Science, Service, Stewardship

2016 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

ERRATA

11/2/2016: For clarification, the last paragraph on page 36 has been revised to read:
Sockeye Salmon (both listed and unlisted) were the most impacted species with roughly 200,000 adults (based on dam counts) of approximately 500,000 adults passing Bonneville Dam being lost in the lower Columbia River (to McNary Dam). Adults – especially those that were transported as juveniles -- were impacted in this reach to a much greater extent than were unlisted sockeye from the upstream Columbia River tributaries. Losses of Snake River Sockeye Salmon were also substantial in the lower Snake River. In total, PIT-tag estimates indicate that less than 90% of adult Snake River sockeye salmon passing Bonneville Dam reached Lower Granite Dam.

5-Year Review: Snake River Species

Species Reviewed	Evolutionarily Significant Unit(s) or Distinct Population Segment
Sockeye Salmon (*Oncorhynchus nerka*)	*Snake River Sockeye*
Chinook Salmon (*O. tshawytscha*)	*Snake River Spring/Summer Chinook* *Snake River Fall-run Chinook*
Steelhead (*O. mykiss*)	*Snake River basin Steelhead*

This page intentionally left blank

Table of Contents

This page intentionally left blank.

Contributors West Coast Region (alphabetical)

Craig Busack
1201 NE Lloyd Blvd, Suite 1100
Portland, OR 97232
503-230-5412
Craig.Busack@noaa.gov

Rob Clapp
1201 NE Lloyd Blvd, Suite 1100
Portland, OR 97232
503-231-2314
Robert.Clapp@noaa.gov

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

Brett Farman
1201 NE Lloyd Blvd
Portland, OR 97232
503-231-6222
Brett.Farman@noaa.gov

Chad Fealko
1205 South Challis Street
Salmon, ID 83467
208-756-5105
Chad.Fealko@noaa.gov

Rosemary Furfey
1201 NE Lloyd Blvd
Portland, OR 97232
503-231-2149
Rosemary.Furfey@noaa.gov

Bob Ries
220 E 5th
Moscow, ID 83530
208-882-6148
Bob.Ries@noaa.gov

Elizabeth Gaar
1201 NE Lloyd Blvd, Suite 1100
Portland, OR 97232
503-230-5434
Elizabeth.Gaar@noaa.gov

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

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

Mark Lacy
3502 Highway 30
La Grande, OR 97850
541-975-1835
Mark.Lacy@noaa.gov

Bill Lind
800 Park Blvd., Suite 220
Boise, ID 83712
208-378-5697
Bill.Lind@noaa.gov

David Mabe
800 Park Blvd., Suite 220
Boise, ID 83712
208-378-5698
David.Mabe@noaa.gov

Enrique Patino
7600 Sand Point Way NE
Seattle, WA 98115
206-526-4655
Enrique.Patino@noaa.gov

Scott Rumsey
1201 NE Lloyd Blvd
Portland, OR 97232
503-872-2791
Scott.Rumsey@noaa.gov

Johnna Sandow
800 Park Blvd., Suite 220
Boise, ID 83712
208-378-5737
Johnna.Sandow@noaa.gov

Northwest Fisheries Science Center (alphabetical)

Tom Cooney
1201 NE Lloyd Blvd, Suite 1100
Portland, OR 97232
503-231-6888
Tom.Cooney@noaa.gov

Mike J. Ford, PhD
2725 Montlake Blvd East
East Building
Seattle, WA 98112-2097
206-860-5612
Mike.Ford@noaa.gov

1. General Information

1.1 Introduction

Many West Coast salmon and steelhead (*Oncorhynchus* spp.) stocks have declined substantially from their historical numbers and now are at a fraction of their historical abundance. Several factors contribute to these declines, including: overfishing, loss and degradation 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 five years. After completing this review, the Secretary must determine if any species should be: (1) removed from the list; (2) have its status changed from threatened to endangered; or (3) have its status changed from endangered to threatened. The most recent listing determinations for most salmon and steelhead occurred in 2005 and 2006. This document describes the results of the agency's 5-year review of the ESA-listed salmonid species in the Snake River basin. These include: Snake River Sockeye Salmon, Snake River spring/summer Chinook salmon, Snake River fall-run Chinook salmon, and Snake River steelhead.

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 distinct population segments of salmon species 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" (ESU) within their species. We consider a group of populations to be an ESU if it is substantially reproductively isolated from other populations, and represents an important component in the evolutionary legacy of the biological species. We consider an ESU as constituting a DPS and therefore a "species" under the ESA.

To identify DPSs of steelhead, we apply the joint U.S. Fish and Wildlife Service-National Marine Fisheries Service DPS policy (61 FR 4722) rather than the ESU policy. 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 the 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 and steelhead DPSs. On August 15, 2011, we published our status reviews and listing determinations for 11 ESUs of Pacific salmon and 6 DPS of steelhead (76 FR 50448).

1.2 Methodology Used to Complete the Review

On February 6, 2015 , we announced the initiation of 5-year reviews for 17 ESUs of salmon and 11 DPSs of steelhead in Oregon, California, Idaho, and Washington (80 FR 6695). We requested that the public submit new information on these species that has become available since our 2011 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 five 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 population viability criteria for the salmon and steelhead species. They also considered any new information available on the composition of the ESUs and DPS. At the end of this process, the science teams prepared reports detailing the results of their analyses (NWFSC 2015).

To further inform the reviews, we also asked our West Coast Region salmon management biologists familiar with hatchery programs to consider new information available since the previous listing determinations. Among other things, they considered whether any hatchery programs have ended, whether new hatchery programs have started, any 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. They produced a report (Jones 2015) describing their findings.

In preparing this report for ESA-listed Snake River basin salmon and steelhead, we considered the best available information, including the work of the Northwest Fisheries Science Center (NWFSC 2015); the report of the regional biologists regarding hatchery programs (Jones 2015); recovery plans for the species in question; technical reports prepared in support of recovery plans for the species in question; the listing record (including designation of critical habitat and adoption of protective regulations); recent biological opinions issued for ESA-listed Snake River basin salmon and steelhead; and information submitted by the public, tribes, and government agencies. Finally, we consulted our NMFS biologists and other salmon management specialists who are familiar with habitat conditions, hydropower operations, and harvest management. This status review 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

80 FR 6695; February 6, 2015.

1.3.2 Listing history

Beginning in 1991, NMFS began listing salmonid species in the Snake River basin under the ESA. Over the next several years, four species of salmonids in this area were listed as threatened or endangered (Table 1).

Table 1. Summary of the listing history under the Endangered Species Act for ESUs and DPS in the Snake River basin.

Salmonid Species	ESU/DPS Name	Original Listing	Revised Listing(s)
Sockeye Salmon (*O. nerka*)	Snake River Sockeye Salmon	**FR Notice:** 56 FR 58619 **Date:** 11/20/1991 **Classification:** Endangered	**FR Notice:** 70 FR 37160 **Date:** 6/28/2005 **Classification:** Endangered
Chinook Salmon (*O. tshawytscha*)	Snake River Spring/ Summer-Run Chinook salmon	**FR Notice:** 57 FR 14653 **Date:** 4/22/1992 **Classification:** Threatened	**FR Notice:** 70 FR 37160 **Date:** 6/28/2005 **Classification:** Threatened
Chinook Salmon (*O. tshawytscha*)	Snake River Fall-Run Chinook Salmon	**FR Notice:** 57 FR 14653 **Date:** 4/22/1992 **Classification:** Threatened	**FR Notice:** 70 FR 37160 **Date:** 6/28/2005 **Classification:** Threatened
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 of listing, if they contain physical or biological features essential to conservation, and those features may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by the species at the time of listing if the agency determines that the area itself is essential for conservation. We designated critical habitat for Snake River Sockeye Salmon and fall-run Chinook salmon in 1993. Critical habitat was designated for Snake River spring/summer Chinook salmon and steelhead in 1999 and 2005, respectively.

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, 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 including regulations that prohibit take (ESA section 4(d)). In 2000, NMFS adopted 4(d) regulations for threatened salmonids that prohibits take except in specific circumstances. In 2005, we revised our 4(d) regulations to take into account our hatchery listing policy.

Table 2. Summary of rulemaking for 4(d) protective regulations and critical habitat for ESUs and DPS in the Snake River basin.

Salmonid Species	ESU/DPS Name	4(d) Protective Regulations	Critical Habitat Designations
Sockeye Salmon (*O. nerka*)	Snake River Sockeye Salmon	ESA section 9 prohibitions apply	**FR Notice:** 58 FR 68543 **Date:** 12/28/1993
Chinook Salmon (*O. tshawytscha*)	Snake River Spring/ Summer-Run Chinook Salmon	**FR Notice:** 65 FR 42422 **Date:** 7/10/2000 **Revised:** 6/28/2005 **(**70 FR 37160)	**FR Notice:** 58 FR 68543 **Date:** 12/28/1993 **Revised:** 10/25/1999 **(**64 FR 57399)
Chinook Salmon (*O. tshawytscha*)	Snake River Fall-Run Chinook Salmon	**FR Notice:** 65 FR 42422 **Date:** 7/10/2000 **Revised:** 6/28/2005 **(**70 FR 37160)	**FR Notice:** 58 FR 68543 **Date:** 12/28/1993
Steelhead (*O. mykiss*)	Snake River Basin Steelhead	**FR Notice:** 65 FR 42422 **Date:** 7/10/2000 **Revised:** 6/28/2005 **(**70 FR 37160)	**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 listed salmon and steelhead in the Snake River basin. These assessments include status reviews conducted by our Northwest Fisheries Science Center and technical reports prepared in support of recovery planning for these species.

Table 3. Summary of previous scientific assessments for the ESUs and DPS in the Snake River basin.

Salmonid Species	ESU/DPS Name	Document Citation
Sockeye Salmon (*O. nerka*)	Snake River Sockeye Salmon	NWFSC 2015 Ford et al. 2011 ICTRT 2007 Good et al. 2005 McClure et al. 2003 ICTRT 2003 Waples et al. 1991
Chinook Salmon (*O. tshawytscha*)	Snake River Spring/ Summer Chinook Salmon	NWFSC 2015 Ford et al. 2011 ICTRT 2007 ICTRT and Zabel 2007 Good et al. 2005 McClure et al. 2003 ICTRT 2003 Myers et al. 1998 Matthews et al.1991
Chinook Salmon (*O. tshawytscha*)	Snake River Fall-Run Chinook Salmon	NWFSC 2015 Ford et al. 2011 ICTRT 2007 ICTRT and Zabel 2007 Good et al. 2005 McClure et al. 2003 ICTRT 2003 NMFS 1999 Waples et al. 1991
Steelhead (*O. mykiss*)	Snake River Basin Steelhead	NWFSC 2015 Ford et al. 2011 ICTRT 2007 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

For recovery plan development, implementation, and resource allocation, we assess three criteria to determine a species' recovery priority number from 1 (high) to 12 (low): (1) magnitude of threat; (2) recovery potential; and (3) conflict with development projects or other economic activity. NMFS re-evaluated the recovery priority numbers for listed species as part of the FY2013-FY2014 ESA Biennial Report to Congress (NMFS 2015a). As a result of the re-evaluation the following priority numbers were assigned: Snake River Sockeye Salmon - 5; Snake River Spring/Summer Chinook salmon - 9; Snake River fall-run Chinook salmon - 9; and Snake River steelhead - 9. Table 4 lists these current recovery priority numbers for the subject species, as reported in NMFS 2015a. Regardless of a species' recovery priority number, NMFS remains committed to continued efforts to recover all ESA-listed species under our authority.

1.3.6 Recovery Plan or Outline

Table 4. Recovery Priority Number and Endangered Species Act Recovery Plans for the ESUs and DPSs in the Snake River basin.

Salmonid Species	ESU/DPS Name	Recovery Priority Number	Recovery Plans/Outline
Sockeye Salmon (*O. nerka*)	Snake River Sockeye Salmon	5	Title: ESA Recovery Plan for Snake River Sockeye Salmon (*Oncorhynchus nerka*) June 8, 2015 (80 FR 32365) Available at: http://www.nmfs.noaa.gov/pr/recovery/plans/snake_river_sockeye_recovery_plan_june_2015.pdf
Chinook Salmon (*O. tshawytscha*)	Snake River Spring/ Summer Chinook Salmon	9	Under Development

Salmonid Species	ESU/DPS Name	Recovery Priority Number	Recovery Plans/Outline
Chinook Salmon (*O. tshawytscha*)	Snake River Fall-Run Chinook Salmon	9	Title: Proposed ESA recovery Plan for Snake River Fall Chinook Salmon (*Oncorhynchus tshawytscha*) October 2015 (80 FR 67389) Available at: http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/snake_river/snake_river_fall_chinook_recovery_plan.html
Steelhead (*O. mykiss*)	Snake River Basin Steelhead	9	Under Development

2. Review Analysis

In this section we review new information to determine whether the species' delineations remain 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 Sockeye Salmon	X	
Snake River Spring/Summer Chinook Salmon	X	
Snake River Fall-Run Chinook Salmon	X	
Snake River Basin Steelhead	X	

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

ESU/DPS Name	YES	NO
Snake River Sockeye Salmon	X	
Snake River Spring/Summer Chinook Salmon	X	
Snake River Fall-Run Chinook Salmon	X	
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 Sockeye Salmon	X		11/20/1991
Snake River Spring/Summer Chinook Salmon	X		04/22/1992
Snake River Fall-Run Chinook Salmon	X		04/22/1992
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 DPS policy standards?

In 1991, NMFS issued a policy on how the agency would delineate DPSs of Pacific salmon for listing consideration under the Endangered Species Act (ESA) (56 FR 58612). Under this policy a group of Pacific salmon populations is considered an “evolutionarily significant unit” (ESU) if it is substantially reproductively isolated from other con-specific populations, and it represents 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 Snake River Basin 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 Snake River basin ESUs/DPSs

ESU/DPS Composition

This section provides a summary of information presented in NWFSC 2015: *Status Review Update for Pacific Salmon and Steelhead Listed Under the Endangered Species Act: Pacific Northwest.*

The Northwest Fisheries Science Center team found no new information since the last status review that would justify a change in the composition of the Snake River Sockeye Salmon ESU, Snake River spring/summer Chinook salmon ESU, Snake River fall-run Chinook salmon ESU, or the Snake River basin steelhead DPS (NWFSC 2015).

Membership of Hatchery Programs

In preparing this report, our management biologists reviewed the available information regarding hatchery membership of these ESUs and DPS (Jones 2015). They considered changes in hatchery programs that occurred since the last status 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 population membership. NMFS intends to address any needed changes and corrections via separate rulemaking subsequent to the completion of these 5-year status reviews.

Five lakes in the Sawtooth Valley of central Idaho historically contained anadromous Sockeye Salmon: Alturas, Pettit, Redfish, Stanley, and Yellowbelly Lakes. Currently, only the Redfish Lake population, supported by a captive broodstock program, is considered extant as described in NMFS’ 2015 ESA Recovery Plan for Snake River Sockeye Salmon (80 FR 32365; June 8, 2015; NMFS 2015b). Artificially propagated Sockeye Salmon from the Redfish Lake Captive Propagation program are considered part of this ESU. In 1993 NMFS determined that the residual population of Snake River Sockeye Salmon that exists in Redfish Lake is substantially reproductively isolated from kokanee (i.e., non-anadromous populations *of O. nerka* that become resident in lake environments over long periods of time), represents an important component in the evolutionary legacy of the biological species, and thus was included in the Snake River Sockeye Salmon ESU (70 FR 37160). As described in the Recovery Plan, the existing captive broodstock program will transition to a recolonization phase with the development of expanded smolt production through Idaho Department of Fish and Game's new Springfield Sockeye Salmon Hatchery program opened in 2013. Jones (2015) did not recommend further review of these hatchery programs.

The Snake River fall-run Chinook ESU includes all naturally spawned populations of fall-run Chinook salmon in the mainstem Snake River below Hells Canyon Dam, and in the Tucannon River, Grande Ronde River, Imnaha River, Salmon River, and Clearwater River subbasins (57 FR 14653, April 22, 1992; 57 FR 23458, June 3, 1992; NMFS 2015c). Four artificial propagation programs are considered to be part of the ESU: the Lyons Ferry Hatchery, Fall Chinook Acclimation Ponds Program, Nez Perce Tribal Hatchery, and Oxbow Hatchery fall-run Chinook hatchery programs (70 FR 37160).

Although the Snake River fall-run Chinook salmon hatchery programs have not changed substantially since the previous ESA status review, Jones (2015) recommended monitoring these programs. Ongoing use of composite broodstock for all programs and low levels of natural-origin fish incorporated into the broodstock may lead to divergence from the listed natural-origin population.

The Snake River spring/summer Chinook salmon ESU includes all naturally spawned populations of spring/summer Chinook salmon in the mainstem Snake River and the Tucannon River, Grande Ronde River, Imnaha River, and Salmon River subbasins (57 FR 23458; June 3, 1992). In the current listing, fifteen artificial propagation programs are also considered to be part of the ESU: the Tucannon River conventional Hatchery, Tucannon River Captive Broodstock Program, Lostine River, Catherine Creek, Lookingglass Hatchery Reintroduction Program (Catherine Creek stock), Upper Grande Ronde, Imnaha River, Big Sheep Creek, McCall Hatchery, Johnson Creek Artificial Propagation Enhancement, Lemhi River Captive Rearing Experiment, Pahsimeroi Hatchery, East Fork Captive Rearing Experiment, West Fork Yankee Fork Captive Rearing Experiment, and the Sawtooth Hatchery spring/summer-run Chinook hatchery programs. We determined that these artificially propagated stocks are 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 37160).

Since the listing, Jones (2015) identified several Snake River spring/summer Chinook salmon hatchery programs that have been revised or may warrant further review. Three hatchery programs in the Salmon River basin (the Lemhi River, East Fork Salmon River, and West Fork Yankee Fork Salmon River captive rearing experiments) were terminated in 2009 and are no longer included as part of the ESU (79 FR 20802; April 14, 2014). There are three new spring/summer Chinook salmon programs (Yankee Fork, Panther, and Dollar Creek) in the upper Salmon River that should be considered for inclusion in the ESU because they were initiated with currently listed stocks and the propagated fish are being released within the ESU's range (Jones 2015). These are recommended changes based on this 5-year review and Jones 2015 and the changes will occur when NMFS completes subsequent rulemaking.

Jones (2015) recommends changing the Salmon Steelhead and Hatchery Assessment Group (SSHAG) categories of three programs that are part of the Snake River spring/summer Chinook salmon ESU. The Lookingglass program was not originally assigned a SSHAG category, and is now assigned to category 1b because the stock is local and integrated into the reestablished population. Similarly, McCall and Pahsimeroi Hatcheries transitioned to integrated broodstock (rather than segregated) and were both changed to category 1a. Additionally, Jones (2015) recommends updating SSHAG categories of unlisted spring Chinook propagated for release in the Clearwater River basin at the Dworshak, Kooskia, Clearwater, and Nez Perce Tribal hatcheries; however, they all remain unlisted because there is no ESA-listed population of spring Chinook in the Clearwater River basin.

In addition, Jones (2015) recommended further review of two existing programs in the Snake River spring/summer Chinook salmon ESU. The Imnaha River hatchery program warrants further review because of shifts in age structure and run timing, combined with decreasing natural-origin contribution in both broodstock and natural spawners. The Big Sheep Creek hatchery program also warrants further review because it is an extension of the Imnaha hatchery program composed of excess Imnaha hatchery broodstock and does not have defined goals. The program has unknown impacts on the natural population in this watershed.

The Snake River steelhead DPS includes all naturally spawned populations of steelhead originating below natural and manmade impassable barriers from the Snake River basin (62 FR 43937; August 18, 1997). Six artificial propagation programs are also considered part of the DPS: the Tucannon River, Dworshak National Fish Hatchery, Lolo Creek, North Fork Clearwater, East Fork Salmon River, and the Little Sheep Creek/Imnaha River Hatchery steelhead hatchery programs (71 FR 834; January 5, 2006).

Jones (2015) recommends changing the SSHAG categories of three Snake River steelhead programs, and adding them to the DPS. These three programs are B-run steelhead programs in the East Fork Salmon River, Squaw Creek, and Little Salmon River. The programs all use Dworshak B-run broodstock which is listed in the Clearwater River basin and included in the DPS. Though these three programs release fish into the Salmon River basin, the broodstock are sourced from the Dworshak program (where they are listed and part of the DPS). The proposed change would clarify the listing status of all fish from this brood source as listed regardless of their release location.

Previously, Jones (2011) recommended further review of four existing programs in the Snake River steelhead DPS. Three of these existing hatchery programs are still recommended for further review because of practices where no natural-origin fish are being used for broodstock: the Dworshak National Fish Hatchery program, Lolo Creek program on the Clearwater River, and the North Fork Clearwater hatchery program. Additionally, the Little Sheep Creek/Imnaha River hatchery is still recommended for further review because of the potential for divergence based on decreasing natural-origin influence and unknown impact on the natural-origin population. These reviews are on-going. No current Snake River basin steelhead hatchery programs have been terminated since the time of the last status review.

2.2 Recovery Criteria

The ESA requires that NMFS develop recovery plans for each listed species. Recovery plans must contain, to the maximum extent practicable, objective measureable criteria for delisting the species, site-specific management actions necessary to recover the species, and time and cost estimates for implementing the recovery plan.

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

ESU/DPS Name	YES	NO
Snake River Sockeye Salmon	X	
Snake River Spring/Summer Chinook Salmon		X
Snake River Fall-Run Chinook Salmon		X
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 Sockeye Salmon	X	
Snake River Spring/Summer Chinook Salmon*	X	
Snake River Fall-Run Chinook Salmon*	X	
Snake River Basin Steelhead*	X	

* The recovery criteria reflect the best available information, but are recommendations only at this point, as they have not yet been adopted in a final recovery plan.

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

ESU/DPS Name	YES	NO
Snake River Sockeye Salmon	X	
Snake River Spring/Summer Chinook Salmon	N/A	N/A
Snake River Fall-run Chinook Salmon*	X	
Snake River Basin Steelhead	N/A	N/A

* The recovery criteria reflect the best available information, but are recommendations only at this point, as they have not yet been adopted in a final recovery plan.

2.2.3 List the recovery criteria as they appear in the recovery plan

In order to present the recovery criteria as they appear in adopted, proposed, or draft recovery plans for the four ESA-listed salmon and steelhead species in the Snake River basin, this section will include the following:

- An update on the status of each recovery plan and a brief description of the relevant recovery criteria;
- An explanation of the relationship between population structure of the different species and recovery criteria based on the Interior Columbia Technical Recovery Team (ICTRT) recovery criteria recommendations; and
- A summary of the recovery criteria from each adopted, proposed, or draft recovery plan.

Status of recovery plan adoption

NMFS adopted the Snake River Sockeye Salmon Recovery Plan on June 8, 2015 (80 FR 32365; NMFS 2015b), which includes recovery criteria. On November 2, 2015, NMFS released the proposed Snake River Fall Chinook Salmon Recovery Plan, including proposed recovery criteria, for public review and comment (NMFS 2015c). The proposed Snake River Spring/Summer Chinook Salmon and Steelhead Recovery Plan, including proposed recovery criteria, will be finalized for public review and comment in 2016.

Population structure and recovery criteria

An understanding of salmon and steelhead population structure and the status of these populations is the foundation for developing recovery criteria. Salmon and steelhead typically exhibit a metapopulation structure (Schtickzelle and Quinn 2007; McElhany et al. 2000). 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. For the purposes of recovery planning and development of recovery criteria, the ICTRT identified independent populations for each Snake River ESA-listed species, and grouped them together into genetically similar major population groups (MPGs) (ICTRT 2003).

The ICTRT also developed specific biological viability criteria for application at the ESU/DPS, MPG, and independent population scales (ICTRT 2007). The viability criteria are based on the VSP concept (McElhany et al. 2000). The ICTRT report identified population-specific biological viability criteria for each of the individual populations within the MPGs, and for each ESU and DPS. These criteria are integrated to develop a total population viability rating. The population viability ratings, in order of increasing risk, are highly viable, viable, moderate risk and high risk. A further bifurcation occurs at the moderate risk rating. Populations rated at moderate risk are candidates for achieving a "maintained" status. Additional criteria to be identified in the recovery plan must be met before a population at moderate risk can be considered "maintained." Populations that do not meet these additional criteria would remain rated at moderate risk and would generally not contribute to viability at the MPG level.

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." The Snake River recovery plans will recognize 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.

The ICTRT recovery criteria are hierarchical in nature, with ESU/DPS-level criteria being based on the status of natural-origin fish assessed at the population level. A detailed description of the ICTRT viability criteria and their derivation (ICTRT 2007) can be found at www.nwfsc.noaa.gov/trt/col/trt_viability.cfm. Under the ICTRT approach, population-level assessments are based on a set of metrics designed to evaluate risk across the four viable salmonid population elements – abundance, productivity, spatial structure, and diversity (McElhany et al. 2000). The ICTRT approach calls for comparing estimates of current natural-origin abundance (measured as a 10-year geometric mean of natural-origin spawners) and productivity (estimate of return-per-spawner at low to moderate parent spawning abundance) against predefined viability curves. In addition, the ICTRT developed a set of specific criteria (metrics and example risk thresholds) for assessing the spatial structure and diversity risks based on current information representing each specific population. The ICTRT viability criteria are generally expressed relative to particular risk threshold - low risk is defined as less than a 5% risk of extinction over a 100-year period and very low risk as less than a 1% probability over the same time period.

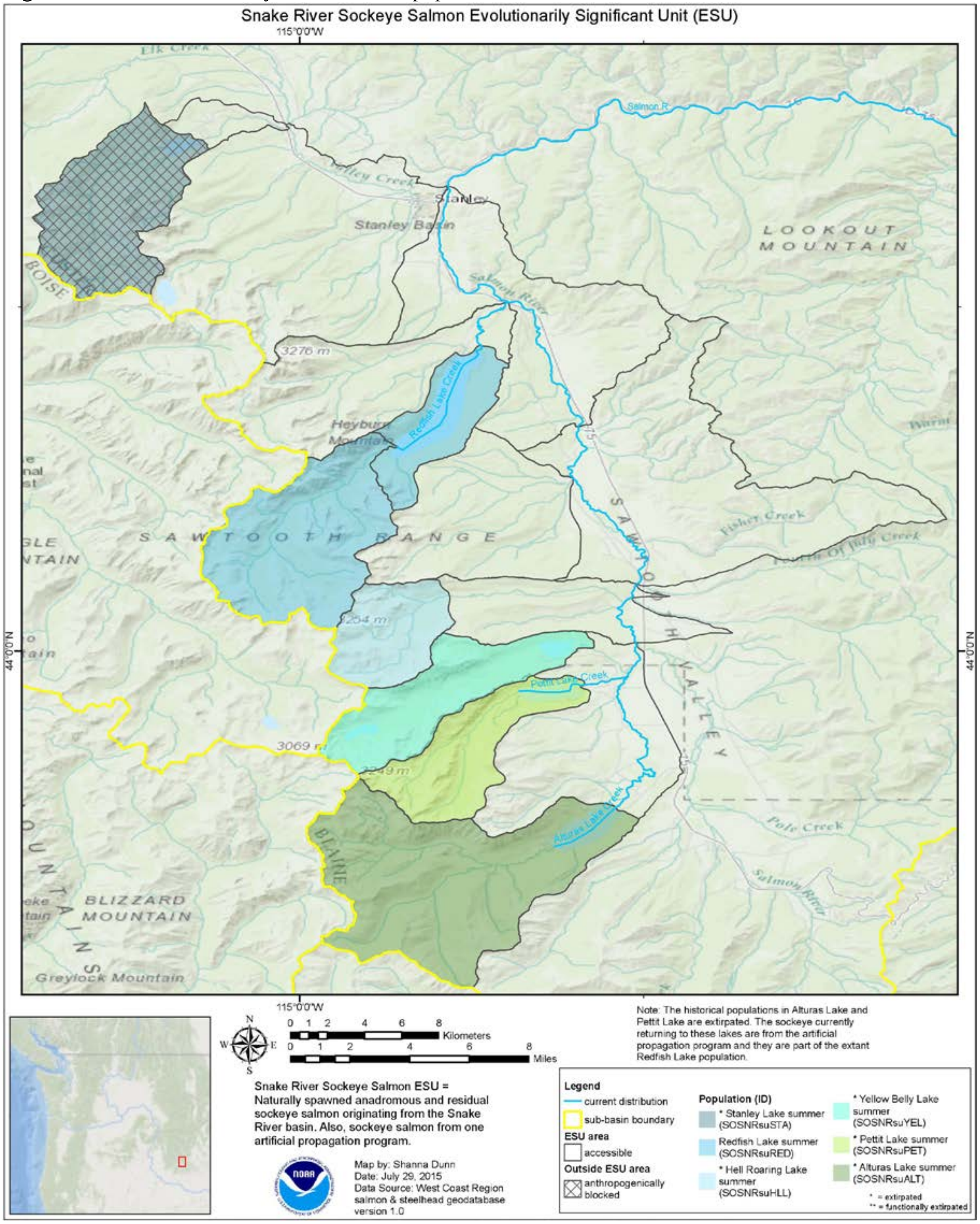
The ICTRT recommends that each extant MPG should include viable populations totaling at least half of the populations historically present, with all major life-history groups represented. In addition, the viable populations within an MPG should include proportional representation of the large and very large populations that were present historically. Within any particular MPG, there may be several alternative combinations of populations that could satisfy the ICTRT criteria. The ICTRT identified example scenarios described below that would satisfy the criteria for all extant MPGs (ICTRT 2007). In each case the remaining populations in an MPG should be at or above maintained status.

The following ICTRT recommended MPG-level scenarios are consistent with the ICTRT biological criteria for each ESU/DPS and were used or will be used to develop proposed recovery strategies for each ESA-listed salmon and steelhead species in the Snake River recovery plans. The recovery scenario presented below for Snake River Sockeye Salmon is part of the adopted recovery plan. The recovery scenario for Snake River fall Chinook is part of the proposed recovery plan, and the scenarios for Snake River spring/summer Chinook and steelhead are not final and may be modified prior to notification for public review in the draft plan that is currently being written by NMFS.

Snake River Sockeye Salmon

Sockeye Salmon are native to the Snake River basin and historically were abundant in several lake systems in Idaho and Oregon. Today, the last remaining Snake River Sockeye Salmon spawn in Sawtooth Valley lakes high in the Salmon River drainage of the Snake River basin in Idaho. Five lakes in the Sawtooth Valley historically contained anadromous Sockeye Salmon: Alturas, Pettit, Redfish, Stanley, and Yellowbelly Lakes. Currently, only the Redfish Lake population, supported by a captive broodstock program, is considered extant. However, reintroduction efforts have been ongoing in Redfish Lake since 1993, Pettit Lake since 1995, and Alturas Lake since 1997 with Redfish Lake stock. The ESU includes all anadromous and residual Sockeye Salmon from the Snake River Basin, Idaho, as well as artificially propagated Sockeye Salmon from the Redfish Lake captive broodstock program. The ESU was first listed as endangered under the ESA in 1991; the listing was reaffirmed in 2005 and 2013 (Figure 1). An ESA recovery plan for the Snake River Sockeye Salmon ESU was adopted by NMFS in June 2015 (NMFS 2015b).

Figure 1. Snake River Sockeye Salmon ESU population structure.



The map above generally shows the accessible and historically accessible areas for the Snake River Sockeye Salmon. The area displayed is consistent with the regulatory description of the boundaries of the Snake River Sockeye Salmon found at 50 CFR17.11, 223.102, and 224.102. Actions outside the boundaries shown can affect this ESU. Therefore, these boundaries do not delimit the entire area that could warrant consideration in recovery planning or determining if an action may affect this ESU for the purposes of the ESA.

To develop the biological viability criteria, the ICTRT adapted its approach to accommodate the biological characteristics and available data for Snake River Sockeye Salmon. Redfish Lake is approximately 62% of the size of Lake Wenatchee in the Upper Columbia Basin, yet the other

Sawtooth Valley lakes are relatively small compared to other lake systems in the Columbia Basin that historically supported Sockeye Salmon production. The ICTRT developed a general approach for assigning individual populations to one of four size categories based on historical habitat intrinsic potential. For Sockeye Salmon, intrinsic potential was estimated in terms of lake surface area based on relationships reported for Sockeye Salmon lakes in Alaska and Canada. Stanley, Pettit, and Yellowbelly Lakes are assigned to the smallest size category. Redfish and Alturas Lakes fall into the next size category – intermediate.

