Science, Service, Stewardship

2022 5-Year Review: Summary & Evaluation of **Upper Columbia River Spring-run Chinook Salmon** and **Upper Columbia River Steelhead**

National Marine Fisheries Service
West Coast Region

5-Year Review: Upper Columbia River Species

Species Reviewed	Evolutionarily Significant Unit or Distinct Population Segment
Chinook Salmon (*Oncorhynchus tshawytscha*)	*Upper Columbia River Spring-run Chinook*
Steelhead (*O. mykiss*)	*Upper Columbia River Steelhead*

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1. General Information

1.1 Introduction

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

The ESA, under section 4(c)(2), directs the Secretary of Commerce to review the listing classification of threatened and endangered species at least once every 5 years. A 5-year review is a periodic analysis of a species' status conducted to ensure that the listing classification of a species as threatened or endangered on the List of Endangered and Threatened Wildlife and Plants (List) (50 CFR 17.11– 7.12; 50 CFR 223.102, 224.101) is accurate (USFWS and NMFS 2006; NMFS 2020a). After completing this review, the Secretary must determine if any species should: (1) be removed from the list; (2) have its status changed from endangered to threatened; or, (3) have its status changed from threatened to endangered. If, in the 5-year review, a change in classification is recommended, the recommended change will be further considered in a separate rule-making process. The most recent 5-year review analysis for West Coast salmon and steelhead occurred in 2016. This document describes the results of the 2022 5-year review of ESA-listed Upper Columbia River (UCR) spring-run Chinook salmon and UCR steelhead.

A 5-year review is:

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

A 5-year review is not:

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

1.1.1 Background on salmonid listing determinations

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

Under the DPS 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. Before 2005, our policy was to include in the listed ESU or DPS only those hatchery fish deemed "essential for conservation" of a species. We revised that approach in response to a court decision. On June 28, 2005, we announced a final policy addressing the role of artificially propagated Pacific salmon and steelhead in listing determinations under the ESA (Hatchery Listing Policy, 70 FR 37204).[1] 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 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 2005 Hatchery Listing Policy changed the way we considered hatchery fish in ESA listing determinations, we completed new status reviews and ESA listing determinations for West Coast salmon ESUs on June 28, 2005 (70 FR 37159), and for steelhead DPSs on January 5,

[1] Policy on the Consideration of Hatchery-Origin Fish in Endangered Species Act Listing Determinations for Pacific Salmon and Steelhead.

2006 (71 FR 834). On August 15, 2011, we published our 5-year reviews and listing determinations for 11 ESUs of Pacific salmon and 6 DPSs of steelhead from the Pacific Northwest (76 FR 50448). On May 26, 2016, we published our 5-year reviews and listing determinations for 17 ESUs of Pacific salmon, 10 DPSs of steelhead, and the southern DPS of eulachon (*Thaleichthys pacificus*) (81 FR 33468), including reaffirming endangered status for UCR spring-run Chinook salmon and threatened status for UCR steelhead.

1.2 Methodology Used to Complete the Review

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

To complete the reviews, we first asked scientists from our Northwest and Southwest Fisheries Science Centers to collect and analyze new information about ESU and DPS viability. To evaluate viability, our scientists used the Viable Salmonid Population (VSP) concept developed by McElhany et al. (2000). The VSP concept evaluates four criteria – abundance, productivity, spatial structure, and diversity – to assess species viability. By applying this concept, the Northwest Fisheries Science Center considered new information on the four salmon and steelhead population viability criteria. They also considered new information on ESU and DPS composition. At the end of this process, the science teams prepared reports detailing the results of their analyses (Ford 2022).

To further inform the reviews, we also asked salmon management biologists from our West Coast Region familiar with hatchery programs to consider new information available since the previous listing determinations. Among other things, they considered hatchery programs that have ended, new hatchery programs that have started, changes in the operation of existing programs, and scientific data relevant to the degree of divergence of hatchery fish from naturally spawning fish in the same area. Finally, we consulted salmon management biologists from the West Coast Region who are familiar with habitat conditions, hydropower operations, and harvest management. In a series of structured meetings, by geographic area, these biologists identified relevant information and provided insight on the degree to which circumstances had changed for each listed entity.

In preparing this report, we considered all relevant information, including the work of the Northwest Fisheries Science Center (Ford 2022); the report of the regional biologists regarding hatchery programs; recovery plans for the species in question; technical reports prepared in support of recovery plans for the species in question; the listing record (including designation of critical habitat and adoption of protective regulations); the recent biological opinions issued for

UCR steelhead and spring-run Chinook salmon; information submitted by the public and other government agencies; and the information and views provided by the geographically based management teams. The present report describes the agency's findings based on all of the information considered.

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

1.3.1 Federal Register Notice Announcing Initiation of this Review

84 FR 53117; October 4, 2019.

1.3.2 Listing History

In 1997, NMFS began listing UCR salmonid species under the ESA. By 1999, NMFS listed two species in this area as endangered, and later reclassified one as threatened (Table 1).

Table 1. Summary of the listing history under the Endangered Species Act for the Upper Columbia River salmonids.

Salmonid Species	ESU/DPS Name	Original Listing	Revised Listing(s)
Chinook Salmon (*O. tshawytscha*)	Upper Columbia River spring-run Chinook Salmon	**FR Notice:** 64 FR 14308 **Date:** 3/24/1999 **Classification:** Endangered	**FR Notice:** 70 FR 37159 **Date:** 6/28/2005 **Classification:** Endangered
Steelhead (*O. mykiss*)	Upper Columbia River Steelhead	**FR Notice:** 62 FR 43937 **Date:** 8/18/1997 **Classification:** Endangered	**FR Notice:** 71 FR 834 **Date:** 1/5/2006 **Classification:** Threatened **FR Notice:** 74 FR 42605 **Date:** 8/24/2009 **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, that contain physical or biological features essential to conservation, that may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by the species at the time of listing that are essential for the conservation of the species. We designated critical habitat for both UCR spring-run Chinook salmon and UCR steelhead in 2005.

Section 9 of the ESA prohibits the take of species listed as endangered. The ESA defines take to mean harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct. For threatened species, the ESA does not automatically prohibit take, but instead authorizes the agency to adopt regulations it deems necessary and advisable for species conservation and to apply the take prohibitions of section 9(a)(1) through ESA section 4(d). In 2000, NMFS adopted 4(d) regulations for threatened salmonids that prohibit take except in specific circumstances. On February 1, 2006, we applied these 4(d) regulations to UCR steelhead (71 FR 5178).

Table 2. Summary of rulemaking for 4(d) protective regulations and critical habitat for salmon and steelhead in the Upper Columbia River.

Salmonid Species	ESU/DPS Name	4(d) Protective Regulations	Critical Habitat Designations
Chinook Salmon (*O. tshawytscha*)	Upper Columbia River spring-run Chinook Salmon	ESA section 9 applies	**FR Notice:** 70 FR 52630 **Date:** 9/2/2005
Steelhead (*O. mykiss*)	Upper Columbia River Steelhead	**FR Notice:** 71 FR 5178 **Date:** 2/1/2006	**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 UCR spring-run Chinook salmon ESU and UCR steelhead DPS. These assessments include reviews conducted by our Northwest Fisheries Science Center and technical reports prepared to support recovery planning for these species.

Table 3. Summary of previous scientific assessments for UCR salmon and steelhead.

Salmonid Species	ESU/DPS Name	Document Citation
Chinook Salmon (*O. tshawytscha*)	Upper Columbia River spring-run Chinook Salmon	Ford 2022 NWFSC 2015 Ford et al. 2011 ICTRT 2007a ICTRT 2007b ICTRT and Zabel 2007 Good et al. 2005 McClure et al. 2005 ICTRT 2003 NMFS 1999 Myers et al. 1998 NMFS 1998
Steelhead (*O. mykiss*)	Upper Columbia River Steelhead	Ford 2022 NWFSC 2015 Ford et al. 2011 ICTRT 2007a ICTRT 2007b ICTRT and Zabel 2007 Good et al. 2005 McClure et al. 2005 ICTRT 2003 NMFS 1997 Busby et al. 1996

1.3.5 Recovery Plan and Species' Recovery Priority Number at Start of 5-Year Review Process

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

Table 4. Recovery Priority Number and Endangered Species Act Recovery Plan for UCR spring-run Chinook salmon and UCR steelhead.

Salmonid Species	ESU/DPS Name	Recovery Priority Number	Recovery Plan/Outline
Chinook Salmon (*O. tshawytscha*)	Upper Columbia River spring-run Chinook Salmon	**1C**	**Title:** Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan Available at: https://www.fisheries.noaa.gov/resource/document/recovery-plan-upper-columbia-spring-chinook-salmon-and-steelhead **Date:** 10/9/2007 **Type:** Final **FR Notice:** 72 FR 57303
Steelhead (*O. mykiss*)	Upper Columbia River Steelhead	**3C**	**Title:** Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan Available at: https://www.fisheries.noaa.gov/resource/document/recovery-plan-upper-columbia-spring-chinook-salmon-and-steelhead **Date:** 10/9/2007 **Type:** Final **FR Notice:** 72 FR 57303

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2. Review Analysis

In this section, we review new information to determine whether the UCR 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
Upper Columbia River Spring-run Chinook Salmon	X	
Upper Columbia River Steelhead	X	

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

ESU/DPS Name	YES	NO
Upper Columbia River Spring-run Chinook Salmon	X	
Upper Columbia River Steelhead	X	

Was the ESU/DPS listed prior to 1996?

ESU/DPS Name	YES	NO	Date Listed if Prior to 1996
Upper Columbia River Spring-run Chinook Salmon		X	n/a
Upper Columbia River Steelhead		X	n/a

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

In 1991, NMFS issued a policy explaining how the agency would apply the definition of "species" in evaluating Pacific salmon stocks for listing consideration under the Endangered Species Act (ESA) (56 FR 58612). Under this policy a group of Pacific salmon populations is considered a "species" under the ESA if it represents an "evolutionarily significant unit" (ESU) which meets the two criteria of being 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 Upper Columbia River 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 UCR Spring-run Chinook Salmon ESU and the UCR Steelhead DPS

ESU/DPS Delineation

This section provides a summary of information presented in Ford 2022: Biological viability assessment update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest.

We found no new information that would justify a change in the delineation of the UCR spring-run Chinook salmon ESU or the UCR steelhead DPS (Ford 2022).

Membership of Hatchery Programs

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

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

UCR Spring-run Chinook Salmon

In the 2016 5-year review, the UCR spring-run Chinook salmon ESU was defined as including naturally spawned spring-run Chinook salmon originating from Columbia River tributaries upstream of the Rock Island Dam and downstream of Chief Joseph Dam (excluding the Okanogan River subbasin). At that time, the ESU also included spring-run Chinook salmon from six artificial propagation programs: the Twisp River Program, Chewuch River Program, Methow Program, Winthrop National Fish Hatchery Program, Chiwawa River Program, and the White River Program (70 FR 37159).

Since 2016, three of the hatchery programs have changed (85 FR 81822). We removed the Chewuch River Program from the listed ESU because the program is now considered part of the listed Methow Composite Program. We added the new Nason Creek Program to the ESU because the source for these fish is local, natural-origin fish from Nason Creek. We added the Chief Joseph spring Chinook Hatchery Program (Okanogan release) to the ESU because the spring Chinook salmon reared at the Chief Joseph Hatchery are from the Winthrop National Fish Hatchery, and these fish are considered part of the UCR spring Chinook salmon ESU (85 FR 81822).

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

UCR Steelhead

At the time of the 2016 5-year review, the UCR steelhead DPS was defined as including naturally spawned anadromous *O. mykiss* (steelhead) originating below natural and manmade impassable barriers from the Columbia River and its tributaries upstream of the Yakima River to the U.S.-Canada border. At that time, the DPS also included steelhead from six artificial propagation programs: the Wenatchee River Program, Wells Hatchery Program (in the Methow and Okanogan Rivers), Winthrop National Fish Hatchery Program, Omak Creek Program, and the Ringold Hatchery Program (71 FR 834). Since 2016, we updated the name of the Omak Creek Program, which is included in the DPS, to the Okanogan River Program (85 FR 81822).

The Wells Hatchery Complex program has three program components that release steelhead into the UCR basin: the Twisp River, Methow River, and Columbia River at Wells Hatchery. The Twisp component uses only natural-origin fish for broodstock collected from the Twisp River. The Methow component is a genetically-linked program with Winthrop National Fish Hatchery to better link its hatchery fish to natural-origin steelhead (NMFS 2017d). All of the steelhead released into the Methow River are ESA-listed. An Okanogan component to the Wells Complex program is currently listed, but this component was discontinued around 2013. The Columbia River component uses the Wells Hatchery stock which is not listed as part of the DPS.

The Wells Hatchery stock is a mixture of multiple populations in the UCR collected at Wells Dam and has been used in the past as the broodstock source for population-specific hatchery programs in the DPS. The Wells Hatchery stock is not representative of any one population nor managed to encourage local adaptation (i.e., incorporation of natural-origin fish into the broodstock). For this reason, the Wells Hatchery stock is considered sufficiently divergent from the UCR steelhead populations that it is not included as part of the DPS (85 FR 81822).

The Ringold Hatchery Program is currently considered to be part of the DPS. However, the program is solely dependent on releases from the Wells Hatchery stock summer steelhead broodstock that are not part of the DPS. As a result, the inclusion of the Ringold Hatchery Program is no longer consistent with the Hatchery Listing Policy (70 FR 37204) since the Ringold Hatchery Program uses a broodstock that is not from the UCR steelhead DPS.

