American Water Resources Association 50 (3):560–584. DOI: 10.1111/jawr.12203

Sykes, G. E., C. J. Johnson, and J. M. Shrimpton. 2009. Temperature and flow effects on migration timing of Chinook salmon smolts. Transactions of the American Fisheries Society 138:1252-1265.

TAC (U.S. v. Oregon Technical Advisory Committee). 2015. TAC Annual Report. Abundance, Stock Status and ESA Impacts. 2014 Summary. May 13-14, 2015.

TAC (U.S. v. Oregon Technical Advisory Committee). 2016. TAC Annual Report. Abundance, Stock Status and ESA Impacts. Summary of 2015 fisheries and fish runs. May 20, 2016.

TAC (U.S. v. Oregon Technical Advisory Committee). 2017. TAC Annual Report. Abundance, Stock Status and ESA Impacts. Summary of 2016 fisheries and fish runs. October 13, 2017.

TAC (U.S. v. Oregon Technical Advisory Committee). 2018. TAC Annual Report. Abundance, Stock Status and ESA Impacts. Summary of 2017 fisheries and fish runs. May 10-11, 2018.

TAC (U.S. v. Oregon Technical Advisory Committee). 2019. Technical Advisory Committee Annual Report: Abundance, Stock Status, Harvest, and Endangered Species Act Impacts. Summary of 2018 Fisheries and Fish Runs. May 9-10, 2019.

TAC (U.S. v. Oregon Technical Advisory Committee). 2020. Technical Advisory Committee Annual Report: Abundance, Stock Status, Harvest, and Endangered Species Act Impacts. Summary of 2019 Fisheries and Fish Runs. May 14-15, 2020.

Tetra Tech, Inc. 2017. Catherine Creek and Upper Grande Ronde River Atlas Restoration Prioritization Framework: User's Manual. Bothell: Tetra Tech.

Thomas, A. C., B. Nelson, M. M. Lance, B. Deagle, and A. Trites. 2016. Harbour seals target juvenile salmon of conservation concern. Can. J. Fish. Aquat. Sci.

Tidwell, K. S. and B. K. van der Leeuw. 2020. Evaluation of pinniped predation on adult salmonids and other fish in the Bonneville Dam tailrace, 2020. U.S. Army Corps of Engineers, Portland District, Fisheries Field Unit. Cascade Locks, OR. 42 pp.

USACE (U.S. Army Corps of Engineers). 2015. Double-crested cormorant management plan to reduce predation on juvenile salmonids in the Columbia River estuary: Final Environmental Impact Statement. U.S. Army Corps of Engineers, Portland District, Portland, Oregon.

USBR (U.S. Bureau of Reclamation). 2011. The Catherine Creek tributary assessment. Grande Ronde River Basin tributary habitat program, Oregon. Bureau of Reclamation, Pacific Northwest Region. Boise, Idaho. August 2011.

USDA (United States Department of Agriculture). 2015. Final Record of Decision for the Crooked River Valley Rehabilitation. Red River Ranger District, Nez Perce – Clearwater National Forests, Idaho County, Idaho. July 2015. 818 pp.

USDA/USDI (U.S. Department of Agriculture and U.S. Department of Interior). 1995. Decision Notice and Finding of No Significant Impact; Environmental Assessment for the interim strategies for managing anadromous fish producing waters in eastern Oregon and Washington, Idaho, and portions of California (PACFISH). Available at: http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsbdev3_033465.pdf (Accessed November 23, 2021).

USDI (U.S. Department of the Interior). 2016. The Federal Land Policy and Management Act of 1976, as amended. U.S. Department of the Interior, Bureau of Land Management, Office of Public Affairs, Washington, DC. 106 pp.

USFWS (U.S. Fish and Wildlife Service) and NMFS (National Marine Fisheries Service). 2006. 5-Year Review Guidance: Procedures for Conducting 5-Year Reviews Under the Endangered Species Act. July 2006.

Uthe, P., B. Knoth, T. Copeland, A. Butts, B. Bowersox, and J. Diluccia. 2017. Intensively monitored watersheds and restoration of salmon habitat in Idaho: Ten-year summary report. Idaho Department of Fish and Game, Boise, Idaho, 12/1/2017.

Veilleux, H. D., J. M. Donelson, and P. L. Munday. 2018. Reproductive gene expression in a coral reef fish exposed to increasing temperature across generations. Conservation Physiology 6:12.

Wainwright, T. C. and L. A. Weitkamp. 2013. Effects of Climate Change on Oregon Coast Coho Salmon: Habitat and Life-Cycle Interactions. Northwest Science. 87:219-242.

Ward, E. J., J. H. Anderson, T. J. Beechie, G. R. Pess, and M. J. Ford. 2015. Increasing hydrologic variability threatens depleted anadromous fish populations. Global Change Biology 21(7):2500-2509.