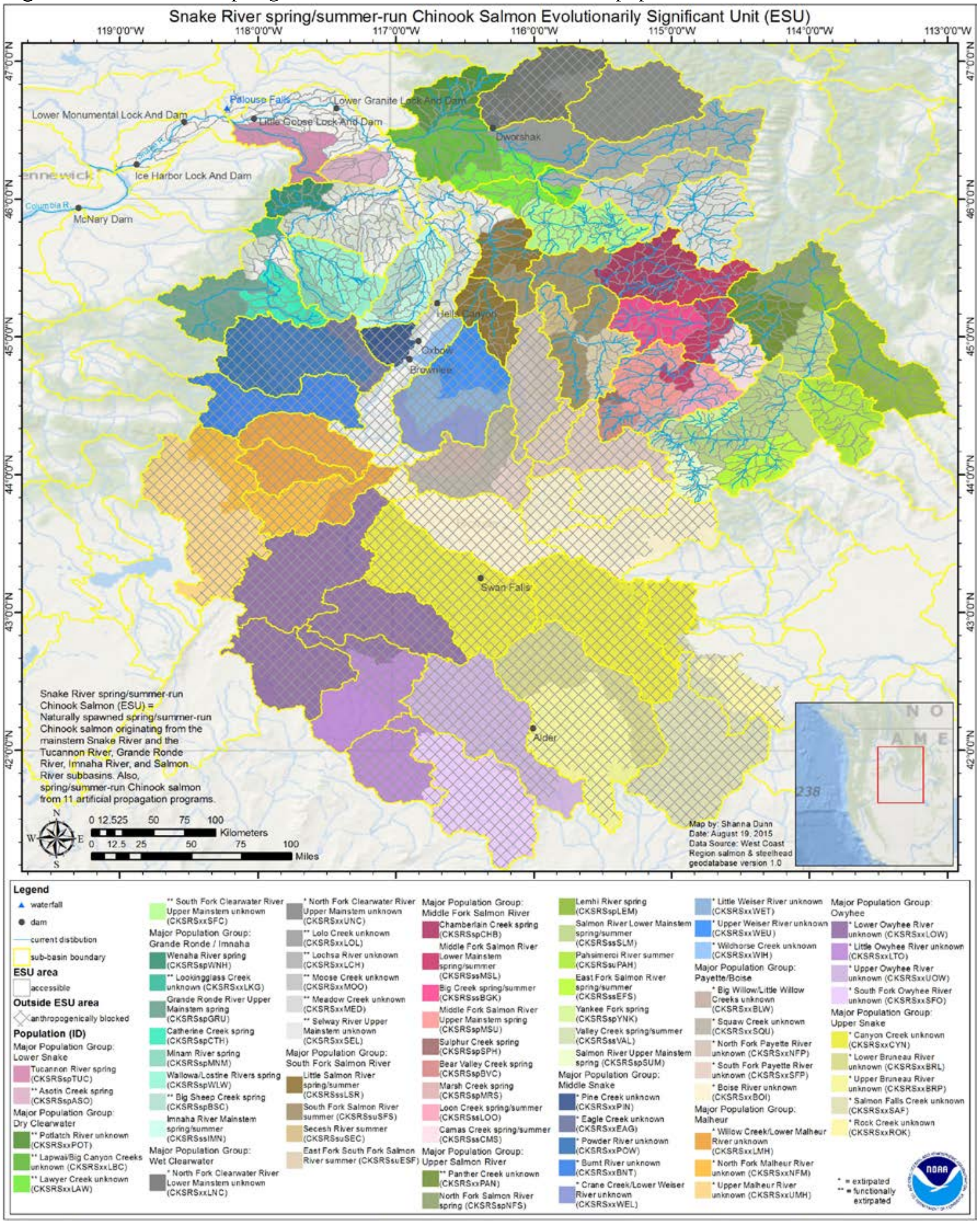
The ICTRT developed viability curves that used quantitative metrics to evaluate the abundance and productivity of the populations. The ICTRT set the minimum spawning abundance threshold at 1,000 natural-origin spawners, measured as a ten-year geometric mean, for the Redfish and Alturas Lake populations, and 500 natural-origin spawners for the smaller Pettit, Yellowbelly, and Stanley Lake populations. For Snake River Sockeye Salmon, the ICTRT determined that risks to ESU life history diversity and spatial structure could be diminished by reestablishing or reintroducing independent Sockeye Salmon populations to Alturas and Pettit Lakes, and possibly eventually into Stanley or Yellowbelly Lakes. Risks to ESU life history patterns could also be reduced by reestablishing historical life history patterns that may have been present in the natal lakes (NMFS 2015b). The Recovery Plan describes a long-term recovery scenario which includes restoring at least two of the three historical lake populations in the ESU to highly viable, and one to viable status, using Redfish Lake, Alturas Lake, and Pettit Lake. The Plan’s recommended criteria (including minimum abundance thresholds) reflect the best information currently available. However, information gained from ongoing studies of the production potential in each of the Sawtooth Valley lakes, and the rates of exchange among them, should be periodically reviewed to determine if the basic assumptions behind the current criteria remain valid, or if updates would be warranted (NMFS 2015b).

Snake River Spring/Summer Chinook Salmon

The Snake River Spring-Summer Chinook salmon ESU includes all naturally spawned populations of spring/summer-run Chinook salmon originating from the mainstem Snake River and the Tucannon River, Grande Ronde River, Imnaha River, and Salmon River subbasins, as well as fifteen artificial propagation programs. The ESU was first listed under the ESA in 1992, and the listing was reaffirmed in 2005 and 2012. This ESU has five MPGs with 28 extant populations (Figure 2).

For the Snake River Spring/Summer Chinook and Steelhead Recovery Plan, we are conducting recovery planning based upon three “management unit (MU) plans” – Idaho, Northeast Oregon, and Southeast Washington – encompassing the MPGs for each species within these three geographic areas. Each MU plan will use consistent ICTRT viability criteria recommendations, and scientific principles based on local initiatives and conditions for populations within each MPG. An ESU/DPS-level Snake River Spring/Summer Chinook and Steelhead Recovery Plan will “roll-up” the information from the three MU plans and provide additional ESA required information needed for a species-level recovery plan.

Figure 2. Snake River Spring/Summer-run Chinook Salmon ESU population structure[1]



[1] The map above generally shows the accessible and historically accessible areas for the Snake River spring/summer Chinook salmon. The area displayed is consistent with the regulatory description of the composition of the Snake River spring/summer Chinook salmon found at 50 CFR17.11, 223.102, and 224.102. Actions outside the range shown can affect this ESU. Therefore, these boundaries do not delimit the entire area that could warrant consideration in recovery planning or determining if an action may affect this ESU for the purposes of the ESA.

Lower Snake River MPG

This MPG historically contained two populations (Tucannon and Asotin); and one, Asotin Creek, is currently considered extirpated. The ICTRT basic criteria would call for both populations being restored to viable status. The ICTRT recommended that recovery planners should give priority to restoring the Tucannon River to highly viable status, and evaluate the potential for reintroducing production in Asotin Creek as recovery planning progresses.

Grande Ronde/Imnaha Rivers MPG

This MPG has eight historical populations, two of which are considered functionally extirpated – Big Sheep Creek and Lookingglass Creek. The basic ICTRT criteria call for a minimum of four populations at viable or highly viable status. The potential scenario identified by the ICTRT would include viable populations in the Imnaha River (representing important run-timing diversity), the Lostine/Wallowa River (representing a large size population), and at least one from each of the following pairs: Catherine Creek or Upper Grande Ronde River (representing large-size populations); and Minam River or Wenaha River.

South Fork Salmon River MPG

Four historical populations comprise this MPG, with two classified as large-size and two as intermediate-size populations. The South Fork Salmon River drainage contains three of the populations; the fourth lies outside of the drainage. Two of the four historical populations (one large and one intermediate) in this MPG should be at restored to viable or highly viable status for the MPG to be considered viable. The ICTRT recommends that the populations in the South Fork drainages be given priority relative to meeting MPG viability objectives given the relatively small size and the high level of potential hatchery integration for the Little Salmon River population.

Middle Fork Salmon River MPG

The ICTRT criteria call for at least five of the nine populations in this MPG to be rated as viable, with at least one demonstrating highly viable status. The ICTRT example recovery scenario included Chamberlain Creek (geographic position), Big Creek (large-size category), Bear Valley Creek, Marsh Creek, and either Loon Creek or Camas Creek. The Loon Creek and Marsh Creek populations are targeted for desired viable status, because of their geographic distribution in the MPG and historic intrinsic production potential.

Upper Salmon River MPG

This MPG included nine historical populations, one of which, Panther Creek, is considered functionally extirpated. The ICTRT example recovery scenario for this MPG includes the Pahsimeroi River (summer Chinook life history), the Lemhi River and Upper Salmon Mainstem (very large-size category), and East Fork Salmon River (large-size category) and Valley Creek.

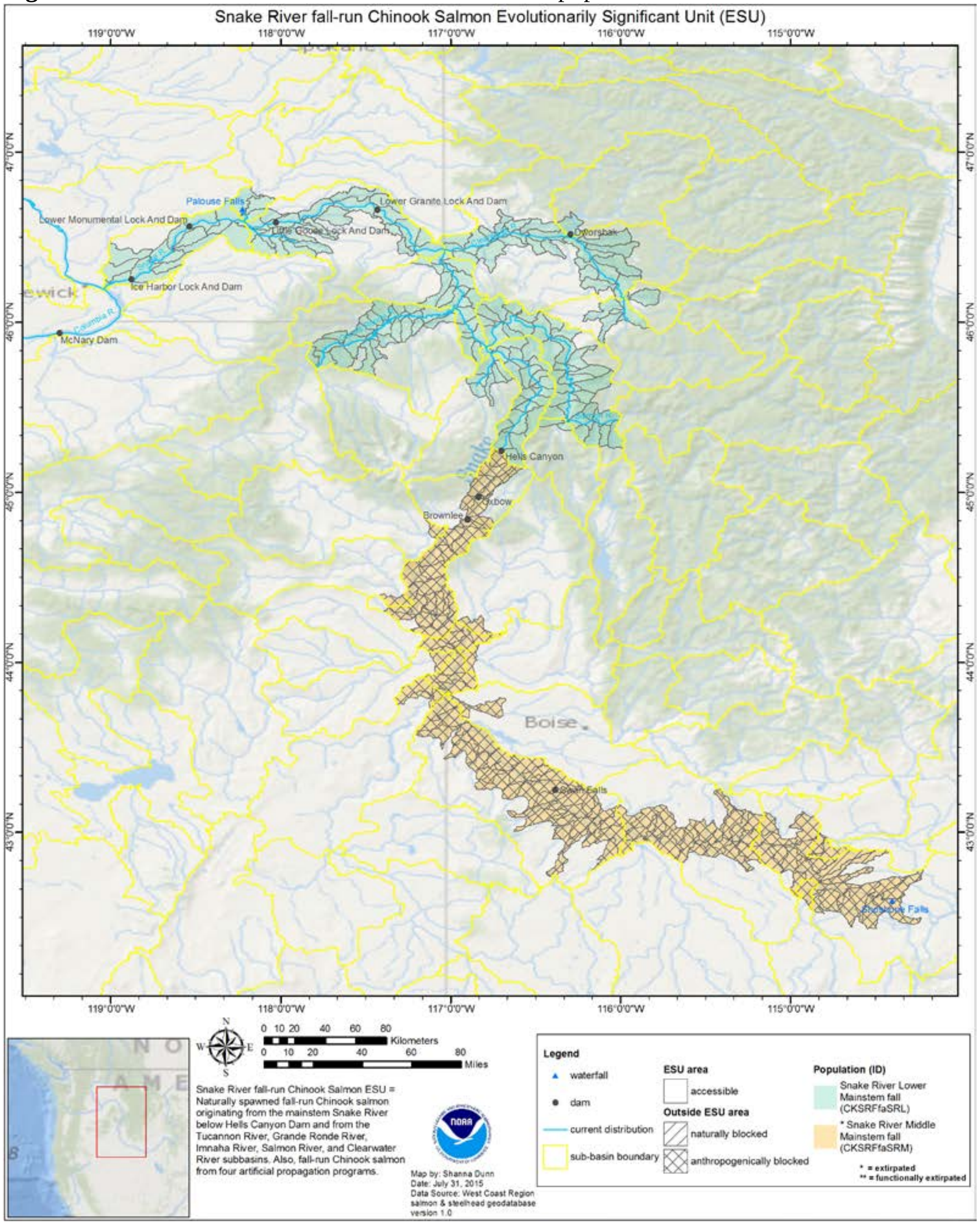
Snake River Fall-run Chinook Salmon

The Snake River fall-run Chinook salmon ESU includes one MPG with one extant population: the Lower Mainstem population (all natural-origin fall-run Chinook salmon originating from the mainstem Snake River below Hells Canyon Dam and from the Tucannon River, Grande Ronde River, Imnaha River, Salmon River, and Clearwater River subbasins) (Figure 3).

Historically, fall Chinook salmon also spawned above the Hells Canyon Dam Complex, in the middle mainstem Snake River and tributaries (ICTRT 2005; 2010). In 2005, the ICTRT identified three historical populations within the single Snake River fall-run Chinook salmon MPG: the extant Lower Mainstem Snake River population and two extirpated populations (Marsing Reach and Salmon Falls) that had spawned above the current site of Hells Canyon Dam (ICTRT 2005). Based on information submitted to NMFS by the US Fish and Wildlife Service (summarized in Connor et al. 2015) as part of this status review, NMFS determined that the two relatively continuous spawning aggregations above the current Hells Canyon Dam were more likely part of a single population (NWFSC 2015; NMFS 2015c).

The area upstream of Hells Canyon supported the majority of all Snake River fall Chinook salmon production until the area became inaccessible due to dam construction. First, construction of Swan Falls Dam in 1901 blocked access to 157 miles of historically productive fall Chinook salmon habitat in the middle Snake River downstream of Shoshone Falls, a natural barrier to further upstream migration. Construction of dams associated with the Hells Canyon Dam Complex barred the fish from remaining spawning areas in the middle mainstem reach. The loss of this upstream habitat and inundation of downstream spawning areas by reservoirs associated with the Hells Canyon Complex and the three lower Snake River dams reduced spawning habitat for the single extant population – the Lower Mainstem Snake River population – to approximately 20 percent of the area historically available (NMFS 2015c).

Figure 3. Snake River Fall-run Chinook Salmon ESU population structure.



The ICTRT concluded that the single MPG in this ESU would need to be at low risk for the ESU to be considered viable (ICTRT 2007). For that single MPG to be considered low risk, basic application of the ICTRT's criteria would require two populations to meet criteria for high viability. Meeting those criteria would require achieving highly viable status for the extant population and re-establishing the extirpated population above Hells Canyon to highly viable status. The ICTRT recognized the difficulty of re-establishing a fall-run Chinook salmon population above Hells Canyon, and suggested that initial recovery efforts emphasize improving the status of the extant population, while creating the potential for re-establishing an additional population (ICTRT 2007). The ICTRT also recognized that in general "different scenarios of

ESU recovery may reflect alternative combinations of viable populations and specific policy choices regarding acceptable levels of risk" (ICTRT 2007).

During recovery planning for Snake River fall Chinook salmon; it became apparent that the spatial complexity and size of the extant population provided opportunities to develop alternative viability scenarios as policy choices for delisting. Each scenario requires specific viability criteria designed to meet the basic set of viability objectives adopted by the ICTRT and potential metrics for measuring viability characteristics. Those alternative recovery scenarios are presented in the proposed recovery plan along with their corresponding alternative metrics for measuring viability. The scenarios provide a range of potential population characteristics that, if achieved, would indicate that the ESU has met the ESU-level objectives. The scenarios are summarized briefly below (NMFS 2015c):

Scenario A – two populations, one highly viable and the other viable: This scenario reflects the general recovery scenario alternative provided by the ICTRT. It would achieve ESU viability by improving the status of the Lower Mainstem Snake River population to highly viable and by reestablishing the extirpated Middle Snake River population above the Hells Canyon Dam Complex to viable status. The protection against catastrophic losses and the opportunities for expressing life history diversity that would be gained by a highly viable Lower Snake River population would allow for targeting a re-introduced Upper Snake River population as viable.

Scenario B – single population measured in the aggregate: Scenario B illustrates a single-population pathway to ESU viability with VSP objectives evaluated in the aggregate (population-wide), based on all natural-origin adult spawners. This single population viability scenario recognizes that the spatial complexity and the associated ability to support life history diversity of the Lower Snake River population provides an opportunity to achieve the basic ICTRT viability objectives for protection against demographic and catastrophic loss as well as providing for diversity. The scenario focuses on the extant Lower Mainstem Snake River population and would require that population to achieve highly viable status/very low risk with a high degree of certainty. In this scenario the population would need to demonstrate that it is exceeding the 1% viability curve (including the minimum abundance threshold of 3,000 natural origin spawners) plus a buffer reflecting prevalent statistical uncertainty levels.

Potential additional scenarios – natural production emphasis areas: There is a potential to develop additional single-population scenarios that would be a variation on scenario B, also taking advantage of the relative spatial complexity of the Lower Snake River population. Under these potential additional scenarios, evaluating the population relative to VSP objectives would explicitly include metrics assessing the abundance and productivity of natural-origin production coming from one or two of the five major spawning areas in the Lower Mainstem Snake River fall Chinook salmon population. These so-called "natural production emphasis areas" would have a low percentage of hatchery-origin spawners and produce a significant level of natural-origin adult spawners. Under such a scenario, the other major spawning areas could have higher acceptable levels of hatchery-origin spawners than under Scenario B. The population would need to achieve a status of highly viable with a high degree of certainty.

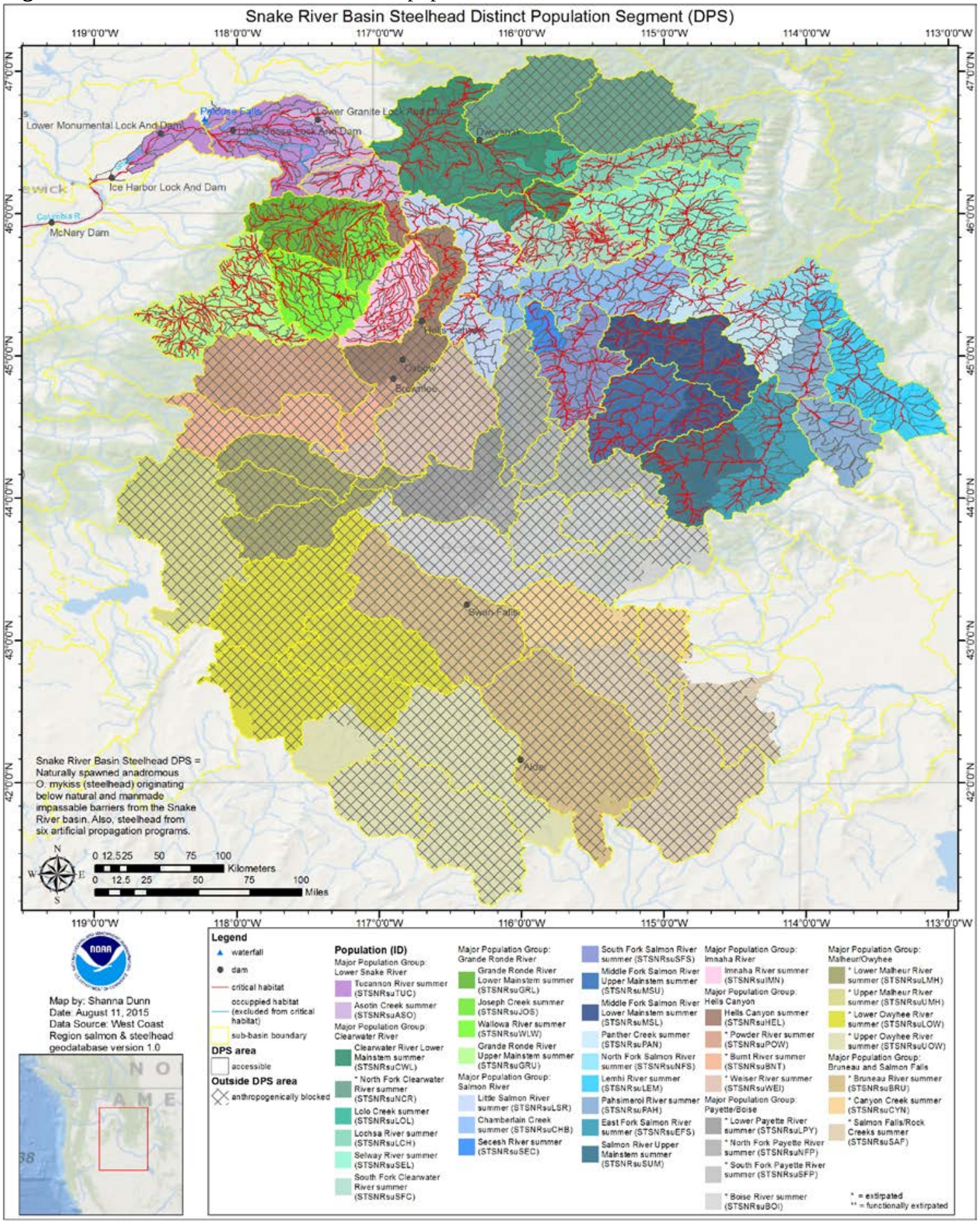
Snake River Steelhead

This DPS has six MPGs (five extant and one – Hells Canyon – with no associated independent populations) with 24 extant populations (Figure 4). The Snake River Steelhead DPS includes all naturally spawned anadromous *O. mykiss* (steelhead) populations originating below natural and manmade impassable barriers from the Snake River basin. Also steelhead from 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; January 5, 2006). This DPS was originally listed as threatened under the ESA on August 18, 1997 (62 FR 43937). This listing was reaffirmed on January 5, 2006 (71 FR 834) and again on April 14, 2014 (79 FR 20802).

For the Snake River Spring/Summer Chinook and Steelhead Recovery Plan, we are conducting recovery planning based upon three "management unit plans" – Idaho, Northeast Oregon, and Southeast Washington – encompassing the MPGs for each species within these three geographic areas. Each MU plan will use consistent ICTRT viability criteria recommendations, and scientific principles based on local initiatives and conditions for populations within each MPG. An ESU/DPS-level Snake River Spring/Summer Chinook and Steelhead Recovery Plan will "roll-up" the information from the three MU plans and provide additional ESA required information needed for a species-level recovery plan.

Snake River steelhead are classified as summer run based on their adult run timing patterns. Much of the freshwater habitat used by Snake River steelhead for spawning and rearing is warmer and drier than that associated with other steelhead DPSs. Snake River steelhead spawn and rear as juveniles across a wide range of freshwater temperature/precipitation regimes. Fisheries managers classify Columbia River summer run steelhead into two aggregate groups, A-run and B-run, based on ocean age at return, adult size at return and migration timing. A-run steelhead predominately spend one year at sea, returning to spawning areas beginning in the summer and are assumed to be associated with low to mid-elevation streams throughout the Interior Columbia basin. B-run steelhead, which begin the migration in the fall, are larger with most individuals returning after two years in the ocean.

Figure 4. Snake River basin Steelhead DPS population structure[2]



[2] The map above generally shows the accessible and historically accessible areas for the Snake River basin steelhead. The area displayed is consistent with the description of the range of the Snake River steelhead found at 50 CFR17.11, 223.102, and 224.102. Actions outside the boundaries shown can affect this DPS. Therefore, these boundaries do not delimit the entire area that could warrant consideration in recovery planning or determining if an action may affect this DPS for the purposes of the ESA.

Lower Snake MPG

The Lower Snake MPG contains two populations. The ICTRT recommends that both populations (Tucannon River and Asotin Creek) be restored to viable status, with at least one meeting the criteria for highly viable.

The overall population viability ratings for both populations reflect a combination of known conditions and uncertainties about key factors, primarily average natural-origin abundance and productivity and hatchery influences. Both populations are currently rated as maintained and at moderate risk overall, with the possibility that the Tucannon River could be at high risk for abundance and productivity. More direct estimates of natural-origin abundance and hatchery contribution rates for a series of years would be required to change ratings in future assessments (NWFSC 2015).

Grande Ronde River MPG

Two of the four populations should achieve viable status to meet the ICTRT criteria for this MPG. In addition, at least one of these populations should be rated as highly viable. Improvements in natural production are planned for all four populations in this MPG. Given their current status, it is expected that Joseph Creek and the Upper Grande Ronde River populations are the most likely to satisfy the MPG-level requirement for one highly viable and one viable population. Although the average abundance levels have dropped from the prior review period, the paired geometric mean natural-origin spawner abundance and productivity estimates for both populations exceed the 1% viability curves for their respective size categories (basic and large respectively) (NWFSC 2015).

The Grande Ronde Steelhead MPG is tentatively rated as achieving viable status. One population (Joseph Creek) is highly viable, the Upper Grande Ronde population meets the criteria for viable, and the remaining two populations are provisionally rated as maintained. Efforts are underway that might lead to population specific abundance and productivity series for those two populations and to a more explicit understanding of the relative distribution of hatchery spawners (NWFSC 2015).

Imnaha River MPG

This MPG contains one population. The Imnaha River population should meet highly viable status for this MPG to be rated as viable under the basic ICTRT criteria. Based on the information currently available, the Imnaha River steelhead population is not meeting the highly viable rating for a single population MPG called for in the draft *Recovery Plan for Northeast Oregon Snake River Spring Summer Chinook and Steelhead Populations*. Achieving a highly viable rating would require achieving a very low risk rating for abundance and productivity and a Low overall risk rating for spatial structure and diversity. There is some evidence indicating that hatchery returns to the Imnaha River population may be concentrated in particular spawning reaches (e.g., Big Sheep Creek and adjacent mainstem reaches). If this is the case and substantial production areas in the population have relatively low hatchery origin inputs, it is possible that additional years of information from the PIT-tag array project and/or refinements to the genetic stock identification program will result in improved estimates in future reviews.

Clearwater River MPG
This MPG includes five extant and one extirpated (North Fork Clearwater River) populations. Three populations must meet viability criteria, one of which must meet the criteria for high viability. The draft recovery scenario for this MPG calls for recovery of the Lower Clearwater River (large size), along with the Lochsa River and the Selway River.

Based on the updated risk assessments, the Clearwater MPG does not meet the ICTRT criteria for a viable MPG. Although the more explicit information on natural-origin spawner abundance indicates that the Lower Clearwater River, Lochsa River and Selway River populations are improved in overall status relative to prior reviews, the South Fork and Lolo Creek populations do not achieve maintained status due largely to remaining uncertainties regarding productivity and hatchery spawner composition.

Salmon River MPG
This relatively large MPG includes 12 extant populations and one extirpated population (Panther Creek). The draft NMFS Idaho MU Recovery Plan identifies six populations to prioritize for viable status across this MPG. The recovery scenario is consistent with the ICTRT recommendations and includes the two Middle Fork Salmon River populations (highest B-run proportions within the MPG), the South Fork Salmon River, Chamberlain Creek, Panther Creek and the North Fork Salmon River populations. The proposed scenario for this MPG includes consideration for historical population size as well as inclusion of populations exhibiting a range of A-run and B-run timing proportions, resulting in a distribution of viable populations across the geographical extent of the MPG.

Hells Canyon Tributaries MPG
This MPG historically contained three independent populations. However, all three of these 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 populations in the MPG it is not expected to contribute to recovery of the DPS.

2.3 Updated Information and Current Species' Status

In addition to recommending recovery criteria, the ICTRT also assessed the current status of each population of the listed salmonid ESUs and DPS within the Snake River basin. Each population was rated against the biological criteria recommended by the ICTRT identified in the final, proposed or draft recovery plans and assigned a current viability rating.

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

Information provided in this section is summarized from NWFSC (2015) - Status Review Update for Pacific Salmon and Steelhead Listed Under the Endangered Species Act: Pacific Northwest.

Snake River Sockeye Salmon

Updated Biological Risk Summary

Adult returns of Sockeye Salmon to the Sawtooth Basin continued to increase through return year 2014. Adult returns in the last seven years include 646 fish in 2008 (including 140 natural-origin fish), 832 in 2009 (including 86 natural-origin fish), 1,355 in 2010 (including 178 natural-origin fish), 1,117 in 2011 (including 145 natural-origin fish), 257 adults in 2012 (including 52 natural-origin fish), 272 adults in 2013 (including 79 natural-origin fish), and 1,579 adults in 2014 (including 453 natural-origin fish) (NMFS 2015b; NWFSC 2015). The large increases in returning adults in recent years reflect improved downstream and ocean survivals as well as increases in juvenile production since the early 1990s. Approximately two-thirds of the adults captured in each year were taken at the Redfish Lake Creek weir; the remaining adults were captured at the Sawtooth Hatchery weir on the mainstem Salmon River upstream of the Redfish Lake Creek confluence. Although total Sockeye Salmon returns to the Sawtooth Basin in recent years have been high enough to allow for some level of spawning in Redfish Lake, the hatchery program's priority is on genetic conservation and building sufficient returns to support sustained outplanting (NMFS 2015b).

At this stage of the recovery efforts for Snake River Sockeye Salmon, information on the relative survival rates for rearing and migratory life stages provides valuable insights into the potential for restoring sustainable natural production and the levels of improvement that may be necessary to accomplish production objectives. The recent increases in the availability of hatchery juveniles has allowed for tagging on a sufficient scale to generate relatively precise estimates of both juvenile and adult life stage survivals. Estimates are summarized in the NMFS Snake River Sockeye Salmon Recovery Plan (NMFS 2015b).

Juvenile outmigrant survivals from releases to Lower Granite Dam have been highly variable, with indications that most mortality is incurred prior to migrants passing the confluence of the North Fork of the Salmon River. Survivals from Lower Granite Dam to below Bonneville Dam reflect two pathways: juveniles collected and transported to below Bonneville Dam and in-river migrants. Juvenile survival from Lower Granite Dam to Bonneville Dam since 2008 has ranged from 40% to 57% (NMFS 2015b; NWFSC 2015).

Upstream adult passage survivals from Bonneville Dam to Lower Granite Dam averaged over 70% from 2010-2012, dropping off to 44% in 2013, likely in response to high temperatures during the migration period (NMFS 2015b). Adult survivals from Lower Granite Dam to the Sawtooth Basin also averaged over 70% for 2010-12, dropping off to 33% in 2013. Temperatures during the adult upstream migration in 2015 were unusually high. Preliminary estimates indicated substantial losses in both reaches with only 14% of pit-tagged fish detected at Bonneville Dam reaching McNary Dam, the last mainstem Columbia River dam before the Snake River confluence (NWFSC 2015). Preliminary indications are that survival from McNary to Lower Granite Dam and beyond were also low. The implications of this range in annual survivals for recovery efforts are uncertain and will depend on the relative frequency of passage conditions across future years. Given their particular run timing, phenotypic and behavioral characteristics, Snake River (and the unlisted Upper Columbia River) Sockeye Salmon may be particularly susceptible to high summer temperatures during their adult migration (Crozier et al. 2011).

ESU Summary

Long-term recovery objectives for this ESU are framed in terms of natural production. At this point in time, natural production of anadromous Snake River Sockeye Salmon remains limited to extremely low levels in Redfish Lake, one of five Sawtooth Valley lakes believed to have historically supported production. As a result, the overall biological status relative to recovery goals is high risk. Substantial progress has been made with the Snake River Sockeye Salmon captive broodstock based hatchery program, but natural production levels of anadromous returns remain extremely low for this ESU. In recent years sufficient numbers of eggs, juveniles, and returning hatchery adults have been available from the captive brood based program to allow for initiation of efforts to evaluate alternative supplementation strategies in support of re-establishing natural production of anadromous Sockeye Salmon (NWFSC 2015).

Limnological studies and direct experimental releases are being conducted to elucidate production potential in three of the Sawtooth Valley lakes that are candidates for Sockeye Salmon restoration. The availability of increased numbers of adults and juveniles in recent years is supporting direct evaluation of lake habitat rearing potential, juvenile downstream passage survivals, and adult upstream survivals. Although the captive broodstock program has been successful in providing substantial numbers of hatchery produced Sockeye Salmon for use in supplementation efforts, substantial increases in survival rates across life history stages must occur in order to re-establish sustainable natural production (e.g., Hebdon et al. 2004, Keefer et al. 2008). The increased abundance of hatchery-reared Snake River Sockeye Salmon reduces the risk of immediate loss, but levels of naturally produced sockeye returns remain extremely low (NWFSC 2015).

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

Snake River Spring/Summer Chinook Salmon

Updated Biological Risk Summary

A major advance since the data compilation efforts leading to the 2011 NMFS status review has been the cooperative efforts of regional fish managers to maintain regionally compatible databases using standardized formats and methods to promote efficiency and access to population-level estimates of key status indicators including spawning abundance, hatchery/natural proportions and age structure.

The majority of populations in the Snake River spring/summer Chinook salmon ESU remain at high overall risk, with one population (Chamberlain Creek in the Middle Fork Salmon River MPG) improving to an overall rating of Maintained due to an increase in abundance (NWFSC 2015). Natural-origin abundance has increased over the levels reported in the prior review for most populations in this ESU, although the increases were not substantial enough to change viability ratings. The relatively high ocean survival in recent years was a major factor in recent abundance patterns. Ten populations increased in both abundance and productivity, seven increased in abundance while their updated productivity estimates decreased, two populations decreased in abundance and increased in productivity. One population, Loon Creek in the Middle Fork Salmon River MPG, decreased in both abundance and productivity. Although all but one population in this ESU remained at high risk for abundance and productivity, there is a considerable range in the relative improvements to life cycle survivals or limiting life stage capacities required to attain viable status. In general, populations within the South Fork Salmon River grouping had the lowest gaps among MPGs. The other multiple population MPGs each have a range of relative gap levels.