2.2 Recovery Criteria

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

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

For Pacific salmon, Technical Recovery Teams (TRTs), appointed by NMFS, defined criteria to assess biological viability for each listed salmon and steelhead species. NMFS then adopted the TRT's viability criteria as the biological criteria for the recovery plans based on best available scientific information and other considerations as appropriate. NMFS also developed criteria to assess progress toward alleviating the relevant threats to Pacific salmon and steelhead species (listing factor [threats] criteria). For the Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan (UCSRB 2007), NMFS adopted the viability criteria metrics defined by the Interior Columbia Technical Recovery Team (ICTRT 2007b) as the biological recovery criteria for the endangered UCR spring-run Chinook salmon ESU and the threatened UCR steelhead DPS.

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

2.2.1 Approved Recovery Plan with Objective, Measurable Criteria

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

ESU/DPS Name	YES	NO
Upper Columbia River Spring-run Chinook Salmon	X	
Upper Columbia River 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
Upper Columbia River Spring-run Chinook Salmon	X	
Upper Columbia River Steelhead	X	

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

ESU/DPS Name	YES	NO
Upper Columbia River Spring-run Chinook Salmon	X	
Upper Columbia River Steelhead	X	

2.2.3 Biological Recovery Criteria as They Appear in the Recovery Plan

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

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

For recovery planning and development of recovery criteria, the Interior Columbia Technical Recovery Team (ICTRT) identified independent populations within the UCR spring-run Chinook salmon ESU and the UCR steelhead DPS and grouped them into genetically similar major population groups (MPGs) (ICTRT 2003). In addition, the ICTRT designated major spawning areas (MaSAs) and minor spawning areas (MiSAs) as a framework for expressing within population spatial structure and diversity criteria. Recovery criteria and strategies outlined in the 2007 Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan are targeted on achieving, at a minimum, the ICTRT (2007) biological viability criteria for each major population grouping in the ESU/DPS.

All the TRTs used the same biological principles for developing their ESU/DPS and population viability criteria. These principles are described below and in more depth in the NMFS 2000 Technical Memorandum NOAA NMFS-NWFSC-42, Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units (hereafter referred to as McElhany et al. 2000). The viable salmonid population (VSP) concept (McElhany et al. 2000) is based on the biological parameters of abundance, productivity, spatial structure, and diversity for an independent salmonid population to have a negligible risk of extinction over a 100-year time frame. While the ESU/DPS is the listed entity under the ESA, the ESU/DPS-level viability criteria are based on the collective viability of the individual populations that make up the ESU/DPS–their characteristics and their distribution throughout the ESU/DPS geographic range.

The VSP concept identifies the attributes, provides guidance for determining the conservation status of populations and larger-scale groupings of Pacific salmonids, and describes a general framework for how many and which populations within an ESU/DPS should be at a particular status for the ESU/DPS to have an acceptably low risk of extinction. The NMFS-appointed ICTRT (2007b) developed combined VSP criteria metrics that describe the probability of population extinction risk in 100 years (Figure 1). NMFS color coded the risk assessment to assist the readers more easily distinguish the various risk categories.

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

Figure 1. VSP Criteria Metrics.

UCR Spring-run Chinook Salmon ESU

The UCR spring-run Chinook salmon ESU includes naturally spawned spring-run Chinook salmon originating from Columbia River tributaries upstream of the Rock Island Dam and downstream of Chief Joseph Dam (excluding the Okanogan River subbasin). This ESU also includes spring-run Chinook salmon from the following artificial propagation programs: the Twisp River Program, Methow Program, Winthrop National Fish Hatchery Program, Chiwawa River Program, Nason Creek Program, White River Program, and the Chief Joseph spring Chinook Hatchery Program (Okanogan release) (85 FR 81822). There is a single MPG, the North Cascades MPG, in this ESU. It is composed of three populations including the Wenatchee, Entiat, and Methow. The Okanogan population is considered extinct; however, NOAA designated a "non-essential experimental population" of spring-run Chinook salmon in the Okanogan River sub-basin under section 10(j) of the ESA in 2014 (79 FR 20802, Figure 2). The spring-run Chinook salmon that are designated as part of an experimental population are not included as part of the ESU.

North Cascades MPG

For the North Cascades MPG, there are three extant populations, Wenatchee River, Entiat River, Methow River, and one functionally extirpated Okanogan River population. The ICTRT (2007) recommended that three populations meet viability criteria, two of which must meet high viability criteria for the ESU to be viable. The final Upper Columbia Salmon Recovery Board (UCSRB) 2007 recovery plan adopted by NMFS recommended that all spring-run Chinook salmon populations within the ESU meet abundance/productivity criteria that represent a 5 percent extinction risk over a 100-year period as the recovery scenario.

UCR Steelhead DPS

The UCR steelhead DPS includes naturally spawned anadromous *O. mykiss* (steelhead) originating below natural and manmade impassable barriers from the Columbia River and its tributaries upstream of the Yakima River to the U.S.-Canada border (Figure 3). The DPS also includes steelhead from the following artificial propagation programs: the Wenatchee River Program, Wells Complex Hatchery Program (in the Methow), Winthrop National Fish Hatchery Program, Ringold Hatchery Program, and the Okanogan River Program (85 FR 81822). There is a single MPG, the North Cascades MPG, in this DPS. It is composed of four populations including the Wenatchee, Entiat, Methow, and Okanogan.

North Cascades MPG

For the North Cascades MPG, there are four extant populations, Wenatchee River, Entiat River, Methow River, Okanogan River, and one functionally extirpated Crab Creek population. The ICTRT (2007) recommended that three populations meet viability criteria, two of which meet high viability criteria for the ESU to be viable. The final UCSRB 2007 recovery plan adopted by NMFS recommended that all steelhead populations within the ESU, except the Crab Creek population, meet abundance/productivity criteria that represent a 5 percent extinction risk over a 100-year period as the recovery scenario.

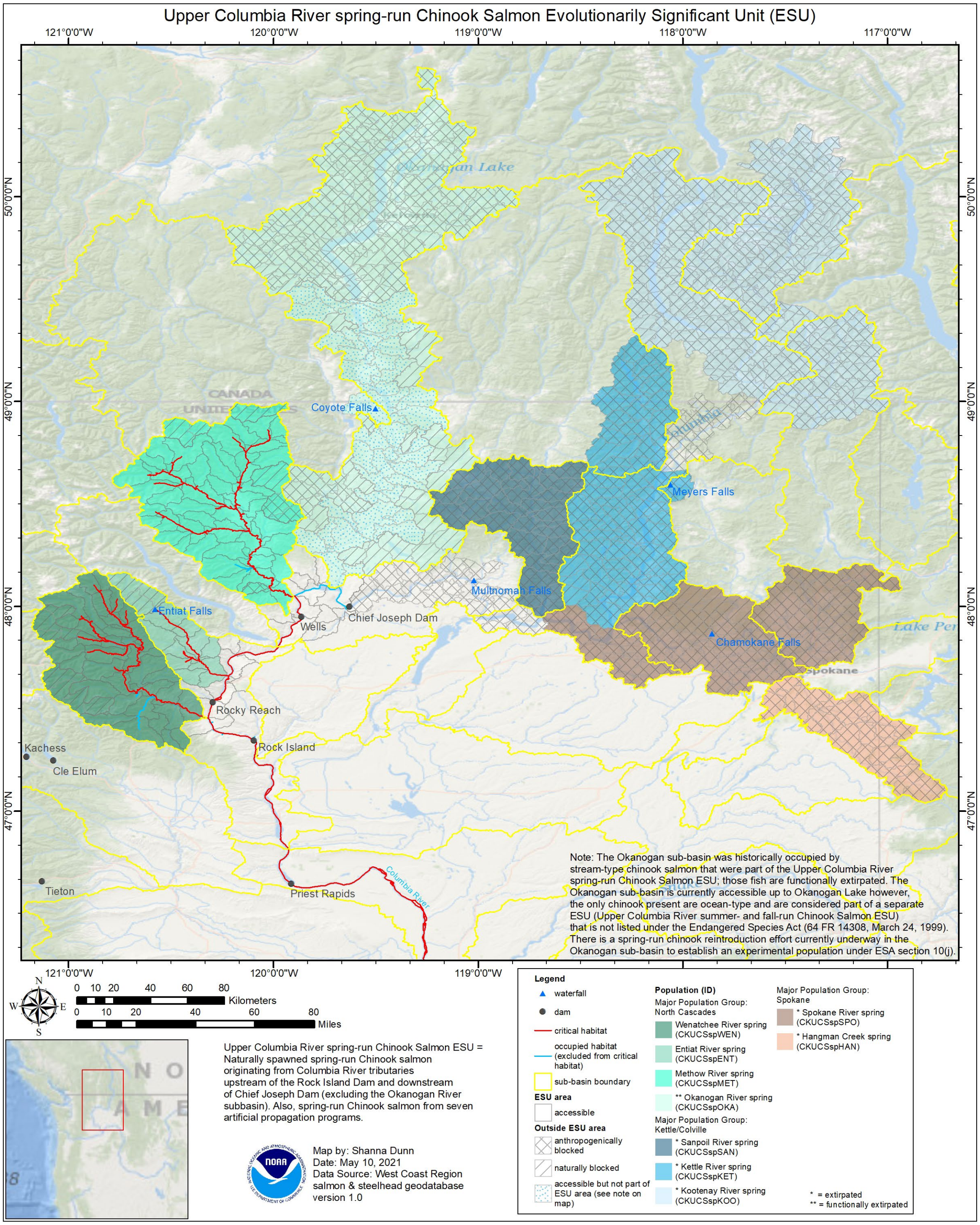

Figure 2. UCR Spring-run Chinook salmon population structure. [2]

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[2] Figure 2 generally shows the currently accessible and historically accessible areas for the UCR Spring-run Chinook salmon ESU. The areas displayed are consistent with the regulatory description of the range of the UCR Spring-run Chinook salmon found at 50 CFR17.11, 223.102, and 224.102. Actions outside the area shown can affect

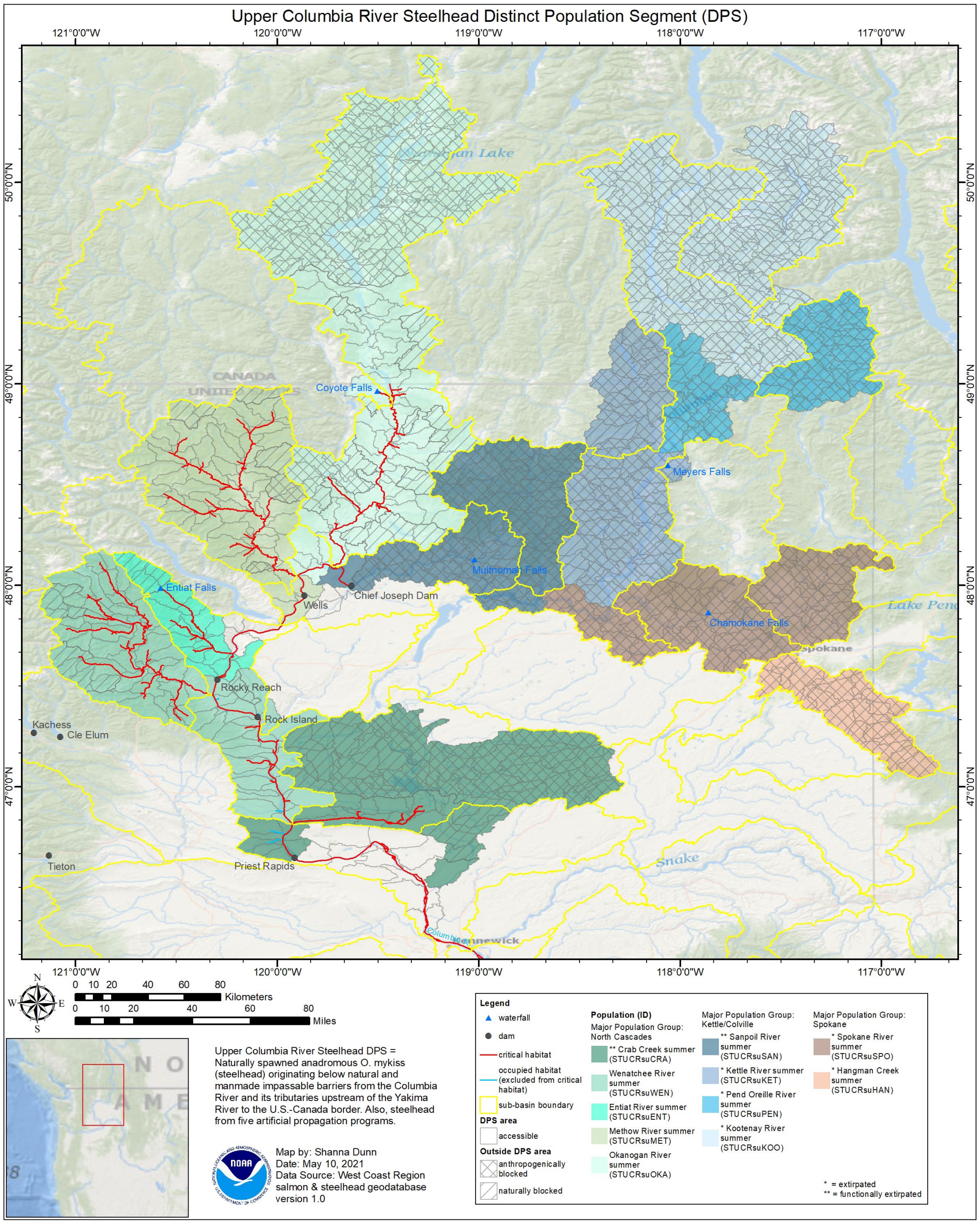

Figure 3. UCR steelhead population structure.[3]

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this ESU. Therefore, these areas 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.