Wheaton, J. M., S. N. Bennett, N. Bouwes, J. D. Maestas, and S. M. Shahverdian (editors). 2019. Low-Tech Process-Based Restoration of Riverscapes: Design Manual. Version 1.0. Utah State University Restoration Consortium. Logan, UT. 286 pp. DOI: 10.13140/RG.2.2.19590.63049/2.

White, S. M., S. Brandy, C. Justice, et al. 2021. Progress Towards a Comprehensive Approach for Habitat Restoration in the Columbia Basin: Case Study in the Grande Ronde River. Fisheries. December 2020. https://afspubs.onlinelibrary.wiley.com/doi/10.1002/fsh.10562

Whitney, J. E., R. Al-Chokhachy, D. B. Bunnell, C. A. Caldwell, S. J. Cooke, E. J. Eliason et al. 2016. Physiological basis of climate change impacts on North American inland fishes. Fisheries 41(7): 332-345.

Williams, J. G., S. G. Smith, J. K. Fryer, M. D. Scheuerell, W. D. Muir, T. A. Flagg, R. W. Zabel, J. W. Ferguson, and E. Casillas. 2014. Influence of ocean and freshwater conditions on Columbia River sockeye salmon Oncorhynchus nerka adult return rates. Fish Oceanogr 23:210-224.

Williams, S., E. Winther, and A. Storch. 2015. Report on the predation index, predator control fisheries, and program evaluation for the Columbia River basin Northern Pikeminnow Sport Reward Program. 2015 Annual Report, April 1, 2015 through March 31, 2016. Pacific States Marine Fisheries Commission, Portland, Oregon.

Williams, S., E. Winther, and C. M. Barr. 2016. Report on the predation index, predator control fisheries, and program evaluation for the Columbia River basin Northern Pikeminnow Sport Reward Program. 2016 Annual Report, April 1, 2016 through March 31, 2017. Pacific States Marine Fisheries Commission, Portland, Oregon.

Williams, S., E. Winther, C. M. Barr, and C. Miller. 2017. Report on the predation index, predator control fisheries, and program evaluation for the Columbia River basin Northern Pikeminnow Sport Reward Program. 2017 Annual Report, April 1, 2017 through March 31, 2018. Pacific States Marine Fisheries Commission, Portland, Oregon.

Williams, S., E. Winther, C. M. Barr, and C. Miller. 2018. Report on the predation index, predator control fisheries, and program evaluation for the Columbia River basin Northern Pikeminnow Sport Reward Program. 2018 Annual report, April 1, 2018 through March 31, 2019. Pacific States Marine Fisheries Commission, Portland, Oregon.

Winther, E., C. M. Barr, C. Miller, and C. Wheaton. 2019 Report on the predation index, predator control fisheries and program evaluation for the Columbia River basin Northern Pikeminnow Sport Reward Program. 2019 Annual Report, April 1, 2019 through March 31, 2020. Pacific States Marine Fisheries Commission, Portland, Oregon.

Wondzell, S. M., M. Diabat, and R. Haggerty. 2019. What Matters Most: Are Future Stream Temperatures More Sensitive to Changing Air Temperatures, Discharge, or Riparian Vegetation? Journal of the American Water Resources Association, 116-132.

Wright, B. 2018. Pinniped counts Astoria east Mooring Basin. Communication to J. Thompson (NMFS) from B. Wright (ODFW), RE: Sea lion counts update, 5/25/2018.

Yan, H., N. Sun, A. Fullerton, and M. Baerwalde. 2021. Greater vulnerability of snowmelt-fed river thermal regimes to a warming climate. Environmental Research Letters 16(5). https://doi.org/10.1088/1748-9326/abf393

Zabel, R. W., M. D. Scheuerell, M. M. McClure, and J. G. Williams. 2006. The interplay between climate variability and density dependence in the population viability of Chinook salmon. Conservation Biology 20(1): 190-200, 2/1/2006.

NATIONAL MARINE FISHERIES SERVICE
5-YEAR REVIEW
Oncorhynchus mykiss: Snake River Basin

Current Classification: Threatened

Recommendation resulting from the 5-Year Review

- [ ] Downlist to Threatened
- [ ] Uplist to Endangered
- [ ] Delist
- [x] No change is needed

Review Conducted By (Name and Office):

West Coast Region Snake River Basin Steelhead DPS Evaluation Team

REGIONAL OFFICE APPROVAL:

Lead Regional Administrator, NOAA Fisheries

Approve Korie Ann Schaeffer Date: 06/30/2022
For Scott M. Rumsey, Ph.D., Acting Regional Administrator

Cooperating Regional Administrator, NOAA Fisheries

[ ] Concur [ ] Do Not Concur [x] N/A

Signature________________________ Date: _______

HEADQUARTERS APPROVAL:

Assistant Administrator, NOAA Fisheries

[x] Concur [ ] Do Not Concur

Signature RAUCH.SAMUEL.D.III.1365850948 Digitally signed by RAUCH.SAMUEL.D.III.1365850948 Date: 2022.08.05 16:19:36 -04'00' Date: _______