Spatial structure ratings remain unchanged from the prior reviews, with low or moderate risk levels for the majority of populations in the ESU. Four populations from three MPGs (Catherine Creek and Upper Grande Ronde River, Lemhi River and Lower Middle Fork Salmon River Mainstem) remain at high risk for spatial structure loss. Three of the five MPGs in this ESU (Lower Snake River, Grande Ronde/Imnaha Rivers, and Upper Salmon River) have populations that are undergoing active supplementation with local broodstock hatchery programs. In most cases those programs evolved from mitigation efforts and include some form of sliding-scale management guidelines designed to maximize potential benefits in low abundance years and reduce potential negative impacts at higher spawning levels. Efforts to evaluate key assumptions and impacts are underway for several programs.

ESU Summary

While there have been improvements in abundance and productivity in several populations relative to prior reviews, those changes have not been sufficient to warrant a change in ESU status.

Snake River Fall-run Chinook Salmon

Updated Biological Risk Summary

The overall current risk rating for the extant Lower Mainstem Snake River fall Chinook salmon population is viable (i.e., low risk). This risk rating is based on a low risk rating for abundance/productivity and a moderate risk rating for spatial structure/diversity (NWFSC 2015; NMFS 2015c). All of the potential delisting scenarios in the proposed recovery plan would require the extant population to meet minimum requirements for highly viable status/very low risk (NMFS 2015c). Those scenarios would require at least an 80 percent certainty that the combination of abundance and productivity exceeds the 1 percent viability curve and at least a low risk rating for spatial structure/diversity (NWFSC 2015; NMFS 2015c).

The geometric mean natural-origin abundance for the most recent 10 years of annual spawner escapement estimates (2005-2014) is 6,418. Although this geometric mean escapement exceeds the buffer for statistical uncertainty in estimated abundance (approximately 4,200), the associated productivity estimates are below the requirements for high certainty of exceeding the 1% viability risk curve. Recent productivity (average recruits per spawner for low to moderate parent escapements for brood years 1990-2009 = 1.5) is lower than the proposed recovery plan criterion of 1.7 (reflects current level of uncertainty in estimating productivity). For abundance/productivity, the current risk rating of low risk reflects uncertainty about whether recent increases in abundance (driven largely by relatively high escapements in the most recent three years) can be sustained over the long run (NWFSC 2015; NMFS 2015c). More detailed life-cycle modeling based approaches are under development for this population that may address in future assessments two problematic issues with estimating its current productivity: (1) the increasingly small number of years that actually contribute to the empirical estimate of the ICTRT's productivity metric (and the concomitant statistical uncertainty), and (2) the fact that the years contributing to the estimate are now far in the past and may not accurately reflect the true productivity of the current population.

For spatial structure/diversity, the moderate risk rating was driven by changes in major life history patterns, shifts in phenotypic traits, and high levels of genetic homogeneity in samples from natural-origin returns. The rating also reflects risk associated with indirect factors, specifically the high levels of hatchery-origin spawners in natural spawning areas, and the potential for selective pressure imposed by current hydropower operations and cumulative harvest impacts (NWFSC 2015; NMFS 2015c).

To achieve the abundance/productivity risk rating consistent with the proposed delisting criteria, an increase in estimated productivity (or a decrease in the year-to-year variability associated with the estimate) would be required, and natural-origin abundance of the extant population would need to remain relatively high. An increase in productivity could occur with a further reduction in mortalities across life stages. Such an increase could be generated by actions such as a reduction in harvest impacts (particularly when natural-origin spawner return levels are below the minimum abundance threshold) and/or further improvements in juvenile survivals during downstream migration. It is also possible that survival improvements resulting from actions (e.g., more consistent flow-related conditions affecting spawning and rearing, and increased passage survivals resulting from expanded spill programs) in recent years have increased productivity, but that increase is effectively masked as a result of the relatively high spawning levels in recent years. A third general possibility is that productivity levels may be decreasing over time as a result of negative impacts of chronically high hatchery proportions across natural spawning areas. Such a decrease would also be largely masked by the high annual spawning levels (NWFSC 2015; NMFS 2015c).

In addition, to achieve highly viable status with a high degree of certainty, the spatial structure/diversity rating needs to be low risk. This status assessment used the ICTRT framework for evaluating population-level status in terms of spatial structure and diversity organized around two major goals: maintaining natural patterns for spatially mediated processes and maintaining natural levels of variation.

For a scenario incorporating natural emphasis areas, achieving low risk for spatial structure/diversity would require that one or more major spawning areas produce a significant level of natural-origin spawners with low influence by hatchery-origin spawners relative to the other major spawning areas. At present (escapements through 2014), given the widespread distribution of hatchery releases and hatchery-origin returns across the major spawning areas within the population, and the lack of direct sampling of reach-specific spawner compositions, there is no indication of a strong differential distribution of hatchery returns among major spawning areas (NWFSC 2015; NMFS 2015c).

ESU Summary

The Lower Mainstem Snake River fall Chinook salmon population is the only extant population remaining from an ESU that historically also included a population upstream of the current location of the Hells Canyon Dam Complex. Abundance of this remaining population has increased substantially in recent years, and the recent increases in natural-origin abundance are encouraging. However, uncertainty remains regarding whether these abundance levels will be maintained, and improvements are needed in the species' productivity and diversity to achieve risk levels consistent with delisting (NWFSC 2015; NMFS 2015c).

Given the combination of current ratings of low risk for abundance/productivity and moderate risk for spatial structure/diversity summarized above, the Snake River fall-run Chinook salmon ESU is rated at low risk relative to ICTRT criteria. The rating reflects ongoing uncertainty regarding the population's productivity, and whether recent increases in natural-origin abundance can be sustained over the long term. It also reflects concerns with the high levels of hatchery-origin spawners in natural spawning areas, and the potential for selective pressure imposed by current hydropower operations and cumulative harvest impacts. Overall, while new information indicates an improvement in ESU abundance, uncertainty about population productivity and diversity indicate that the biological risk category has not changed enough since the last status review to achieve the desired viability status of highly viable and support delisting (NWFSC 2015; NMFS 2015c).

Snake River Basin Steelhead

Based on new genetic stock identification (GSI) information for stock groups within this DPS, the major life history pattern designations determined by the ICTRT have been updated (NWFSC 2015). With one exception, all of the populations assigned by the ICTRT as A-run type remain the same. The former B-run population designations are revised to reflect the relative proportions of large (<78 cm) adults in the individual stock groups in the genetic assessments of natural-origin returns. The Lower Clearwater population falls into a single population stock group in the genetic analyses, although it has a relatively high potential misclassification rate. The estimated proportion of B size class adults to this group is high enough that it is provisionally classified as Low B in updating the ICTRT life history pattern assignments.

<u>Updated Biological Risk Summary</u>
Four out of the five MPGs are not meeting the specific objectives in the draft recovery plan being written by NMFS based on the updated status information available for this review, and the status of many individual populations remains uncertain (NWFSC 2015). The Grande Ronde MPG is tentatively rated as viable; 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. The additional monitoring programs instituted in the early 2000s to gain better information on natural-origin abundance and related factors have significantly improved our ability to assess status at a more detailed level. The new information has resulted in an updated view of the relative abundance of natural-origin spawners and life history diversity across the populations in the DPS. The more specific information on the distribution of natural returns among stock groups and populations indicates that differences in abundance/productivity status among populations may be more related to geography or elevation rather than being categorized as purely A-run vs. B-run. Based on these results, the major life history category designations for populations in the DPS have been updated. A great deal of uncertainty still remains regarding the relative proportion of hatchery fish in natural spawning areas near major hatchery release sites within individual populations.

<u>DPS Summary</u>
Overall, the information analyzed for this status review does not indicate a change in biological risk status (NWFSC 2015).

2.3.2 Five-Factor Analysis

Section 4(a)(1)(b) 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 human-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

For the analysis of this listing factor, we summarize habitat information since our last 2011 status review with:

1. A discussion of improvements in mainstem hydrosystem operations and fish passage, impacts of recent high summer temperatures, unaccounted adult losses, and a summary of survival improvements expected from implementation of the FCRPS Biological Opinion (BiOp) tributary habitat program;

2. Habitat information for Snake River basin geographic areas addressing all four ESA-listed Snake River species. The Snake River basin geographic areas are: (1) mainstem Snake River, (2) Northeast Oregon, (3) Southeast Washington, (4) Clearwater River basin, (5) South Fork Salmon River basin, (6) Middle Fork Salmon River basin, and (7) Upper Salmon River basin. For each of these geographic areas, we address: (1) the current status and trends in habitat condition, focusing on the top concerns that potentially have the biggest impact on salmon and steelhead viability; (2) key emergent or ongoing habitat concerns; (3) key protective measures and/or major restoration actions; (4) key regulatory measures that are inadequate and are contributing substantially to the key habitat concerns; and (5) recommended future actions, including: key near-term restoration actions that would address the key concerns summarized above; projects to address monitoring and research gaps; initiatives to address inadequate regulatory mechanisms, and highlighting priority habitat areas that should be prioritized when sequencing restoration actions;

3. A discussion of overarching issues related to management of tributary habitat in the Snake River basin; and

4. A conclusion about Listing Factor A.

Hydropower Operation Effects on Columbia River Mainstem Conditions

Improvements in Operations and Fish Passage at Hydropower Facilities and Dams

Implementation of the Federal Columbia River Power System (FCRPS) Biological Opinion (Opinion) (NMFS 2008a; NMFS 2010) is providing a number of actions aimed at survival improvements: reduced duration of outmigration to the estuary, improved juvenile survival and condition, and increased access to habitats. We subsequently developed a 2014 Supplemental FCRPS Biological Opinion to address a 2011 Court Remand Order requiring us to re-examine the 2008 and 2010 biological opinions and more specifically identify habitat actions planned for the 2014-2018 period of the opinion. We adopted the 2014 Supplemental FCRPS Biological Opinion on January 17, 2014 (NMFS 2014a).

Since 2006, voluntary spill has been provided at all mainstem dams 24 hours a day during the juvenile migration season, and surface passage routes (spillway weirs) for juvenile migrants have been installed at Little Goose Dam (2009), Lower Monumental Dam (2008), McNary Dam (two weirs in 2007-08), John Day Dam (two weirs in 2008), and Bonneville Dam (conversion of the Powerhouse I sluiceway to a surface flow outlet in 2010). These actions are also likely to benefit steelhead kelts and volitional adult Chinook and sockeye salmon fallbacks at the mainstem dams. At Bonneville Dam, improved spillway operations (2007-2008), increased Powerhouse II fish guidance efficiency improvements (2008), and installation of new Minimum Gap Runner turbine units (2010) should also improve juvenile survival rates. A spillway wall was installed at The Dalles Dam in 2010, and a tailrace bird wire array was added in 2011 to improve juvenile egress conditions (and survival) downstream of the dam. A tailrace bird wire array was added at John Day Dam in 2010. The juvenile bypass outfall was relocated at McNary Dam in 2011 to improve egress, and direct and indirect survival of bypassed fish. Spillway chute and/or deflector modifications were enacted at Ice Harbor Dam in 2015 to further reduce injury and improve survival of fish passing via the removable spillway weir. The juvenile bypass outfall pipe was relocated at Little Goose Dam in 2009 and at Lower Monumental Dam in 2012 to improve egress, and direct and indirect survival of bypassed fish.

Spill and transport operations (in conjunction with installation of spillway weirs at the three Snake River collector projects) have resulted in substantially reduced smolt transportation rates since 2006. Transportation at McNary Dam was deemed ineffective and terminated (NMFS 2014a).

Previously installed surface passage routes continue to operate along with 24-hour voluntary spill at Lower Granite (2003) and Ice Harbor (2005) dams on the Snake River and at Bonneville Dam (corner collector at Powerhouse 2 in 2004).

Juvenile and adult passage facilities at mainstem dams are the subject of ongoing testing for passage survival and behavioral responses with the results informing further changes to facility design and project operations under the principle of adaptive management. Additional measures to enhance conditions in the Snake River migration corridor also continue. Cool water continues to be released from Dworshak Dam on the North Fork Clearwater River between July and September to reduce temperatures for migrating adults and juvenile Snake River fall-run Chinook salmon. Also, the U.S. Bureau of Reclamation and Idaho Power Company continue to release water to augment flows during the summer migration period. Lastly, Idaho Power Company's Hells Canyon Complex is operated to maintain stable spawning flows for spawning Snake River fall-run Chinook salmon and ensure that dam operations do not dewater Snake River fall-run Chinook salmon redds.

The 2014 FCRPS Supplemental Biological Opinion also continues efforts to assess hydropower critical uncertainties and future management decisions. Some examples include the continuation of transport survival studies to assess seasonal trends in smolt to adult returns; installation of adult PIT-tag detectors at all adult fishways (with the exception of John Day Dam) to better assess adult losses in the Snake and lower Columbia rivers; and collaborative efforts (with *U.S. v Orego*n Technical Advisory Committee representatives) to assess unexplained adult losses of adult Snake River steelhead, spring/summer Chinook salmon and sockeye salmon in the lower Columbia River; and continued efforts to develop spillway PIT-tag detectors.

Altogether, these improvements have increased average survival rates and decreased median travel times for smolts passing through the mainstem migration corridor, which likely also improves juvenile survival in the lower estuary and ocean, and ultimately adult returns.

The 2008 FCRPS Opinion also set up an offsite mitigation program that includes habitat restoration below Bonneville Dam. These projects are designed to reconnect portions of the historical floodplain that have been isolated behind dikes and levees for many years. Upper Columbia River spring Chinook salmon and steelhead are expected to benefit from increased flux of insect prey from the river margins to the mainstem migration corridor (Diefenderfer et al. 2013).

Recent High Summer Temperatures in Columbia River Mainstem

Hot summer temperatures in 2013 (see discussion in 2014 FCRPS Supplemental BiOp) and impaired migration conditions affected adult Snake River Sockeye Salmon and summer Chinook salmon in the lower Snake River. Adult Snake River fall Chinook salmon and steelhead appear to have been substantially less affected – either holding in cool water refugia below McNary Dam or migrating later to avoid peak summer temperatures.

Temporary pumps were operated in both 2014 and 2015 at Lower Granite Dam to draw cooler water from deep in the reservoir to the auxiliary water supply and exit section of the ladder to improve passage conditions.

Unusually hot weather patterns in 2015 resulted in very high tributary and mainstem temperatures across the Columbia River Basin in June and July. Water released from large reservoirs (Brownlee and Grand Coulee) was substantially cooler than inflowing water during these months, or conditions would have been even worse in the mainstem. Federal managers responded by releasing cool water from Dworshak Dam several weeks earlier than usual. The Corps of Engineers operated temporary pumps at the Lower Granite Dam adult ladder to moderate temperatures, and, in coordination with NMFS and other co-managers, altered turbine unit and spill operations in an attempt to improve passage conditions (hydraulic attractiveness) in the fishway at Lower Granite and Little Goose Dams. Because of concerns about cumulative thermal effects and to avoid hot temperatures in the Salmon River, NMFS authorized IDFG to trap some adult Snake River Sockeye Salmon at Lower Granite Dam and transport them directly to their hatchery facility in Eagle, Idaho.

Sockeye Salmon (both listed and unlisted) were the most impacted species with roughly 200,000 adults (based on dam counts) of approximately 500,000 adults passing Bonneville Dam being lost in the lower Columbia River (to McNary Dam). Adults – especially those that were transported as juveniles -- were impacted in this reach to a much greater extent than were unlisted sockeye from the upstream Columbia River tributaries. Losses of Snake River Sockeye

Salmon were also substantial in the lower Snake River. In total, PIT-tag estimates indicate that less than 90% of adult Snake River sockeye salmon passing Bonneville Dam reached Lower Granite Dam.

Adult summer Chinook salmon appear to have been similarly affected in the lower Columbia River (based on raw dam counts), but were far less affected than Sockeye Salmon in the lower Snake River.

August temperatures to date have been more typical and initial information does not suggest that substantial losses of adult steelhead or fall Chinook salmon are occurring upstream of Bonneville Dam.

Summer temperature data for the tributary rivers and streams still needs to be analyzed, particularly regarding the potential impacts of high stream temperatures on adults trying to over summer in these areas before they can spawn, i.e., pre-spawning mortality.

NMFS, in coordination with IDFG and the Corps of Engineers, plans to complete an “After Action Report” in 2016 which will summarize factors, management actions, and recommendations for future years should these conditions recur. A permanent structure to provide a more reliable source of cooler water to the Lower Granite adult fishway will be installed in 2016.

Unaccounted Adult Losses in Columbia River Mainstem

The 2014 FCRPS Supplemental Biological Opinion identified that PIT-tag based conversion rate (minimum survival rate) estimates for Snake River spring/summer Chinook and steelhead have recently been substantially lower (by roughly 6% to 10% on average) than was expected in the 2008 FCRPS BiOp. Snake River Sockeye Salmon conversion rates also appear to be lower than our preliminary estimates (using unlisted sockeye stocks as surrogates) in the 2008 BiOp for the lower Columbia River reach. It is unclear whether Mid-Columbia River steelhead conversion rates have declined (as observed for Snake River steelhead) or not (as observed for Upper Columbia River steelhead).

At present, NMFS is uncertain whether the recent estimates represent a true reduction in base survival rates. There is no obvious explanation (i.e., no changes in dam configuration or ladder operations, reported harvest, or river environmental conditions) for the apparent recent declines. Other factors that could potentially be affecting adult passage and observed conversion rates include: environmental factors (flows, spill operations, temperature, etc.), structural modifications, errors in the harvest or stray rate estimation methods, variability in stock run timing, or some combination of these factors. NOAA's Northwest Fisheries Science Center, in cooperation with NOAA's West Coast Region office and *U.S. vs Oregon* Technical Advisory Committee members, are evaluating these factors in relation to PIT-tag based conversion rate estimates. The results of this investigation should become available within the next 1-2 years.

The Corps of Engineers installed PIT-tag detectors in the fishways at The Dalles Dam (2013) and Lower Monumental and Little Goose Dams (2014). At present, John Day Dam is the only mainstem dam lacking an adult fishway detections system; though feasibility assessments for adult PIT detectors are underway. Information from these systems should greatly assist regional managers to assess where within the Bonneville to McNary (Snake River spring/summer Chinook salmon) and McNary to Lower Granite reaches (Snake River steelhead) these discrepancies are occurring.

Summary of Survival Improvements Expected from implementation of the FCRPS BiOp Tributary Habitat Program

The Reasonable and Prudent Alternative (RPA) in the 2008 FCRPS BiOp incorporates a process by which the Action Agencies are to identify and implement tributary habitat improvement actions sufficient to meet specific habitat quality—and associated population survival—improvements for 56 populations of salmon and steelhead in the Interior Columbia River Basin[3]. The technical foundation of the tributary habitat program is a method for estimating the changes in habitat function that are reasonably certain to result from implementation of habitat improvement actions and the corresponding changes in fish population survival (i.e., change in recruits per spawner) that are reasonably certain to occur as the productive capacity of habitat changes. As of 2012, the Action Agencies had implemented tributary habitat improvement actions addressing all 56 populations included in the RPA (NMFS 2008a, 2014a).

NMFS has determined that the approach the Action Agencies use to estimate benefits of habitat improvement actions and the corresponding survival (i.e., recruits per spawner) improvements represents the best science available that can be consistently applied throughout the Columbia Basin to assess the effects of actions occurring across the diverse watersheds of the basin and affecting a variety of listed salmonid ESUs/DPSs, and that the projected improvements are reasonably certain to occur (NMFS 2008a, 2010, 2014a).

The Action Agencies have also evaluated survival (i.e., recruits per spawner) improvements projected for each population from actions implemented under the FCRPS BiOp RPA through 2011, as well as the total survival improvements projected from actions implemented through 2011 and those planned for implementation through 2018. Improvements are projected to meet or exceed BiOp requirements for all 56 populations. For Snake River spring/summer Chinook salmon populations, significant improvements from actions implemented through 2011 are projected for the Lemhi River (28%), Valley Creek (13%), and Pahsimeroi River (62%) populations. Actions implemented through 2018 are projected to result in significant improvements for seven populations: Tucannon River (29%), Catherine Creek (15-23%), Upper Grande Ronde River (23%), Lemhi River (32%), Valley Creek (19%), Yankee Fork Salmon River (43%), and Pahsimeroi River (70%). For other spring/summer Chinook salmon

[3] In the 2008 FCRPS BiOp, projected population survival improvements are expressed in terms of percent increase in recruits per spawner – in other words, tributary habitat improvements are projected to lead to egg-to-smolt survival improvements, which are assumed to translate into a proportional increase in recruits per spawner at the population level.

populations, projected improvements range from <1 to 15 percent. For Snake River steelhead, survival improvements projected as a result of actions implemented through 2011 are 23% for the Lemhi River population, 27% for the Pahsimeroi River population, and <6% for other populations. Actions planned for implementation through 2018 are projected to result in relatively large survival improvements for the Tucannon River (47%), Lolo Creek (18%), Lochsa River (17%), South Fork Clearwater River (17%), Lemhi River (27%), and Pahsimeroi River (37%) populations (for other populations improvements are projected to range from <1 to 8%). Snake River fall Chinook and Sockeye Salmon were not assigned a performance standard for survival improvements as a result of tributary habitat improvements actions (NMFS 2014a).

While in some cases these projected survival improvements are significant and will contribute significantly to the long-term recovery of these ESUs, the improvements generally are well below the survival improvements needed to achieve ESA delisting goals.

Snake River Basin Geographic Area: *Mainstem Snake River above Lower Granite Dam*

Current Status and Trends in Habitat Conditions

Both hydropower and land use activities have had significant impacts on habitat in the mainstem Snake River above Lower Granite Dam. A total of twelve dams have blocked and inundated habitat, impaired fish passage, altered flow and thermal regimes, and disrupted geomorphological processes in the mainstem Snake River.[4] These impacts have affected juvenile and adult salmon and steelhead through loss of historical habitat, altered migration timing, elevated dissolved gas levels, juvenile fish stranding and entrapment, and increased susceptibility to predation. In addition, land use activities, including agriculture, grazing, resource extraction, and development have adversely affected water quality and diminished habitat quality throughout this reach (NMFS 2015c). While all Snake River salmon ESUs and the steelhead DPS have been affected to some extent, these impacts have been greatest for Snake River fall Chinook salmon, and this discussion focuses primarily on that ESU.

The Hells Canyon Dam Complex blocks access to or inundates the spawning habitat that historically was the most productive for Snake River fall Chinook salmon. A large portion of this historical upriver habitat was lost following construction of Swan Falls Dam on the Snake River in 1901, but construction of the Hells Canyon Complex of dams in the late 1950s and 1960s blocked access to remaining upriver spawning areas, and resulted in the extirpation of one of two populations that constituted this ESU historically. As a result, all of the ESU's spawning now occurs in an area downstream of Hells Canyon Dam, where historically only limited spawning occurred (NMFS 2015c).[5]

4 Eight dams comprise the Idaho Power Company Project: Upper Salmon Falls Dam (RM 580.8), Lower Salmon Falls Dam (RM 575.3), Bliss Dam (RM 560.3), CJ Strike Dam (RM 494), Swan Falls Dam (RM 457.7), Brownlee Dam (RM 284.6), Oxbow Dam (RM 272.5), and Hells Canyon Dam (RM 247.6). Downstream of the Idaho Power Project are four federal dams that are part of the Federal Columbia River Power system: Ice Harbor Dam, Lower Monumental Dam, Little Goose Dam, and Lower Granite Dam.

[5] Other hydropower effects on fall Chinook salmon, including altered thermal regime, dissolved gas levels, and rapidly fluctuating flows that create the potential for stranding, are not considered priority concerns at this time.

While habitat loss is the primary factor that has limited the Snake River fall Chinook salmon ESU, a second major factor in the mainstem Snake River above Hells Canyon is highly degraded water quality. Agriculture, grazing, mining, timber harvest, and development activities have led to excessive nutrients, sedimentation, toxic pollutants, low dissolved oxygen, and altered flows. Although successful reintroduction of fall Chinook salmon above the Hells Canyon Dam Complex would improve persistence probability for the ESU, mainstem habitat above the complex is currently too degraded to support anadromous fish. Thirty-six segments of the Snake River above Hells Canyon are listed under the Clean Water Act 303(d) list of impaired waters for parameters including total suspended solids, phosphorus, sediment, dissolved oxygen levels, and nutrients (NMFS 2015c).

Below Hells Canyon Dam, the one extant population in this ESU consists of a spatially complex set of five historical major spawning areas: two reaches of the mainstem Snake River, the lower mainstem reaches of the Grande Ronde River, the Clearwater River, and the Tucannon River. Habitat concerns in fall Chinook salmon spawning areas of the Clearwater River include temperature, sediment, nutrients, flow issues, and toxic pollutants. The lower Clearwater River is also highly influenced by operations at Dworshak Dam, located 1.9 miles up the North Fork Clearwater River. Since 1992, cold water releases at Dworshak Dam have been managed to improve migration conditions (temperature and flow) in the lower Snake River (NMFS 2015c).

In the Lower Grande Ronde River mainstem, limiting factors include lack of habitat quality and diversity, excess fine sediment, degraded riparian conditions, low summer flows, and poor water quality. Many stream segments within the Lower Grande Ronde subbasin are identified as limited for bacteria, dissolved oxygen, pH, sediment, and temperature. A Total Maximum Daily Load (TMDL) study for the lower Grande Ronde subbasin sets TMDLs to address 303(d) listings for temperatures and bacteria. The Tucannon River is limited primarily by sediment load and habitat quantity, with sediment impacts on fall Chinook salmon egg incubation and fry colonization considered moderate to high in most reaches, primarily due to agricultural land uses (NMFS 2015c).

As noted above, Snake River spring/summer Chinook salmon, steelhead, and Snake River Sockeye Salmon have also been affected by these same factors in the mainstem Snake River above Lower Granite Dam.[6] Spring/summer Chinook salmon, steelhead, and Sockeye Salmon are particularly vulnerable to increased water temperatures in late summer and fall, when adults of these species are migrating. These high temperatures, which result from flow regulation, reservoir construction, and environmental conditions, can stop or delay migration, increase fallback at dams, and increase susceptibility to disease and predation (NMFS 2015b).

[6] While significant historical habitat for spring/summer Chinook salmon and steelhead has also been blocked by dam construction, the effects on recovery potential at the ESU and DPS level are not as severe for these species as they are for fall Chinook.

In late July and September 2013, low summer flows combined with high air temperatures and little wind created thermally stratified conditions in Lower Granite reservoir and the adult ladder, disrupting fish passage for more than a week. The events resulted in approximately 15% of the migrating summer Chinook salmon, 12% of the migrating steelhead, and ~30% of migrating Sockeye Salmon failing to pass Lower Granite Dam. In 2015, in response to high water temperatures (created primarily by unusually hot weather) during Sockeye Salmon migration, regional fish managers collected adult Snake River Sockeye Salmon at Lower Granite Dam and transported them to the Eagle Hatchery in Idaho.

Key Protective Measures

Fall Chinook

Abundance of natural-origin Snake River fall Chinook salmon in the one extant population has increased substantially since listing. We attribute this increase to a combination of actions that improved survivals through the hydropower system, as well as to reduced harvest and increased natural production through hatchery supplementation. Key protective actions related to Snake River fall Chinook mainstem and tributary habitat include (NMFS 2015c):

- Continued implementation of Idaho Power Company's fall Chinook salmon spawning program to enhance and maintain suitable spawning and incubation conditions;
- Continued implementation of the FCRPS Biological Opinion, including hydrosystem operations, such as cool-water releases from Dworshak Dam to maintain adequate migration and rearing conditions in the lower Snake River; summer flow augmentation and summer spill at multiple projects to maintain migration and passage conditions; and operations at Lower Granite Dam to address adult passage blockages caused by warm surface waters entering the fish ladders;
- Continued implementation of Lower Snake River Programmatic Sediment Management Plan (PSMP) measures to reduce impacts of reservoir and river channel dredging and disposal on Snake River fall Chinook salmon.
- Continued implementation of recovery plan actions in tributary lower mainstem habitats to maintain and improve spawning and rearing potential for Snake River fall Chinook salmon (although these actions are generally focused on Snake River spring/summer Chinook salmon and steelhead and therefore located above fall Chinook salmon spawning and rearing habitats the tributaries, the actions have cumulative beneficial effects on downstream habitats).

Spring/Summer Chinook Salmon, Steelhead, and Sockeye Salmon

- Continued releases of cool water from Dworshak Dam during late summer to reduce mainstem Snake River temperatures and maintain adequate migration conditions for adults and juveniles in the lower Snake River.
- Continued flow augmentation by Bureau of Reclamation from upper Snake Basin to enhance flows in lower Snake during July and August.
- Continued efforts to improve adult passage at the ladder at Lower Granite Dam; these options will build on current releases of cool water from Dworshak Dam during late summer to reduce mainstem Snake River temperatures (NMFS 2015b).
- The Snake River Sockeye Salmon Recovery Plan includes a recovery action to identify specific actions and responsible parties/entities to improve water quantity and the quality of juvenile and adult migration corridor habitats and monitor the actions to address altered hydrology, elevated water temperature, and reduced stream flow.
- Carry out water transactions in the mainstem Salmon River to improve conditions for Snake River spring/summer Chinook salmon and steelhead. These actions will likely also improve the survival of adult migrant Sockeye Salmon returning to the Sawtooth Valley in July and August (NMFS 2015b).

Key Regulatory Measures that are Inadequate

All Species

- Water quality criteria, including criteria for sediment, are currently inadequate to protect of listed salmonids.
- Implementation of National Pollution Discharge Elimination System permit programs to address point source pollution are not being fully implemented.

Recommended Future Actions

Fall Chinook

First, it is crucial to continue the ongoing protective actions noted above. Another focus of the recovery strategy for Snake River fall Chinook salmon is research, monitoring and evaluation (RM&E) to confirm the factors driving recent abundance increases and to validate or update management actions needed to sustain those increases as well as to confirm the additional actions most likely to provide further benefits (NMFS 2015c).

Potential opportunities for additional improvements in ESU viability include (NMFS 2015c):

- Implementing structural and operational changes at Lower Granite Dam to more reliably address adult passage blockages caused by warm surface waters entering fish ladders;

- Modifying the Corps of Engineers' transportation program as appropriate to enhance adult returns of migrating juvenile salmon;
- Evaluating the potential to improve survival of juvenile fall Chinook salmon passing Lower Granite Dam in late fall and early spring and implementing appropriate modifications to configurations;
- Installing, if feasible, a passive integrated transponder (PIT) tag detector in the removable spillway weir at Lower Granite Dam to enhance understanding of smolt-to-adult returns and the contributions of alternative life history strategies;
- Implementing actions to improve the quality of water discharged from the Hells Canyon Complex (dissolved oxygen, total dissolved gas) - as called for in NMFS' recommendations for the Hells Canyon Federal Energy Regulatory Commission (FERC) relicensing;
- Prioritizing and filling monitoring gaps based on information in Appendix B (Research, Monitoring & Evaluation for Adaptive Management) of the Proposed ESA Recovery Plan for Snake River Fall Chinook Salmon (NMFS 2015c);
- Completing and implementing TMDLs to improve water quality in tributary habitats that affect Snake River fall Chinook salmon spawning and rearing habitats;
- Targeting high priority opportunities to restore October spawning life history patterns, e.g., by evaluating potential spawning and rearing habitats in the lower reaches of the Selway, Lochsa, and South Fork Clearwater Rivers;
- Evaluating and prioritizing opportunities to restore tributary side channel rearing habitats to increase natural production capacity for Snake River fall Chinook salmon in all major spawning areas and associated tributary spawning areas; and
- Developing and conducting life-cycle modeling to gain a better understanding of the relative and combined effects of different limiting factors and targeted actions on species viability.

Spring/Summer Chinook, Steelhead, and Sockeye Salmon

As with fall Chinook, it is crucial to continue the ongoing protective actions noted above. Potential opportunities for additional improvements in ESU viability include:

- Upon completion of transportation studies, modify transportation program to enhance adult returns of migrating juvenile Snake River spring/summer Chinook salmon and steelhead.
- Evaluate and implement structures or operations at Lower Granite Dam to address adult passage blockages for Snake River Sockeye Salmon caused by warm surface waters entering the fish ladders (NMFS 2015b).

- Implement a plan for collection of returning Snake River Sockeye Salmon spawners at Lower Granite Dam to reduce exposure to elevated temperatures in the Snake River and mainstem Salmon River during late July and August (NMFS 2015b).
- Implement research and monitoring recommended in the Snake River Sockeye Salmon Recovery Plan to determine the effect of predation in the migration corridor on the abundance and productivity of the natural population.
- Implement actions to reduce September water temperatures for adult migration and passage at Lower Granite Dam.
- Implement actions to improve the quality of water discharged from the Hells Canyon Complex (dissolved oxygen, total dissolved gas) - as called for in NMFS recommendations for the Hells Canyon FERC relicensing.
- Reduce impacts of reservoir and river channel maintenance dredging and disposal, including impacts from predatory bird colonies that could establish on dredge spoil islands, and impacts of winter dredging and in-water disposal.
- Develop and implement Clean Water Act TMDLs to improve water quality in the mainstem reaches.
- Develop and conduct life cycle modeling to gain a better understanding of the relative and combined effects of different limiting factors and targeted actions on species viability.