[3] Figure 3 generally shows the currently accessible and historically accessible areas for the UCR steelhead DPS. The areas displayed are consistent with the regulatory description of the range of the UCR steelhead found at 50 CFR17.11, 223.102, and 224.102. Actions outside the area shown can affect this DPS. Therefore, these areas do not

2.3 Updated Information and Current Species' Status

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

Information provided in this section is summarized from Ford (2022) – Biological viability assessment update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest.

UCR Spring-run Chinook Salmon ESU

Updated Biological Risk Summary

All three populations in the UCR spring-run Chinook salmon ESU remain at high overall risk. Natural origin abundance has decreased over the levels reported in the prior review for all populations in this ESU, in many cases sharply. The abundance data for the entire ESU show a downward trend over the last 5 years, with the recent 5-year abundance levels for all three populations declining by an average of 48 percent. The consistent and sharp declines for all populations in the ESU are concerning. Relatively low ocean survivals in recent years were a major factor in recent abundance patterns.

Spatial structure and diversity ratings remain unchanged from the prior review and continue to be rated at low to moderate risk for spatial structure but at high risk for diversity criteria. Large-scale supplementation efforts in the Methow and Wenatchee Rivers are ongoing, intended to counter short-term demographic risks given current survival levels. Under the current recovery plan, habitat protection and restoration actions are being implemented that are directed at key limiting factors.

Given the high degree of year-to-year variability in life stage survivals and the time lags resulting from the 5-year life cycle of the populations, it is not possible to detect incremental gains from habitat actions implemented to date in population level measures of adult abundance or productivity. Efforts are underway to develop life stage specific estimates of performance (survival and capacities) and to use a life cycle model framework to evaluate progress (Zabel and Jordan 2020). Based on the information available for this review, the risk category for the UCR spring-run Chinook ESU remains unchanged from the prior review (NWFSC 2015). Although the recent decline of population abundances is concerning, each population remains well above the abundance levels of when they were listed. All three populations remain at high risk (Figure 4).

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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.

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

Figure 4. Upper Columbia River Spring Chinook Salmon ESU: North Cascades MPG population risk ratings integrated across the four VSP parameters. Viability key: Dark Green = highly viable; Green = viable; Orange = maintained; and Red = high risk (does not meet viability criteria) (Ford 2022, Table 5, p. 19).

UCR Steelhead DPS

Updated Biological Risk Summary

All four populations in the UCR steelhead DPS remain at high overall risk. Natural origin abundance has decreased over the levels reported in the prior review for all populations in this DPS, in many cases sharply. The abundance data for the entire DPS show a downward trend over the last 5 years, with the recent 5-year abundance levels for all four populations declining by an average of 48 percent. The consistent and sharp declines for all populations in the DPS are concerning. Relatively low ocean survivals in recent years were a major factor in recent abundance patterns.

Spatial structure ratings remain unchanged from the prior review and continue to be rated at low risk for the Wenatchee and Methow populations, moderate risk for the Entiat population, and high risk for the Okanogan population. The overall diversity ratings remain unchanged at high risk. The high risk ratings for diversity are largely driven by high levels of hatchery spawners within natural spawning areas and lack of genetic diversity among the populations. Under the current recovery plan, habitat protection and restoration actions are being implemented that are directed at key limiting factors.

Given the high degree of year-to-year variability in life stage survivals and the time lags resulting from the 5-year life cycle of the populations, it is not possible to detect incremental gains from habitat actions implemented to date in population level measures of adult abundance or productivity. Based on the information available for this review, the risk category for the UCR steelhead remains unchanged from the prior review (NWFSC 2015). Although, the recent decline of population abundances is concerning, each population remains well above the abundance levels of when they were listed. All four populations remain at high risk (Figure 5).

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

Figure 5. Upper Columbia River Steelhead DPS: North Cascades MPG population risk ratings integrated across the four VSP parameters. Viability key: Dark Green = highly viable; Green = viable; Orange = maintained; and Red = high risk (does not meet viability criteria) (Ford 2022, Table 9, p. 32).

2.3.2 ESA Listing Factor Analysis

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

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

Significant habitat restoration and protection actions at the Federal, state, and local levels have been implemented to improve habitat conditions and restore fish passage at specific locations. 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. Generally, it takes one to five decades to demonstrate such increases in viability. Meanwhile, system-wide habitat is affected by unfavorable water temperatures, inadequate volume, modified flow regimes, curtailed habitat complexity and reduced floodplain connectivity, degraded water quality, and poor riparian conditions. In the marine environment, climate change appears to be shifting sea temperatures, salinity, and acidity, each of which separately and in combination may be disruptive to prey species' presence and abundance. Climate concerns are addressed in *Listing Factor E: Other natural or manmade factors affecting its continued existence*.

In the 2020 Columbia River System (CRS) biological opinion (NMFS 2020b), NMFS concluded that while some degraded areas in the UCR spring-run Chinook salmon ESU and UCR steelhead DPS are likely improving because of restoration actions and improved land-use practices, in general tributary habitat conditions are still degraded through past and present anthropogenic activities (levees, water withdrawals, roads, dams, etc.). These degraded habitat conditions continue to negatively affect UCR spring-run Chinook salmon and UCR steelhead abundance, productivity, spatial structure, and diversity. In addition, ongoing development and land-use activities may also have negative effects into the foreseeable future.

The quality and quantity of habitat from freshwater tributaries to the mainstem Columbia, estuary, and ocean has a profound impact on the status of Upper Columbia salmon and steelhead populations. Within freshwater tributary habitat, numerous stream processes can affect the success of spawning and rearing of salmonids (UCSRB 2014). For all populations in the Upper Columbia, many factors have contributed to habitat degradation. The historic pattern of land use in the Upper Columbia Basin follows a familiar pattern for basins in the Pacific Northwest, including beaver trapping, mining, livestock grazing, water diversions, agriculture, and timber harvest activities, to name a few. These factors have reduced habitat diversity, connectivity, water quantity and quality, and riparian function in many assessment units within the basin. However, some of the assessment units contain headwater areas that remain in relatively pristine condition and serve as "strongholds" for listed species (UCRTT 2014). Since the last 5-year review there have been a few large-scale prioritization, planning, and monitoring efforts that are worth noting.

In 2019, the Upper Columbia Regional Technical Team and UCSRB started working together to update the regional Biological Strategy for prioritizing habitat actions (restoration and protection). Prioritization is a critical component of the Biological Strategy, which had its last major update in 2014. This strategy aims to provide a consistent, repeatable, systematic, and well-documented approach for prioritizing restoration and protection actions and locations for restoration and protection. This strategy was completed in 2021 and provides a transparent prioritization process that will assist restoration practitioners and managers with making decisions.

Between 2016 and 2019, the Cascade Columbia Fisheries Enhancement Group was awarded funding from Washington's Recreation and Conservation Office to complete a comprehensive assessment of potential fish passage barriers in the four anadromous subbasins of the Upper Columbia. As part of that project, they completed a prioritization of barriers based on recovery-based criteria. The UCSRB and Upper Columbia Regional Technical Team (UCRTT) developed a prioritization approach in 2018 for use across the region, and they subsequently updated this in 2020 (UCSRB 2020a).

There have been a number of new reach assessments completed since the last 5-year review. Reach assessments are rigorous evaluations of the current and historic geomorphic conditions of one or more valley segments (one or more reaches) within an individual stream. Reach assessment results provide a quantitative foundation for identifying appropriate strategies to improve or protect salmonid habitat and the data feeds directly into the biological strategy prioritization process. The new assessments include three in the Methow subbasin, one in the Wenatchee subbasin, and one in the Entiat subbasin. An additional reach assessment in Upper Nason Creek is in progress and will likely be completed in 2022. Reach assessments are summaries of information that provide a technical foundation for understanding existing conditions for the purpose of identifying appropriate restoration strategies to improve or protect aquatic habitat conditions. Reach assessments, in particular have played an important role in the region in helping to identify and develop projects and in providing the foundation of information used in the regional prioritization strategy.

The Colville Confederated Tribes (CCT) and ICF International (ICF) have collaboratively developed a habitat status and trend analysis and reporting tool for the Okanogan and Methow subbasins. This tool integrates the Ecosystem Diagnosis and Treatment Model (EDT) with quantitative habitat status and trend monitoring data collected by the Okanogan Basin Monitoring and Evaluation Program (OBMEP) (OBMEP 2021). The integrated platform uses quantitative and qualitative OBMEP habitat metrics to estimate habitat potential for salmon and steelhead at subbasin, watershed, and reach scales. These results allow for characterization of habitat status and trends in terms of the change over time in the ability of the habitat to support a species of interest. The data can work in concert with reach assessments or independently depending on the need and location. In the Okanogan subbasin, the CCT has completed three runs of EDT, with the last run occurring in 2017; a future run will occur in 2022 using data collected through 2021. In the Methow subbasin, CCT completed their initial run of EDT in 2014 and are finalizing the outputs of their next run, using data collected through 2020. Ongoing and long-term habitat status and trend monitoring with associated modeling provide critical information needed to assess tributary habitat changes over time, limiting factors, and guide future habitat restoration actions. In addition, the data collected feeds directly into the biological strategy prioritization process.

In recent years there has been renewed interest in removing Enloe Dam to provide upstream passage for anadromous fish in the Similkameen River. The dam has blocked upstream fish passage since it was completed in 1923 and has not produced electricity since 1958. In July 2019, the Federal Energy Regulatory Commission terminated the license for Enloe Dam. Dam removal would provide access to hundreds of miles of habitat for anadromous fish and restore riverine processes in a portion of the Similkameen River. In addition, this newly-accessible habitat would be more resilient to projected temperature increases linked to climate change. The benefits of dam removal to anadromous fish, including UCR steelhead and UCR spring-run Chinook, are expected to improve all viability parameters of both species including abundance, productivity, spatial structure, and diversity.

Over the course of the last decade, the Upper Columbia United Tribes (UCUT) have been pursuing and researching the feasibility of reintroducing anadromous species above Chief Joseph and Grand Coulee dams in the Columbia River. In 2019, the UCUT completed their Phase 1 report and published its findings. Phase 1 studies consisted of a reintroduction risk and donor stock assessment, multiple assessments of habitat availability and suitability, an evaluation of fish passage technologies at high-head dams, and life cycle modeling. Results from these studies indicate reintroduction could be successful based on current habitat conditions and currently available stocks of anadromous fish. In 2021, the UCUT released the draft Phase 2 Implementation Plan: Testing Feasibility of Reintroduced Salmon in the Upper Columbia River Basin. This report outlines the research needed and tools to be used for reintroduction including establishing the sources of salmon donor stocks, developing interim hatchery and passage facilities, and testing the key biological assumptions made in the Phase 1 report. The Phase 2 plan will be completed in a stepwise fashion over the next 20 years and separated into two main steps. The first step focuses on the collection of baseline information and the development of support programs and facilities. The second step focuses on the incremental design, build, and testing of fish passage facilities. The UCUT are early in the Phase 2 process, but over the next 5 years we look forward to better understanding what opportunities exist for anadromous fish in the blocked areas and if they can contribute the recovery of ESA-listed stocks.

The following section describes the tributary habitat for each MPG. Migration corridor habitat in the Columbia River is vitally important to both the UCR spring-run Chinook salmon ESU and UCR steelhead DPS and is addressed under *Listing Factor C (Disease and Predation) and Listing Factor D (Inadequacy of Regulatory Mechanisms: Columbia River System).*

Current Status and Trends in Habitat

Below, we summarize information for both UCR spring-run Chinook salmon and UCR steelhead populations to evaluate current status and trends in habitat conditions for these two species since our previous 2016 5-year review. We specifically address:

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

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

(3) population-specific key protective measures and major restoration actions taken since the 2016 5-year review toward achieving the recovery plan viability criteria established by the ICTRT (2007b) and adopted in the 2007 Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan (UCSRB 2007) as efforts that substantially address a key concern noted in **above #1 and #2**, or, that represent a noteworthy conservation strategy;

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

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

North Cascades MPG: Wenatchee River Salmon and Steelhead Populations

The Wenatchee River is unique among subbasins in the Upper Columbia Region in that it supports the greatest diversity of populations and overall abundance of salmonids. The basin has many major spawning areas for both spring-run Chinook salmon and steelhead (UCRTT 2014). Both spring-run Chinook salmon and steelhead spawn in five major spawning areas. While spring-run Chinook salmon have four minor spawning areas, and steelhead have 13 (ICTRT 2005).

1) Population-Specific Key Emergent or Ongoing Habitat Concerns Since the 2016 5-Year Review

As reported in the 2016 5-year review, the primary habitat conditions in the Wenatchee River subbasin that currently limit abundance, productivity, spatial structure, and diversity of salmon and steelhead include a lack of habitat diversity and quantity, excessive sediment load, obstructions, a lack of channel stability, low flows, and high summer water temperatures. Habitat diversity is affected by channel confinement, loss of floodplain connectivity and off-channel habitat, reduced quantities of large wood, and a lack of riparian vegetation. The mainstem and many of its tributaries also lack high-quality pools and spawning areas associated with pool tail-outs. The lack of pools in many areas is probably directly related to the loss of riparian vegetation, removal of large wood, and channel confinement (UCRTT 2014). Since the previous 2016 5-year review, the habitat concerns remain essentially unchanged for the Wenatchee River population. However, there is a better understanding of the importance of cold-water refuges to serve as critical holding areas for adult salmon prior to spawning.

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

Specific geographic areas of habitat concern include:

- Pre-spawning mortality of Wenatchee River spring-run Chinook salmon in the Nason, Upper Wenatchee, and Little Wenatchee Rivers.
- Impairment of tributary habitat-forming processes and functions from upland actions that influence channel structure, complexity, connectivity, and vegetation on Federal lands in the Little Wenatchee, Nason, Chiwawa, Icicle, Peshastin, Chumstick, and Mission watersheds.

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

The highest priorities within the North Cascades MPG Wenatchee subbasin are the restoration and protection of habitat that supports salmonid communities so that the populations are robust to environmental disturbances, can increase in abundance, and expand their range to adjacent watersheds. These high priority watersheds within the Wenatchee subbasin include the Chiwawa River, Lower Nason Creek, and the upper and middle mainstem Wenatchee River (UCRTT and UCSRB 2021).

The major population-specific protective measures and restoration actions taken within the Wenatchee River subbasin since the 2016 5-year review include:

Completion of the Chelan County Natural Resources Department's Nason Creek Upper White Pine Floodplain Restoration project in 2018. This project relocated Chelan Public Utility District (PUD) power lines out of the floodplain and removed ~0.5 mile of levee then re-located 0.5 miles of straightened mainstem into a reconstructed meander alignment and reconnected 27 acres of floodplain. The primary goal of the project was to improve and increase salmonid habitat in this important stretch of Nason Creek to increase the abundance and productivity of Wenatchee River spring-run Chinook salmon and steelhead populations (UCSRB 2019).

In June 2020, Trout Unlimited completed the Icicle Creek Boulder Fish Passage Project. The project allows Wenatchee River steelhead to access 23 miles of mainstem Icicle Creek habitat and dozens of miles of tributary habitat.

In June 2018, Western Rivers Conservancy purchased the 3,714 acre Nason Ridge property owned by Weyerhaeuser. This land will now be managed for the long-term health of the forest, Lake Wenatchee, and Nason Creek.

In 2019, Chelan Douglas Land Trust acquired 73 acres adjacent to Kahler Creek to maximize stream and riparian protection. The property includes one mile of frontage on Kahler Creek (both sides for 0.5 miles), an additional 0.3 miles on Nason Creek, and 0.2 miles of well-shaded side channel, which had, until 1995, been the main channel. This property adjoins the above noted 3,714-acre Nason Ridge property and completes protection of the entire 3.5 square mile Kahler Creek watershed from headwaters to mouth of Nason Creek (UCSRB 2020b).

4) Key Regulatory Measures Since the 2016 5-Year Review

The NMFS recovery plan (UCSRB 2007) and the previous 5-year review identified inadequate regulatory mechanisms as a priority issue affecting UCR spring-run Chinook salmon and UCR steelhead recovery in the North Cascades MPG. Various Federal, state, and county regulatory mechanisms are in place to minimize or avoid habitat degradation caused by human use and development. New information available since the last 5-year review indicates that the adequacy of a number of regulatory mechanisms has stayed the same on average, with some mechanisms showing the potential for some improvement while others have made it more challenging to protect and recover our species. See *Listing Factor D: Inadequacy of Regulatory Mechanisms* in this document for details.

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

The greatest opportunities to advance recovery of UCR spring-run Chinook salmon and UCR Steelhead in the Wenatchee subbasin through tributary habitat restoration include:

- Implement habitat restoration actions that address anthropogenic features limiting natural riverine processes (e.g., removal or modification of levees, roads, culverts, irrigation infrastructure, bank stabilization, etc.).
- Reduce road and stream interactions to restore aquatic habitat function, in-stream flow and sediment regimes, water quality, and biological functions (spawning, rearing, foraging, and migration) on Federal lands in the Little Wenatchee, Nason, Chiwawa, Icicle, Peshastin, and Mission watersheds.
- Protect and restore floodplain function and reconnection, off-channel habitat, and channel migration processes to increase juvenile rearing habitat.
- Address the importance of cold water refugia to salmon and steelhead by providing access to cold water tributaries, enhancing cold water habitat, and restoring natural hydrographs.
- Continue developing a life-cycle model for spring-run Chinook salmon and steelhead to help predict how habitat restoration, hatchery operations, predation, and hydropower management contribute to species recovery.

North Cascades MPG: Entiat River Salmon and Steelhead Populations

Entiat River spring-run Chinook salmon is a relatively small population with a simple spatial structure of one major spawning area and no minor spawning areas. Entiat River steelhead have two major spawning areas and three minor spawning areas (ICTRT 2005).

1) Population-Specific Key Emergent or Ongoing Habitat Concerns Since the 2016 5-Year Review

The primary habitat conditions in the Entiat Basin that currently limit abundance, productivity, spatial structure, and diversity of salmon and steelhead include stream channel configuration and complexity that has been reduced due to logging in the riparian zone, flood control measures that straightened the channel and removed large wood from the river channel. These historic and ongoing activities have led to a condition with low instream habitat diversity including few pools, lack of large wood accumulations, and disconnected side channels, wetlands, and floodplains. The result is a reduction in resting and rearing areas for both adult and juvenile salmon and steelhead throughout the Entiat River (UCRTT 2014). Since the previous 2016 5-year review, the habitat concerns remain essentially unchanged. However, there has been a focused effort to assess the impacts of summer-run Chinook salmon on spring-run Chinook salmon in the Entiat River. There have been observations of redd superimposition and hybridization between spring-run Chinook salmon and summer-run Chinook salmon. Additional studies and possible management actions may be warranted.

2) Population-Specific Geographic Areas of Habitat Concern Since the 2016 5-Year Review

Specific geographic areas of concern include:

- Habitat capacity for juvenile salmonids (particularly overwintering parr) with a focus on the upper portions of spring-run Chinook salmon distribution.
- Impairment of tributary habitat-forming processes and functions from upland actions that influence channel structure, complexity, connectivity, and vegetation, particularly Federal land road networks in the Upper Entiat and Mad River watersheds.

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

The highest priories within the Entiat subbasin are the restoration and protection of habitat that supports salmonid communities so that the populations are robust to environmental disturbances, can increase in abundance, and expand their range to adjacent watersheds. These high priority areas for restoration within the Entiat subbasin include the Middle Entiat Stillwater, Mad River, and Upper-Middle Entiat (Gray and Stormy) (UCRTT 2021; UCRTT and UCSRB 2021).

The major population-specific protective measures and restoration actions taken within the Entiat River subbasin since the 2016 5-year review include:

- In 2019 and 2020, multiple sponsors completed the Gray and Stormy projects that enhanced fish habitat along the Entiat River between river mile (RM) 16.2 and RM 20.1 through the construction of large wood structures and reestablishment of side channels (UCSRB 2020b).
- In 2018, the Yakama Nation and U.S. Forest Service (USFS) Entiat Ranger District reconnected both Tillicum Creek and the Mad River with the Tillicum Creek alluvial fan floodplain. The project created roughly 1,000 feet of new side channel habitat in the old sheep pasture on the alluvial fan, created new perennial side channels to the Mad River, extensively restored native riparian and floodplain vegetation on Tillicum fan, and incorporate new large wood structures into the Mad River and Tillicum Creek to create more complex bank margin habitat (Yakama Nation Fisheries 2019).
- Between 2016 and 2019, the Chelan-Douglas Land Trust acquired high-priority properties (Bremer, Stormy, Cottonwood, Bockoven, Enlow) in the Gray and Stormy reaches of the middle Entiat Stillwater reach that provides critical habitat for Entiat River spring-run Chinook salmon and steelhead, and bull trout. Completion of this project resulted in the protection of five properties including 94.5 acres of prime habitat with

1.18 miles of riverfront, permanently preventing degradation of existing habitat from development, facilitating restoration activities to enhance the habitat, and creating compatible public access and education activities (UCSRB 2018).

- In 2018, Trout Unlimited completed the Roaring Creek project replacing two surface water diversions and leaking delivery system with new groundwater wells. The work resulted in 1.5 cfs more instream flow in the lower 1.3 miles of Roaring Creek. The project benefits Entiat River steelhead adult holding and spawning and juvenile rearing to smoltification. Entiat River spring-run Chinook salmon juveniles will likely also benefit in the lower reaches of the stream (UCSRB 2019).

4) Key Regulatory Measures Since the 2016 5-Year Review

The NMFS recovery plan (UCSRB 2007) and the previous 5-year review identified inadequate regulatory mechanisms as a priority issue affecting UCR spring-run Chinook salmon and UCR steelhead recovery in the North Cascades MPG. Various Federal, state, and county regulatory mechanisms are in place to minimize or avoid habitat degradation caused by human use and development. New information available since the last 5-year review indicates that the adequacy of a number of regulatory mechanisms has stayed the same on average, with some mechanisms showing the potential for some improvement while others have made it more challenging to protect and recover our species. See *Listing Factor D: Inadequacy of Regulatory Mechanisms* in this document for details.

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

- The greatest opportunities to advance recovery of UCR spring-run Chinook salmon and UCR Steelhead in the Entiat subbasin through tributary habitat restoration include:
- Implement habitat restoration actions that address anthropogenic features limiting natural riverine processes (e.g., removal or modification of levees, roads, culverts, irrigation infrastructure, bank stabilization, etc.).
- Reduce road and stream interactions to restore aquatic habitat function, in-stream flow and sediment regimes, water quality, and biological functions (spawning, rearing, foraging, and migration) on Federal lands in the Upper Entiat and Mad River watersheds.
- Continue developing a life-cycle model for spring-run Chinook salmon and steelhead to help predict how habitat restoration, hatchery operations, predation, and hydropower management contribute to species recovery.
- Gain a better understanding of the spring-run Chinook salmon and summer-run Chinook salmon interactions including spawning bed imposition and juvenile competition.

North Cascades MPG: Methow River Salmon and Steelhead Populations

The ICTRT classified the Methow River spring-run Chinook salmon population as “very large” in size based on historic habitat potential. They also identified four major spawning areas and one minor spawning area for the Methow River spring-run Chinook salmon population, and four major and eight minor spawning areas for the Methow River summer steelhead population (ICTRT 2005).

1) Population-Specific Key Emergent or Ongoing Habitat Concerns Since the 2016 5-Year Review

The Methow River has a high proportion of pristine habitat in the upper portions of major tributaries. The primary habitat conditions in the Methow Basin that currently limit abundance, productivity, spatial structure, and diversity of salmon and steelhead are mostly found in the middle and lower mainstem and lower portions of major tributaries that have been affected by state highways, county roads, and residential and agricultural development that have diminished the overall function of the stream channel and floodplain. This has impaired stream complexity, wood and gravel recruitment, floodwater retention, and water quality. Additionally, late summer and winter instream flow conditions often reduce migration, spawning, and rearing habitat for salmonids. This problem is partly natural (a result of watershed-specific weather and geomorphic conditions) but is exacerbated by irrigation withdrawals (UCSRB 2014b). The most widespread ecological concerns in the subbasin (by occurrence in assessment units) are riparian condition, bed and channel form, decreased water quality, and instream structural complexity (UCSRB 2014b). Since the previous 2016 5-year review, the habitat concerns remain essentially unchanged.

2) Population-Specific Geographic Areas of Habitat Concern Since the 2016 5-Year Review

Specific geographic areas of habitat concern include:

- Impairment of tributary habitat-forming processes and functions from upland actions that influence channel structure, complexity, connectivity, and vegetation, caused by Federal land road networks in the Chewuch River, Twisp River, and Beaver Creek watersheds.
- Two fish passage barriers in the Chewuch River watershed that include the road created passage barrier at river mile 1.7 on Eightmile Creek and a road ford on Twenty-mile Creek.

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

The highest priority within the Methow subbasin is the protection of habitat that supports robust spring Chinook and steelhead populations that have the capacity to be resilient to environmental disturbances, can increase in abundance, and expand their range to adjacent watersheds. Priority watersheds to protect within the Methow Subbasin are the Lost, Twisp, Chewuch, Upper and Middle Methow Rivers, and Early Winters Creek (UCSRB 2014b).

The major population-specific protective measures and restoration actions taken within the Methow River subbasin since the 2016 5-year review include:

- In 2018, The Yakama Nation completed the Chewuch River Mile (RM) 15.5 to 20 Fish Enhancement Project designed to: (1) protect existing areas where high ecological integrity and natural ecosystem processes persist; (2) increase habitat diversity by adding instream structures where appropriate to initiate a more natural process; and (3) protect and restore riparian habitat along spawning/rearing areas and identify long-term opportunities for riparian habitat enhancement. To achieve these goals, the Yakama Nation installed log jams along 4.5 miles of stream to create pools and complex habitat for juvenile Methow River spring-run Chinook salmon and steelhead (Yakama Nation Fisheries 2019).
- In 2020, Trout Unlimited completed the Barkley Irrigation Efficiency Project to improve instream flow in the Methow River. Although the amount of instream flow addition will vary as a result of the on-demand design, it will include 26 cfs protected in the Methow River. In addition to the instream flow improvement components, there have been significant benefits which include a reduction in mortality by eliminating the annual construction of the Barkley push-up dam, diversion channel maintenance, and the juvenile stranding ditch between intake and screen.
- In July 2019, the Methow Salmon Recovery Foundation completed the Twisp River Floodplain Restoration Phase II project at approximately RM 4 of the Lower Twisp River. This project expanded the successes of the phase 1 project completed in 2016. Both phases were designed to reconnect floodplain and off-channel habitats to improve rearing conditions for juvenile spring-run Chinook salmon and steelhead. The Phase II project: (1) constructed an alcove at the outlet of an intermittent side channel; (2) connected an existing off-channel pond with the Twisp River; (3) removed an additional portion of the Methow Valley Irrigation District West levee; (4) constructed an alcove feature at the outlet of Estes Creek, a perennial spring-fed tributary to the Twisp River; (5) replaced an undersized culvert over Estes Creek; and (6) planted 0.64 acres of native riparian forest (UCSRB 2020b).