Northeast Oregon Geographic Area

Status and Trends in Habitat Conditions

The alteration of tributary habitats due to past and/or present land use remains a concern for Northeast Oregon Snake River spring/summer Chinook salmon and steelhead populations. Both fish species spend long periods of their lives in the Grande Ronde and Imnaha River systems, and thus are very sensitive to changes in their freshwater ecosystems. NMFS' draft Northeast Oregon Snake River Spring/Summer Chinook Salmon and Steelhead Management Unit Plan identifies four primary interrelated limiting factors that reduce the viability of all Northeast Oregon Snake River spring/summer Chinook salmon and steelhead populations: excess fine sediment, water quality (primarily temperature), water quantity (primarily low summer flows), and habitat quantity/diversity (primarily limited pools and lack of large wood) (NMFS 2014b).

The Bureau of Reclamation completed habitat assessments in Catherine Creek in 2012 and the Upper Grande Ronde 2014. These assessments were used in the BPA-funded Atlas habitat prioritization process that was completed in 2015 (http://www.grmw.org/data/assessment/#ccta and http://www.grmw.org/data/assessment/#ugrta).

Since the last status review, the BPA-funded Atlas process has enabled local agency and tribal staff to prioritize restoration actions by stream reach for Catherine Creek and the Upper Grande Ronde River. This process used the limiting factors and life history information in the draft NMFS Northeast Oregon Snake River Spring/Summer Chinook Salmon and Steelhead Management Unit Plan. Participating Atlas partners include the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), Oregon Department of Fish and Wildlife (ODFW), NMFS Northwest Fisheries Science Center (NWFSC), and Union County Soil and Water Conservation District (UCSWCD). Both sub-basin analyses were completed in 2015 (http://www.grmw.org/data/assessment/#atlas).

The Columbia River Habitat Monitoring Program (CHaMP) habitat surveys in the Grande Ronde basin began in 2012 to assess and provide a repeatable habitat survey protocol for the Columbia Basin on private and federal lands. Beginning in 2015, ODFW Aquatic Habitat Inventory (AQI) surveys are being completed on the main stem Grande Ronde from Island City to the natural barrier upstream of East Fork Grande Ronde River. Where ODFW habitat surveys overlap with CHaMP sites, data will be gathered so comparisons can be made between protocols to see what it will take to extrapolate CHaMP data to the entire basin. In addition, ODFW will conduct snorkel surveys on every pool for salmon and steelhead species composition, distribution, and cold water refugia (Sedell 2015).

Habitat Restoration and Funding

Restoration

Numerous habitat restoration projects located on private land have continued to be implemented under BPA's Habitat Improvement Program (HIP III) Programmatic BiOp for instream and floodplain restoration including: wood placement projects, riparian plantings, fencing, off channel stock water development, and culvert replacement projects.

The Wallowa Whitman National Forest (WWNF) has continued using the Aquatic Habitat Restoration Activities Programmatic Biological Opinion for the U.S. Forest Service, Bureau of Land Management and Bureau of Indian Affairs ("ARBO") for instream and floodplain unanchored wood placement projects, riparian plantings, fencing, off channel stock water development, and culvert replacement projects.

Funding

Numerous habitat restoration projects have been completed in Northeast Oregon for spring/summer Chinook salmon and steelhead recovery by multiple partners: Nez Perce Tribe (NPT), CTUIR, Grande Ronde Model Watershed (GRMW), ODFW, UCSWCD, U.S. Fish and Wildlife Service, and U.S. Forest Service. Funding has been provided by BPA, Oregon Watershed Enhancement Board (OWEB), NOAA's Pacific Coast Salmon Recovery Fund (PCSRF), and the Natural Resources Conservation Service's programs such as the Conservation Reserve Enhancement Program (CREP) or Wetland Reserve Program (WRP), and the individual partners.

CTUIR has used BPA Accords funding to acquire valuable properties with water rights through long term leases and by purchase to restore riparian, instream, and floodplain reconnections, to improve and provide complex instream habitat for aquatic species and Snake River salmonids in the Grande Ronde River watershed.

Instream flows have slightly improved in Catherine Creek and the Lostine River from leasing water by the Freshwater Trust (FWT) using funds from BPA-funded Columbia Basin Water Transaction Program (CBWTP).

Funding to protect aquatic and riparian areas with fencing has been provided by the Natural Resources Conservation Service (NRCS) using either the CREP and/or WRP in Northeast Oregon.

Newly Adopted Regulatory Mechanisms

Screening, Passage, Instream Flow
The Oregon Fish and Wildlife Commission adopted a statewide, prioritized unscreened diversion assessment in 2013 (available at: http://www.dfw.state.or.us/fish/screening/priority_unscreened_diversion_inventory.asp).

The Oregon Fish and Wildlife Commission adopted a statewide, fish passage priority list in 2013 (available at http://www.dfw.state.or.us/fish/passage/).

The Oregon Water Resources Commission adopted the state's first Integrated Water Resources Strategy on August 2, 2012 (http://www.oregon.gov/owrd/pages/law/integrated_water_supply_strategy.aspx). The Strategy provides a blueprint to help the state better understand and meet its instream and out-of-stream needs, taking into account water quantity, water quality, and ecosystem needs (OWRD 2012).

Inadequate Regulatory Mechanisms

There is a lack of documentation or analysis on the effectiveness of land-use regulatory mechanisms and land-use management programs.

Potential Long Term Issues

Concern about drought management issues have increased since the last status review due to widespread drought conditions. There is concern that local drought declarations may have some potential detrimental effects on aquatic resources through a relaxation of current land use protections. For example, land protected under existing Conservation Reserve Program (CRP) projects may be grazed or hayed to compensate for drought impacts. CRP tends to focus more on upland habitats, but impacts on these lands could potentially affect water quality. There are no drought provisions for grazing in riparian enclosures under the NRCS Conservation Reserve Enhancement Programs (CREP). This program has been widely used in eastern Oregon for stream protection.

There is ongoing concern for water quality in the Grande Ronde basin from agriculture runoff into streams that are flow constrained from over allocation of irrigation water and resulting concentrations of contaminants from chemical runoff, sewage treatment operations, and other sources which may impact various life history stages of ESA-listed fish populations.

Pre spawning mortality may increase due to low and warm water conditions that increases the disease potential for salmonids (i.e., *Aeromonas salmonicida*, furunculosis bacteria). Other fish diseases identified in the Northeast Oregon watersheds are: infectious hematopoietic necrosis virus (IHNV), Bacterial Kidney Disease (BKD), and Enteric Redmouth Bacteria (ERM). These diseases could be exacerbated from warm water temperatures, decreased flows, and weir operations (Onjukka 2015).

Another impact of drought conditions is the change in weir operations that keep hatchery fish off natural-origin fish spawning areas. Weir operations may be curtailed or halted due to higher stream temperatures during drought conditions. There are hatchery programs using weirs in the Grande Ronde, and Imnaha basins to control distribution of hatchery fish in the Grande Ronde, Catherine Creek and Imnaha basins. This weir operation curtailment may impact the genetic integrity of wild fish in the Upper Grande Ronde and Imnaha basins. For example, in 2015, the Grande Ronde weir operation was terminated due to high river temperatures. This allowed all migrating natural-origin and hatchery fish to pass into the upper Grande Ronde basin. Continued drought and/or low water/high temperature conditions could have similar effects in other basins where weirs are used to manage hatchery influence on the spawning grounds, thus potentially impacting genetic integrity of natural-origin populations.

Southeast Washington Geographic Area

Current Status and Trend in Habitat Conditions

Prominent habitat issues affecting Southeast Washington populations include: loss of riparian trees; confinement of the floodplain and channel meander; excessive fine sediments; reduced stream flows; and high summer water temperatures. Overall habitat conditions affecting Southeast Washington populations are generally similar to those described in previous status reviews, with the exception of the Tucannon River watershed where large-scale restoration activities by the Washington Department of Fish and Wildlife, U.S. Forest Service, and Snake River Salmon Recovery Board have achieved measureable habitat improvements. From 2012 through 2015, roughly 3,480 pieces of large wood have been distributed over more than 13 miles of the Tucannon River as individual pieces and constructed log jams. In the same time period, 2.3 miles of levees have been removed, side channels have been increased by 6.4 miles, and roughly 190 acres of floodplain has been created or reconnected. These recent activities, combined with many other watershed restoration activities that have occurred in the past decade, have helped achieve restoration goals for sediment, temperature, and flow (Hill and Bennett 2014).

These restoration activities are of sufficient scale to have resulted in less fine sediment, more stream flow, and lower summer temperature; and the river is trending toward goals for reducing confinement. Upper Tucannon River and Asotin Creek population areas have met the established goals for temperature, in part a result of riparian improvements, instream complexity and floodplain connection, and improved flows.

Key Emergent or On-going Habitat Concerns

The majority of fish barriers have been addressed as well as known screening issues; but a small number of passage barriers remain. Lower Tucannon River has not met the established goals for temperature and confinement, but these conditions have improved and are trending towards their goals.

Noteworthy Restoration Measures

Region-wide improvements in Best Management Practices (BMPs) and the use of CRP/CREP have greatly reduced turbidity and embeddedness to meet the goals for all populations.

Thanks to persistence and support from the Snake River Salmon Recovery Board, Washington Department of Fish and Wildlife, and local restoration partners, large-scale restoration projects in the Tucannon River have been highly effective in reestablishing channel functions related to temperature, floodplain connectivity, channel morphology, and habitat complexity. Programs such as these are the basis for addressing threats and limiting factors, and improving viability for listed species. It is critically important that these programs continue.

In 2015, the statewide Washington Department of Fish and Wildlife’s Fish Barrier Removal Board was established. The Board focuses on barrier removal actions where most needed in Southeast Washington watersheds, particularly in the Tucannon River.

In 2015, adoption of new rules for the Washington Department of Fish and Wildlife’s Hydraulic Project Approval (HPA) program added new science findings to the permitting of construction projects or activities in or near state waters to ensure projects meet state conservation standards for aquatic species and their environment.

Inadequacy of Key Regulatory Measures

Continued focus on fish passage barrier removal projects and improved stream flow through implementation of existing laws and regulations by state, local, tribal and federal partners will likely result in improved habitat conditions.

Recommended Future Actions

Seasonal habitat needs and availability for juvenile life stages are still somewhat unknown. Spawning habitat availability/quality, mostly in smaller tributaries, also needs further evaluation.

Continued monitoring and data collection is needed to evaluate progress toward habitat goals and future needs. Existing flow and temperature gauges, and existing monitoring efforts, need to be maintained. Predictable funding sources need to be obtained to maintain the long-term operation of some flow and temperature gauges.

In addition, much of the restoration work accomplished thus far has been incentive-based for landowners and/or grant funded, and this needs to be maintained for continued success and work.

Clearwater River Geographic Area

Listed fish: Snake River steelhead and Snake River fall Chinook salmon

Current Status and Trend in Habitat Conditions

The Clearwater River basin is an expansive area that includes a wide range of environments and habitat conditions. Near-natural conditions exist in roadless areas of the Nez Perce – Clearwater National Forests, while highly altered conditions exist in the lower-elevation valleys where major road systems and urban development are concentrated. There is insufficient monitoring information available in most of this area to identify trends in habitat conditions. In locations where surveys are available, they have generally noted widespread habitat degradation in watersheds dominated by urban and agricultural uses. In watersheds where forestry is the primary land use, habitat conditions exhibit a range of habitat quality that varies with factors such as the amount of roads, timber harvest, and wildfire history. Key habitat alterations commonly affecting listed fish in Clearwater River tributaries are high summer temperatures, low flow, loss of floodplain access, and reduced channel/habitat complexity. Restoration activities have been focused primarily on tributary watersheds important to steelhead such as Lapwai Creek, Potlatch River, Big Canyon Creek, Newsome Creek, and Crooked River where significant habitat alterations have occurred from historic or present-day land uses. Modest habitat improvements have been evident in stream reaches where restoration activities have occurred, but habitat alterations are extensive and most restoration projects thus far have had mostly local effects. A significant number of artificial passage barriers have been removed, but artificial passage barriers still remain in many smaller streams and in a few large streams. Based on anecdotal accounts of families that have resided in the area for multiple generations, summer stream flows have been trending toward much lower discharge and longer periods of intermittent surface flow.

Key Emergent or On-going Habitat Concerns

Recent stream inventories (Banks and Bowersox 2015; Bowersox et al. 2011; Chandler 2013) have found small intermittent streams to be a significant component of steelhead habitat in the Clearwater River Basin. Intermittent streams are particularly vulnerable to effects of warmer winters that produce earlier and smaller snow melt periods and low summer flows. Climate effects on intermittent streams are exacerbated by activities and developments that have reduced floodplain area, increased stream flashiness, or interfered with natural pool-forming processes, which are common problems in watersheds in the Clearwater River Basin. Natural channelforming processes and hydrologic regimes that create thermal refugia in summer and deep pools for cover in winter are impaired in much of the area. Effects of altered groundwater hydrology on steelhead populations are poorly understood, yet this may be an important limiting factor. An assessment of hydrologic alterations and their effects on steelhead would help determine the effects of hydrologic alterations and guide future restoration action. Lidar mapping and ground water monitoring are key pieces of information that would improve the understanding of hydrologic impacts.

With the dramatic increases in numbers of fall Chinook salmon in the past decade, the adult salmon appear to be steadily expanding upstream in the larger rivers (Selway, Lochsa, and South Fork Clearwater Rivers) and into some of the lower reaches of moderately-sized rivers such as the Potlatch River and the mouth of Lapwai Creek. Habitat conditions for fall Chinook salmon are marginal in many of these expansion areas due to reduced stream flows from water withdrawals and alteration of channels and floodplains to accommodate developments.

Noteworthy Restoration Measures

Notable improvements in fish habitat have occurred throughout the basin from passage barrier removals and in several drainages where combined effects of multiple restoration activities have improved summer stream flows or habitat complexity over long distances.

A dam owned by the City of Troy, Idaho, in Dutch Flat Creek was removed in 2013 to restore fish passage to 35 miles of streams above the dam. Idaho Department of Fish and Game observed nine redds above the former dam in 2015.

Significant improvements in channel complexity have been achieved in Newsome Creek and Crooked River from rehabilitating channels impaired by legacy effects of dredge mining.

In the Lapwai Creek drainage significant increases in stream flow have occurred in Sweetwater Creek, Webb Creek, and the mainstem of Lapwai Creek below the confluence with Sweetwater Creek from changes in operation of water diversions operated by the Lewiston Orchards Irrigation District. The irrigation district is foregoing diversion of a portion of their water available for irrigation to improve flows for fish. The additional water has restored connected surface flows throughout the summer in Sweetwater and lower Webb creeks, and improved streamflows in the lower 13 miles of Lapwai Creek. Stream flows in summer will soon be increased even further by an agreement established by the irrigation district and BOR to change the water supply from the present surface water diversions to deep wells that draw water from aquifers that empty into the Snake River. Installation of the first well began in 2015 and it should be operational by 2017, or earlier. Levee set-backs and other riparian/floodplain restoration activities in the Lapwai Creek basin have augmented the irrigation district’s efforts to provide higher flows.

In the Potlatch River drainage multiple efforts have been underway to improve summer flows and increase overwintering habitat. Hydrologic restoration in meadow systems in the Corral

Creek drainage are being expanded and evaluated for effectiveness; the sewage treatment plant in Troy, Idaho, is using treated sewage effluent to augment flows in Little Bear Creek; and large wood and habitat complexity have been increased in portions of the East Fork Potlatch River.

Inadequacy of Key Regulatory Measures

Low stream flows are a widespread and significant limiting factor in the Lower Clearwater River Basin, due in part to inadequate regulatory mechanisms. Steelhead are adapted to coping with natural flow regimes that include occasional droughts. However, steelhead have difficulty coping with low flows that occur on an annual basis from the combined effects of decreasing snow packs, natural droughts, and water withdrawals. Hydrologic conditions for fish are damaged further by reductions in groundwater recharge due to floodplain losses and reduced influence of beavers through trapping and removal of beaver dams. Many tributaries potentially usable by steelhead in the Clearwater River basin are made unusable due to insufficient flows.

Idaho water law contains limited mechanisms to prevent water users from withdrawing surface waters from streams to the point where flows are insufficient to support salmon or steelhead. Changes in water law could be enacted by the State of Idaho to provide greater protection of surface flows where they are needed to sustain steelhead.

The Clearwater River Basin includes a significant number of stream environments where beavers were historically abundant. Beaver dams can substantially alter the physical, chemical, and biological characteristics of river ecosystems, providing benefits to plants, fish, and wildlife. Beavers create and maintain complex stream ecosystems by constructing dams that impound water and capture sediment and organic materials. Where beavers have been removed from streams with historic beaver activity, the loss of beaver dams has often caused fish habit quality and complexity to decline by lowering groundwater tables, reducing floodplain extent, reducing base flows in summer, altering water temperatures, and altering riparian plant communities (Pollock et al. 2015). Listed anadromous fish would benefit from increased efforts by fish and wildlife management agencies to promote or protect beaver populations in valleys where beavers historically influenced stream flows, floodplain formation, and channel morphology.

Protective measures in U.S. Forest Service and Bureau of Land Management Land and Resource Management Plans (management plans) that were implemented under PACFISH (U.S. Forest Service and Bureau of Land Management 1995) have likely played a key role in reducing management-related degradation of anadromous fish habitat on federal lands. The Nez Perce – Clearwater Forests are revising their management plans and the continuation of the protective measures provided under PACFISH is uncertain.

Intermittent streams that have beaver activity retain higher surface flows in summer than streams lacking beaver activity. Beaver trapping is prohibited in a few areas, but beaver trapping is not excluded from the majority of steelhead habitats in the Clearwater River Basin.

Recommended Future Actions

Restoration actions should continue to focus on reducing temperatures, and restoring hydrologic functions and processes that create channel and habitat complexity.

Portions of the fish habitat in the Clearwater River Basin lack inventories. Additional inventories and monitoring are needed to identify and prioritize future restoration actions and to assess the effects of restoration actions.

Cooperative efforts among the Bureau of Reclamation, Lewiston Orchards Irrigation District, and the Nez Perce Tribe to convert from surface water diversions from Sweetwater and Webb Creeks to deep wells should continue as funds become available. The ecological effects of using the reservoirs to augment stream flows in summer should be evaluated as a potential mechanism to offset effects of domestic wells and other habitat alterations that contribute to high water temperatures and low flows in summer.

Revision of the Nez Perce-Clearwater Forests management plan would benefit listed fish by retaining standards or guidelines that are effective in preventing degradation of aquatic ecosystems and through the inclusion of an aquatic conservation strategy for project-level planning that is based on restoring or maintaining physical and biological processes that influence the quality and complexity of aquatic ecosystems. Recommended management plan provisions are the subject of the April 18, 2014, interagency memo: *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.*

South Fork Salmon River and Little Salmon River Geographic Area

Current Status and Trends in Habitat Conditions

The South Fork Salmon River and Little Salmon River drainages provide over 2,000 kilometers of accessible habitat to anadromous fish. Within the South Fork Salmon River drainage, approximately 98% of the area is managed by the U.S. Forest Service, of which about 30% is wildness or recommended wilderness. The primary limiting factors in this drainage include excess sediment, degraded riparian conditions, passage barriers, high water temperatures, and a lack of instream habitat complexity.

In the Little Salmon River drainage, roughly 70% of the land is federally (U.S. Forest Service and BLM) managed and generally encompasses tributaries to the Little Salmon River. The majority of privately owned land is situated along the Little Salmon River. The limiting factors identified for the Little Salmon River drainage mirror those of the South Fork Salmon River and also include low summer flows.

Historic land use practices (mining, logging, etc.) in these drainages and forest fires have exacerbated habitat degradation. Location and armoring of streamside roads have locked stream channels in place, altered floodplain function, degraded riparian function, and exacerbated high summer water temperatures. Agricultural water use, particularly in the upper Little Salmon River basin, has led to reduced instream flows and high stream temperatures in warm summer months.

Key Emergent or Ongoing Habitat Concerns

Ongoing sediment monitoring continues to occur in the South Fork Salmon River drainage where legacy road networks continue to contribute sediment to streams. Although generally trending in a positive direction (Zurstadt 2015), levels of instream sediment are still a concern considering the importance of spawning habitat in the drainage. Chemical contamination of streams in the East Fork South Fork Salmon River drainage is also a concern due to historic mining activities, ongoing mining pressures on federal and patented land, and potential future development of a large-scale mining in the East Fork South Fork Salmon River drainage.

Habitat impacts associated with the increasing recreational fishing pressure in the South Fork Salmon River drainage is also an ongoing concern. In addition, continued fording of streams in spawning areas by full-sized and all-terrain vehicles as well as public pressure to increase motorized recreational opportunities in the drainage, continue to present challenges for achieving functional riparian and instream habitat conditions.

Key Protective Measures or Major Restoration Actions

Since 2009, restoration actions in the South Fork Salmon River and Little Salmon River have focused on reducing sediment delivery, restoring fish passage, and improving hydrologic function. This has been accomplished primarily through road obliteration and decommissioning, improving aquatic organism passage at road crossings, and performing reforestation and meadow restoration. The Nez Perce Tribe has partnered with the U.S. Forest Service in accomplishing many of these restoration actions. In the South Fork Salmon River drainage, over 150 miles of historic road prisms have been fully obliterated since 2009. In addition, improvements to the open road system (e.g., graveling, stabilizing crossings, replacing fords with bridges or culverts allowing aquatic organism passage, installing drainage features, etc.) have occurred to reduce sediment delivery. Eleven fish passage barriers in the South Fork Salmon River basin were replaced with crossings allowing for aquatic organism passage, restoring access to over 20 miles of habitat. In the Little Salmon River drainage, five culvert barriers have been replaced with structures allowing access to about six miles of habitat.

Although habitat above the Little Salmon River cascades located near the confluence of Round Valley Creek is not likely to be occupied by anadromous salmonids, enhancement of habitat in this area will result in water quality improvements farther downstream. Riparian planting projects on private lands have occurred in the upper portion of the Little Salmon River. Recently, the U.S. Corps of Engineers approved a wetland mitigation bank to create 16 acres of wetlands adjacent to the Little Salmon River and Big Creek in an area that has been used for livestock grazing. Implementation of this action is expected to result in water quality improvements that will translate downstream.

In 2009, the Nez Perce Tribe obtained funding to establish a conservation easement on the Wapiti Meadow Ranch along Johnson Creek in partnership with the land owner and the Rocky Mountain Elk Foundation. Streambank stabilization and significant riparian planting have been implemented at this location to protect and improve fish habitat along Johnson Creek and its tributaries. In total, meadow enhancement and reforestation in the South Fork Salmon River drainage have occurred on over 140 and 20,360 acres, respectively.

The Nez Perce Tribe continues to collect data on sediment delivery to streams from roads and fish passage barriers in the South Fork Salmon River subbasin. They also recently completed an inventory of dispersed recreation sites along the South Fork Salmon River. Data gathered through these efforts will be used to guide and prioritize future restoration efforts in the area. In addition, eDNA monitoring in smaller tributaries is being used by the Boise National Forest, Payette National Forest, and Nez Perce Tribe as an emerging tool for better documenting fish presence throughout the drainage.

Inadequacy of Key Regulatory Measures

The amount of land designated as federal wilderness and recommended for wilderness protection results in a high level of habitat protection in the South Fork Salmon River drainage. Future development of land management plans will guide the next 10 to 30 years of federal management, including areas outside wilderness. Those plans need to successfully adopt the Deputy Regional Directors' 2008 Framework for Incorporating the Aquatic and Riparian Component of the Interior Columbia basin Strategy to maximize long-term protections. The 1872 Mining Law continues to limit the authority of federal action agencies and active and potential future mining activities exist within the area, threatening degradation of aquatic habitats. There is also continued pressure from counties and the local public to expand motorized recreation and to limit road decommissioning efforts in portions of the South Fork Salmon River drainage.

Water diversions in the Little Salmon River drainage and habitat-degrading management of private land along the main corridor of the Little Salmon River continue to impact anadromous fish habitat. State water law requires water diversions to provide passage for fish (including screening) and monitor the volume of water withdrawal; however, these requirements have not been aggressively pursued by the Idaho Department of Water Resources. Encouraging State water management agencies to consistently and routinely apply existing laws and regulations would likely result in improved habitat conditions. Land use regulations regarding development in riparian and floodplain areas are inadequate and these activities continue to threaten habitat conditions in the drainages.

Recommended Future Actions

To address the limiting factors previously identified, land managers should continue to obliterate and decommission legacy roads, restore riparian habitats, relocate dispersed recreation outside of riparian conservation areas, eliminate fords in occupied habitats, ensure effective road closures are in place to prevent ongoing use, and continue road improvements and road relocation efforts. The U.S. Forest Service should develop and implement a recreation and travel management plan for the South Fork Salmon River subbasin. The travel management plan should identify road and trail segments causing resource degradation and define the minimum road network necessary to manage the forest and accommodate recreational use in the area. The recreation management plan should address the impacts of fishing pressure, motorized vehicle use, and dispersed recreation on riparian and instream habitats. The Payette National Forest should strive to implement the restoration actions (e.g., decommissioning of more than 40 miles of existing roads, relocation of road segments out of the riparian area, etc.), included in the Lost Creek Boulder Creek Landscape Restoration Project.

Fish passage barriers at road stream crossings should continue to be identified, prioritized, and replaced with crossings that restore aquatic organism passage. Abandoned mining claims on federal and patented land should be reclaimed/rehabilitated, including the Cinnabar mine site. Local governments should restrict future growth along the mainstem Little Salmon River and the mainstem Salmon River. Restoration of degraded riparian and instream habitats in the upper Little Salmon River should continue to be implemented. State agencies, local governments, and non-governmental organizations should work with private landowners to restore riparian habitats and to implement practices that minimize adverse impacts on aquatic habitats (e.g., restrict grazing in riparian areas; improve water diversion systems and operations).

Middle Fork Salmon River Geographic Area

Current Status and Trend in Habitat Conditions

The majority of the Middle Fork Salmon River area is in the federally managed Frank Church River of No Return Wilderness Area (wilderness). As such, much of the habitat in the area has little influence from contemporary land management activities and is in near-pristine condition. Where historic impairments persist in wilderness areas, restoration is typically passive. Overall, habitat conditions in this area remain similar to conditions described in previous status reviews. In non-wilderness portions of the Middle Fork Salmon River, including private inholdings within the wilderness, fish habitat has often been compromised by livestock grazing, water withdrawal, mining, road construction, and recreation. Although few habitat impairments exist in the area, recognized limiting factors and threats for ESA-listed salmonids include: (1) low streamflows, barriers, and entrainment associated with water diversions; (2) nutrient deficiencies related to depressed adult returns; (3) excess sediment; (4) elevated water temperature; and (5) isolated areas with degraded riparian and floodplain conditions. Given the predominance of wilderness within this area, habitat conditions are believed to be static or improving over the past five years, with minor improvements occurring in non-wilderness.

Key Emergent or On-going Habitat Concerns

Climate change is likely to influence available habitat by reducing summer baseflows and increasing summer water temperature maxima, particularly in low and mid-elevation reaches. Few opportunities for increasing flow are available in this area. Water gains must be realized through improvements in floodplain connection and hydraulic processes where they have been historically impaired. Protection of cold water resources is necessary in the remaining areas.

Mineral exploration on federal and patented lands in the Big Creek drainage is ongoing, and although the outcome of such exploration is uncertain, there is potential for future mineral development that could impact water quality and aquatic habitat in Big Creek and its tributaries. In addition, there are ongoing concerns over road maintenance and management in the Big Creek drainage.

Key Protective Measures or Major Restoration Actions

During the 5-year review period, efforts to improve habitat conditions have generally focused on the non-wilderness areas. Notable improvements during this time include: (1) elimination of a fish passage barrier by modifying a hydropower diversion in Loon Creek, which restored passage to more than 13.5 miles of habitat (seasonal passage limitations may still persist); (2) replacement of a vehicle ford through spawning habitat in Big Creek with a bridge; (3) Completed ESA Section 7 consultation on federal water diversions in Camas Creek. Three diversions are now required to be screened and have regular flow monitoring. Additional consultations in progress on Lower Middle Fork Salmon River population tributaries should produce similar future benefits; (4) completed ESA Section 7 consultation on water diversions in Big Creek, which requires screens, operable flow control devices and monitoring of diverted flows; (5) completed ESA Section 7 consultations on federal grazing allotments in the Camas Creek, Upper Middle Fork Salmon River, and Marsh Creek populations. Consultations eliminated all livestock overlap with spawning Chinook salmon, increased implementation and effectiveness monitoring, and are expected to provide for improved habitat conditions.

Inadequate Regulatory Mechanisms

The amount of land within the federal wilderness system results in a high level of habitat protection across the area. Future development of land management plans will guide the next 10 to 30 years of federal management, including areas outside wilderness. Those plans need to successfully adopt the Deputy Regional Directors’ 2008 Framework for Incorporating the Aquatic and Riparian Component of the Interior Columbia basin Strategy to maximize long-term protections. The 1872 Mining Law continues to limit the authority of federal action agencies and active mining threats exist within the area. Many private parcels within the wilderness have diversions and other land uses that impact anadromous fish habitat. The U.S. Forest Service has limited or no authority over activities on most of these parcels. State water law requires water diversions provide passage for fish (including screening), yet these requirements have not been aggressively pursued by Idaho Department of Water Resources. Encouraging State water management agencies to consistently and routinely apply existing laws and regulations would likely result in improved habitat conditions.

Recommended Future Actions

Continue to protect and preserve existing high quality habitats and processes. Continue to formally consult with federal land managers on the effects of water diversions where agencies retain discretionary authority to modify current practices. Engage remaining water users to pursue system modifications that eliminate fish passage barriers and entrainment as well as increase streamflow during critical periods. Pursue road system upgrades identified by the Boise National Forest (Fly et al. 2010) and being considered by the Payette National Forest (Big Creek Restoration and Access Management Plan) to reduce sediment delivery to key spawning streams. Pursue similar sediment analysis in roaded watersheds within area to identify high priority treatment sites. Restore hydrologic processes and fish connectivity where they have been compromised by past land uses (e.g., Silver Creek water temperatures [tributary to Camas Creek], Loon Creek water distribution system, mines, etc.). Pursue nutrient enhancement in locations where positive results on fish productivity can be meaningfully evaluated and expand efforts to a broader area after tangible benefits are identified or determined to be highly likely. Continue monitoring for noxious weeds and treating new and existing infestations to limit their spread. Encourage beaver activity where their presence would increase riparian and floodplain function.

Habitat Factor Conclusion

Information that has become available since the last status review indicates freshwater habitats in the Middle Fork Salmon River have improved slightly as a result of restoration and habitat protection efforts. The majority of the area is sufficiently protected from human influences given the large extent of designated wilderness. We therefore conclude that the risk to the species' persistence because of habitat destruction or modification has improved slightly since the last status review. However, habitat concerns outside the Middle Fork Salmon River drainage, particularly in regards to water quality, water quantity, riparian condition, and geomorphic processes, continue to influence salmonid returns to this near pristine area. Uncertainty regarding the long-term impacts of climate change and the ability of listed salmon and steelhead to successfully adapt to an evolving ecosystem add additional risks to recovery potential. Numerous small-scale opportunities for habitat restoration and protection remain throughout the Middle Fork Salmon River. In addition to securing additional habitat restoration actions, a more complete understanding of the specific factors limiting individual populations will be necessary to bring listed salmon and steelhead in the Middle Fork Salmon River to a viable status.

Upper Salmon River Geographic Area

Current Status and Trends in Habitat Conditions

The Salmon River, flowing 660 km (410 miles) through central Idaho, joins the Snake River in lower Hells Canyon. The headwaters of the Salmon River and five natal lakes for Snake River Sockeye Salmon lie within the Sawtooth National Recreation Area, managed by the U.S. Forest Service. The headwaters of each lake drain lands in the Sawtooth Wilderness Area. Overall, habitat conditions in these high mountain lakes remain in relatively pristine condition. The lakes are, and were historically, oligotrophic - lacking in nutrients and with relatively low natural aquatic productivity compared to lower elevation lakes in other areas. In addition, zooplankton abundance and composition vary across the lakes, which may be an important factor in successfully reintroducing anadromous Sockeye Salmon production. Lake nutrient supplementation has been implemented in Redfish, Pettit, and Alturas Lakes to increase Sockeye Salmon carrying capacity. Summer water temperatures in the lakes also temporarily spike to levels that make Sockeye Salmon more susceptible to disease and infection.

Roads, scattered settlements, and recreational development occur in the Sawtooth Valley. Current and legacy effects of land use and other human activities such as mining, lake poisoning, and introduction of non-native species have altered Sockeye Salmon habitat and may still constitute limiting factors for Sockeye Salmon survival. Land use practices may also be affecting Sockeye Salmon by reducing stream flows to critical levels; however, more information is needed to better understand this potential concern. Future land and water use, such as development of new ponds for aesthetics and irrigation purposes, could potentially affect salmon populations by reducing water quality. More information is needed to understand the potential impacts of this and other possible emerging threats.

Much of the upper Salmon River basin is managed for public use, with some of the basin protected in wilderness or roadless areas. High watershed and aquatic integrity is found in the East Fork Salmon and Middle Salmon–Chamberlain watersheds (NPCC 2004). Habitats tend to be more modified or degraded in the major watersheds that have broad valleys and easier access for humans and development, such as the lower Salmon, Pahsimeroi, and Lemhi watersheds.

Private lands tend to be concentrated along the valley bottoms, i.e. near the river. The small towns in the subbasin are located along the river (Stanley, Challis, Salmon), with rural populations scattered in the surrounding areas. Most of these towns have populations under 500 residents. The town of Salmon is the largest, with slightly more than 3,000 people (NPCC 2004). Cattle ranching and agriculture are the main economic activities, and irrigation diversions are common; logging and mining were important historically but have declined since the 1990s (NPCC 2004). Water quality in many areas of the subbasin is affected to varying degrees by land uses that include livestock grazing, road construction, irrigation withdrawals, logging, and mining (NPCC 2004).

One of the largest impacts to salmonid habitat in the upper Salmon River comes from the effects of irrigation diversions and evapotranspiration of crops (USBWP 2005). Consumptive water use in the upper Salmon River basin reduces streamflow in individual tributaries and cumulatively in the Salmon River. Reductions during juvenile spring migration and during summer and fall adult migrations reduce the amount and function of available habitat, leading to reduced survival (Arthaud and Morrow 2007, 2013). Smallmouth bass thrive in the lower Salmon River mainstem extending upstream to Salmon, Idaho. Introduced smallmouth bass, brook trout, hatchery steelhead, and hatchery rainbow trout compete with and prey upon emigrating juveniles (Peterson et al. 2013).

Although efforts to restore habitat conditions in the upper Salmon River basin continue to be broadly pursued, a consistent procedure for tracking basin-wide habitat trends does not yet exist. This complicates our ability to quantify current habitat conditions and trends; particularly in a quantitative sense. Local stakeholders continue to participate in the FCRPS' expert panel process, which likely provides the most comprehensive evaluation of: (1) existing conditions; (2) gaps between habitat potential and/or desired conditions; and (3) the value of completed and proposed habitat restoration activities for the listed species. Unfortunately, the expert panel process timeframes do not directly overlap with ESA status review periods, resulting in an incomplete picture of current status and trend from that process at this time. Status and trend discussions presented below relied in part on previous expert panel discussions, as well as information provided by FCRPS action agencies regarding the number and type of habitat projects completed during the 2011 to 2015 period considered in this review.

The Upper Salmon Basin Watershed Project revised their Screening and Habitat Improvement Prioritization for the Upper Salmon Subbasin (SHIPUSS) in 2012 (Upper Salmon Basin Watershed Project 2012). The SHIPUSS document helps focus local restoration efforts on limiting factors where the greatest potential population benefits are believed to exist. The Bureau of Reclamation also completed a detailed tributary assessment of the Yankee Fork Salmon River (BOR 2012). That assessment has supported the development of focused restoration work in the Yankee Fork Salmon River subbasin, with multiple projects now complete and several others in planning stages. These products have proven to be useful tools for restoration practitioners, and additional efforts focused on key uncertainties in the basin are likely to provide helpful insight.

Key Emergent or On-going Habitat Concerns

Ongoing water use practices in several sub-basins continue to limit the quantity and quality of available habitat through reduced streamflow. In addition to generating fish passage issues, existing water use contributes to reduced juvenile growth in natal areas, which leads to lower survival in and out of the basin. Habitat reductions from water use may also contribute to observed density dependent relationships in natal areas (ISAB 2015; Walters et al. 2013), and may exacerbate projected climate change influences on recovery and survival.

Physical barriers continue to limit or completely block adult and juvenile access to key tributary streams within important populations for recovery. Barriers are typically irrigation diversion structures or poorly designed road crossings. Reduced access to historically occupied habitats limits the species' range, reduces life history variability, restricts access to thermal refugia, and potentially contributes to density dependent limitations in occupied habitats.

Although the Upper Salmon River basin contains a highly functional and extensive irrigation screening program, many of the existing structures are nearing the end of their design life. At the same time funding for screen maintenance and reconstruction has been flat or reduced. Any reduction in screen efficacy, either from structure failure or poor maintenance, is a potential threat to current population status in the area.

Riparian habitats and floodplain function remain compromised across the Upper Salmon River basin's more developed valley bottom reaches. Agricultural practices and transportation infrastructure generate the most significant impacts with flood protection structures also compromising habitat in more developed reaches. Much of the most valuable floodplain and riparian habitats for extant salmonid populations have been disconnected, simplified, or eliminated.

Water temperatures continue to limit full life history expression in the area, especially where streamflow has been reduced, riparian vegetation removed or altered, and where floodplains have been disconnected. Areas of concern include the mainstem Salmon River (downstream of approximately Clayton, Idaho), lower mainstem Lemhi and Pahsimeroi River reaches, and tributary streams with heavy flow depletion.

Likely changes in temperature and precipitation patterns due to climate change have profound implications for survival of Upper Salmon River populations in freshwater habitats. For example, stream flows and temperatures - the environmental attributes that climate change will affect - already limit Snake River Sockeye Salmon productivity in areas of the Sawtooth Valley lakes and Salmon River, and in the mainstem Columbia and Snake Rivers. All other threats and conditions remaining equal, future deterioration of water quality, water quantity, and/or physical habitat due to climate change can be expected to reduce viability or survival of naturally produced Chinook and Sockeye Salmon returning to the Upper Salmon River basin and Sawtooth Valley lakes.

Key Protective Measures and Major Restoration Actions

The Sawtooth National Recreation Area (Sawtooth NRA) managed by the U.S. Forest Service works to protect and conserve natural ecological processes in the Sawtooth Valley by continuing to manage wilderness areas which protect headwaters for the natal lakes, implementing Sawtooth NRA habitat and lake shore restoration actions and fish screening projects in coordination with the Idaho Department of Fish and Game screen shop, and restoration projects on Pole Creek, Valley Creek and Fourth of July Creek.

The Shoshone Bannock Tribes have conducted research studies for the last five years monitoring the physical and chemical characteristics of the natal Sockeye Salmon lakes. Zooplankton forage and *O. nerka* abundance are used to evaluate lake carrying capacities, lake productivity and shifts in plankton assemblages as Sockeye Salmon abundance increases. This research addresses the habitat uncertainty regarding the sockeye rearing capacities of the natal lakes because of kokanee competition and climate change.

In 2013, the Springfield Hatchery was completed by the Idaho Department of Fish and Game in order to address the recovery strategy of increasing the abundance of naturally spawning Sockeye Salmon by releasing, over time, up to one million Sockeye Salmon smolts to increase the number of returning anadromous adults and adults that can be released into the Sawtooth Valley lakes.

The Sawtooth NRA in cooperation with the Idaho Department of Agriculture has conducted an aquatic invasive species prevention program on Sawtooth Valley lakes that are popular boating destinations and are vulnerable to aquatic invasive species (i.e., mud snails, mussels, etc.). The program involves public outreach and education, boater surveys, and lake monitoring.

Numerous habitat projects have been completed to address key limiting factors and threats since the previous status review. Notable recovery projects across the area are discussed below.

Patterson Big Springs Creek (Pahsimeroi River populations), was reconnected to the Pahsimeroi River. The reconnect was accomplished by increasing streamflow by more than 20 cubic feet per second (cfs) and removing multiple physical barriers associated with irrigation. Post-implementation, approximately 40% of annual Chinook salmon redds occurred in the newly accessible habitat and steelhead distribution also likely improved. Increased distribution of spawning and rearing fish is likely to improve the populations' potential for recovery and survival.

In the Pahsimeroi and Lemhi subbasins, easement acquisition, land purchases, and fence construction projects protected and improved more than 6,985 riparian acres and approximately 41 miles of river and stream. Most of these improvements protected areas within or directly adjacent to existing salmon and steelhead strongholds. Additional riparian conservation occurred in the Valley Creek, Upper and Lower Salmon River Mainstem, East Fork Salmon River, Yankee Fork Salmon River and Panther Creek subbasins.

Fish passage barriers continue to be addressed throughout the area. Ten Lemhi River tributaries were completely or partially reconnected.[7] Approximately 33 barriers were addressed to benefit the Lemhi River Chinook salmon population. More than 24 barriers were addressed in the Pahsimeroi River area – improving access to more than 34 miles of stream with additional new stream access (e.g., mainstem Pahsimeroi River, Sulphur Creek, and Mill Creek). Pole Creek, in the Salmon River Upper Mainstem Chinook salmon population area, was reconnected and flows augmented with 12 cfs – fully reconnecting this important upper basin tributary. Four additional mainstem Salmon River tributaries also had barriers removed,[8] improving access to thermal refugia and increasing spatial distribution. Three of six Valley Creek tributaries identified as priorities for barrier removal in draft recovery plans (NMFS 2011) were also remedied.

Water transactions and on-farm irrigation improvement projects increased summer stream flow in many locations across the Upper Salmon River basin. For example, 24 transaction, four

[7] Little Springs, Lee, lower Canyon, lower Big Timber, Bohannon, Kenney, Wallace, lower Carmen, Wimpey, and Hawley Creeks all had barrier(s) addressed.
[8] Garden, Bayhorse, Iron, and Poison Creeks.

easements, and irrigation changes in the Lemhi River basin generated about 85[9] cfs of flow improvement in key tributary and mainstem habitats. Some projects successfully contributed to tributary reconnections, and duration of water transaction contracts generally increased slightly since the last review. Flow improvement projects focused on key reaches and tributaries. However, the extent of flow depletion across the landscape, the magnitude of over allocation in many streams, and limited legal framework to maximize downstream distances influenced by individual projects continue to limit success.

In the last status review, we recognized that significant progress in federal lands livestock grazing management and monitoring was necessary to improve the status of streams for salmon and steelhead recovery. Since then, over 60 federal grazing allotments in the Upper Salmon River Basin have undergone new ESA section 7 consultations. These allotments' management plans were revised, sometimes substantially, to reduce their individual and cumulative impacts on aquatic habitat and fish. The USFS and the BLM also implemented additional implementation and effectiveness monitoring which should enable federal land managers to quickly identify and change grazing management where it is inconsistent with needed aquatic habitat improvements.

Inadequate Regulatory Mechanisms

- Management of passage obstructions in Sawtooth Valley
- Water allocations for irrigation diversions and Instream flow management
- Management of non-native species (lake trout)
- Mining – potential future impacts
- Research about current conditions and management of predators – warm water fish predators
- Prevention and management of toxic sources contamination
- Inadequate land use regulations and practices – ag, forestry, development impacts on habitat functions: riparian and floodplain; instream flow; sediment processes

Due to the vast acreage of federal land throughout the range of salmon and steelhead in the Snake River basin, conservation of these ESUs' and the DPS's habitat on federal land is a recovery priority. However, there is uncertainty over the future conservation of salmon and steelhead on federal lands in the Snake River basin. The level of protection afforded to these ESU's and DPS's habitat will be determined by land management plans currently under development by the U.S. Forest Service and BLM. In our last review we identified the importance of successfully implementing the Deputy Regional Directors' 2008 Framework for Incorporating the Aquatic and Riparian Component of the Interior Columbia basin Strategy into

[9] This includes the recent acquisition made in 2015 by the Lemhi Regional Land Trust, based in Salmon, Idaho, of the Tyler Ranch easement which protects 4,682 acres in the Lemhi River watershed. This protects 11 miles of the Lemhi River, including important mainstem spawning habitat. This easement results in 8.3 cfs of water instream after abandoning a water diversion on the property.

Bureau of Land Management and Forest Service Plan Revisions. Little progress on plan revisions has occurred in this area in the past five years. The framework components, in conjunction with the successful integration of recovery plan direction, remain fundamental to successful salmon recovery planning in this area.

Climate change is anticipated to reduce the current range of native fish (Eby et al. 2014, Isaak et al. 2012, Wenger et al. 2011, Wenger et al. 2013) and could confound efforts to recover extant populations (Munoz et al 2014). Modeling of climate change scenario's effects on future stream temperature suggests high elevation areas of the Snake River Basin, much of which are federally managed, are likely to provide long-term cold water refugia important for the survival and recovery of native fish (Isaak et al. 2015), including Snake River salmon and steelhead. Federal land management must recognize the importance of these habitats in preserving native biodiversity and take pro-active steps to prioritize watersheds for long-term protection and enhancement. Incorporating "climate shield" analyses into future land management plan revisions is a high priority for maintaining current species' status and a necessity to facilitate improved future status under a warming climate.

Significant opportunities exist for recovery and/or conservation actions on federal lands as part of the ESA section 7(a)(1) responsibilities. NMFS will continue to work with the U.S. Forest Service and BLM to identify opportunities for restoration actions on federal lands. We will also work with these agencies, to the degree possible, to provide funding and technical assistance for projects that benefit the salmon and steelhead in the Snake River basin. Initiation and completion of consultation by U.S. Forest Service and BLM on all actions where consultation is required is also a conservation priority.

Recommended Future Actions

Implement actions in the Snake River Sockeye Salmon Recovery Plan (NMFS 2015b), including RM&E, and develop an implementation schedule based on the recovery plan actions to address priorities and progress and relate these to the public.

Continue on-going Shoshone Bannock Tribes limnological research on Sawtooth Valley natal lakes' carrying capacity, nutrients, and ecology. Refine the carrying capacity model to incorporate differences in grazing patterns among anadromous sockeye, residual sockeye, and kokanee.

Continue to fund and expand implementation of the Sawtooth NRA and Idaho Department of Agriculture invasive species prevention program, including the early detection/rapid response plan for the most probable aquatic invasive species.

Lake Trout are currently confined to Stanley Lake, yet there is concern about future dispersal to and establishment of Lake Trout in other Sawtooth Valley Lakes. Continued eDNA studies are recommended to further test the efficacy of this analytic method and refine this tool. Continued

Lake Trout population dynamic studies are underway to determine population size, diet, and spawning areas in Stanley Lake.

Maintain current wilderness protections and protect pristine habitat and natural ecological processes in the Sawtooth Valley.

Investigate and improve conditions in the Salmon River and tributaries to support increased survival of migrating juvenile and adult ESA-listed salmonids.

Monitor and control predation, disease, aquatic invasive species, and competition.

Respond to climate change threats by implementing RM&E to track indicators and by preserving biodiversity.

Implement Sockeye Salmon recovery strategy for the Pettit Lake Population: Protect and enhance spawning and rearing habitat in Pettit Lake. Improve/replace the juvenile trapping structure on Pettit Lake. After several years of direct outplanting of adults sourced from the Redfish Lake population, stop stocking and evaluate the natural production response; continue to allow anadromous Pettit Lake-origin adults to return for volitional spawning.

Implement Sockeye Salmon recovery strategy for the Alturas Lake Population: Protect and enhance spawning and rearing habitat in Alturas Lake. Trap and transport or allow volitional migration of anadromous adults identified as Alturas Lake origin to Alturas Lake for volitional spawning. Identify appropriate donor stocks and investigate strategies to establish a new hatchery captive broodstock program for anadromous Alturas Lake Sockeye Salmon. Investigate alternative strategies for the early stream spawning Alturas Lake population that will support and enhance anadromy.

To improve population resiliency to a changing climate, identify tributary thermal refugia and restore more natural flow regimes, including improving hyporheic exchange in thermally limited reaches, to improve recovery potential. Reduced discharge from tributary streams likely eliminates thermal refugia for juvenile and adults migrating through mainstem river reaches during critical time periods. For example, research indicates that adult steelhead from the Snake River basin using cool-water tributaries and cold water refugia during migration in the lower Columbia River mainstem have lower rates of return to natal streams and higher rates of disappearance due to incidental mortality from fishing in refugia tributaries and other unknown reasons (Keefer et al. 2009).

Complete recovery plans for Snake River spring/summer Chinook salmon and Snake River steelhead and provide adequate funding to facilitate their implementation.

As requested by the Idaho Office of Species Conservation, develop a working definition of the summer life history strategy as it applies to the Pahsimeroi River population of spring/ summer Chinook salmon. Define this life history type and identify actions to retain it.

Secure permanent water leases for mainstem Lemhi River flow targets at the L-6 diversion. Increase flow target where doing so is practicable and would improve recovery potential.

Identify the location of overwintering habitats for juvenile Chinook. Research is necessary to identify habitat providing the highest survival to adult and return, or population sinks. This will aid in identifying appropriate habitat improvements to directly improve survival/productivity for increased cost/benefit.

Evaluate need for and implement active riparian restoration where passive approaches have been insufficient in addressing limiting factors.

Increase quantity of off-channel habitat to support key rearing life stages, particularly where historic alterations have simplified or eliminated habitats.

Pursue more focused reintroduction of beaver to landscapes where their presence could increase the quantity and quality of aquatic habitat, moderate impacts of climate change on streamflow and water temperature, or reduce sediment.

Address data gaps - Across populations, we need to better validate existing limiting factors' influence on productivity and/or identify limiting factors that have been overlooked in light of higher priorities. Currently, managers do not completely understand: (1) different life historys' overwintering habitats or the degree of change from historic conditions (i.e., off-channel habitats, mainstem conditions, ice influence, etc.); (2) actual impacts on reduced nutrient inputs from marine-derived sources, and how this may affect primary productivity and in turn density dependency across local populations; and (3) productivity impacts from the lost quantity and location of connected floodplains and historic removal of beaver from the landscape.

Address density dependence concerns – Evaluate local populations to determine what life stage(s) are generating observed density dependent productivity stock: recruitment curves in order to better target future restoration activities.

Evaluate what role increased/decreased ice formation resulting from historic channel and floodplain alterations might have on overwintering juveniles. Is increased ice formation resulting in increased juvenile fish stranding on winter floodplains, or is increased ice and associated bed scour contributing to decreased overwinter survival?

<u>Overarching Issues Related to Management of Tributary Habitat in the Snake River Basin</u>

Recovery projects throughout the Snake River basin include: (1) improved fish passage and increased access to high quality habitat; (2) riparian vegetation restoration through fencing and planning; (3) instream habitat improvements; (4) screening of irrigation diversions; (5) land acquisitions or acquiring easements to protect existing high-quality habitat; (6) voluntary market-based water leasing programs and improved irrigation efficiencies to increase instream flows; and (7) water quality standards review.

Formal NMFS consultation was completed on more than 50 habitat improvement or pollution control projects in the Snake River basin since the previous status review. Many of these projects were accomplished in cooperation with and/or funding from: the Washington Salmon Recovery Funding Board (for projects in the Southeast Washington implemented by the Snake River Salmon Recovery Board), Snake River Basin Adjudication funds in Idaho, NMFS' Pacific Coastal Salmon Recovery Fund, Tribal Accord funds, Habitat Conservation Plans, Bonneville Power Administration, Army Corps of Engineers, U.S. Forest Service, U.S. Bureau of Land Management, Bureau of Reclamation, Idaho Office of Species Conservation, the Oregon Watershed Enhancement Board for projects in Northeast Oregon, local Soil and Water Conservation Districts in all three states, multiple non-governmental organizations, and other federal, state, and local landowners. Some of these key habitat improvements that have been implemented since the previous status review includes:

- Continued restoration of stream flows and passage improvements in the upper Salmon River in Idaho and Catherine Creek in Northeast Oregon.
- Development and implementation of water quality plans in Idaho that, as of 2012, have resulted in 30 percent of stream/river miles fully supporting uses and 36 percent not fully supporting uses. The number of stream/river miles needing a total maximum daily load decreased by nearly 21 percent (IDEQ 2014). Completed or updated TMDLs in critical habitat during the past five years include Lolo Creek, Lemhi River, Little Salmon River, Lochsa River, Pahsimeroi River, Lower Salmon River/Hells Canyon Tributaries, and South Fork Salmon River.
- Adoption by NMFS of the final Snake River Sockeye Salmon Recovery Plan in June 2015 which was written in cooperation with Idaho Department of Fish and Game, Shoshone Bannock Tribes, U. S. Forest Service, Sawtooth National Recreation Area, BPA, NMFS Northwest Fisheries Science Center, and NMFS' Interior Columbia Basin Office (NMFS 2015b).
- Development of draft Snake River Spring/ Summer Chinook Salmon and Snake River Steelhead Management Unit Plans for Northeast Oregon and Idaho. And draft of the Roll-up Plan for Snake River Spring/Summer Chinook and Steelhead for stakeholder review in late 2015.
- A proposed NMFS recovery plan for Snake River Fall Chinook Salmon was noticed for public review and comment on November 2, 2015 (NMFS 2015c).
- U.S. Forest Service and Bureau of Land Management –PACFISH /INFISH Biological Opinion improvements in watershed management and annual monitoring of progress.

- Development of the Northeast Oregon Snake River Management Unit Draft Recovery Plan, including identification of priority limiting factors and proposed recovery actions used by partners implementing tributary habitat restoration projects.
- Implementation of FCRPS Reasonable and Prudent Alternatives by the FCRPS Action Agencies, including analyses identifying priority areas and actions.
- Implementation of the Columbia basin Fish Accords providing funding for state and tribal restoration and recovery actions.
- Continuation of the BPA-funded Columbia Basin Water Transaction Program to increase stream flow in rivers and streams, particularly in the Lemhi River, Pahsimeroi River and Catherine Creek.
- Continued implementation of fish screening programs for water diversion sites.
- Implementation of the FCRPS Biological Opinion (FCRPS Opinion) (NMFS 2008a; NMFS 2010; NMFS 2014a) is providing a number of actions that are resulting in survival improvements: from 1980 to 2000 inriver survival estimates for Snake River steelhead were about 22%, now we are measuring 55 to 65% survival rates for inriver fish, reduced duration of outmigration to the estuary, improved juvenile survival and condition, and increased access to habitats.

A key landscape-scale factor that negatively affects the Snake River species is the overall loss of floodplain habitat connectivity and complexity. The reduction and degradation in total habitat through the loss of habitat complexity has progressed over decades as flood control and wetland filling occurred to support agriculture, silviculture, or conversion of natural floodplains to urbanized uses. Loss of habitat through conversion was identified among the factors for decline for these species. In addition, NMFS' 2000 4(d) rule protective regulations for West Coast salmon and steelhead stated "NMFS believes altering and hardening stream banks, removing riparian vegetation, constricting channels and flood plains, and regulating flows are primary causes of anadromous fish declines" (NMFS 2000).

Floodplains provide shallow/slack water refugia during flood conditions. Channel migration, through erosional and depositional processes that occur with floods create multi thread channels, off-channel and side channel habitat. Flood storage in natural floodplains is a vital mechanism for hyporheic recharge of streams providing base flows of cool water. Flood waters on natural floodplains bring an abundant and varied prey base to juvenile salmonids. Because of the vital role functioning floodplains have on life history and habitat needs of salmonids, the designation of critical habitat identified floodplain connectivity as a primary constituent element of rearing habitat for juvenile life stages among 20 west coast salmonids. "Essential features for the listed ESUs of salmon and steelhead include sites essential to support one or more life stages of a population necessary to the conservation of the ESU." These sites in turn contain generic features that contribute to their conservation value for the ESU. Specific types of sites and their generic features include: Freshwater rearing sites with sufficient water quantity and floodplain connectivity to form and maintain physical habitat conditions and allow salmonid development and mobility (NMFS 2003).

Floodplains that retain all or most of their natural features and functions support a variety of vital life history needs, though the specific needs vary by species. For example, spring Chinook salmon have long freshwater residency, which episodically exposes juveniles from multiple populations across their range to flood conditions. During floods, rivers that are disconnected from floodplains expose these juvenile fish to high volumes and velocities without access to shallow water refugia, or strands them in the disconnected areas, raising the risk of injury and mortality. Juveniles that have access to ephemeral floodplain habitats during flood events show higher growth, and rates of survival (Sommer et al. 2001; Jeffres et al. 2008). Spring Chinook salmon have unique genetic and spatial contribution to Chinook salmon ESUs, and are vital to ESU-level viability. Steelhead have multi-year freshwater residency, and when flood conditions occur, they will affect multiple age cohorts from multiple populations from the steelhead DPSs. Loss of habitat complexity has also contributed to the decline of steelhead (62 FR 43937; August 18, 1997). The draft NMFS Snake River Spring/Summer Chinook Salmon and Steelhead Recovery Plan identifies reduced floodplain connectivity as a limiting factor affecting numerous life history stages for many populations.

Significant habitat restoration and protection actions at the federal, state, and local levels have been implemented to improve degraded habitat conditions and restore fish passage. 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.

Listing Factor A Conclusion

New information available since the last status review indicates there is improvement in freshwater and estuary habitat conditions due to restoration and habitat protection. Changes to hydropower operations have increased juvenile survival rates through the mainstem Columbia River corridor. Improvements to fish passage and numerous tributary habitat improvement restoration projects should result in improved survival for the ESUs and DPS. We therefore conclude that the risk to the species' persistence because of habitat destruction or modification has improved slightly since the last status review. However, habitat concerns remain throughout the Snake River basin particularly in regards to mainstem and tributary stream flow, floodplain management and water temperature in areas that exceed water quality standards due to anthropogenic causes. It is common for flow levels to be depleted by numerous small diversions that cumulatively contribute to low flow and high temperature problems. Some reaches of small – and mid-sized tributaries providing key rearing habitat are often dry during the summer due to demand for surface water to be used for domestic, industrial, and irrigation purposes (NMFS 2012a; NMFS 2012b).

Uncertainty regarding the long-term impacts of climate change and the ability of listed salmon and steelhead to successfully adapt to an evolving ecosystem add additional risks to species recovery. There is growing awareness about the importance of thermal refugia in migration corridors and that these areas may be limiting during summer months, which is likely to be exacerbated with climate change. Numerous opportunities for habitat restoration and protection remain throughout the Snake River basin. In addition to completing more habitat protection or restoration actions, a more complete understanding of the specific factors limiting individual populations will be necessary to bring listed salmon and steelhead in the Snake River basin to viable status.

Listing Factor B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Harvest

No harvest changes in mainstem fisheries management have occurred since the previous status review. The adoption of the May 2008 *U.S. v. OR* Management Agreement (2008-2017) has, on average, reduced impacts of freshwater fisheries to all Snake River ESUs/DPS (TAC 2011-2014). The continued implementation of harvest rates based on run size for all U.S. fisheries is predicted to improve management for Snake River salmon and steelhead.

Current fisheries management frameworks for Snake River spring/summer Chinook salmon in Snake River tributaries include abundance-based sliding-scales to determine year-specific allowable harvest rates. A similar approach is being considered in developing harvest frameworks for Snake River fall Chinook salmon and Snake River steelhead. More fisheries data would help to verify existing scientific information on catch-and-release mortality in recreational fisheries.

Research, Monitoring and Evaluation

The FCRPS Action Agencies are implementing a comprehensive fish population and habitat research, monitoring, and evaluation (RM&E) program under the 2008 FCRPS BiOp and its 2010 Supplement (NMFS 2008a; NMFS 2010). Major program components include:

- Monitoring to evaluate fish response to the aggregate effects of multiple habitat actions at the watershed or population scale through the use of intensively monitored watersheds (IMWs). Under the BiOp, IMWs are underway in the Entiat, Methow, John Day, and Lemhi rivers. In addition, IMWs funded by NMFS are underway in Asotin Creek, the Upper Middle Fork John Day River, and the Potlatch River. IMWs have robust experimental design, including data of sufficient quantity, duration, spatial scale, and resolution, to detect change despite environmental variation.
- Habitat status and trends monitoring (under the Columbia Habitat Monitoring Program, or CHaMP) strategically paired with adult and juvenile fish status and trends

monitoring.[10] This monitoring will provide data to calibrate mathematical models simulating the overall effects of habitat improvements on changes in habitat condition and, in turn, the effects of these changes on fish abundance and productivity within each MPG and each ESU or DPS within the interior Columbia basin. This information will also help detect trends in habitat condition over broader geographic scales, including effects of climate change.

- Development of tributary habitat models that take advantage of advancements in habitat monitoring and fish/habitat relationships to link, both empirically and mechanistically, measures of habitat quality with fish survival. This will allow for improved estimates of the effect of changes in habitat quantity and quality on fish population trajectories as well as improved targeting of habitat restoration efforts.
- Action effectiveness monitoring to determine if actions are meeting their biological objectives and to help identify actions that most effectively address specific limiting factors.
- Implementation and compliance monitoring to verify that habitat improvement actions are completed as planned and are functioning as intended.

This multifaceted RM&E approach will inform conclusions regarding habitat status and trends, fish population status and trends, fish-habitat relationships (i.e., how changes in habitat affect fish survival), fish response to various treatment types, and the effectiveness of various types of actions in addressing specific limiting factors. The RM&E program allows testing and validation of assumptions in a step-by-step process:

- When an action was implemented, did habitats start changing the way we thought they would?
- If we opened up habitat, are fish using it?
- For major types of actions, is habitat changing in the direction we had anticipated?
- Are fish populations responding in the way we had anticipated?

Data, analysis, and understanding regarding one population, location, or type of action can be applied appropriately to other populations and locations.

Data from the NMFS 2008 BiOp RM&E program (NMFS 2014a, BPA and USBR 2013) are preliminary but appear to be supporting the working hypothesis that implementation of tributary habitat improvement actions under the RPA is contributing to improvements in fish population abundance and productivity. Results are showing the types of changes in habitat that we would expect to see, along with increased fish densities in areas treated with improvement actions (e.g.,

[10] CHaMP monitoring is underway under the FCRPS BiOp (NMFS 2014a) in the Asotin, Entiat, John Day, Lemhi, Methow, Minam, South Fork Salmon, Tucannon, Umatilla, Upper Grande Ronde, Wenatchee, and Yankee Fork Salmon subbasins.

Entiat River IMW, Methow River IMW, Upper Middle Fork John Day) (NMFS 2014a). Results in Bridge Creek and the Lemhi River also show improved fish survival (NMFS 2014a).

Research is also establishing relationships between habitat quality and fish survival and is identifying the factors that most influence juvenile salmon and steelhead productivity. An understanding of those relationships, combined with detailed watershed and population assessments, is helping biologists and managers target the most critical habitat issues and more accurately estimate the benefits for fish. It is crucial to continue this monitoring, to expand it strategically, and to ensure that mangers use the results in planning and implementing actions.

In the Lemhi subbasin, for example, data from various programs on habitat status and trends, fish abundance and survival, and empirical fish-habitat relationships are being leveraged and combined in a watershed model to enhance the evaluation of completed habitat improvement actions and predict the benefits of future actions (BPA and USBR 2013).

Although the absolute quantity of take authorized for scientific research and monitoring in the Snake River basin has been relatively low, take authorizations have in some instances increased over the past five years. Our records of take authorization under ESA sections 10(a)(1)(A) and 4(d) for salmon and steelhead in the Snake River basin reveal a patchy increase in take requests for the purposes of scientific research. In most cases, but not all, the absolute take numbers have increased, but if that take is expressed as a percentage of species abundance, only about half the components we track (species, age, origin) have actually seen increased take. Further, in most instances the mortalities associated with that take —when they are expressed as a percentage of abundance—have decreased. It seems likely that this trend reflects greater expertise and understanding on the researchers' part.

Still, we expect take requests to increase at least somewhat for the foreseeable future as better tools become available and programs such as intensively monitored watersheds come fully online. As that happens, the impacts from electroshocking, trapping, tagging, marking, and handling (e.g., direct mortality, delayed mortality, and sub-lethal effects) need to be better understood, and there are regional efforts currently underway to do that. In addition, it will be necessary to prioritize the Research Monitoring and Evaluation tasks before they can be implemented fully. Given the greater demand for take under various research and monitoring schemes, it is likely that these activities are having a larger (and gradually increasing) impact since the last ESA status review, and so that impact needs to be carefully monitored. However, it is worth noting that we expect those increasing effects to be mitigated somewhat by decreasing mortality rates as techniques become less intrusive and technology and expertise improve.

<u>Listing Factor B Conclusion</u>

New information available since the last ESA status review indicates harvest impacts have remained relatively constant (TAC 2011-2014), but research impacts have increased slightly. It should be noted that much of the research being conducted is intended to fulfill managers' obligations under the ESA to investigate the status of the species. Improving our understanding and estimates of the impacts coming from all Research, Monitoring, and Evaluation activities (electrofishing, weir operation, handling, tagging, marking, trapping, etc.) is recommended. Impacts from these sources of mortality, however, are not considered to be major limiting factors for these ESUs and DPS. We therefore conclude that the risk to the species' persistence because of overutilization remains essentially unchanged since the last status review

Listing Factor C: Disease, Predation and Aquatic Invasive Species

Disease

Disease rates over the past five years are believed to be consistent with the previous review period. Climate change impacts such as increasing temperature may increase susceptibility to diseases. Recent reports indicate the spread of a new strain of infectious hematopoietic necrosis virus along the Pacific coast that may increase disease-related concerns for Snake River salmon and steelhead in the future.

Avian Predation

Although actions to reduce avian predation in the Columbia Basin have been ongoing with implementation of the FCRPS Biological Opinion, high levels of avian predation by Caspian terns and double-crested cormorants continue to affect the Snake River salmon ESUs and steelhead DPS. A Columbia Basin-wide assessment of avian predation on juvenile salmonids indicates that the most significant impacts to smolt survival occur in the Columbia River estuary (Collis et al. 2009).