4) Key Regulatory Measures Since the 2016 5-Year Review

The NMFS recovery plan (UCSRB 2007) and the previous 5-year review identified inadequate regulatory mechanisms as a priority issue affecting UCR spring-run Chinook salmon and UCR steelhead recovery in the North Cascades MPG. Various Federal, state, and county regulatory mechanisms are in place to minimize or avoid habitat degradation caused by human use and development. New information available since the last 5-year review indicates that the adequacy of a number of regulatory mechanisms has stayed the same on average, with some mechanisms showing the potential for some improvement while others have made it more challenging to protect and recover our species. See *Listing Factor D: Inadequacy of Regulatory Mechanisms* in this document for details.

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

- The greatest opportunities to advance recovery of UCR spring-run Chinook salmon and UCR steelhead in the Methow subbasin through tributary habitat restoration include:
- Implement habitat restoration actions that address anthropogenic features limiting natural riverine processes (e.g., removal or modification of levees, roads, culverts, irrigation infrastructure, bank stabilization, etc.).
- Reduce road and stream interactions to restore aquatic habitat function, in-stream flow and sediment regimes, water quality, and biological functions (spawning, rearing, foraging, and migration) through significant reductions of the road system network on Federal lands focusing in the Chewuch and Twisp River watersheds.
- Restore fish passage in Eightmile Creek and Twenty-mile Creek, tributaries to the Chewuch River.
- Continue developing a life-cycle model for spring-run Chinook salmon and steelhead to help predict how habitat restoration, hatchery operations, predation, and hydropower management contribute to species recovery.

North Cascades MPG: Okanogan River Steelhead Populations

The Okanogan/Similkameen is the largest and most complex subbasin in the region (UCSRB 2014b). The ICTRT identified 10 major and 24 minor spawning areas for the Okanogan summer steelhead population. However, only two major and five minor spawning areas are within the U.S. portion of the subbasin (ICTRT 2005). Thirteen watersheds see regular use by spawning summer steelhead (Loup Loup, Omak, Salmon, Johnson, Bonaparte, Antione, Tonasket and Ninemile Creeks). The mainstem Okanogan and Similkameen Rivers are regularly used by hatchery summer steelhead for spawning, but their offspring rarely contribute to natural origin returns due to poor incubation success from rapidly warming spring water temperatures (Okanogan River) and bed scouring (Similkameen River).

1) Population Specific Key Emergent or Ongoing Habitat Concerns Since the 2016 5-Year Review

In the Okanogan River Basin warm summer temperatures push restoration priorities into tributary streams that provide cooler stream temperatures. Barriers, fine sediments, poor water quality, and low late-summer instream flows (mainstem and tributary) historically limited the survival, distribution, and productivity of steelhead, and continue to do so today. The habitat concerns since the previous 2016 5-year review remain essentially unchanged. However, the importance of cold water refugia for steelhead in the Okanogan River and its tributaries has become more pronounced. Transboundary planning and implementation are ongoing and critical because more than half of the subbasin is within British Columbia (UCSRB 2014b), although, in recent years the majority of summer steelhead are produced in the United States portion of this subbasin.

2) Population-Specific Geographic Areas of Habitat Concern Since the 2016 5-Year Review

Specific geographic areas of concern include:

- Low instream flow levels, elevated water temperatures, and barriers particularly in Salmon Creek, Omak Creek, Antoine Creek, and Johnson Creek.
- Impairment of tributary habitat-forming processes and functions from upland actions that influence channel structure, complexity, connectivity, and vegetation. Particularly from large scale wildfires over the last decade, levee infrastructure, the road network in Loup Loup Creek, Omak Creek, Johnson Creek, and Salmon Creek watersheds.
- Concerns with fish passage and entrainment at the U.S. Bureau of Reclamation and Okanogan Irrigation District fish screen, diversion structure, and fishway in Salmon Creek.
- Juvenile rearing habitat in lower tributaries and winter rearing in the mainstem Okanogan River that provide complex channel structure, floodplain connectivity, and forage.
- High stream temperatures in the Okanogan River.

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

Restoration actions in the Okanogan River MPG since the previous 2016 5-year review have included action items both in the United States and Canada such as the additional improvement of passage over Canadian dams and into tributary habitat. The Colville Confederated Tribes and others have continued restoring tributary habitat in the Okanogan through projects in Salmon Creek, Johnson Creek, large wood projects, and numerous land acquisitions (UCSRB 2020b; OBMEP 2021).

Additional population-specific key protective measures and restoration actions taken in the Okanogan River subbasin since the 2016 5-year review are listed below:

- In 2018, the BPA and CCT constructed a new irrigation diversion structure on the North Fork of Salmon Creek and installation of culverts capable of delivering increased flow (up to 70 cfs) under the Salmon Creek road to the existing Salmon Lake Feeder piping system (a tributary to the Okanogan River). This will allow increased storage in Salmon Lake which will supplement instream flows in Salmon Creek and all year-round rearing and overwintering of steelhead (UCSRB 2019).
- In 2019 and 2020, the Washington State Department of Transportation and CCT replaced multiple culverts and upgraded diversion structures throughout Johnson Creek to improve flows and fish passage (Washington State Recreation and Conservation Office 2019).
- In 2019, the U.S. Bureau of Reclamation, CCT, and Okanogan Irrigation District (OID) agreed to provide perennial flows in Salmon Creek that re-established flow downstream

of the irrigation diversion dam, allowing access to quality spawning and rearing habitat for summer steelhead.

- In 2020, the Washington Department of Ecology and CCT signed an agreement for the acquisition of land and water rights to Antoine Creek including Fancher Dam clearing the way for improved water management to improve seasonal access for spawning summer steelhead and operational flexibility to maximize juvenile rearing flows.
- Since 2015, the Okanagan Nation Alliance and others have made both passage improvements at dams and improved spawning beds in the Canadian portion of the Okanogan River for salmon and steelhead. These include ongoing improvements at McIntyre Dam, Skaha Lake Dam, and in 2019 passage at Penticton Dam. Other restoration activities enhanced spawning beds in the Penticton River Channel and provided access to side channel habitat.

4) Key Regulatory Measures Since the 2016 5-Year Review

The NMFS recovery plan (UCSRB 2007) and the previous 5-year review identified inadequate regulatory mechanisms as a priority issue affecting UCR spring-run Chinook salmon and UCR steelhead recovery in the North Cascades MPG. Various Federal, state, and county regulatory mechanisms are in place to minimize or avoid habitat degradation caused by human use and development. New information available since the last 5-year review indicates that the adequacy of a number of regulatory mechanisms has stayed the same on average, with some mechanisms showing the potential for some improvement while others have made it more challenging to protect and recover our species. See *Listing Factor D: Inadequacy of Regulatory Mechanisms* in this document for details.

5) Recommended Future Recovery Actions over the Next 5 Years Toward Achieving Population Viability

The greatest opportunities to advance recovery of UCR steelhead in the Okanogan subbasin through tributary habitat restoration include:

- Protect and restore floodplain function and reconnection, off-channel habitat, and channel migration processes to increase juvenile rearing habitat through implementation of habitat restoration actions.
- Restore access to anadromous salmon and steelhead habitat in the Similkameen River above Enloe Dam.
- Address the importance of cold water refugia to steelhead by providing access to cold water tributaries, enhancing cold water habitat, and restoring natural hydrographs.
- Finalize and implement a long-term agreement between U.S. Bureau of Reclamation, OID, and CCT to maintain perennial stream flow in the lower 4.3 miles of Salmon Creek.

- Increase storage capacity in the Salmon Creek sub-watershed by expanding Salmon Lake storage. This increase in storage would provide more flow in Salmon Creek and provide additional management flexibility for fish flows and irrigators.
- Address issues relating to the fish screen, diversion structure, and fishway in Salmon Creek.
- Reduce road and stream interactions to restore aquatic habitat function, in-stream flow and sediment regimes, water quality, and biological functions (spawning, rearing, foraging and migration) through significant reductions of the road system network on Tribal, Washington State Department of Natural Resources, and Bureau of Land Management (BLM) lands focusing on the Omak, Loup, and Antoine Creek subwatersheds.
- Address the effects of past large fires throughout the Okanogan River Basin to reduce fine sediment inputs, protect against flash flooding and landslides, enhance complexity, reduce incision, and restore floodplain structure and function.
- Continue to implement and improve the CCT's Okanogan Basin Monitoring and Evaluation Program (OBMEP) that provides ongoing and long-term habitat status and trend monitoring and the associated modeling and reporting tools.

Listing Factor A Conclusion

Despite significant efforts to improve habitat conditions, much of the habitat in the range of UCR spring-run Chinook salmon and UCR steelhead remains degraded. Restoring habitat to historic conditions may not be needed to attain viability, but considerable improvement is needed to restore habitat to levels that will support viable populations of both UCR steelhead and spring-run Chinook salmon. There are significant opportunities to improve habitat conditions in the Okanogan, Methow, Entiat, and Wenatchee River watersheds.

New information available since the last 5-year review indicates that many restoration and protection actions have been implemented in freshwater tributary habitat, but those actions do not change overall trends in habitat quality, quantity, and function. We remain concerned with habitat conditions throughout the range of the UCR steelhead DPS and UCR spring-run Chinook salmon ESU, particularly with regard to water quality, water quantity, riparian condition, and floodplain function. We therefore conclude that the risk to the species' persistence because of habitat destruction or modification remains high and has not changed since the previous 2016 5-year review.

Continued large-scale watershed and stream habitat restoration remains a key component of recovering this UCR spring-run Chinook salmon and UCR steelhead. Important considerations for tributary habitat restoration over the next 5 years include:

- Prioritize projects that improve habitat resiliency to climate change. Actions to restore riparian vegetation, streamflow, and floodplain connectivity and to re-aggrade incised stream channels can ameliorate temperature increases, base flow decreases, and peak flow increases, and thereby improve population resilience to certain effects of climate change (Beechie et al. 2013).

- Support and enhance local- to basin-scale frameworks to guide and prioritize habitat restoration actions and integrate a landscape perspective into decision making.
- Implement habitat restoration at a watershed scale. Roni et al. (2010) found that, for a watershed, at least 20 percent of floodplain and in-channel habitat in a watershed need to be restored to see a 25 percent increase in salmon smolt production. Most watersheds occupied by this species have not yet reached that level of floodplain and habitat restoration.
- Reconnect stream channels with their floodplains. Reintroducing beaver (Pollock et al. 2017) and low-tech process-based methods (Wheaton et al. 2019) will facilitate widespread, low-cost floodplain restoration across larger areas, increasing the productivity of freshwater habitat for Chinook salmon and steelhead.
- Implement habitat improvement actions consistent with best practices for watershed restoration (see, e.g., Beechie et al. 2010; Hillman et al. 2015; Appendix A of NMFS 2020b).

This conclusion for Listing Factor A applies to tributary habitat for the UCR spring-run Chinook salmon ESU and UCR steelhead DPS. Migration habitat conditions in the Columbia River are crucial to the status and recovery of both species. We discuss and evaluate current migration corridor habitat conditions under *Listing Factor C (Disease and Predation) and Listing Factor D (Inadequacy of Regulatory Mechanisms: Columbia River System)*.

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

Harvest

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

Upper Columbia River Spring-run Chinook Salmon

Contributions of UCR spring-run Chinook salmon are considered negligible in Pacific Fishery Management Council (PFMC) fisheries, and NMFS has determined that these fisheries are not likely to jeopardize the ESU (PFMC 2016; Thom 2020). UCR spring-run Chinook salmon are encountered in fisheries in the Columbia River and some tributaries. The majority of the harvest-related impacts occur in Columbia River fisheries. These fisheries are limited to an incidental take of 5.5 to 17 percent (depending on run size) of UCR spring-run Chinook salmon returning to the Columbia River mouth (NMFS 2018). Actual incidental take has remained the same since the last 5-year review and averaged 11 percent for the years 2014-2019 (TAC 2015, 2016, 2017, 2018, 2019, 2020).

Upper Columbia River Steelhead

Steelhead encounters in the ocean are rare and incidental impacts to steelhead in ocean fisheries targeting other species are inconsequential (low hundreds of fish each year) to very rare (PFMC 2020). The majority of harvest on UCR steelhead occurs in the mainstem Columbia River. Non-treaty fisheries in the Columbia River are limited to an incidental take of 2 percent during the combined winter, spring, summer period 2 percent during the fall management period (NMFS 2018). Overall, impacts on UCR steelhead have remained the same or declined since the last 5-year review. Impacts in non-treaty fisheries have averaged 0.57 percent and 1.28 percent for the winter/spring/summer and fall management periods, respectively during the years 2014-2019 (TAC 2015, 2016, 2017, 2018, 2019, 2020). There are no specific limits for impacts in treaty fisheries for UCR steelhead but harvest rates have remained the same since the last 5-year review and are not expected to change under the 2018 Management Agreement (NMFS 2018).