NMFS' 2008 FCRPS Opinion recommended that the Action Agencies implement the Caspian Tern Management Plan to substantially reduce this species' nesting habitat and salmonid predation rates in the Columbia River estuary by 2018 (NMFS 2008a). NMFS also recommended that the Action Agencies reduce predation by Caspian terns nesting in the inland Columbia basin, including those on Goose Island in Potholes Reservoir and Crescent Island in McNary Reservoir. Survival benefits to upper Columbia River steelhead and spring Chinook salmon began to increase when nesting dissuasion actions began in early 2014. Tern predation on the Upper Columbia species will decrease further when dissuasion begins at Crescent Island in 2015.

The number of double-crested cormorants nesting in the Columbia River estuary has increased from about 150 pairs in the early 1980s to 11,000 to 13,500 pairs, with most of the increase taking place over the past 10 years (Appendix E in NMFS 2014a). Consumption rates of juvenile salmon and steelhead also increased during this period; in 2006, double-crested cormorants probably consumed more than 4% of the juvenile yearling Chinook and about 13% of the juvenile steelhead in the lower Columbia River, including those from the Snake River salmon ESUs and steelhead DPS. In the 2014 FCRPS Supplemental Opinion, NMFS therefore recommended that the Action Agencies develop a cormorant management plan and implement actions to reduce cormorant numbers to no more than 5,380 to 5,939 nesting pairs on East Sand Island. The Corps completed a Cormorant Management Environmental Impact Statement and

Management Plan in early 2015 and began implementation on East Sand Island in late May by culling adults and oiling eggs. In conclusion, avian predation has increased during the period considered in this status review which could have affected the productivity of the upper Columbia River species, especially steelhead. Avian predation management measures have been started, but they are either still in the future or too recent to have made any difference in this review

Pinniped Predation

Pinniped predation continues to remain a concern for listed species in Oregon and Washington due to a general increase in pinniped populations along the West Coast. For example, California sea lions have increased at a rate of 5.4% per year between 1975 and 2011 (NMFS 2015d), Steller sea lions have increased at a rate of 4.18% per year between 1979 and 2010 (Allen and Angliss 2014), and harbor seals likely remain at or near carrying capacity in Washington and Oregon (Jefferies et al. 2003, Brown et al. 2005, respectively, as cited in NMFS 2014c).[11]

In the Columbia River Basin, there has been a steady influx of pinnipeds (Figure 5), especially California sea lions, over the past five years with sharp increases in California sea lion presence in 2013 of 750 animals, 1,420 animals in 2014,[12] and 2,340 animals in 2015.[13]

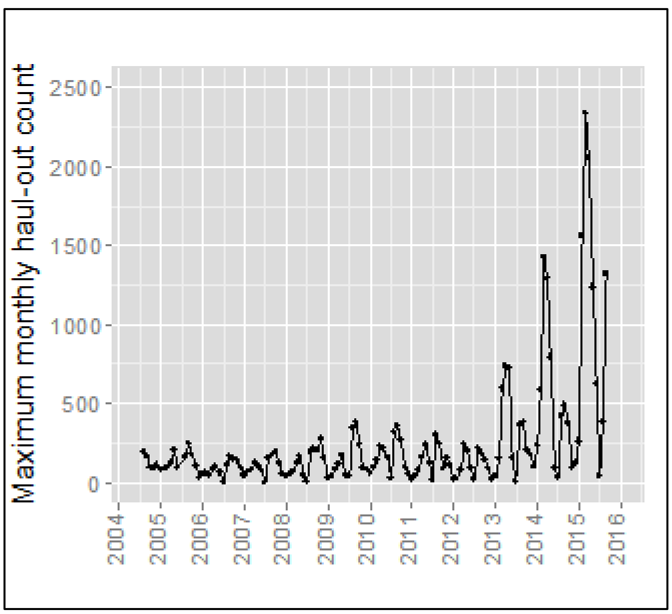


Figure 5. Estimated peak counts (spring and fall) of California sea lions in the East Mooring Basin in Astoria, Oregon, 2004 through 2015.

As pinniped numbers have increased in the Columbia River Basin over the past 13 years (2002 through 2014), more than 40,000 fish from listed and non-listed salmon and steelhead stocks

[11] The last population estimates of harbor seals in Washington (coastal population) and Oregon was in 2003 and 2005 (Jefferies et al. 2003, Brown et al. 2005, respectively, as cited in NMFS 2014c), when the population growth rate was estimated at 7% (NMFS 2014a).

[12] E-mail to Robert Anderson, NMFS, from Bryan Wright, ODFW, October 28, 2015.

[13] E-mail to Robert Anderson, NMFS, from Bryan Wright, ODFW, October 28, 2015.

(listed stocks: Upper Columbia River spring-run Chinook salmon, Snake River spring/summer-run Chinook salmon, Upper Columbia River steelhead, Snake River Basin steelhead, Middle Columbia River steelhead; non-listed stocks: Middle Columbia River spring-run Chinook salmon, Upper Columbia River summer-run Chinook salmon, Deschutes River summer-run Chinook salmon) have been consumed by California sea lions in the vicinity of Bonneville Dam (Stansell et al. 2014). Most, but not all, California sea lions leave Bonneville Dam by the end of May, and there have been a handful that have taken residence in the area between Bonneville Dam forebay and The Dalles Dam. All up-river stocks are subject to pinniped predation in the vicinity of Bonneville Dam, although it is the spring-run stocks that are at greatest risk.

The states of Oregon, Washington, and Idaho are operating under an Marine Mammal Protection Act Section 120 authorization, which allows for the lethal removal of California sea lions that are individually identifiable and observed to be having a significant negative impact on ESA-listed salmonids at Bonneville Dam, to address the threat of predation by California sea lions in the vicinity of Bonneville Dam. Between 2008 and 2014 this program has prevented the loss of between 7,000 and 24,000 salmonids at Bonneville Dam (Wright et al. 2015).

Ongoing research in the Columbia River (Wargo Rub et al. 2014) suggests that 10 to 45 percent of the returning adult salmon are unaccounted for during the 146 mile migration between the Columbia River estuary and Bonneville Dam, at the time when the California sea lions are present in the Columbia River in large numbers. If California sea lions are in fact responsible for a substantial fraction of this estimated loss, then this additional source of pinniped predation (in addition to documented predation at Bonneville Dam) may represent a significant shift in the severity of pinniped predation to the recovery of listed Columbia River Basin salmon and steelhead stocks, in addition to anthropogenic threats (e.g., impacts from habitat loss, dams, etc.). Additionally, California sea lions numbers over the past five years at Willamette Falls, 28 miles south of the confluence of the Willamette and Columbia Rivers at Portland, Oregon, have been steadily increasing and their predation on listed salmonid stocks has reached significant levels (Brown et al. 2015). In the late winter and spring months of 2014 and 2015, some 25-50 California sea lions consumed between 8-14% of the listed spring-run Chinook salmon and winter-run steelhead, respectively, attempting to pass the falls to upriver spawning areas (Wright et al. 2015).

The effect of marine mammal predation on the productivity and abundance of Columbia River Basin salmon and steelhead stocks has not been quantitatively assessed at this time. The absolute number of animals preying upon salmon and steelhead throughout the lower Columbia River and Willamette River is not known. In addition to pinniped predation on salmonids, this steady influx of pinnipeds into the Columbia River may also represent a threat to other species, such as eulachon. For example, in 2015 WDFW[14] estimated, based on biomass reconstruction for eulachon consumption, that harbor seals were consuming an estimated 2,700,000 eulachon per day in the Columbia River estuary.

[14] E-mail (forwarded) to Robert Anderson, NMFS, from Brent Norberg, NMFS, on February 19, 2015, from Steven Jefferies, WDFW, regarding sea lion counts in Astoria, Oregon (Norberg 2015).

The information available since the last status review clearly indicates that predation by pinnipeds on listed stocks of Columbia River Basin salmon and steelhead, as well as eulachon, has increased at an unprecedented rate. So while there are management efforts to reduce pinniped predation in the vicinity of Bonneville Dam, this management effort is insufficient to reduce the severity of the threat, especially pinniped predation in the Columbia River estuary (river miles 1 to 145), and at Willamette Falls.

A sport fishing reward program was implemented in 1990 to reduce the numbers of Northern pikeminnow in the Columbia basin (NMFS 2010). The program continues to meet expected targets, which may reduce predation on smolts in the mainstem Columbia River.

Aquatic Invasive Species

Non-indigenous fishes affect salmon and their ecosystems through many mechanisms. A number of studies have concluded that many established non-indigenous species (in addition to smallmouth bass, channel catfish, and American shad) pose a threat to the recovery of ESA-listed Pacific salmon. 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).

Listing Factor C Conclusion

New information available since the last status review indicates there is an increase in the level of avian and pinniped predation on Snake River salmon and steelhead. At this time we do not have information available that would allow us to quantify the change in extinction risk due to predation. We therefore conclude that the risk to the species' persistence because of predation has increased by an unquantified amount since the last status review. The disease rates have continued to fluctuate within the range observed in past review periods and are not expected to affect the extinction risk of the ESUs or DPS.

Listing Factor D: Inadequacy of Existing 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, as well as hydrosystem, harvest and hatchery impacts, and predation. New information available since the last status review indicates that the adequacy of some regulatory mechanisms has improved. Examples include:

- Mainstem Hydrosystem Improvements: Implementation of the Federal Columbia River Power System (FCRPS) Biological Opinion (Opinion) (NMFS 2008a; NMFS 2010) provided a number of actions aimed at survival improvements, reduced duration of outmigration to the estuary, improvements in juvenile survival and condition, and increased access to habitats. We subsequently developed a 2014 Supplemental FCRPS Biological Opinion to address a 2011 Court Remand Order requiring us to re-examine the 2008 and 2010 biological opinions and more specifically identify habitat actions planned for the 2014-2018 period of the opinion. We adopted the 2014 Supplemental FCRPS Biological Opinion on January 17, 2014 (NMFS 2014a).

- Improvements in Operations and Fish Passage at FERC-licensed Hydropower Facilities and Dams: The implementation of the Reasonable and Prudent Alternative (RPA) in the 2008 Federal Columbia River Power System (FCRPS) Biological Opinion (Opinion) (NMFS 2008a), as amended in 2010 (NMFS 2010) and supplemented in 2014 (NMFS 2014a), has provided a number of actions that are improving the survival and condition of salmon and steelhead migrants through the mainstem Columbia River:
    - Flow management from storage reservoirs
    - Increased spill levels at McNary and John Day dams
    - Operations and maintenance activities to maintain biological performance
    - Piscivorous fish, avian, and pinniped predation control measures
- Oregon Department of Environmental Quality submitted Oregon's 2010 Integrated Report and 303(d) list to EPA in May 2011. The Integrated Report was approved by EPA and finalized in December, 2012 (http://www.deq.state.or.us/wq/assessment/assessment.htm).
- In 2015, establishment of the statewide Washington Department of Fish and Wildlife's Fish Barrier Removal Board that will focus on barrier removal actions where most needed in Southeast Washington watersheds, particularly in the Tucannon River.
- In 2015, adoption of new rules for the Washington Department of Fish and Wildlife's Hydraulic Project Approval (HPA) program, which add new science findings to the permitting of construction projects or activities in or near state waters, to ensure projects meet state conservation standards for aquatic species and their environment.
- Washington State Use-based (e.g., aquatic life use) Surface Water Quality Standards, 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 (http://www.ecy.wa.gov/programs/Wq/303d/index.html).
- Revised harvest practices according to abundance-based sliding scale rates identified in 2008 *U.S. v. OR* Agreement.
- Revisions of Idaho Forest Practices to improve shade and large woody debris delivery on private forest lands.
- Washington State Use-based (e.g., aquatic life use) Surface Water Quality Standards, Washington Administrative Code (WAC) 173-201A. The 2003 standards were amended in 2006 to provide additional spawning and incubation temperature criteria for salmon, trout, and char. The standards include an Antidegradation Policy, which was approved by Environmental Protection Agency (EPA) in May 2007. The EPS approved Washington State's 2010 updated Water Quality Assessment 305(b) report and 303(d) list in 2012 (http://www.ecy.wa.gov/programs/Wq/303d/index.html).

- Oregon's Integrated Water Resource Strategy, a new statewide program further restore and protect streamflow throughout the state, was initiated in August 2012 (OWRD 2012).
- Columbia River Harvest Management, *U.S.* v. *Oregon*: Harvest impacts on Snake River ESUs and DPS in the mainstem Columbia River fisheries in commercial, recreational, and treaty fisheries continue to be managed under the 2008-2017 *U.S. v. Oregon* Management Agreement (NMFS 2008b). The agreement sets harvest rate limits on fisheries impacting these species and these harvest limits continue to be annually managed by the fisheries co-managers (TAC 2011-14). Treaty tribes, states, and federal fisheries managers have begun discussions on the development of a new *U.S. v. Oregon* Management Agreement to replace the current agreement prior to 2019.
- Year-specific allowable harvest rates are determined by an abundance-based framework that constrains fisheries in years of low abundance and allows for increased harvest opportunity in years of high abundance. Information available since the last status review indicates harvest rates have remained relatively constant in the aggregate of these fisheries for Snake River spring/summer Chinook salmon, 10.3 percent annually; fall Chinook salmon, 33.4 percent annually; and the A-run component for steelhead, 1.3 percent in recreational fisheries (TAC 2011-14). Since 2011 harvest impacts have been trending downwards for Snake River Sockeye Salmon, from near 8.8 percent annually to less than 4.9 percent, and the B-run component for steelhead, from 17.3 percent in fall treaty fisheries and 1.4 percent in recreational fisheries to less than 13.8 percent and 1.0 percent respectively (TAC 2011-14).

At the same time, there are a number of concerns regarding existing regulatory mechanisms, including:

- Lack of documentation or analysis on the effectiveness of land-use regulatory mechanisms and land-use management programs.
- Revised land-use regulations to allow development on rural lands (Adoption of Measure 37, with modification by Measure 49, in Oregon).
- Water rights allocation and administration issues in Oregon and Idaho.
- Continued implementation of management actions in some areas which impact riparian areas.
- Completed TMDLs in Oregon currently lack implementation and documented impacts or improvements.
- 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. Issues related to mining threats in the Snake River basin have expanded since the last status review. For example, this renewed 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 habitat important for recovery. The East Fork South Fork Salmon River population has some of the highest recorded levels of mercury contamination in the nation as a result of mining activity. 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 currently trying to expand. 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 and decreasing population viability.

- NMFS has performed a series of consultations on the effects of commonly applied chemical insecticides, herbicides, and fungicides which are authorized for use per EPA label criteria. All West Coast salmonids are identified as jeopardized by at least one of the analyzed chemicals; most are identified as being jeopardized by many of the chemicals. In 2015, jeopardy biological opinions were issued for Idaho and Oregon for water quality standards for toxic substances (NMFS 2014d). This will result in promulgation of new standards for mercury, selenium, arsenic, copper, and cyanide in Idaho; and for cadmium, copper, ammonia, and aluminum in Oregon.
- Other water quality standards are also being reviewed including ammonia and certain temperature criteria.
- Development within floodplains continues to be a regional concern. This frequently results in stream bank alteration, stream bank armoring, and stream channel alteration projects to protect private property that do not allow streams to function properly and resulting in degraded habitat. It is important to note that, where it has been analyzed, floodplain development that occurs consistently with the National Flood Insurance Program's minimum criteria has been found to jeopardize three species of salmonids and southern resident Killer Whales in Puget Sound, Washington. A NMFS biological opinion on the Federal Emergency Management Agency's floodplain management program in Oregon is currently being finalized.
- Future U.S. Forest Service Plan reviews need to continue to address how forest practices can support recovery of salmon and steelhead.

Listing Factor D Conclusion

We conclude that the risk to the species' persistence because of the adequacy of existing regulatory mechanisms has decreased slightly, based on the improvements noted above. However, many ongoing threats to salmon and steelhead habitat could be ameliorated by strengthening existing regulatory mechanisms.

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

Climate Change

Likely changes in temperature, precipitation, wind patterns, ocean acidification, and sea level height have implications for survival of Snake River spring/summer Chinook salmon and steelhead, Snake River fall-run Chinook, and Snake River Sockeye Salmon in their freshwater, estuarine, and marine habitats. Recent descriptions of expected changes in Pacific Northwest climate that are relevant to listed salmon and steelhead include Elsner et al. (2009), Mantua et al. (2009), Mote and Salathe (2009), Salathe et al. (2009), Mote et al. (2010), Chang and Jones (2010), and Crozier (2012, 2013). Reviews of the effects of climate change on salmon and steelhead in the Columbia River basin include ISAB (2007), NMFS (2010), Hixon et al. (2010), Dalton et al. (2013), and NMFS (2014c).

The NMFS Northwest Fisheries Science Center's December 2015 *Status Review Update for Pacific Salmon and Steelhead* includes a chapter on climate change and recent trends in marine and terrestrial environments (NWFSC 2015). The Center will also be producing annual updates describing new information regarding effects of climate change relevant to salmon and steelhead as part of the FCRPS Adaptive Management Implementation Plan. The following is a short summary of expected climate change effects that may be pertinent to the four Snake River salmon and steelhead ESUs and DPS, as derived from the above sources.

Climatic conditions affect salmonid abundance, productivity, spatial structure, and diversity through direct and indirect impacts at all life stages. Salmon have adapted to a wide variety of climatic conditions in the past, and thus inherently could likely survive substantial climate change at the species level in the absence of other anthropogenic stressors (NWFSC 2015).

Currently, the adaptive ability of these threatened and endangered species is depressed due to reductions in population size, habitat quantity and diversity, and loss of behavioral and genetic variation. Without these natural sources of resilience, systematic changes in local and regional climatic conditions due to anthropogenic global climate change will likely reduce long-term viability and sustainability of populations in many Pacific Northwest ESUs and DPSs, including those in the Snake River basin. Adapting to climate change may eventually involve changes in multiple life history traits and/or local distribution, and some populations or life-history variants might die out. Importantly, the character and magnitude of these effects will vary within and among ESUs and DPSs (NWFSC 2015).

Freshwater Environments

Climate records show that the Pacific Northwest has warmed about 0.07 °C since 1900, or about 50 percent more than the global average warming over the same period (Dalton et al. 2013). As the climate changes, air temperatures in the Pacific Northwest are expected to continue to rise <1 °C in the Columbia Basin by the 2020s, and 2 °C to 8 °C by the 2080s (Mantua et al. 2010). While total precipitation changes are predicted to be minor (+1% to 2%), increasing air temperature will alter the snow pack, stream flow timing and volume, and water temperature in the Columbia Basin (Figure 6).

Climate experts predict physical changes to rivers and streams in the Columbia Basin that include:

- Warmer temperatures will result in more precipitation falling as rain rather than snow.

- Snow pack will diminish, and stream flow volume and timing will be altered. More winter flooding is expected in transitional and rainfall-dominated basins. Historically transient watersheds will experience lower late summer flows.

A trend towards loss of snowmelt-dominant and transitional basins is predicted. Summer and fall water temperatures will continue to rise.

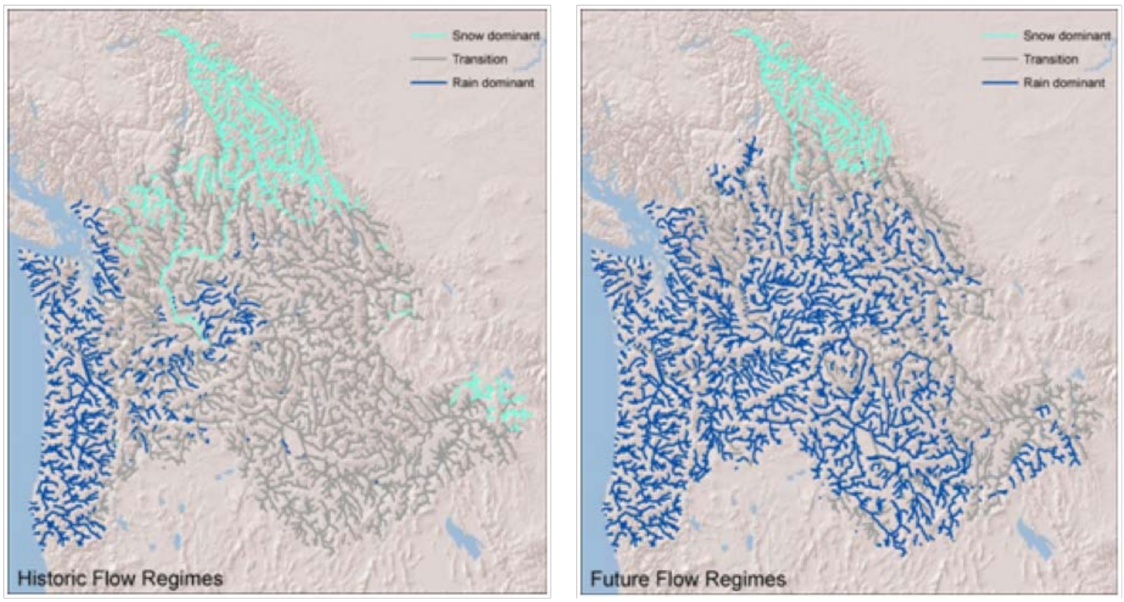


Figure 6. Preliminary maps of predicted hydrologic regime for (A) the period 1970-1999 and (B) the period 2070-2099 using emission scenario A1B and global climate model CGCM3.1(T47), based on classification of annual hydrographs as in (Beechie et al. 2006). Data from University of Washington Climate Impacts Group (http://www.hydro.washington.edu/2860/).

Generally, these changes in air temperatures, river temperatures, and river flows are expected to cause changes in salmon and steelhead distribution, behavior, growth, and survival. The magnitude and timing of these changes, however, remain unclear — and specific effects are likely to vary among populations. The degree to which phenotypic or genetic adaptations may partially offset these effects is being studied but is currently poorly understood.

Biological effects of climate change in freshwater areas could include:

- Winter flooding in transient and rainfall-dominated watersheds may scour redds, reducing egg survival.
- In both the Northwest and Southwest, widespread tree mortality has been observed, wildfires have increased in both frequency and area burned, and insect outbreaks have increased. These conditions reduce habitat and water quality, and are expected to continue.

- Warmer 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. Lower late summer flows in tributaries below natal lakes in the Sawtooth Valley, Idaho may preclude Sockeye Salmon adult passage to spawning areas.
- Warmer temperatures will increase metabolism, which may increase or decrease juvenile growth rates and survival, depending on availability of food.
- Overwintering survival may be reduced if increased flooding reduces suitable habitat.
- Timing of smolt migration may be altered due to 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 lethal temperatures, 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, fall-run Chinook, and Sockeye Salmon and steelhead.
- 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, and Snake River Sockeye Salmon could have higher rates of mortality and disease.
- Increases in air temperatures, river temperatures, and river flows are expected to cause changes in adult Sockeye Salmon migration rates and survival. Higher temperatures during adult migration in late summer may lead to increased mortality or reduced spawning success due to lethal temperatures, delay, increased fallback at dams, or increased susceptibility to disease and pathogens. For example, in 2015 only 4% of adult Snake River Sockeye Salmon survived the migration from Bonneville to Lower Granite Dam after experiencing temperatures over 22 degrees Celsius in the lower Columbia River (NWFSC 2015). After prolonged exposure to temperatures of 20 degrees Celsius, salmon are especially likely to succumb to diseases that they might otherwise have survived (NWFSC 2015). They are also more vulnerable to any sort of stress, such as catch-and-release fisheries (NWFSC 2015).
- Effects of climate change on the limnology of natal lakes in the Salmon River basin is uncertain, so effects of climate change on Snake River Sockeye Salmon spawning, emergence, and juvenile rearing are currently unknown.

- Increased water temperatures in the lower Snake River could cause migrating adult Snake River fall-run Chinook and Sockeye Salmon to delay passage or fail to enter fish ladders due to high temperatures. Higher mainstem temperatures during adult passage is also identified in the FCRPS BiOp (NMFS 2010, 2014a) as a key concern requiring ongoing monitoring and evaluation, and possible additional actions to improve survival through the 2008 BiOp's adaptive management provisions (NMFS 2014a).

Estuarine and Plume Environments

Climate change is affecting the estuarine and marine environments as well, resulting in increasing sea-surface temperatures, sea-level height, and ocean acidity. These factors are expected to have negative consequences by restricting available habitat, reducing food sources, altering prey survival and productivity, and possibly altering salmon and steelhead migration patterns, growth, and survival.

Effects of climate change on Snake River spring/summer and fall-run Chinook and Sockeye Salmon and steelhead in the estuary and plume may include the following:

- Higher winter freshwater flows and higher sea levels may increase sediment deposition in the plume, possibly reducing the quality of rearing habitat.
- Lower freshwater flows in late spring and summer may lead to upstream extension of the salt wedge, possibly influencing the distribution of salmonid prey and predators.
- Increased temperature of freshwater inflows and seasonal expansion of freshwater habitats may extend the range of non-native, warm-water species that are normally found only in freshwater.

In all of these cases, the specific effects on Snake River spring/summer Chinook salmon and steelhead, Snake River fall-run Chinook, and Snake River Sockeye Salmon abundance, productivity, spatial distribution, and diversity remain poorly understood. The juvenile spring/summer Chinook salmon and steelhead, and Sockeye Salmon like other stream-type salmonids, often move quickly through the estuary and then the plume, before reaching the ocean. In the estuary, Sockeye Salmon would be primarily affected by increased predation. Juvenile salmon and steelhead may be affected by habitat changes in the plume environment due to flow- or sediment-related changes; however, use of plume habitat by the fish remains poorly understood.

<u>Marine Conditions and Marine Survival</u>

Varying conditions in the marine environment have a large influence on the status of Snake River listed salmon and steelhead species. They affect growth and survival rates, adult returns, and population viability. This section summarizes what is known about marine conditions and their likely impact on salmon and steelhead productivity and survival. The Module for the Ocean Environment (Fresh et al. 2015) provides a more detailed discussion on the effects of the marine environment on Snake River salmon and steelhead.

Changes in ocean conditions (shifts from good ocean years to bad ocean years) represent an important environmental factor that affects growth and survival of Snake River ESA-listed salmon and steelhead (Fresh et al. 2015). Environmental conditions in both fresh and marine waters inhabited by Snake River salmon and steelhead, and other Pacific Northwest salmon, are influenced, in large part, by two ocean-basin scale drivers: the Pacific Decadal Oscillation (PDO; Mantua et al. 1997) and the El Niño-Southern Oscillation (El Niño or ENSO). Since late 2013, however, abnormally warm conditions in the Central NE Pacific Ocean known as the "warm blob" (Bond et al. 2015) have also had a strong influence on both marine and freshwater habitats.

Pacific Decadal Oscillation. The PDO describes variability in North Pacific sea surface temperatures (SSTs), with positive values characterized by warm SSTs along the West Coast of North America and cold SSTs in the central North Pacific; negative values have the opposite pattern, with cold SSTs along the coast and warm SSTs in the central North Pacific. The PDO also influences inland environments, especially during winter. Positive PDO values are associated with warm and dry Pacific Northwest winters (especially for the Interior Columbia Basin and therefore low snowpack), while negative values are associated with cold wet winters in the Interior Columbia Basin and high snowpack (Mantua et al. 1997).

The PDO has been positive since January 2014. It reached the highest monthly levels ever observed during December 2014 (+2.51), and January (+2.45) and February (+2.3) 2015 (Figure 7). Current forecasts of global water temperatures (from the NOAA NCEP coupled forecast system model version 2[15]) indicate that SSTs along the West Coast will remain 0.5-1 °C above average through the period of forecast (Mar-May 2016).

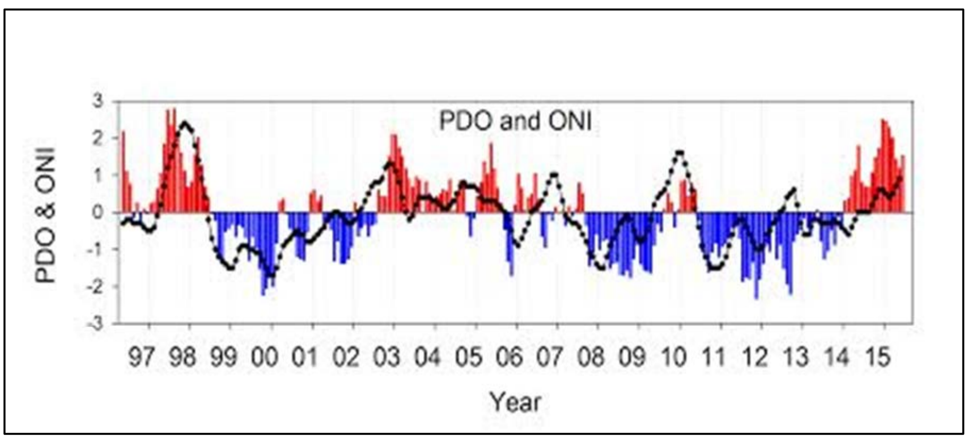


Figure 7. Time series of the Pacific Decadal Oscillation (PDO; red and blue vertical bars) and Oceanic El Niño Index (ONI; black line) during 1996-2015. The PDO shifts between positive (warm) to negative (cold) values at roughly decadal scales and has been positive since January 2014, while the ONI has a higher frequency. Figure from B. Peterson (NWFSC).

El Niño-Southern Oscillation. ENSO is a tropical phenomenon that influences climate patterns around the globe. Much like the PDO, the warm phase (El Niño) is characterized by warm SSTs

[15] http://www.cpc.ncep.noaa.gov/products/CFSv2/CFSv2seasonal.shtml

along the West Coast of North America, while negative values (La Niña) produce cold SSTs along the coast. Like the PDO, ENSO also influences inland environments, and Pacific Northwest winter snowpack is generally low during warm El Niño events and high during cool La Nina years.

Large El Niño events can have significant impacts on marine conditions for Snake River salmon and steelhead, but are less predictable and poorly understood than changes in the PDO. Large El Niño events are relatively infrequent (the last two large events occurred in 1982/83 and 1997/98), and with variable impacts. The typical El Niño year impacts in the California Current (an eastern boundary current that flows south along the coasts of Vancouver Island, Washington, Oregon, and California) are similar to those associated with the warm phases of the PDO, and in some extreme cases much more dramatic (like those associated with the extreme 1982/83 and 1997/98 El Niño events). NOAA declared the existence of a weak El Niño in April 2015. It is expected (>95% probability) that El Niño conditions will strengthen and continue through winter 2015/2016, gradually weakening through spring 2016. How strong this El Niño event will be is difficult to predict.

The Warm Blob. Marine waters in the North Pacific ocean have been warmer than average since late fall 2013, when the "warm blob" first developed in the central Gulf of Alaska (Bond et al. 2015). The warm blob was caused by lower than normal heat loss from the ocean to the atmosphere and the relatively weak mixing of the upper ocean, due to unusually high and persistent sea level pressure. It was accompanied by near-surface (upper ~100 m) water temperatures that exceeded 3 °C in January 2014, or 4 standard deviations (Freeland and Whitney 2014). These anomalies were the greatest observed in this region and season since at least the 1980s and possibly as early as 1900 (Bond et al. 2015). The warm blob spread from the offshore waters into the coastal domain of Alaska and northern British Columbia in May 2014, and then into the nearshore waters of the Pacific Northwest in September 2014, causing rapid increases in SSTs (Chandler et al. 2015). For example, surface temperatures recorded at Stonewall Bank (NOAA Buoy 46050; 20 nautical miles west of Newport, Oregon), increased by 5.6 °C during a 21-hour period on September 14-15, 2014, as the warm blob moved ashore www.ndbc.noaa.gov/. Sea surface temperatures across the NE Pacific remained 1-3 °C above average during winter and spring of 2015 (http://polar.ncep.noaa.gov/sst/ophi/).

Consequences of Marine Environmental Conditions

Ocean conditions during the first weeks or months of marine life have a large influence on overall marine survival for salmon and steelhead (Pearcy 1992; Pearcy and Wkinnell 2007). Accordingly, where salmon are during the first summer of ocean residence, and the conditions they experience, has a large impact on their survival. In general, salmon from the Pacific Northwest can be grouped by their ocean migration patterns: sockeye and spring Chinook salmon move rapidly north along the continental shelf to Alaskan waters and reside in the Gulf of Alaska for most of their ocean residence, while fall Chinook remain in local waters (although their location during winter months is largely unknown). Steelhead generally exhibit a unique marine migration pattern and move directly offshore and apparently west across the North Pacific Ocean (Daly et al. 2014; Hayes et al. 2012; Myers et al. 1996).