Scientific Research and Monitoring

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

Any time we seek to issue a permit for scientific research, we consult on the effects that the proposed work would have on each listed species' natural- and hatchery-origin components. However, because research has never been identified as a threat or a limiting factor for any listed species, and because most hatchery fish are considered excess to their species' recovery needs, examining the quantity of hatchery fish taken for scientific research would not inform our analysis of the threats to a species' recovery. Therefore, we only discuss the research-associated take of naturally produced fish in these sections. From 2015 through 2019, researchers were approved to take a yearly average of fewer than 360 adult (<20 lethally) and fewer than 14,700 juvenile (<460 lethally) UCR Chinook salmon. During the same period, researchers were approved to take a yearly average of fewer than 370 adult (<15 lethally) and fewer than 27,700 juvenile (<720 lethally) UCR steelhead (NMFS APPS database; https://apps.nmfs.noaa.gov/).

For the vast majority of scientific research permits, history has shown that researchers generally take far fewer salmonids than the number authorized every year. From 2015 through 2019, actual yearly reported take averaged fewer than 15 adults (one or zero lethally) for both UCR Chinook salmon and UCR steelhead. During that same period, the yearly average reported juvenile take was fewer than 2,300 (<16 lethally) for UCR Chinook salmon and fewer than 2,600 (<22 lethally) for UCR steelhead on average per year.

The majority of the requested research take for juvenile UCR Chinook salmon and steelhead has been (and is expected to continue to be) capture via screw traps, electrofishing units, beach seines, weirs, and hook and line angling, with smaller numbers being captured via other seines and nets. Adult take from both species has primarily been (and is expected to continue to be) requested as capture via adult fish facilities and weirs, with smaller numbers being captured by hook and line sampling and other methods intended to target juveniles (NMFS APPS database; https://apps.nmfs.noaa.gov/). Our records indicate that mortality rates for screw traps are typically less than one percent and rates for backpack electrofishing are typically less than three percent. Unintentional mortality rates from seining, handling at weirs and fish facilities, and hook and line methods are also limited to no more than three percent.

Expanded requests for research over the past 5 years resulted in increases in the amount of take authorized for both species compared to the prior 5 years. The total take authorized for naturally produced adults and juveniles from 2015 through 2019 was 44 percent higher for UCR Chinook salmon and 132 percent higher for UCR steelhead than the total take authorized from 2010 to 2014. Actual numbers of reported total take (non-lethal and lethal) from 2015 through 2019 also increased (UCR Chinook salmon more than doubled and UCR steelhead by 38 percent). However, reported lethal take actually decreased (reduced by 30 percent for UCR steelhead and by 46 percent for UCR Chinook salmon), as researchers caused even fewer mortalities than anticipated relative to the number of fish handled compared to the prior 5 years.

Overall, research impacts remain minimal due to the low mortality rates authorized under research permits and the fact that research is spread out geographically throughout the Upper Columbia River Basin. In addition, and because the mortality rates for both species have decreased while authorized take levels have increased, we conclude that the risk to the species' persistence because of utilization related to scientific studies remains essentially unchanged since the last 5-year review (NMFS 2016c).

Listing Factor B Conclusion

New information available since the last ESA 5-year review indicates harvest impacts have remained relatively constant (TAC 2015, 2016, 2017, 2018, 2019, 2020).

Scientific research impacts authorized through the West Coast Region have remained relatively unchanged (non-lethal impacts increased while lethal impacts decreased) compared to the past 5 years (NMFS APPS database; https://apps.nmfs.noaa.gov/). Impacts from these sources of mortality are still not considered to be major limiting factors for this ESU or DPS. The risk to the species' persistence because of overutilization remains essentially unchanged since the 2016 5-year review with harvest and research/monitoring sources of mortality slowing down the rate of recovery for the UCR spring-run Chinook salmon ESU and UCR steelhead DPS.

2.3.2.3 Listing Factor C: Disease and Predation

Disease

Disease rates over the past 5 years are believed to be consistent with the previous review period. Climate change impacts such as increasing temperature likely increase susceptibility to diseases. For the 2016 5-year review (NMFS 2016c), we reported the spread of a new strain (i.e., M clade) of infectious hematopoietic necrosis virus (IHNV) along the Pacific coast that may increase disease-related concerns for Upper Columbia River salmon and steelhead in the future. Since then, the M clade of IHNV has not appeared in Upper Columbia River stocks and does not appear to pose an additional risk to the ESU (Linda Rhodes, NWFSC, email sent to J. Yeager, NMFS, August 6, 2021, regarding IHNV status).

Overall, projections for increasing water temperatures across the species range, the possibility of increased disease prevalence, and an associated increase in salmon and steelhead susceptibility to disease when in warmer water presents a potential increasing risk to the species since the prior review period.

Avian Predation

Avian predation in the lower Columbia River estuary

Piscivorous colonial waterbirds, especially terns, cormorants, and gulls, are having a significant impact on the survival of juvenile salmonids (including UCR spring-run Chinook salmon and UCR steelhead) in the Columbia River. Caspian terns on Rice Island, an artificial dredged-material disposal island in the estuary, consumed about 5.4 to 14.2 million juveniles per year in 1997 and 1998, or 5 to 15 percent of all the smolts reaching the estuary (Roby et al. 2017). Efforts began in 1999 to relocate the tern colony 13 miles closer to the ocean at East Sand Island, where marine forage fish were available to diversify the terns' diet. Roby et al. (2017) estimated that terns on East Sand Island consumed an average of 5.1 million smolts per year, a 59 percent reduction from when the colony was on Rice Island.

UCR Chinook

Based on PIT-tag recoveries at East Sand Island, average annual tern and cormorant predation rates for this ESU were about 4.3 percent before efforts to manage the size of this colony (Roby et al. 2021). Tern predation rates have decreased to 1.9 percent since 2007, a statistically credible difference. This improvement was offset to an unknown degree by about 1,000 terns trying to nest on Rice Island in 2017 (Evans et al. 2018) and smaller numbers roosting or trying to nest on Rice, Miller, and Pillar Islands in 2018 and 2019 (Harper and Collis 2018; USACE 2019).

Before the management plan for double-crested cormorants was first implemented, the vast majority of those in the Columbia River estuary nested on East Sand Island. The average annual predation rate by this colony on UCR spring-run Chinook salmon in 2003 to 2014 was 3.8 percent. Starting in 2016, however, cormorants did not establish a nesting colony throughout the entire peak of the smolt outmigration period (April to June). Instead, large numbers of birds dispersed from East Sand Island to other locations, especially the Astoria-Megler Bridge, where smolts are likely to constitute a larger proportion of the cormorants' diet. The average annual predation rate on UCR spring-run Chinook salmon reported by Lawes et al. (2021) for the East Sand Island cormorant colony during the two post-management periods was 4.1 during 2015 to 2017 and 0.6 percent in 2018.

<u>UCR Steelhead</u>

Based on PIT-tag recoveries at East Sand Island, average annual tern predation rates for this DPS were about 17.2 percent before efforts to manage the size of this colony (Roby et al. 2021). Tern predation rates have decreased to 11.0 percent since 2007, a statistically credible difference. This improvement was offset to an unknown degree by about 1,000 terns trying to nest on Rice Island in 2017 (Evans et al. 2018) and smaller numbers roosting or trying to nest on Rice, Miller, and Pillar Islands in 2018 and 2019 (Harper and Collis 2018; USACE 2019).

Before the management plan for double-crested cormorants was first implemented, the vast majority of those in the Columbia River estuary nested on East Sand Island. The average annual predation rate by cormorants on the East Sand Island colony on UCR steelhead in 2003 to 2014 was 6.3, but smolts are now likely to constitute a larger proportion of the diet, implying higher predation rates, for cormorants nesting on the Astoria-Megler Bridge. The average annual predation rates on UCR steelhead reported by Lawes et al. (2021) for the East Sand Island cormorant colony during the two post-management periods was 5.8 during 2015 to 2017 and 0.7 percent in 2018.

Avian predation in the mainstem Columbia

Both UCR spring-run Chinook salmon and UCR steelhead survival is affected in the mainstem by avian predators that forage at the mainstem dams and in the reservoirs. The 2008 Federal Columbia River Power System biological opinion required that the Action Agencies implement avian predation control measures to increase survival of juvenile salmonids in the lower Snake and Columbia Rivers through effective monitoring, hazing, and deterrents at each project. All CRS projects have been using several effective strategies, including wire arrays that crisscross the tailrace areas, spike strips along the concrete, water sprinklers at juvenile bypass outfalls, pyrotechnics, propane cannons, and limited amounts of lethal take. Zorich et al. (2012) estimated that, compared to the numbers of smolts consumed at John Day Dam in 2009 and 2010, 84 to 94 percent fewer smolts were consumed by gulls in 2011. At The Dalles Dam, 81 percent fewer smolts were consumed in 2011 than in 2010. Zorich et al. (2012) attribute the observed changes in predation rates between years to variation in the number of foraging gulls but imply that deterrence activities provide some (unquantifiable) level of protection.

Juvenile UCR spring-run Chinook salmon and UCR steelhead migrating downstream are also vulnerable to predation by terns nesting in the interior Columbia plateau, including colonies on islands in McNary Reservoir, in the Hanford Reach, and in Potholes Reservoir. The objective of the Inland Avian Predation Management Plan (IAPMP) (USACE 2014) is to reduce predation rate to less than 2 percent per listed ESU/DPS per tern colony per year. The primary management activities have been focused on keeping terns from nesting on Goose Island in Potholes Reservoir (managed by Reclamation) and on Crescent Island in McNary Reservoir (managed by the Corps) using passive dissuasion, hazing, and revegetation. The Corps has been successful at preventing terns from nesting on Crescent Island since 2015, and similar efforts by Reclamation are in progress at Goose Island.

Predation rates on the UCR spring-run Chinook salmon were 2.5 percent for terns on Goose Island before implementation of the IAPMP, were reduced to less than 0.1 percent (predation rates for terns on Crescent Island and North Potholes Island are less than 0.1 percent) (Collis et al. 2021). Predation rates on the UCR steelhead DPS, which were 15.7 percent for terns on Goose Island, 4.1 percent on North Potholes Island, and 2.5 percent on Crescent Island before implementation of the IAPMP, were reduced to less than 0.1 percent at each site (Collis et al. 2021). However, movement of terns to Blalock Islands in John Day Reservoir increased predation rates on UCR spring-run Chinook salmon and UCR steelhead from less than 0.1 and 0.5 percent to 0.8 percent and 4.5 percent, respectively, reducing any net gain in the likelihood of survival.

Predation by gulls was not considered to warrant management actions at the time the IAPMP was developed, and there are no regional plans to manage these colonies. PIT-tag recoveries indicate that predation rates on smolts from this ESU/DPS by gulls on Miller Rocks averaged 2.1 percent and 8.2 percent during 2007 to 2019 (Cramer et al. 2021). Predation rates on UCR spring-run Chinook salmon were less than 2 percent per colony for gulls nesting on Island 20, Badger, and Crescent Islands in recent years (Cramer et al. 2021). Predation rates on UCR steelhead have averaged more than 2 percent per colony for gulls nesting on Island 20 (4.1 percent), Badger Island (5 percent), Crescent Island (5.8 percent), and the Blalock Islands (3.9 percent) in recent years (Cramer et al. 2021).

Marine Mammal Predation

The four main marine mammal predators of salmonids in the eastern Pacific Ocean are California sea lions (*Zalophus californianus*), and Steller sea lions (*Eumetopias jubatus*), harbor seals (*Phoca vitulina richardii*), and fish-eating killer whales (*Orcinus orca*).

Recent research over the past 5 years suggests that predation pressure on ESA-listed salmon and steelhead from seals, sea lions, and killer whales has been increasing in the northeastern Pacific over the past few decades (Chasco et al. 2017a, 2017b). Models developed by Chasco et al. (2017a) estimate that consumption of Chinook salmon in the eastern Pacific Ocean by three species of seals and sea lions and fish-eating (Resident) killer whales may have increased from 5 to 31.5 million individual salmon of varying ages since the 1970s, even as fishery harvest of Chinook salmon has declined during the same time period (Marshall et al. 2015; Chasco et al. 2017a; Ohlberger 2019). This same modeling suggests that these increasing trends have continued across all regions of the northeastern Pacific over the past 5 years. The potential predation impacts of specific marine mammal predators of ESA-listed salmonids on the West Coast are discussed individually below.

Pinnipeds (Seals and Sea Lions)

The three main seal and sea lion (pinniped) predators of ESA-listed salmonids in the eastern Pacific Ocean are California sea lions, Steller sea lions, and harbor seals. With the passing of the Marine Mammal Protection Act (MMPA) in 1972, these pinniped stocks along the West Coast of the United States have steadily increased in abundance (Carretta et al. 2019). With their increasing numbers and expanded geographical range marine mammals are consuming more Pacific salmon and steelhead, and some are having an adverse impact on some ESA-listed species (Marshall et al. 2015; Thomas et al. 2016; Chasco et al. 2017a).

For the UCR spring-run Chinook salmon ESU, the highest risk from pinnipeds comes from sea lions in the Lower Columbia River consuming adult Chinook as they enter the river and begin their upstream migration. Predation occurs in concentrated areas such as directly below Bonneville Dam, but also occurs at more dispersed levels throughout the lower Columbia River (Rub et al. 2019). Figure 6 shows a marked increase in the estimated numbers of California sea lions at East Mooring Basin, Astoria, Oregon, in the Lower Columbia River, starting in 2013, compared to previous years. Over the past 5 years at East Mooring Basin there were 3,834 animals in 2016, 2,345 animals in 2017, 1,030 animals in 2018, 805 animals in 2019, and 952 in 2020[4]. Both California and Stellar sea lions are present in the Lower Columbia River in the spring, overlapping with the migration of the UCR spring-run Chinook salmon ESU.

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

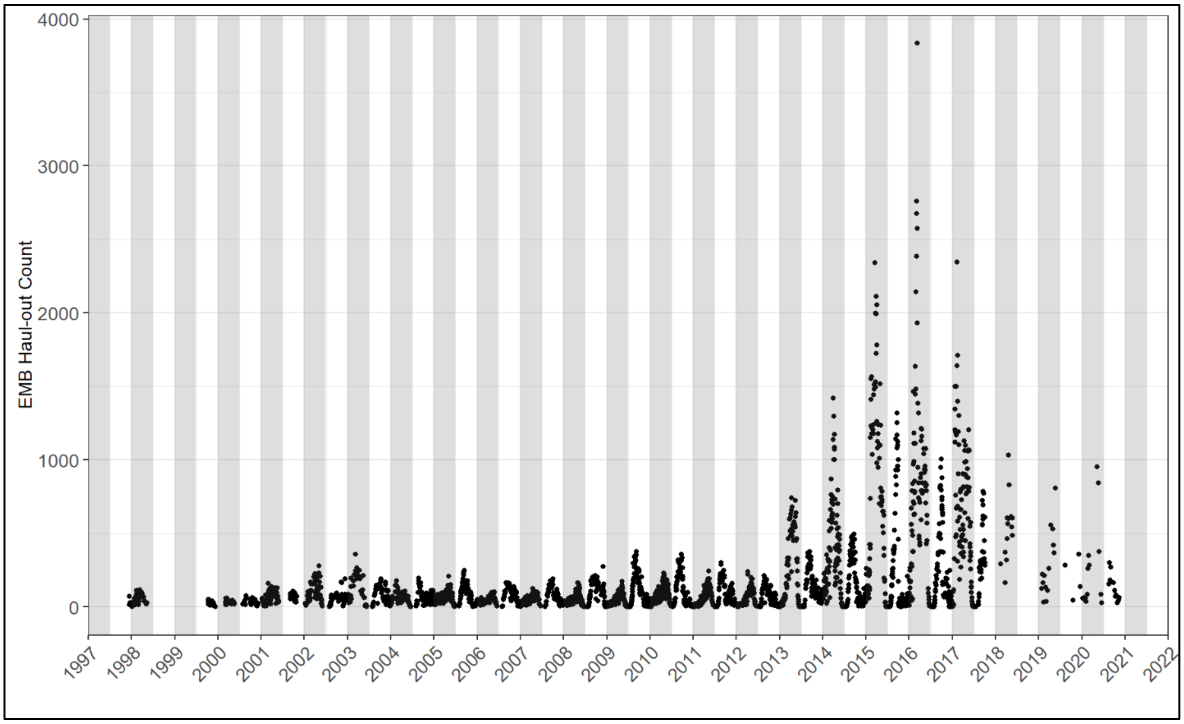

Figure 6. Estimated peak counts (spring and fall) of California sea lions in the East Mooring Basin in Astoria, Oregon, 1998 through 2020.[5]

Sea lion consumption of Chinook salmon directly below Bonneville Dam has been well studied. At Bonneville Dam, estimated consumption of adult salmon and steelhead by both California and Steller sea lions between 2016 and 2019[6] has ranged from a low of 2,201 fish in 2019 to a high of 9,525 fish in 2016 (Tidwell et al. 2020). The percentage of salmon and steelhead runs consumed by both California and Steller sea lions at Bonneville Dam has ranged from a low of 3.0 percent in 2018 to a high of 5.8 percent in 2016 (Tidwell et al. 2020).

Although California sea lions have been the primary focus of pinniped management efforts at Bonneville Dam to date, the presence of Steller sea lions has been increasing over time, and now poses a risk to salmon and steelhead recovery. At Bonneville Dam, predation in 2017, 2018, and 2019 on salmon and steelhead by Stellar sea lions exceeded that of California sea lions.

The number of Steller sea lions at Bonneville Dam over the past 5 years has been less on average than the previous 5 years, with a high of 66 animals in 2018 and a low of 50 animals in 2019, compared to a high of 89 animals in 2011 and a low 65 animals in 2014. However, predation as a percentage of the run on Pacific salmon and steelhead stocks by Steller sea lions has been steadily increasing and was higher than that by California sea lions in 2017 (2.8 percent compared to 1.9 percent), 2018 (2.3 percent compared to 0.7 percent), and 2019 (3.1 percent compared to 0.3 percent) (Tidwell et al 2020). They also estimated that pinniped predation on all

[5] E-mail to Robert Anderson, NMFS, from Bryan Wright, ODFW, November 17, 2020.
[6] At the time of this 5-year review, consumption data was only available through 2019.

steelhead was about 1.6 percent. Furthermore, the number of individuals and residence times of Steller sea lions at Bonneville Dam have more than doubled compared to the 10-year average (Figure 7). The highest numbers of Steller sea lions tend to be during the spring, overlapping with the migration of UCR spring-run Chinook (Figure 7).

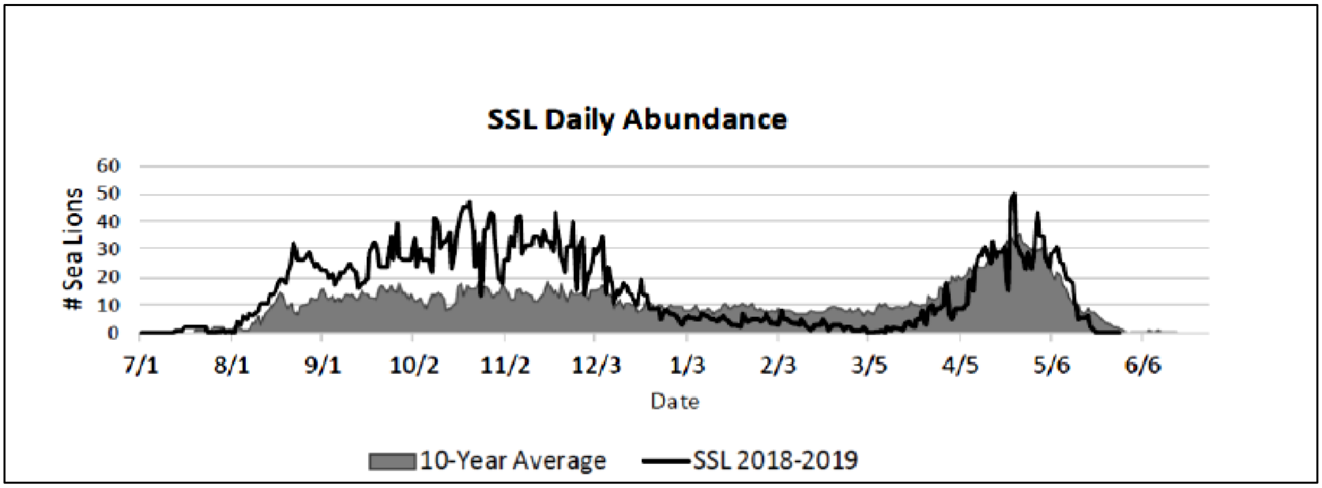

Figure 7. Maximum daily count of Steller sea lions at Bonneville Dam from 1 July 2018 through 30 June 2019 compared to the 10-year maximum daily average (Tidwell et al 2020).

A recent study by Rub et al. (2019) suggests that the overall impact of pinniped predation on spring-run Chinook salmon occurring throughout the Lower Columbia River is much higher than originally thought. Rub et al. (2019) estimated that non-harvest mortality of spring-run Chinook salmon varied from 20-44 percent between the mouth of the Columbia River and Bonneville Dam. They attributed the majority of this mortality to pinniped predation. Using these estimates and the California sea lion abundance data, Rub et al. (2019) calculated that the odds of survival for spring-run Chinook salmon decrease by 32 percent for every additional 467 sea lions present in the Columbia River.

A recent analysis by Sorel et al. (2020) looked at the effect of seasonal sea lion abundance in the Columbia River on adult Chinook salmon survival during migrations through the lower Columbia River. Sorel et al. (2020) looked at data on California sea lion abundance and adult survival in 18 populations of ESA-listed spring/summer Chinook salmon (Snake River and Upper Columbia) with different spring migration times. Of the 18 populations examined, earlier migrating Chinook populations experienced lower survival in association with increased exposure to higher California sea lion abundance. The authors estimated that in years with high California sea lion abundance, the nine earliest-migrating populations experienced an additional 21.1 percent mortality compared to years with baseline California sea lion abundance years, while the nine latest migrating populations experienced an additional 10.1 percent mortality. Specifically, for UCR spring-run Chinook salmon populations, later migrating spring-run Chinook salmon from the Methow and Wenatchee River populations are at relatively low risk of pinniped predation compared to the earlier migrating Entiat River population. As for UCR steelhead, pinniped predation is a cause of adult mortality, however, steelhead migrate later in the year than spring-run Chinook salmon so the pinniped predation rate and risk to species is lower.

Management efforts are underway to reduce pinniped predation on Pacific salmon and steelhead in the Lower Columbia River. These efforts are discussed under *Listing Factor D (Inadequacy of Regulatory Mechanisms)*.

Killer Whales

New information since the last 5-year review indicates predation of salmon, particularly Chinook salmon, by resident killer whales (*Orcinus orca*) has been increasing in the northeastern Pacific Ocean since the 1970s. Recent studies suggest this increase is in part due to a large increase in consumption by Northern Resident Killer Whales off the West Coast of Vancouver Island and British Columbia (Chasco et al. 2017a). The number of Chinook salmon required to maintain the endangered Southern Resident Killer Whale population, which occurs throughout the coastal waters off Washington, Oregon, and Vancouver Island, is estimated to be substantial (Williams et al. 2011), although this population of whales has been declining in recent years (Center for Whale Research, 2020). UCR Chinook salmon are known to be consumed by Southern Resident killer whales (NMFS and WDFW 2018) and migrate north after entering the ocean where they may also be consumed by Northern Residents as adults. Although there is uncertainty about the impact this has on the UCR spring-run Chinook salmon ESU, we believe that this topic warrants continued research and monitoring.

Fish Predation

The native northern pikeminnow is a significant predator of juvenile salmonids in the Columbia River followed by non-native smallmouth bass and walleye (reviewed in Friesen and Ward 1999; ISAB 2011, 2015). Before the start of the Northern Pikeminnow Management Program in 1990, this species was estimated to eat about 8 percent of the 200 million juvenile salmonids that migrated downstream in the Columbia River each year. Williams et al. (2017) compared current estimates of northern pikeminnow predation rates on juvenile salmonids to before the start of the program and estimated a median reduction of 30 percent. The NPMP's Sport Reward Fishery removed an average of 188,708 piscivorous pikeminnow (> 228 mm fork length) per year during 2015 to 2019 in the Columbia and Snake Rivers (Williams et al. 2015, 2016, 2017, 2018; Winther et al. 2019). Sport Reward Fishery harvest from the area below Bonneville Dam accounted for 62 percent of total fishery removals in 2019 (among all locations from the estuary to Lower Granite reservoir), and 54 percent in 2018, and has been the highest-producing zone for all but one season since system-wide implementation began in 1991 (Williams et al. 2018; Winther et al. 2019). In the 2018 and 2019 Sport Reward Fishery, the second highest pikeminnow catch (removal) location was Bonneville Reservoir (17.4 percent in 2018 and 15 percent in 2019). From 2015 to 2019, an annual average of 43 adults, 18 jacks, and 104 juvenile Chinook salmon were incidentally caught in the Sport Reward Fishery (Williams et al. 2015, 2016, 2017, 2018; Winther et al. 2019). Although it was not practical for the field crews to identify these fish to ESU/DPS, we assume that some were UCR spring-run Chinook salmon and UCR steelhead. In general, fish predation on both juvenile UCR spring-run Chinook salmon and UCR steelhead contribute to lower survival rates in tributaries to the Columbia River and during their outmigration in the Columbia River. Managing fish predators is one way to increase juvenile salmon and steelhead survival, but to what extent is not known.

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

The extinction risk posed to the ESU by disease, avian predation, and predation by other fish species has remained largely the same since the last 5-year review. Disease rates over the past 5 years are believed to be consistent with the previous review period. Avian predation of Chinook and steelhead smolts has decreased in some areas (e.g., Caspian terns at East Sand Island and Potholes), but increased in other areas (e.g., cormorants at the Astoria-Megler Bridge).

New information since the last 5-year review suggests that the risk to the ESU from pinniped predation in the Lower Columbia River is higher than previously understood. In addition to consuming between 2.9 to 5.9 percent of spring Chinook salmon returning to Bonneville Dam in each of the last 5 years (Tidwell et al. 2020), pinnipeds also appear to be consuming large numbers of spring-run Chinook salmon throughout the Lower Columbia estuary (Rub et al. 2019). Rub et al (2019) estimated average non-harvest mortality of adult spring Chinook salmon through the Lower Columbia estuary at 20 to 44 percent annually. New management actions authorized under the Endangered Salmon Predation Prevention Act to lethally remove sea lions are expected to reduce pinniped predation on adult UCR spring-run Chinook salmon in the Lower Columbia River. However, given the logistical challenges of removing sea lions and other uncertainties, the magnitude of this expected reduction in pinniped predation is uncertain. Pinniped predation on UCR steelhead is not a major concern at this point, but continued monitoring is warranted.