Differences in migration patterns paired with heterogeneous ocean conditions result in species and population differences in survival. Pacific salmon are a cold water species and flourish in cold and productive marine ecosystems. Thus, elevated water temperatures can be detrimental to salmonid growth and survival, both directly and indirectly (Crozier et al. 2008; Wainwright and Weitkamp 2013). In marine environments, temperature changes are typically associated with different environmental conditions that have their own planktonic ecosystem, including salmon prey and predators. They can have a strong effect on the available food web, and the influence of this and other indirect effects is larger than those due directly to physiological effects of changing temperatures (Beauchamp et al. 2007; Trudel et al. 2002). For example, Snake River salmon and steelhead benefit from negative PDO (cool water off the Washington/Oregon coast) as do northern copepods and anchovy, which are part of their food web. Northern copepods have much higher lipid levels than southern copepods, and therefore likely produce food webs that promote high growth and survival in salmon (juvenile salmon don’t eat copepods directly) (Peterson et al. 2014). Species that prosper during positive PDOs (warmer waters) include southern copepods and sardines (Lindegren et al. 2013; Peterson and Schwing 2003; Shanks 2013).

Large El Niño events can have significant impacts on marine conditions. Several important biological impacts were noted during the two extreme El Niño events in the 1980s and 1990s. During both events, there were dramatic increases in poleward flow, elevated temperatures to 200m depth, reduced upwelling, and greatly reduced nutrient levels (Huyer et al. 2002; Pearcy and Schoener 1987). The biological impact of these conditions resulted in changes throughout the ecosystem. During the 1982/83 event, primary and secondary production was greatly reduced from southern California to Vancouver Island, especially in 1983 (Pearcy and Schoener 1987). During the 1997/98 event, the copepod assemblage along the Newport Hydrographic line became dominated by southern and offshore species starting in late summer 1997, while normally dominant northern species had almost completely disappeared; the overall abundance of copepods were also greatly reduced. These changes to the copepod assemblage persisted for roughly a year, although some northern species did not recover to normal levels until the summer of 1999 (Peterson et al. 2002).

Overall, the changing marine conditions that the four ESA-listed Snake River salmon and steelhead species encounter during their ocean journeys have and will continue to impact differences in species abundance and productivity. For example, the 1982/83 El Niño had much more severe impacts on Chinook and Coho salmon populations with “southern” distributions, than those with more northern distributions, such as Snake River sockeye and spring Chinook salmon. Similarly, Snake River fall Chinook salmon that entered the ocean in 2011 returned in record high numbers, while spring Chinook salmon entering in the same year had low returns (and below predictions). This difference is thought to be due to differences in ocean conditions encountered by the two runs: spring Chinook salmon migrate rapidly to Alaska, where ocean conditions were extremely unproductive in 2011, while fall Chinook remained off the Washington/Oregon coast, where conditions were quite productive. A reverse situation to 2011 appears to have occurred in spring 2014. The exceptionally warm marine waters in 2014 and 2015 may have favored a subtropical food web that contributed to poor early marine growth and survival; however, the effects of these conditions will not be known until the fish return as adults.

Expectations for Pacific Salmon

It is well established that ocean conditions during the first weeks or months of marine life have a large influence on overall marine survival for salmon (Pearcy 1992; Pearcy and Wkinnell 2007). Accordingly, where salmon are during the first summer of ocean residence and the conditions they experience has a large impact on their survival. In general, Pacific salmon from the Pacific Northwest can be grouped by their ocean migration patterns: sockeye, chum, and spring Chinook salmon move rapidly north along the continental shelf to Alaskan waters and reside in the Gulf of Alaska for most of their ocean residence, fall Chinook remain in local waters (although their location during winter months is largely unknown), while Coho salmon display a hybrid pattern: some move rapidly northern while other remain in local waters during the first summer before moving north to Alaska (Burke et al. 2013; Fisher et al. 2014; Myers et al. 1996). Steelhead have a unique marine migration pattern and move directly offshore and apparently west across the North Pacific Ocean (Daly et al. 2014; Hayes et al. 2012; Myers et al. 1996). There can also be large variation within these general groups, such as the large change in marine distributions for Coho salmon from the Washington Coast vs Columbia River and south (Weitkamp and Neely 2002), or the change in Chinook marine distributions for populations north and south of Cape Blanco, Oregon (Nicholas & Hankin 1988; Weitkamp 2010).

Conclusion for Marine Conditions

It is clear that current anomalously warm marine and freshwater conditions will be unfavorable for adult returns in 2016 and 2017 for Pacific Northwest salmon (NWFSC 2015). How extreme the effects will be is difficult to predict, although decreased salmon productivity and abundance observed during prior warm periods provide a useful guide. How long the current conditions will last is also unknown, but NOAA's coupled forecast system model (CFS version 2) suggests that the warm conditions associated with the strengthening El Niño will persist at least through spring 2016. The model currently predicts temperature anomalies during the March-April-May 2016 period will exceed 2°C at the equator and 0.5-2°C in the NE Pacific. Unfortunately, longer forecasts are not available.

Pacific salmon are a cold water species: they flourish in cold streams and cold and productive marine ecosystems, such as those present in the early 2010s, resulting in record returns for many ESUs. The exceptionally warm marine waters in 2014 and 2015 and warm stream temperatures observed during 2015 were unfavorable for high marine or freshwater survival. The overall effects of these environmental conditions will not be known until adults return over the next few years (NWFSC 2015).

Drought Management

Drought conditions have impacted habitat, streams, and water resources in Washington, Oregon and Idaho since the 2011 status review. For example, in 2015, the Governor of Washington declared a statewide drought. In Oregon, drought was declared by the Governor for three quarters of the state's counties in July 2015. It is unclear what these drought declarations mean for fish resources; however, low elevation steelhead populations living in intermittent streams are affected during drought years. If droughts become more common with climate change, these conditions resulting in lower steam flow and elevated stream temperatures could become a problem for these populations. This will necessitate water management strategies to reserve water for flows and temperature management later in the season, including potential emergency funding for water transactions during critical drought years. The importance of protecting and expanding cold water refugia for fish survival is heightened during drought conditions. In the mainstem Columbia and Snake Rivers, NMFS is working with our partners to ensure that the FCRPS improves passage conditions for salmon and steelhead. Measures include:

- Cool water releases from Dworshak Dam to moderate temperatures in the lower Snake River mainstem; and
- July 2015 authorization by NMFS for the Idaho Department of Fish and Game to transport adult Snake River Sockeye Salmon around Lower Granite Dam to avoid high water temperatures in the mainstem Snake and Salmon Rivers. These temperatures are believed to have caused significant adult Sockeye Salmon mortalities in the Columbia basin during 2015.

Summary for Climate Change

Analysis of ESU-specific vulnerabilities to climate change by life stage will be available in the near future, upon completion of the *West Coast Salmon Climate Vulnerability Assessment* by the Northwest Fisheries Science Center. In summary, both freshwater and marine productivity tend to be lower in warmer years for most populations considered in this status review. These trends suggest that many populations might decline as mean temperatures rise. However, the historically high abundance of many southern populations is reason for optimism and warrants considerable effort to restore the natural climate resilience of these species (NWFSC 2015).

Summary of Science on Hatchery Impacts

Hatchery programs can help preserve genetic resources, increase spatial distribution, and provide a short-term demographic benefit in abundance in low return years. However, artificial propagation also poses risks to natural productivity and diversity. The magnitude and type of the risk is dependent on the status of affected populations and on specific practices in the hatchery program.

The effects, positive and negative, for two categories of hatchery programs are summarized in Table 5 (NMFS 2014e). Generally speaking, effects range from beneficial to negative for programs that use local fish for hatchery broodstock. Even when a hatchery program uses genetic resources that represent the ecological and genetic diversity of the target or affected natural population(s), they may pose a risk to the fitness of the population based on the proportion of natural-origin fish being used as hatchery broodstock and the proportion of hatchery-origin fish spawning in the wild (Lynch and O'Hely 2001; Ford 2002). However, NMFS also recognizes that there are benefits that may outweigh these risks under circumstances where demographic or short-term extinction risk to the population is greater than risks to population diversity and productivity.

Conversely, when hatchery programs use non-local broodstock that do not represent the ecological and genetic diversity of the targeted or affected natural population(s), effects may be negative. In these situations, isolating hatchery fish and avoiding co-occurrence of hatchery and natural-origin fish reduces the risks.

Table 5. Overview of the range in effects on natural population viability parameters from two categories of hatchery programs.

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

Hatchery practices for the Snake River species have evolved as the status of natural populations changed, and new plans are now under development for every hatchery program in the Snake River basin. In addition, a comprehensive assessment of hatchery benefits and risks is now underway across the Snake River basin. The assessment is expected to result in operational refinements and changes that benefit listed species and satisfy mitigation requirements.

Snake River Sockeye Salmon extirpation and further loss of genetic diversity have been averted, largely due to the hatchery broodstock program, and the program is now adjusting to promote increased population structure, spatial structure, and recovery of the ESU. Release numbers of Snake River spring/summer Chinook salmon and steelhead within the spawning and rearing areas of the Snake River Sockeye Salmon ESU have generally remained flat since 2011, though some release strategies have been changed.

Snake River spring/summer Chinook salmon hatchery program production levels have remained stable since last review. Many captive broodstock programs initiated during the 1990s to conserve Snake River spring/summer Chinook salmon genetic resources have been terminated after the status of these fish improved. One small-scale reintroduction program (Panther Creek in the Pahsimeroi River watershed) will be implemented in the basin. The program will use broodstock that are included in the ESU, and will add to the spatial structure of the existing ESU.

Snake River fall-run Chinook salmon hatchery production has increased and so have adult returns (particularly hatchery-origin returns). Natural-origin spawner abundance has increased relative to the levels reported in the last NWFSC status review (Ford et al. 2011), driven largely by relatively high escapements in the most recent three years. Considerable uncertainty remains about the effect of the Snake River fall Chinook salmon hatchery programs on the Lower Mainstem Snake River population. Much of this uncertainty reflects the fact that the remaining population is very difficult to study because of geographic extent, habitat, and logistics. The uncertainties, however, are more important in the case of Snake River fall Chinook salmon than in many other populations because the current population is the only extant population in the ESU, and it must reach a level of high viability for ESU recovery (NMFS 2015c).

A high priority element of the proposed Recovery Plan's recovery strategy for Snake River fall Chinook salmon involves evaluating and adapting the hatchery programs as warranted to achieve the full range of ESA recovery objectives. This will include continuing to interpret and apply emerging RM&E data related to homing fidelity and dispersal patterns, and working with co-managers to identify and assess potential management frameworks that would achieve delisting. Such frameworks potentially could include creating natural production emphasis areas (i.e., major spawning areas that produce a substantial level of natural-origin adult spawners with a low proportion of hatchery-origin spawners) or reducing hatchery-origin spawners in the population overall.

Steelhead programs in the Snake River basin are under ESA review. One important issue is determining where and to what extent unaccounted for hatchery steelhead are interacting with depressed listed populations, particularly those in Idaho. The practice of releasing steelhead into mainstem areas where they are difficult to monitor and manage has been reduced since the last review.

<u>Listing Factor E Conclusion</u>

The certainty of modeled climate change impacts has increased since the last status review, as has our understanding of likely impacts of these changes on salmonid populations. Climate change impacts remain a recovery concern over the long term and although it is likely these impacts have changed in the few years since the last review, we cannot quantify the change in extinction risk due to climate change and recent trends in marine conditions. We therefore conclude that since the 2011 status review the risk to species' persistence because of climate change and marine trends has increased by an unquantified amount. Hatchery programs have continued to be reviewed and modified since the 2011 status review to support survival of natural-origin populations. New information available since the 2011 status review indicates that there have been improvements in our knowledge of the extent to which hatcheries present risks to the persistence of these species, however, further research and investigation is needed.

Efforts Being Made to Protect the Species

When considering whether to list a species as threatened or endangered, section 4(b)(1)(A) of the ESA requires that NMFS take into account any efforts being made to protect that species. Throughout the range of the Snake River salmon ESUs and steelhead DPS, there are numerous federal, state, tribal and local programs that protect anadromous fish and their habitat. The proposed listing determinations for West Coast salmon and steelhead (69 FR 33102) reviewed these programs in detail.

In the final listing determinations for the Snake River salmon species (70 FR 37160) and steelhead species (71 FR 834), we noted that while many of the ongoing protective efforts are likely to promote the conservation of listed salmonids, most efforts are relatively recent, have yet to demonstrate their effectiveness, and for the most part do not address conservation needs at scales sufficient to conserve entire ESUs or DPSs. Therefore, we concluded that existing protective efforts did not preclude listing the ESUs of salmon and DPSs of steelhead.

Considerable progress has been made since the last 5-year status review to implement salmon and steelhead recovery actions in watersheds throughout the Snake River basin. Recovery actions are being coordinated through state sanctioned organizations such as Washington's Snake River Salmon Recovery Board, Idaho's Clearwater Basin Technical Team and Upper Salmon Basin Partnership Program, and Oregon's Grande Ronde Model Watershed program. These organizations work in partnership with tribes, state agencies, federal land managers, and local land owners to prioritize recovery actions, monitor projects, and adjust actions through adaptive management. These collaborative processes are critically important to the continued viability improvements needed to recover these Snake River salmon and steelhead.

Since the last 5-year status review, NMFS has worked with state, federal, and tribal staff to write and adopt the Snake River Sockeye Salmon Recovery Plan (NMFS 2015b) in June 2015, and the proposed 2015 Snake River Fall Chinook Salmon Recovery Plan was made available for public review and comment (NMFS 2015c). In addition, NMFS is working with its Snake River basin recovery partners to finish writing the proposed Snake River Spring/Summer Chinook Salmon and Steelhead Recovery Plan, which will be noticed for public review and comment in 2016. These recovery plans represent significant cooperation and partnership between NMFS and its state, tribal, federal, and local partners to develop recovery strategies, actions, and research and monitoring, together with on-going efforts to implement recovery actions on the ground. In the context of recovery planning, coordination across the Snake River basin is taking place through the Snake River Coordination Group and technical teams working on individual recovery plans.

In our above five factor analysis, we note the many habitat, hydropower, hatchery, and harvest improvements that occurred in the past five years. We currently are working with our federal, state, and tribal co-managers to develop monitoring programs, databases, and analytical tools to assist us in tracking, monitoring, and assessing the effectiveness of these improvements.

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 five 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 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.

The updated status review completed by our Northwest Fisheries Science Center indicates that while there have been improvements in the viability ratings for some of the component populations, none of the Snake River ESUs or DPS are currently meeting the viability criteria recommended by the ICTRT (NWFSC 2015). For example, the overall current risk rating for the extant Lower Mainstem Snake River fall Chinook salmon population is viable (i.e., low risk) which is an improvement from the last status review where it was rated as maintained (i.e., at moderate risk). Yet the overall viability rating for this ESU must be highly viable, and therefore, it still does not meet the ICTRT viability criteria.

While improvements in ESU and DPS viability have been observed over the last five years, there is no new information to indicate that the extinction risk has decreased to desired levels, or increased. In its most recent review, the Science Center concluded, after reviewing the available new information, that the biological risk category for the Snake River Sockeye Salmon, Snake River spring/summer Chinook salmon, Snake River fall-run Chinook salmon, and Snake River steelhead has not changed since the time of the last status reviews in 2011 (NWFSC 2015). Thus, populations within the ESUs and DPS will need improved viability ratings in order to meet the ESU and DPS viability criteria.

Our analysis of the ESA section 4(a)(1) factors indicates that the collective risk to the Snake River salmon and steelhead species' persistence has not changed significantly since our last status review in 2011. Improvements have been made to the operation of the FCRPS and numerous habitat restoration projects have been completed in many Snake River tributaries. Harvest rates remain relatively low and stable. The protection afforded by some regulatory mechanisms, such as revised harvest practices identified in the 2008 *U.S. v. Oregon* Agreement, has increased. Conversely, habitat problems are still common throughout the Snake River basin and many more habitat improvements are likely needed to achieve viability, particularly for Snake River spring/summer Chinook salmon and Snake River steelhead. Many existing regulatory mechanisms could be improved to better protect salmon and steelhead habitat. In addition, predation from an increase in pinniped populations and significant avian impacts remain a concern, as are the impacts that climate change and related marine conditions pose to long-term recovery.

After considering the biological viability of the listed Snake River salmon and steelhead and the current status of the ESA section 4(a)(1) factors, we conclude that the status of some populations in these ESUs and DPS have improved since they were listed in 2005 and 2006. Yet, overall, no Snake River ESU or DPS currently meets its viability criteria. Consequently, the implementation of sound management actions in each "H"—hydropower, habitat, hatcheries, and harvest—are essential to the recovery of these ESUs and DPS and must continue. Establishing additional populations of Snake River Sockeye Salmon and Snake River fall-run Chinook salmon is also a conservation priority.

The biological benefits of habitat restoration and protection efforts, in particular, have yet to be fully expressed and will likely take decades to result in measurable improvements to population viability. By continuing to implement actions that address the factors limiting population survival and monitoring the effects of the action over time, we will ensure that restoration efforts meet the biological needs of each population and, in turn, contribute to the recovery of these ESUs and DPS. The adopted Snake River Sockeye Salmon Recovery Plan (NMFS 2015b) and the proposed Snake River Fall Chinook Recovery Plan (NMFS 2015c), and future proposed Snake River Spring/Summer Chinook and Snake River Steelhead Recovery Plan will be the primary guides for identifying future actions to target and address salmon and steelhead limiting factors and threats. Over the next five years, it will be important continue to implement these actions and monitor our progress.

2.4.1 ESU/DPS Delineation and Hatchery Membership

The Northwest Fisheries Science Center's review (NWFSC 2015) found that no new information has become available that would justify a change in composition of the naturally spawning fish comprising the Snake River ESUs and DPS.

The West Coast Regional Office's review of new information to inform the ESU/DPS membership status of various hatchery programs (Jones 2015) noted the following changes since the last status evaluation:

- None of the hatchery programs for the four Snake River species has been terminated since the last ESA status review.
- Two hatchery programs have changed names since the last status review: (1) the Snake River Fall Chinook Oxbow Hatchery is now called the Idaho Power Hatchery; and (2) the Snake River spring/summer Chinook Big Sheep Creek Hatchery is now called the Big Sheep Creek Program-Adult Outplanting from Imnaha Program.
- Several Snake River spring/summer Chinook salmon hatchery programs have been revised or recommended to be added to the ESU since the previous status review:
    - Three programs (Yankee Fork, Dollar Creek and Panther Creek) are recommended to be included in the ESU and this change will not occur until NMFS completes future rulemaking.
    - The Lookingglass Hatchery reintroduction program for Lookingglass Creek in the Grande Ronde Basin was not originally assigned a SSHAG category and is now assigned a SSHAG category value of 1b. This rating is because the program was founded using local fish from Catherine Creek which are within the MPG and the hatchery fish are now integrated with natural-origin returns. Once the stock becomes localized and the program is self-sustaining, the program will support an integrated population in Lookingglass Creek.
    - The McCall Hatchery had its SSHAG category value changed from 1a/2a to 1a. This program was segregated at the time of the last review, but is transitioning to a program with an integrated component using natural-origin fish which prevents further genetic divergence from natural origin fish.
    - The Pahsimeroi Hatchery program also had its SSHAG category value changed from 1a/2a to 1a. This program had been segregated at the time of the last review, but is transitioning to a program with an integrated component using natural-origin fish.
    - The Yankee Fork reintroduction program is recommended to be included in the ESU and its SSHAG category value is changed from 2 to 1b. This program was started with fish from the Sawtooth/Pahsimeroi programs because there is no natural population in the Yankee Fork Salmon River. Once the stock becomes localized and the program is self-sustaining, the program will support an integrated population in the Yankee Fork Salmon River. The recommended inclusion of these fish into the ESU will not occur until NMFS completes future rulemaking.
    - The Dollar Creek program has had its SSHAG category value changed from 2 to 1a because this program is using eggs supplied from the South Fork Salmon River spring/summer Chinook population, and Dollar Creek is within the geographic area of this population. The Panther Creek program is a new proposal and not yet begun operations. It

will use hatchery-origin fish from the Pahsimeroi program because there is no natural population currently in Panther Creek. Once the stock becomes localized and the program is self-sustaining, the program will support an integrated population in Panther Creek.

- No current Snake River basin steelhead hatchery programs have been terminated since the time of the last status review.
- For the Snake River basin steelhead DPS, Jones (2015) recommended that three programs (East Fork Salmon River, Squaw Creek, and Little Salmon River) should be included in the DPS and this change will require subsequent rulemaking by NMFS. Hatchery listing clarifications have been made for these three hatchery programs that use Dworshak/North Fork/ Clearwater River B-run steelhead by recommending that they be included in the DPS.
- Another hatchery program clarification was recommended. The South Fork Clearwater B-run steelhead program (which is listed as part of the DPS) has been clarified with steps taken to try and localize this stock to the South Fork Clearwater River by using only hatchery-origin fish returning to the South Fork Clearwater River. The brookstock origin is the Dworshak stock/North Fork Clearwater River which is now being localized to the South Fork Clearwater.

2.4.2 ESU/DPS Viability and Statutory Listing Factors

- The Northwest Fisheries Science Center's review of updated information (NWFSC 2015) does not indicate a change in the biological risk category for any of the Snake River ESUs or DPS since the time of the 2011 five-year review (Ford et al. 2011).
- Our analysis of ESA 4(a)(1) factors indicates that the risk to the Snake River ESUs' and the Snake River steelhead DPS' persistence has not changed significantly since our 2011 5-year review. The overall level of concern remains the same.

3. Results

3.1 Classification

Listing Status:

Based on the information identified above, we recommend that:

- The Snake River Sockeye Salmon ESU should remain listed as endangered.
- The Snake River spring/summer Chinook salmon ESU should remain listed as threatened.
- The Snake River fall-run Chinook salmon ESU should remain listed as threatened.
- The Snake River basin steelhead DPS should remain listed as threatened.

ESU/DPS Delineation:

No change is appropriate for ESU or DPS delineations.

Hatchery Membership:

- Snake River Sockeye Salmon hatchery program has not changed substantially from the previous ESA status review.
- Snake River spring/summer Chinook salmon hatchery programs:
    - The Lemhi River, East Fork Salmon River, and West Fork Yankee Fork captive rearing experiments have all been terminated and should be removed from the ESU, which will require future NMFS rulemaking.
    - Three new spring/summer Chinook salmon programs (Yankee Fork, Panther, and Dollar Creek) are recommended for inclusion in the ESU, which will require future NMFS rulemaking.
    - Two existing programs (Imnaha River and Big Sheep Creek) are included in the ESU, but warrant further review because of the potential divergence from natural-origin populations.
    - Three existing programs (Lookingglass Creek and McCall hatcheries which are part of the ESU, and the Pahsimeroi hatchery which is not included in the ESU) should have their SSHAG categories updated to reflect that they are now integrated hatchery programs using natural-origin population broodstock.
- The Snake River fall-run Chinook salmon hatchery programs have not changed substantially from the previous ESA status review.

- Snake River steelhead hatchery programs:
  - Three new steelhead programs (the Streamside Incubator Project in the Upper Salmon River watershed, Yankee Fork, and Squaw Creek B-run) are not recommended for inclusion in the DPS.
  - Three existing programs (East Fork Salmon River B-run, Squaw Creek B-run, and Little Salmon River B-Run) should be added to the listing because they all use Dworshak-derived broodstock (which are included in the listing currently).
  - Four existing hatchery programs warrant further review: (1) Dworshak National Fish Hatchery; (2) Lolo Creek Hatchery – Clearwater River; (3) North Fork Clearwater Hatchery; and (4) Little Sheep Creek/Imnaha River Hatchery.
  - No current Snake River steelhead hatchery programs have been terminated since the time of the last status review.

3.2 New Recovery Priority Number

Since the previous 5-year review, NMFS revised the recovery priority numbers to the following: Snake River Sockeye Salmon - 5; Snake River Spring/Summer Chinook salmon - 9; Snake River fall-run Chinook - 9; and Snake River steelhead - 9 (NMFS 2015a), as listed in Table 4 of this document.

4. Recommendations for Future Actions

In our review of the listing factors, we identified several actions that are critical to improving the status of the Snake River ESUs and DPS. The most important actions to be taken over the next five years include implementation of the high-priority strategies and actions in the Snake River Sockeye Salmon Recovery Plan (NMFS 2015b), and adoption and implementation of a Snake River Fall-run Chinook Salmon Recovery Plan, and Snake River Spring/summer Chinook Salmon and Snake River Steelhead Recovery Plan. Additional actions include implementation and renegotiation of the 2008 *U.S. v. Oregon* Management Agreement, implementation of the 2014 FCRPS Biological Opinion and development of the 2018 FCRPS Biological Opinion, and completion of ESA consultations on the hatchery programs in the Snake River ESUs and DPS.

Improved coordination and cooperation of federal, state, tribal, and local partners is critical to the successful implementation of these plans and agreements. Efforts to improve instream flow management and floodplain and habitat conditions represent the greatest opportunities to advance recovery for the Snake River salmon ESUs and steelhead DPS and should be aggressively pursued. Several federal agencies are currently pursuing such opportunities, including the U.S. Army Corps of Engineers, U.S. Forest Service, Bonneville Power Administration, Bureau of Land Management, as well as the Bureau of Reclamation in the Grande Ronde River basin. Additional actions recommended to be implemented are as follows:

Implement Research Monitoring and Evaluation (RM&E) actions to address critical uncertainties:

Life Cycle Modeling

- Conduct life-cycle monitoring to evaluate density dependence and other impacts on populations and at what specific life-stages and populations to ensure that we are focusing/targeting restoration efforts at the appropriate geography and life-stage.

Life History Patterns

- Continue to evaluate the relationship between A-run and B-run steelhead, and the relative impacts of threats to those runs. A better understanding of the impacts and threats to these runs is needed to maintain life history diversity.
- Investigate factors that contribute to the sub-yearling life history pattern of spring/summer Chinook salmon and the limiting factors that determine adult returns. Understand where this is happening in the over-wintering life stage.
- Conduct research to understand the drivers for the following expressions of the life-history diversity in Snake River salmon and steelhead, contributions to viability, causes and distribution of juvenile loss between natal streams and the hydrosystem, the effects of reservoir habitat conditions, and appropriate actions to address the sources of this loss:

  - Downstream spring/summer Chinook salmon migrants that overwinter before outmigration;
  - Expression of “true” sub-yearling spring/summer Chinook salmon life-history;
  - Relationship between A-run and B-run steelhead forms; and
  - Duration and intervals of movement and holding, presumable for resting and feeding, of downstream yearling and sub-yearling Chinook salmon in both free-flowing and reservoir mainstem reaches. The common view of these fish as being flushed nearly continuously to the ocean from tributary rearing areas may be insufficient for effective management (ISG 2000).
- Investigate factors that contribute to the Snake River Fall Chinook yearling versus sub-yearling life-history types.
- Investigate losses between juvenile rearing habitat and hydro system. PIT-tag studies have been used to estimate survival rates for Snake River spring/summer Chinook salmon from upstream hatcheries and smolt traps to Lower Granite Dam. Yearling Chinook from Snake River hatcheries showed a significant negative linear relationship between migration distance and survival during 1998-2014 ($R2 = 0.850$, $P = 0.003$). Survival rates varied from a 17-year mean of 0.779 for smolts released from Dworshak Hatchery (116 km to Lower Granite Dam) to 0.444 for those released from the Salmon River Hatchery (747 km to Lower Granite Dam) (Faulkner et al. 2015). The survival probabilities of wild Chinook smolts during 2014 were also inversely related to the distance of the trap from Lower Granite Dam. Sources of mortality during the outmigration could be investigated by identifying sub-reaches where active (e.g., radio or acoustic) tags disappeared and then looking for contributing factors.
- Identify habitat restoration actions to address sources of juvenile losses in mainstem habitat after they leave tributaries and before reaching hydro system.
- These questions above highlight the importance of maintaining long-term tagging and monitoring programs, such as the one in the Grande Ronde River basin.

Regional RM&E Programs

- Review regional RM&E programs and identify the ones that should be maintained.
- For the Upper Salmon, Clearwater, and Lostine/Wallowa River basins, identify whether there is a need to implement a process similar to the “Atlas” exercise carried out by BPA in the Catherine Creek and Upper Grande Ronde River basins.
- Bring together researchers and local technical experts to review the best science on fish use and habitat relationships and habitat conditions, with a focus on how to best influence life stage survival. As part of this process, identify how to effectively sequence restoration actions, using principles from conservation biology.

- Implement RM&E recommendations in Snake River Sockeye Salmon Recovery Plan (NMFS 2015b).
- Continue implementation of RM&E actions identified in NMFS' 2008/2010/2014 FCRPS Biological Opinions.
  - Develop a long-term framework for implementation of RM&E under the FCRPS opinions with specific strategies through 2028.
  - Continue to affirm and enhance our understanding of fish-habitat relationships, the effectiveness of habitat treatments, and projecting fish/habitat benefits of restoration actions.
  - Continue systematic mapping of current fish habitat conditions relative to potential to inform prioritization and sequencing of conservation actions.
- Continue regional monitoring programs that evaluate *representative* population-specific smolt migration, timing, and mortality rates through the lower Snake and Columbia Rivers.
- Continue investigating factors that could contribute to latent mortality of fish passing through the hydro system.
- Improve estimates of RM&E handling (electrofishing, weirs, catch and release, tagging, marking, trapping, and sorting) impacts.
- Continue research on the reproductive success of hatchery-origin fish spawning in the wild and the benefits and/or risks to natural-origin populations with which they interact.
- Continue developing research on unexplained loss of adults between Bonneville Dam and Lower Granite Dam.
- Research factors contributing to "overshoot" of Tucannon River steelhead and Chinook salmon above Lower Granite Dam and investigate actions to improve volitional passage of adults back downstream.
- Implement actions to provide a direct measure of Snake River fall-run Chinook salmon natural population productivity and implement further actions to measure effects of high levels of hatchery-origin spawners on natural population of Snake River fall-run Chinook salmon productivity, diversity, and response to natural-selective processes.
  - Develop a strategic framework for implementing RM&E recommendations in the proposed Snake River Fall Chinook Salmon Recovery Plan, and continue to refine RM&E priorities to inform actions to address viability gaps.
  - Develop methods/indices for the estimation of the relative contribution of naturally spawning hatchery Snake River fall-run Chinook salmon across major spawning areas to productivity and diversity.
- Continue research on local climate change impacts on Snake River basin salmon and steelhead habitat and populations, and refine restoration strategies and priorities to improve resiliency to climate change.

- Continue to investigate ocean indicators of marine survival for Snake River salmonids and life-history types, and projections of climate change impacts on these relationships.

Predation

- Continue research on the source(s) of adult spring Chinook salmon loss between the Columbia River mouth and Bonneville Dam, including improved understanding of pinniped predation on specific salmonid populations.
- Expand monitoring efforts in the Columbia River and Willamette River to assess predator-prey interactions between pinnipeds and listed species.
- Maintain predatory pinniped management actions at Bonneville Dam to reduce the loss of up-river listed salmon and steelhead stocks.
- Complete life-cycle/extinction risk modeling to quantify predation rates by predatory pinnipeds on listed salmon and steelhead stocks in the Columbia River.
- Expand research efforts in the Columbia River estuary on survival and run timing for adult salmonids migrating through the lower Columbia River to Bonneville Dam.

Recommended Future Actions to Address Habitat

- Continue to fund state-sanctioned recovery organizations in Washington, Oregon, and Idaho (Snake River Salmon Recovery Board, Clearwater Tech Team, Upper Salmon Basin Watershed Program, and the Grande Ronde Model Watershed) to continue implementation of recovery actions, monitoring, action prioritization, and adaptive management through partnerships with state, tribal, federal, and local cooperators.
- Research and develop improved methods to acquire and conserve instream flows that will allow conserved water to bypass downstream junior water rights holders and stay instream longer to benefit Snake River salmon and steelhead.
- Expand and implement structured tributary-habitat assessments and prioritization of conservation actions (e.g., ATLAS process in Grande Ronde basin). Such efforts need to integrate scientific data on habitat quality, habitat potential, and fish distribution to determine a strategy of prioritized and sequenced site-specific treatments to maximize habitat and population response.
- Continue to focus and prioritize recovery actions on population-specific limiting factors and threats.
- Continue to implement and sustain current habitat efforts (permits, enforcement, restoration, and protection).
- Continue to develop and implement TMDLs in areas containing listed salmon and steelhead and occupied downstream areas (e.g., above Brownlee Dam on the Snake River).

- Implement the Bureau of Reclamation Tributary Assessment on middle and lower Catherine Creek.
- Use Oregon's 2013 statewide priority fish passage and unscreened diversions inventory to prioritize and implement fish passage projects.
- Fund operational maintenance of fish screening structures to ensure continued benefits of existing infrastructure.
- Manage federal lands to recognize the importance of cold-water refugia in protecting species' status in face of a warming climate. The conservation and enhancement of these areas must be incorporated in updates to forest management plans.
- Identify and implement actions to conserve and reintroduce beavers into their historical range. Work with willing landowners to protect or reintroduce beavers to increase aquatic habitat complexity and improve stream hydrologic function.
- Continue to implement the Columbia Basin Water Transaction Program in Oregon, Washington, and Idaho to improve stream flow, water quality, and related habitat limiting factors to Snake River salmon and steelhead recovery.
- Identify locations of seasonal use of cold water refugia and research reasons for loss of fish using these cold water refugia. Based on research results, identify actions to protect and restore cold water refugia to improve survival of fish using this habitat.

Recommended Future Actions to Address Hatcheries

- Evaluate the ecological or genetic impacts of non-listed hatchery fish (both anadromous and resident) which are released in areas where they interact with listed salmon and steelhead.
- Evaluate the ecological or genetic impacts of releasing hatchery-origin B-run steelhead into areas where they were not historically present and how the hatchery fish interact with native listed steelhead.
- Develop and implement a gene bank program for spring/summer Chinook salmon in coordination with the Nez Perce Tribe and others for cryopreservation storage for Northeast Oregon populations as described in the draft ESA Recovery Plan for Northeast Oregon Snake River Spring and Summer Chinook Salmon and Snake River Steelhead Populations.
- Implement relative reproductive success studies that evaluate spawner effectiveness of hatchery fish, as well as their impact on natural-origin fish.
- Investigate the use of sliding scales to manage hatchery proportions for broodstock and natural spawning as it relates to demographic risk and conservation benefit for listed species.
- Implement the captive broodstock program strategy and associated research, monitoring, and evaluation actions in the Snake River Sockeye Salmon Recovery Plan (NMFS

2015b) to conserve population genetic and life history diversity and increase spatial structure. Continue to implement alternative release strategies such as releasing smolts for volitional emigration and releasing adults for volitional spawning.

- Evaluate and adapt the hatchery program for Snake River fall Chinook salmon as warranted to achieve the full range of ESA recovery objectives. This is a high priority element of the recovery strategy for Snake River fall Chinook salmon. It will include continuing to interpret and apply emerging RM&E data related to homing fidelity and dispersal patterns and working with co-managers to identify and assess potential management frameworks that would achieve delisting. Such frameworks potentially could include creating natural production emphasis areas (i.e., major spawning areas that produce a substantial level of natural-origin adult spawners with a low proportion of hatchery-origin spawners) or reducing hatchery-origin spawners in the population overall.

Recommended Future Actions to Address Harvest

- Evaluate the utility of using either PIT-tag or genetic-based information to improve estimates of harvest-related mortality.
- Evaluate whether the current harvest monitoring programs for treaty and nontreaty fisheries provide estimates of harvest-related mortality that are sufficiently accurate and precise. If not, provide recommendations for modifying the sampling design or supplementing the effort as needed.
- Improve estimates of harvest catch-and-release impacts.

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.

November 20, 1991 (56 FR 58619). Final Rule: Endangered and Threatened Species; Endangered Status for Snake River Sockeye Salmon.

April 22, 1992 (57 FR 14653). Final Rule: Endangered and Threatened Species; Threatened Status for Snake River Spring/Summer Chinook Salmon, Threatened Status for Snake River Fall Chinook Salmon.

June 3, 1992 (57 FR 23458). Correction: Endangered and Threatened Species; Threatened Status for Snake River Spring/Summer Chinook Salmon, Threatened Status for Snake River Fall Chinook Salmon.

December 28, 1993 (58 FR 68543). Final Rule: Designated Critical Habitat; Snake River Sockeye Salmon, Snake River Spring/Summer Chinook Salmon, and Snake River Fall Chinook 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.

October 25, 1999 (64 FR 57399). Final Rule: Designated Critical Habitat: Revision of Critical Habitat for Snake River Spring/Summer Chinook Salmon.

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).

June 14, 2004 (69 FR 33102). Final Rule: Endangered and Threatened Species: Proposed Listing Determinations for 27 ESUs of West Coast Salmonids.

June 28, 2005 (70 FR 37160). 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.

April 14, 2014 (79 FR 20802). Endangered and Threatened Wildlife; Final Rule To Revise the Code of Federal Regulations for Species Under the Jurisdiction of the National Marine Fisheries Service.

June 8, 2015 (80 FR 32365). Notice of availability: Endangered and Threatened Species; Recovery Plans.

February 6, 2015 (80 FR 6695). Notice of Initiation of 5-year Reviews: Endangered and Threatened Species; Initiation of 5-Year Reviews for 32 Listed Species of Pacific Salmon and Steelhead, Puget Sound Rockfishes, and Eulachon.

5.2 Literature Cited

Allen, B. M., and R. P. Angliss. 2014. Steller Sea Lion Eastern U.S. Stock Assessment. NOAA-TM-AFSC-301.

Arthaud, D., and J. Morrow. 2007. Survival of Snake River sockeye salmon migrating from Stanley basin lakes into the Federal Columbia River Power System. National Marine Fisheries Service, Idaho Habitat Office. Boise, Idaho.

Arthaud, D., and J. Morrow. 2013. Improving migration survival estimates of Snake River Sockeye Salmon. National Marine Fisheries Service, Idaho Habitat Office. Boise, Idaho.

Banks, R., and B. Bowersox. 2015. Potlatch River steelhead monitoring and evaluation report. Annual Report 2012. IDFG #15-104. Idaho Department of Fish and Game. Lewiston, Idaho.

Beauchamp, D. A., A. D. Cross, and J. L. Armstrong. 2007. Bioenergetic responses by Pacific salmon to climate and ecosystem variation. North Pacific Anadromous Fish Commission 4:257-269.

Beechie, T. J., E. Buhle, M. H. Ruckelhaus, A. H. Fullerton, and L. Holsinger. 2006. In press. Hydrologic regime and the conservation of salmon life history diversity. Biological Conservation. 1/1/2006.

BOR (Bureau of Reclamation). 2012. Yankee Fork Tributary Assessment Upper Salmon Subbasin. Boise, Idaho.

Bond, N. A., M. F. Cronin, H. Freeland, and N. Mantua. 2015. Causes and impacts of the 2014 warm anomaly in the NE Pacific. Geophysical Research Letters 42:3414-3420.

Bowersox, B., R. Banks, and N. Davids. 2011. Potlatch River steelhead monitoring and evaluation report. Annual Performance Report 2011. IDFG #12-108. Pacific Coastal Salmon Recovery Fund Contract # 052 08 CW M5. NOAA Intensively Monitored Watershed Fund Contract # 10-37. Idaho Department of Fish and Game. Lewiston, Idaho.

BPA (Bonneville Power Administration) and USBR (United States Bureau of Reclamation). 2013. Benefits of Tributary Habitat Improvement in the Columbia River Basin; Results of Research, Monitoring and Evaluation, 2007-2012. Bonneville Power Administration, Portland, Oregon.

Brown et al. 2015. Briefing on the current status of marine mammal populations in the lower Columbia and Willamette Rivers. PowerPoint presentation to Northwest Power and Conservation Council (January 6, 2015).

Burke, B. J., M. C. Liermann, D. J. Teel, and J. J. Anderson. 2013. Environmental and geospatial factors drive juvenile Chinook salmon distribution during early ocean migration. Canadian Journal of fisheries and Aquatic Sciences 70:1167-1177.

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.

Chandler, C. 2013. Lower Clearwater River Subbasin salmonid distribution & relative abundance monitoring. Project # 2007-23-300 / Contract #00058153, Reporting Period: September 2007-August 2013. Nez Perce Tribe Department of Fisheries Resources Management, Watershed Division. Lapwai, ID. Prepared for: U.S. Department of Energy Bonneville Power Administration, Environment, Fish and Wildlife. Portland, OR.

Chandler, P. C., S. A. King, and R. I. Perry. 2015. State of the physical, biological, and selected fishery resources of Pacific Canadian marine ecosystems in 2014. Canadian Technical Report of Fisheries and Aquatic Science., 3131:1-211.

Chang, H., and J. Jones. 2010. Climate change and freshwater resources in Oregon. Pages 69–149 in K. D. Dello, and P. W. Mote, eds. Oregon Climate Assessment Report. Oregon Climate Change Research Institute, College of Oceanic and Atmospheric Sciences, Oregon State University, Corvallis, Oregon. Available: www.occri.net/OCAR.

Collis, K., D. D. Roby, D. E. Lyons, Y. Suzuki, J. Y. Adkins, L. Reinalda, N. Hostetter, L. Adrean, M. Bockes, P. Loschl, D. Battaglia, T. Marcella, B. Cramer, A. Evans, M. Hawbecker, M. Carper, J. Sheggeby, and S. Sebring. 2009. Research, Monitoring, and Evaluation of Avian Predation on Salmonid Smolts in the Lower and Mid-Columbia River. 2008. Final Season Summary. Prepared for the Bonneville Power Administration and the U.S. Army Corps of Engineers, Portland District, Portland, Oregon.

Connor, W. P., B. D. Arnsberg, J. A. Chandler, T. D. Cooney, P. A. Groves, J. A. Hesse, G. W. Mendel, D. J. Milks, D. W. Rondorf, S. J. Rosenberger, M. L. Schuck, K. F. Tiffan, R. S. Waples, and W. Young. 2015. A Retrospective (circa 1800–2015) on abundance, spatial distribution, and management of Snake River Basin fall Chinook salmon. Draft 1. http://www.streamnetlibrary.org/?page_id=1181 (Available September 30, 2015).

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

Crozier, L. 2012. Literature review for 2011 citations for BIOP: Biological effects of climate change. In: Endangered Species Act Federal Columbia River Power System 2011 Annual ESA Progress Report: Section 2, Appendix A, July 2012.

Crozier, L. 2013. Impacts of climate change on Columbia River salmon. Review of the scientific literature published in 2012. Prepared by L. Crozier (NMFS) for Bonneville Power Administration, Portland, Oregon. Document available in Appendix D.1 in the 2014 Supplemental FCRPS BiOp.

Crozier, L., M. Scheurell, and R. Zabel. 2011. Using time series analysis to characterize evolutionary and plastic responses to environmental change: a case study of a shift toward earlier migration date in sockeye salmon. American Naturalist 178:755-773.

Dalton, M., P. W. Mote, and A. K. Stover. 2013. Climate change in the Northwest: implications for our landscapes, waters and communities. Island Press, Washington, D.C.

Daly E. A., J. A. Scheurer, and R. D. Brodeur. 2014. Juvenile steelhead distribution, migration, feeding and growth in the Columbia River estuary, plume and coastal waters. Marine and Coastal Fisheries 6:641-659.

Diefenderfer, H. L., G. E. Johnson, R. M. Thom, A. B. Borde, C. M. Woodley, L. A. Weitkamp, K. E. Buenau, and R. K. Kropp. 2013. An evidence-based evaluation of the cumulative effects of tidal freshwater and estuarine ecosystem restoration on endangered juvenile salmon in the Columbia River. PNNL-23037. Final report prepared for the U.S. Army Corps of Engineers Portland District, Portland, Oregon, by Pacific Northwest National Laboratory and NOAA Fisheries. Richland, Washington. December 2013.

Eby, L. A., O. Helmy, L. M. Holsinger, and M. K. Young. 2014. Evidence of climate-induced range contractions in bull trout Salvelinus confluentus in a Rocky Mountain watershed, U.S.A. PLoS ONE. 9(6): e98812.

Elsner, M. M., L. Cuo, N. Voisin, et al. 2009. Implications of 21st century climate change for the hydrology of Washington State. Pages 69-106 in: Washington Climate Change Impacts Assessment: Evaluating Washington’s future in a changing climate. Climate Impacts Group, University of Washington, Seattle, Washington, 6/1/2009.

Faulkner, J. R., S. G. Smith, D. L. Widener, T. M. Marsh, and R. W. Zabel. 2015. Survival estimates for the passage of spring-migrating juvenile salmonids through Snake and Columbia River dams and reservoirs, 2014. Report of the National Marine Fisheries Service to the Bonneville Power Administration, Portland, Oregon. Available at http://www.nwfsc.noaa.gov/publications/scipubs/searchdoc.cfm

Fisher, J. P., L. A. Weitkamp, D. J. Teel, et al. 2014. Early ocean dispersal patterns of Columbia River Chinook and coho salmon. Transactions of the American Fisheries Society. 143:252-272.

Fly, C., K. Grover-Wier, J. Thornton, T. Black, and C. Luce. 2010. Bear Valley Road Inventory (GRAIP) Report, In Support of the Bear Valley Category 4b Demonstration. USDA Forest Service, Boise National Forest. February 24, 2010, 54 p.

Ford, M. J. 2002. Selection in captivity during supportive breeding may reduce fitness in the wild. Conservation Biology. 16(3): 815-825.

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: Northwest. Draft U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-113, 281p.

Freeland, H. and F. Whitney. 2014. Unusual warming in the Gulf of Alaska. PICES press 22:51-52.

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. Department of Commerce, NOAA Technical Memorandum. NMFS-NWFSC-66, 598 p.

Hayes, S. A., M. H. Myers, and M. J. Ford. 2007. Status review of Puget Sound steelhead (Oncorhynchus mykiss). U.S. Department of Commerce, NOAA Tech. Memo, NMFS-NWFSC-81.

Hamlet, A. F., D. P. Lettenmaier, et al. 2005. Effects of temperature and precipitation variability on snowpack trends in the western U.S. J of Clim, 18 (21): 4545-4561.

Hebdon, J. L., P. Kline, D. Taki, and T. A. Flagg. 2004. Evaluating reintroduction strategies for redfish lake sockeye salmon captive broodstock progeny. In: *Propagated Fish in Resource Management* (eds. Nickum MJ, Mazik PM, Nickum JG, Mackinlay DD), pp. 401-413.

Hill, A., and S. Bennett. 2014. Tucannon River Restoration Effectiveness Monitoring: 2013 Results. December 5, 2014. Prepared for Snake River Salmon Recovery Board, Dayton, Washington. Sumbitted by Ecological Research, Inc., Providence Utah.

Hixon, M. A., S. Gregory, and W. D. Robinson. 2010. Oregon's fish and wildlife in a changing climate. Chapter 7. In: K. D. Dello and P.W. Mote (eds). Oregon climate assessment report. Oregon Climate Change Research Institute, College of Oceanic and Atmospheric Sciences, Oregon State University, Corvallis, December 2010.

Huyer, A., R. L. Smith, and R. L. Fleischbein. 2002. The coastal ocean off Oregon and northern California during the 1997-8 El Nino. Progress in Oceanography 54:311-341.

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). 2005. Memorandum To: NMFS NW Regional Office, Co-managers and Other Interested Parties re: Updated Population Delineation in the Interior Columbia Basin. May 11, 2005.

ICTRT (Interior Columbia Technical Recovery Team). 2007. 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.

ICTRT (Interior Columbia Technical Recovery Team). 2010. Current status reviews: Interior Columbia Basin salmon ESUs and steelhead DPSs. Vol. 1. Snake River ESUs/DPS. 786 p. + attachments.

IDEQ (Idaho Department of Environmental Quality). 2014. Idaho's 2012 Integrated Report. Boise, Idaho: Idaho Department of Environmental Quality.

Isaak, D. J., C. C. Muhlfeld, A. S. Todd, R. Al-Chokhachy, J. Roberts, J. L. Kershner, K. D. Fausch, and S. W. Hostetler. 2012. The past as prelude to the future for understanding 21st-Century climate effects on Rocky Mountain trout. Fisheries. 37(12): 542-556.

Isaak, D. J. M. K. Young, D. E. Nagel, K. L. Horan, and M. C. Groce. 2015. The cold-water climate shield: delineating refugia for preserving salmonid fishes through the 21st century. Global Change Biology. Volume 21, pgs.2540-2553.

ISAB (Independent Scientific Advisory Board). 2007. Climate change impacts on Columbia River basin fish and wildlife. ISAB 2007-2.

ISAB (Independent Scientific Advisory Board). 2015. Density Dependence and its Implications for Fish Management and Restoration in the Columbia River Basin. Northwest Power and Conservation Council, Columbia River Basin Indian Tribes, and National Marine Fisheries Service. Portland, OR. February 25, 2015. 258 pps.

ISG (Independent Science Group). 2000. Return to the River, Part I: A new conceptual foundation. Prepared for the Northwest Power Planning Council, Portland, Oregon. Available from https://www.nwcouncil.org/reports/2000/2000-12.

Jeffres, C. A., J. J. Opperman, and P. B. Moyle. 2008. Ephemeral floodplain habitats provide best growth conditions for juvenile Chinook salmon in a California River. Environmental Biology of Fishes 83:449-458.

Jones, R. 2015. 2015 5-Year Review – Updated Evaluation of West Coast Hatchery Programs in 28 Listed Salmon Evolutionarily Significant Units and Steelhead Distinct Population Segments for listing under the Endangered Species Act. Memorandum to Chris Yates.

Keefer, M. L., C. C. Caudill, C. A. Peery, and S. R. Lee. 2008. Transporting juvenile salmonids around dams impairs adult migration. *Ecological Applications* 18, 1888-1900.

Keefer, M.L., C. Peery, and B. High. 2009. Behavioral thermoregulation and associated mortality trade-offs in migrating adult steehead (Oncorhynchus mykiss): variability among sympatric populations. Canadian Journal of Fisheries and Aquatic Sciences 66:1734-1747.

Lindegren, M., D. M. Checkley, T. Johnson and N. Sands. 2013. Climate, fishing, and fluctuations of sardine and anchovy in the California current. Proceedings of the National Academy of Scinecnes of the United States of America. 110:13672-13677.

Lynch, M., and M. O'Hely. 2001. Captive breeding and the genetic fitness of natural populations. Conservation Genetics. 2: 363-378

Mantua N. J., S. R. Hare, Y. Zhang, J. M. Wallace, and R. C. Francis. 1997. A Pacific interdecadal climate oscillation with impacts on salmon production. Bulletin of the American Meteorological Society 78:1067-1079.

Mantua, N., I. Tohver, and A. F. Hamlet. 2009. Impacts of climate change on key aspects of freshwater salmon habitat in Washington State. Pages 217–254 in M. M. Elsner, J. Littell, and L. W. Binder eds. The Washington climate change impacts assessment. Center for Science in the Earth System, Joint Institute for the Study of the Atmosphere and Oceans, University of Washington, Seattle.

Matthews, G. M., and R. S. Waples. 1991. Status review for Snake River spring and summer Chinook salmon. U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-F/NWC-20.

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 13:964–989.

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

Mote, P. W. and E. P. Salathe, Jr. 2009. Future climate in the Pacific Northwest. In: Washington Climate Change Impacts Assessment: Evaluating Washington's future in a changing climate. Climate Impacts Group, University of Washington, Seattle, Washington, 6/1/2009.

Mote, P. W. and E. P. Salathé, Jr. 2010. Future Climate in the Pacific Northwest. Climatic Change 102(1-2): 29-50.

Munoz, N. J., A. P. Farrell, J. W. Heath, and B. D. Neff. 2014. Adaptive potential of a Pacific salmon challenged by climate change. Nature Climate Change Letters. Published online December 22, 2014.

Myers, J. M., R. G. Kope, G. J. Bryant, D. J. Teel, L. J. Lierheimer, T. C. Wainwright, W. S. Grant, F. W. Waknitz, K. G. Neely, and R. S. Waples. 1998. Status review of Chinook salmon from Washington, Idaho, Oregon and California. U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC-35.

Myers, K. W., K. Y. Aydin, R. V. Walker, S. Fowler and M. L. Dahlberg. 1996. Known ocean ranges of stocks of Pacific salmon and steelhead as shown by tagging experiments, 1956-1995. North Pacific Anadromous Fish Commission Document, 192.

Nicholas, J. W., and D. G. Hankin. 1988. Chinook salmon populations in Oregon coastal river basins: descriptions of life histories and assessment of recent trends in run strengths. Oregon Department of Fish and Wildlife, Fish Division Information Report 88-1, Corvallis.

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. Available on the Internet at: http://www.westcoast.fisheries.noaa.gov/publications/status_reviews/salmon_steelhead/steelhead/sr1997-steelhead1.pdf

NMFS (National Marine Fisheries Service). 1999. Status Review Update for Four Deferred ESUs of Chinook Salmon: Central Valley Spring-run, Central Valley Fall and Late-Fall Run, Southern Oregon and California Coastal, and Snake River Fall Run. July 16, 1999, NMFS-NWFSC Status Review Update Memo. Available on the Internet at: http://www.westcoast.fisheries.noaa.gov/publications/status_reviews/salmon_steelhead/chinook/sr1999-chinook.pdf

NMFS (National Marine Fisheries Service). 2000. ESA 4(d) rule (protective regulations) for listed West Coast salmon and steelhead. July 10, 2000.

NMFS (National Marine Fisheries Service). 2003. Notice of proposed rulemaking on ESA critical habitat designations for 20 ESUs of Pacific salmon and steelhead in California, Washington, Oregon and Idaho; request for comments. September 29, 2003.

NMFS (National Marine Fisheries Service). 2004. Salmonid Hatchery Inventory and Effects Evaluation Report (SHIEER). An Evaluation of the Effects of Artificial Propagation on the Status and Likelihood of Extinction of West Coast Salmon and Steelhead under the Federal Endangered Species Act. Technical Memorandum NMFS-NWR/SWR. May 28, 2004. U.S. Dept. of Commerce, National Marine Fisheries Service, Portland, Oregon. 557p.

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, Eleven 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. Biological Opinion: Impacts of *U.S. v. OR* Fisheries in the Columbia River in years 2008-2017 on ESA listed Species and Magnuson-Stevens Act Essential Fish Habitat. May 5, 2008.

NMFS (National Marine Fisheries Service). 2009. NMFS Endangered Species Act Section 7 Consultation, Biological Opinion: Environmental Protection Agency Registration of Pesticides Containing Carbaryl, Carbofuran, and Methomyl. Washington, D.C.: U.S. Department of Commerce.

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). 2011. Draft Idaho management unit plan for Snake River spring/summer chinook and steelhead. Boise, Idaho.

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). February 27, 2012. NMFS No: 2005/00061. 148 pps.

NMFS (National Marine Fisheries Service). 2012b. Endangered Species Act Section 7 Formal Consultation and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for Diversions located on National Forest Lands in the Upper Salmon River Watershed, HUCs 1706020117 and 1706020118, Custer County, Idaho. August 10, 2012. NMFS No: 2004/01982. 133 pps.

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. http://www.westcoast.fisheries.noaa .gov/publications/hydropower/fcrps/2014_supplemental_fcrps_biop_final.pdf.

NMFS (National Marine Fisheries Service). 2014b. Draft ESA recovery plan for northeast Oregon snake river spring and summer chinook salmon and snake river steelhead populations. West Coast Region. October 2014. http://www.westcoast.fisheries .noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/snake_river/snake_river_sp-su_chinook_steelhead.html

NMFS (National Marine Fisheries Service). 2014c. Harbor Seal. Oregon/Washington Coast Stock Report.

NMFS (National Marine Fisheries Service). 2014d. Endangered Species Act Section 7(a)(2) biological opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation: Idaho Water Quality Standards for Toxic Substances. NMFS Consultation Number 2000-1484. Boise, Idaho.

NMFS (National Marine Fisheries Service). 2014e. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Conference Report, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. Issuance of Section 10(a)(1)(A) Permit 18928 for the Chief Joseph Hatchery Okanogan Spring Chinook Salmon. West Coast Region, Sustainable Fisheries. October 27, 2014. NMFS Consultation No.: WCR-2014-607. 131p.

NMFS (National Marine Fisheries Service). 2015a. Species in the Spotlight: Survive to Thrive – Recovering Threatened and Endangered Species FY 2013-2014 Report to Congress. 37 p. Available at: http://www.nmfs.noaa.gov/pr/laws/esa/final_biennial_report_2012-2014.pdf

NMFS (National Marine Fisheries Service). 2015b. ESA Recovery Plan for Snake River Sockeye Salmon (*Oncorhynchus nerka*) – June 8, 2015. 431 p. Available at: http://www.westcoast.fisheries.noaa.gov/publications/recovery_planning/salmon_steelhead/domains/interior_columbia/snake_river_sockeye_recovery_plan_june_2015.pdf

NMFS (National Marine Fisheries Service). 2015c. Proposed ESA Recovery Plan for Snake River Fall Chinook Salmon (*Oncorhynchus tshawytscha*) – November 2015. 326 p. Available at: http://www.westcoast.fisheries.noaa.gov/protected_species /salmon_steelhead/recovery_planning_and_implementation/snake_river/snake_river_fall _chinook_recovery_plan.html

NMFS (National Marine Fisheries Service). 2015d. California sea lion. U.S. Stock Report.

NWFSC (Northwest Fisheries Science Center). 2015. Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest.

Norberg, B. 2015. E-mail (forwarded) to Robert Anderson, NMFS, from Brent Norberg, NMFS, on February 19, 2015, from Steven Jefferies, WDFW, regarding sea lion counts in Astoria, Oregon

NPCC (Northwest Power and Conservation Council). 2004. Salmon subbasin management plan. Written by Ecovista, Contrated by Nez Perce Tribe Watershed Division and Shoshone-Bannock Tribes.

Onjukka, S. 2015. Mark Lacey (NOAA) personal communication with Sam Onjukka, ODFW Fish Disease Laboratory at Eastern Oregon University. 2015.

OWRD (Oregon Water Resources Department). 2012. Oregon Integrated Water Resources Strategy. August 2, 2012. http://www.oregon.gov/owrd/pages/law/integrated_water_supply_strategy.aspx

Pearcy, W. G. and A. Schoener. 1987. Changes in the marine biota coincident with the 1982-1983 El Nino in the northeastern subarctic Pacific Ocean. Journal of Geophysical Research-Oceans. 92:14417-14428.

Pearcy, W. G. 1992. Ocean ecology of North Pacific salmonids. University of Washington Press, Seattle, WA.

Pearcy, W. G. and S. M. Wkinnell. 2007. The ocean ecology of salmon in the northeast Pacific Ocean – An abridged history. In: Ecology of Juvenile Salmon in the Northeast Pacific Ocean: Regional Comparisons (eds. Grimes, C.B., Brodeur R.D., Haldorson L.J., and S.M. McKinnell), pp. 7-30.

Peterson, W. T., J. E., Keister, and L. R. Feinberg. 2002. The effects of the 1997-99 El Nino/La Nina events on hydrography and zooplankton off the central Oregon coast. Progress in Oceanography 54:381-398.

Peterson, W. T., and F. B. Schwing. 2003. A new climate regime in northeast pacific ecosystems. Geophysical Research Letters 30.

Peterson, M., K. Plaster, K. Kruse, K. McBaine, and C. Kozfkay. 2013. Snake River Sockeye Salmon Captive Broodstock Program: Research Element, 1/1/2011-12/31/2011. Annual Report, 2007-402-00. IDFG, Nampa, ID to BPA, Portland, OR.

Peterson, M. K., C. A. Morgan, and O. J. Peterson. 2014. Ocean ecosystem indicators of salmon marine survival in the northern California current. Unpublished report. Available online at http://www.nwfsc.noaa.gov/research/divisions/fe/estuarine/oeip/documents/Peterson et al 2014.pdf.

Pollock, M. M., G. Lewallen, K. Woodruff, C. E. Jordan and J. M. Castro (Editors). 2015. The Beaver Restoration Guidebook: Working with Beaver to Restore Streams, Wetlands, and Floodplains. Version 1.0. United States Fish and Wildlife Service, Portland, Oregon. 189 pp. https://www.fws.gov/oregonfwo/ToolsForLandowners/RiverScience/Documents/BRG%20v.1.0%20final%20reduced.pdf

Salathe, E. P., L. R. Leung, Y. Qian, and Y. Zhang. 2009. Regional climate model projections for the state of washington for Chapter 2 in: Littell, J.S., M.M. Elsner, L.C. Whitely and AlL. Snover (eds). The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate. Climate Impacts Group, U. of Washington, Seattle, WA.

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.

Sedell, T. 2015. Mark Lacey personal communication with Ted Sedell and Charlie Stein (ODFW). 2015.

Shanks, A. L. 2013. Atmospheric forcing rives recruitment variation in the Dungeness crab (Cancer magister), revisited. Fisheries Oceanography 22:263-272.

Sommer, T. R., M. L. Nobriga, W. C. Harrell, and W. J. Kimmerer. 2001. Floodplain rearing of juvenile chinook salmon: evidence of enhanced growth and survival. Canadian Journal of fisheries and Aquatic Sciences. 58(2):325-333.

Stansell, R. J., B. K. van der Leeuw, K. M. Gibbons, and W. T. Nagy. 2014. Evaluation of pinniped predation on adult salmonids and other fish in the Bonneville Dam tailrace. U.S. Army Corps of Engineers.

TAC (U.S. v Oregon Technical Advisory Committee). 2011. TAC Annual Report. Abundance, Stock Status and ESA Impacts. 2011 Summary, May 31-June 1, 2012.

TAC (U.S. v Oregon Technical Advisory Committee). 2012. TAC Annual Report. Abundance, Stock Status and ESA Impacts. 2012 Summary, May 30-31, 2013.

TAC (U.S. v Oregon Technical Advisory Committee). 2013. TAC Annual Report. Abundance, Stock Status and ESA Impacts. 2013 Summary, May 29-30, 2014.

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

Trudel, M., S. Tucker, and J. E. Zamon. 2002. Bioenergetic response of Coho salmon to climate change. North Pacific Anadromous Fisheries Commission Bulletin 4:59-61.

U.S. Forest Service and Bureau of Land Management. 1995. Decision Notice/Decision Record, Finding of No Significant Impact, and Environmental Assessment for the Interim Strategies for Managing Anadromous Fish-producing Watersheds in Eastern Oregon and Washington, Idaho, and Portions of California. http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsbdev3_033465.pdf.

USBWP (Upper Salmon Basin Watershed Project). 2005. Screening and habitat improvement prioritization for the upper salmon subbasin (SHIPUSS). Prepared by the Upper Salmon Basin Watershed Project Technical Team, August 2005. 34 p.

USBWP (Upper Salmon Basin Watershed Project). 2012. Screening and habitat improvement prioritization for the upper salmon subbasin (SHIPUSS) – Revised. Salmon, Idaho. http://modelwatershed.org/wp-content/uploads/2013/09/SHIPPUS - Tables-2-and3-conbined-2005-and-2012-ranks-corrected-09_27_2013.pdf.

Wainwright, T. C. and L. A. Weitkamp. 2013. The density dilemma: limitation on juvenile production in threatened salmon populations. Marine Fisheries Review 53:11-22.

Walters, A. W., T. Copeland, and D. Venditti. 2013. The density dilemma: limitations on juvenile production in threatened salmon populations. Ecology of Freshwater Fish. 22:508-519.Waples, R. S., O. W. Johnson, and R. P. Jones Jr. 1991a. Status review for Snake River sockeye salmon. U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-F/NWC-195.

Waples, R. S., R. P. Jones Jr., B. R. Beckman, and G. A. Swan. 1991. Status review for Snake River fall Chinook salmon. U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-F/NWC-201.

Wargo Rub, A. M. 2014. Preliminary report on survival and run timing of adult spring/summer Chinook salmon through the lower Columbia River to Bonneville Dam. PowerPoint presentation to Northwest Power and Conservation Council (October 27, 2014).

Weitkamp, L., and Neely, K. 2002. Coho salmon (Oncorhynchus kisutch) ocean migration patterns: insight from marine coded-wire tag recoveries. Canadian Journal of fisheries and aquatic Sciences. 59: 1100-1115.

Weitkamp, L.A. 2010. Marine distributions of Chinook salmon from the West Coast of North America determined by coded wire tag recoveries. Transactions of the American Fisheries Society 139:147-170.

Wenger, S. J., D. J. Isaak, C. H. Luce, H. M. Neville, K. D. Fausch, J. B. Dunham, D. C. Dauwalter, M. K. Young, M. M. Elsner, B. E. Rieman, A. F. Hamlet, and J. E. Williams. 2011. Flow regime, temperature, and biotic interactions drive differential declines of trout species under climate change [includes Supporting Information]. Proceedings of the National Academy of Science (PNAS). 108(34): 14175-14180.

Wenger, S. J., N. A. Som, D. C. Dauwalter, D. J. Isaak, H. M. Neville, C. H. Luce, J. B. Dunham, M. K. Young, K. D. Fausch, and B. E. Rieman. 2013. Probabilistic accounting of uncertainty in forecasts of species distributions under climate change. Global Change Biology. Accepted paper. doi: 10.1111/gcb.12294.

Wright, B., T. Murtagh, R. Brown, A. Barnes, B. Moser, C. Owen, T. Parsons, T. Tillson, and T. Wise. 2015. Willamette Falls Pinniped Monitoring Project. Oregon Department of Fish and Wildlife.

Zurstadt, C. 2015. Deposition of Fine Sediment in the South Fork Salmon River Watershed, Payette and Boise National Forests, Idaho. Statistical Summary of Intragravel Monitoring 1977-2014, and Interstitial and Surface Sediment Monitoring 1986-2014. Payette National Forest. March, 2015.

National Marine Fisheries Service

2016 5-Year Review

Snake River Sockeye Salmon
Snake River Spring/Summer Chinook Salmon
Snake River Fall-run Chinook Salmon
Snake River Basin Steelhead

Conclusion:

Based on the information identified above, we conclude:

- The Snake River Sockeye Salmon ESU should remain listed as endangered.
- The Snake River Spring/Summer Chinook salmon ESU should remain listed as threatened.
- The Snake River Fall-run Chinook salmon ESU should remain listed as threatened.
- The Snake River basin steelhead DPS should remain listed as threatened.

REGIONAL OFFICE APPROVAL

Approve: Michael P. Tehan Date: 03/29/2016

Michael P. Tehan
Assistant Regional Administrator
Interior Columbia Basin Office
West Coast Region
NOAA Fisheries