Recommended future actions:

- Develop and implement a long-term management strategy to reduce pinniped predation on Pacific salmon and steelhead in the Columbia River Basin by removing, reducing, or minimizing the use of manmade haul outs used by pinnipeds in select areas, e.g., river mouths/migratory pinch points.

- Expand, develop, and implement monitoring efforts in the Columbia River Basin to identify pinniped predation interactions in select areas, e.g., river mouths/migratory pinch points, and quantitatively assess predation impacts by pinnipeds on Pacific salmon and steelhead stocks.
- Continue monitoring and adaptively managing both managed and unmanaged Caspian Tern colonies in the Columbia Plateau region to reduce predation rates on juvenile salmonids. Other recommendation included in the Avian Predation on Salmonids in the Columbia River Basin: A Synopsis of Ecology and Management 2021 report should also be considered.

2.3.2.4 Listing Factor D: Inadequacy of Regulatory Mechanisms

Various Federal, state, county, and tribal regulatory mechanisms are in place to reduce both habitat loss and degradation caused by human use and development, such as hydrosystem, as well as harvest. For this review, we focus our analysis on regulatory mechanisms for Habitat and for Harvest that have either improved for UCR steelhead and UCR spring-run Chinook salmon, or that are still causing the most concern in terms of providing adequate protection for these UCR species.

Habitat

Habitat concerns are described throughout Listing Factor A as having either a system-wide influence, or more localized influence, on the populations and MPGs that comprise the species. The habitat conditions across all habitat components (tributaries, mainstems, estuary, and marine) necessary to recover listed UCR steelhead and UCR spring-run Chinook salmon are influenced by a wide array of Federal, state, and local regulatory mechanisms. The influence of regulatory mechanisms on listed salmonids and their habitat resources is based in large degree by the underlying ownership of the land and water resources as Federal, state, or private holdings.

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

Within the Upper Columbia basin, Federal lands comprise a large proportion of the land base with approximately 52 percent of lands in some type of Federal ownership mostly in the headwaters. The Okanogan-Wenatchee National Forest (OWNF) is the biggest Federal landowner with over 4 million acres. Although much of the region remains undeveloped, an extensive forest road network has arisen over the past 100 years. These forest roads have widespread effects on landscape-scale processes and aquatic habitat in the Upper Columbia. Road densities in the region are some of the highest in the state and many of the issues with roads occur in the core areas for salmon and steelhead production. Other important factors that influence watershed health include fire and forest condition (UCSRB 2014a).

The U.S. Bureau of Reclamation, along with other state and Federal agencies and private groups manage the water resources for the Columbia River's many, and sometimes competing, uses. There are 14 dams on the Columbia River mainstem from Bonneville at river mile 146 to Mica in British Columbia at river mile 1,018. In addition, there are 281 hydropower dams larger than one-tenth megawatt in size in the Columbia River Basin and about 200 more dams built for other purposes, such as irrigation and flood control. These affect water quality and quantity both tributaries and mainstem rivers (NWPCC 2021). The primary purposes of dams are flood protection, water storage and delivery for agriculture, navigation, and/or hydropower production.

Regulatory Mechanisms Resulting in Adequate or Improved Protection

New information available since the previous 2016 5-year review indicates that the adequacy of some habitat regulatory mechanisms has improved and has increased protection of UCR spring-run Chinook salmon and steelhead. These include both Federal and state water management regulatory mechanisms:

1. The Endangered Species Act Section 7 Biological Opinions

1.1 Columbia River System. Prior to 2019, under the biological opinions for the Columbia River System (CRS) (NMFS 2008a, 2014), the U.S. Army Corps of Engineers, U.S. Bureau of Reclamation, and Bonneville Power Administration (collectively referred to as the CRS Action Agencies) operated the Columbia River System (formerly referred to as the Federal Columbia River Power System) in accordance with a Reasonable and Prudent Alternative (RPA) that included both operational and non-operational measures expected to minimize project effects and improve the survival of migrating ESA-listed salmon and steelhead (as well eulachon and green sturgeon) and the function of their critical habitat in the Columbia River.

Beginning in 2019, the CRS Action Agencies proposed to continue many operational and non-operational measures from the previous RPA but also included mainstem dam operations consistent with a 2019 to 2021 Spill Operation Agreement. The NMFS 2019 biological opinion evaluated the effects of that interim proposed action. The NMFS 2020 biological opinion evaluated the effects of the CRS Action Agencies' longer-term proposed action, which included increased spill operations intended to improve passage conditions for juvenile salmon, and habitat mitigation intended to improve habitat conditions in the tributaries, as well as in the lower Columbia River estuary. Implementation of the tributary habitat program has focused primarily on UCR spring Chinook salmon and steelhead.

Improved Juvenile Passage. The CRS Action Agencies proposed increased spring spill levels at many of the mainstem hydroelectric projects with the goal of further improving passage conditions for juvenile salmon and steelhead, thereby reducing the proportion of juveniles passing mainstem dams via turbine units or juvenile bypass systems and thus, potentially increasing adult returns.

Improved Tributary Habitat. Implementation of the tributary habitat program has focused primarily on UCR spring-run Chinook salmon and steelhead and Snake River spring/summer Chinook salmon and Snake River Basin steelhead. Some actions have also been targeted to address Mid-Columbia steelhead. In addition, the CRS Action Agencies formally convened a Tributary Habitat Steering Committee (THSC) and under the 2020 proposed action, a Tributary Technical Team has been formed to provide scientific input on implementation of the program to help ensure that program goals and objectives are achieved.

Improved Floodplain and Estuary Habitat. The CRS Action Agencies are implementing an estuary habitat improvement program (the Columbia Estuary Ecosystem Restoration Program, CEERP), reconnecting the historic floodplain below Bonneville to the mainstem Columbia River. From 2007 through 2019, the Action Agencies implemented 64 projects, including dike and levee breaching or lowering, tide-gate removal, and tide-gate upgrades that reconnected over 6,100 acres of historic tidal floodplain habitat to the mainstem and another 2,000 acres of floodplain lakes (Karnezis 2019; BPA et al. 2020). In addition to this extensive reconnection effort, about 2,500 acres of currently functioning floodplain habitat have been acquired for conservation.

2. State of Washington's Hydraulic Project Approval, and rules for mineral prospecting and placer mining.

In 2019, legislation was approved in Washington State to provide the Washington Department of Fish and Wildlife with greater enforcement capacity under the Hydraulic Code, including sections on shore protection in saltwater areas. The law addressed whether a project proposed landward of the ordinary high-water line (OHWL) requires a hydraulic project approval (HPA). The bill also enhanced the department's civil compliance enforcement authority and repealed a statute relating to marine beachfront protective bulkheads or rock walls for single-family residences. Washington Administrative Codes were updated in 2020 to implement the statutory changes. Mineral prospecting and pacer mining rules for these activities are issued by "pamphlet" and are updated regularly. The rules are intended to protect fish and their habitats. These rules have become more restrictive since the last status update, and now do not authorize the use of any suction dredges, dryland dredges, gravity siphons, or motorized methods (including, but not restricted to, power sluice/suction dredge combinations, motorized highbankers or power sluices, spiral wheels, and vac-pacs). Miners must obtain a separate, written HPA to use methods not specifically authorized in the pamphlet.

3. State of Washington's Fish Passage Barrier Removal Board (Revised Code of Washington (RCW) 77.95.160)

In 2015, the Washington state legislature created the Fish Passage Barrier Removal Board to establish a new statewide strategy for fish barrier removal and administering grant funding available for that purpose. The legislation established several key objectives for the new strategy including:

- Coordination with all relevant state agencies and local governments to maximize state investments in removing fish barriers.
- Realizing economies of scale by bundling projects whenever possible.
- Streamlining the permitting process whenever possible without compromising public safety and accountability.

Chaired by the Washington Department of Fish and Wildlife, the board includes representatives of the Washington State Department of Transportation, Washington Department of Natural Resources, tribes, city and county governments, and the Governor's Salmon Recovery Office. In developing the statewide strategy, the board has been working closely with salmon recovery organizations to approve statewide guidelines. Highlights of the Boards work include:

Approving two project pathways:

- Watershed Pathway - Remove multiple barriers within a stream system.
- Coordinated Project Pathway - Remove additional barriers upstream or downstream of a planned and funded project.
- Approving the initial focus areas for Watershed Pathway.
- Analyzing barriers submitted for Coordinated Project Pathway.

Regulatory Mechanisms Resulting in Inadequate or Decreased Protection

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

1. Northwest Forest Plan

The Northwest Forest Plan (NWFP) is a series of Federal policies and guidelines governing land use on Federal lands in the Pacific Northwest region of the United States. It covers 10 million hectares within Western Oregon and Washington as well as a small part of Northern California. Since 1994, the Northwest Forest Plan (NWFP) has guided the management of 17 Federal forests in the U.S. Pacific Northwest and BLM lands in Western Oregon (USDA 1994; NMFS 2015). The aquatic conservation strategy contained in this plan includes elements such as designation of riparian management zones, activity-specific management standards, watershed assessment, watershed restoration, and identification of key watersheds (USDA 1994; NMFS 2015).

The Okanogan-Wenatchee National Forest (OWNF) has over 8,200 miles of system roads, including hundreds of miles of unauthorized roads that are recognized as one of the primary issues affecting the aquatic environment, as a major contributor of sediment into spawning and rearing streams.

Over the last 5 years, the OWNF has shifted to landscape-scale restoration through the inclusion of their 2012 Forests Restoration Strategy and their Procedures for Watershed and Aquatic Resource Assessment, Analysis and Development for Whole Watershed Scale Projects (USFS 2012). In addition to these two documents, the OWNF had some other policy documents that helped pave the way for aquatic restoration, including a roads policy and Emergency Repair of Forest Roads guidance. However, OWNF has had challenges in updating their forest plan and travel management plan, which has delayed the OWNF in implementing modifications to their road system and road management that would provide benefits to ESA-listed fish and their habitat. The extensive roads network in national forests impairs riparian values, continues to be a source of sediment to tributary habitat, and encourages off-road recreation that degrades spawning and rearing areas. In addition, large landscape-scale projects have had their own challenges with funding, staffing changes, and sheer size and complexity of the projects.

2. Federal Land Policy and Management Act

The Federal Land Policy and Management Act governs multiple uses of Federally-owned lands such as recreation, mineral extraction, timber and food crop production, and livestock grazing, each of which can affect tributary and mainstem habitat conditions, including water riparian conditions, water quality and habitat complexity. This statute, which governs Federal forestland managed by the Forest Service and land managed by the Bureau of Land Management, remains largely unmodified since it was passed in 1976. On Forest Service lands and BLM lands, grazing and recreational uses continue to impair streamside riparian habitat, water quality, stream temperatures, and spawning conditions.

3. The Flood Control Act of 1965, and Public Law 84-99, and the Water Resources Development Act

Using this trio of authorities, the Corps of Engineers Civil Works program has modified river systems and their floodplains by constructing levees to constrain floods, channelizing rivers, to convey water in simplified systems, dredging gravels and cobbles from rivers to maintain conveyance capacity, and prevent establishment of riparian vegetation, even on levee systems that are no longer Federally-owned. In areas behind “100 year certified” levees, the lands behind are no longer mapped as special flood hazard areas, meaning they can be developed without considering flood risk, per the National Flood Insurance Program’s mapping and management standards. Levees constructed primarily to constrain flood waters from reaching land converted to agricultural purpose often ultimately support subsequent intensification of land use, and constraints on river and stream alignment and complexity become permanent.

4. National Flood Insurance Program

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

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

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

5. Washington Growth Management Act, Revised Code of Washington Ch. 36.70A

Although not all counties and cities in Washington State are fully planning under the Washington Growth Management Act (GMA) pursuant to RCW 36.70A.040, all counties and cities in the state are required to adopt development regulations to protect critical areas, and to periodically review those regulations. As with the Shoreline Management Act, the GMA also has an update process for city and county critical areas ordinances (CAOs). Most CAOs were originally adopted following GMA's enactment in 1990-1991. Updates are required every 8 years.

Communities that have updates since the 2016 review include:

- Chelan County in 2017;
- Douglas County in 2017 and again in 2019; and
- Okanogan County has a draft plan dated 2018.

CAOs are required for Wetlands, Aquifer Recharge Areas, Geologically Unstable Areas, Frequently Flooded Areas, and Fish and Wildlife Conservation Areas. The Washington State Department of Commerce adopted a Critical Areas Handbook in 2018. It should be noted here that frequently flood areas critical areas ordinances for most cities and counties are based on the NFIP minimum criteria. These minimum criteria may not be protective enough to allow floodplain function and aquatic habitat to function naturally.

6. 90.94 RCW Streamflow Restoration

In January 2018, the Washington state legislature passed the Streamflow Restoration law that helps restore streamflows to levels necessary to support robust, healthy, and sustainable salmon populations while providing water for homes in rural Washington. The State law requires that enough water is kept in streams and rivers to protect and preserve instream resources and values such as fish, wildlife, recreation, aesthetics, water quality, and navigation. One of the most effective tools for protecting streamflows is to set instream flows, which are flow levels adopted into rule. Instream flows cover nearly half of the state's watersheds and the Columbia River. In Washington – and especially on the east side of the state – out-of-stream uses, especially irrigation, exacerbate seasonally low flows, leading to passage and temperature problems, and the loss of habitat living space. Other water uses also play a contributing role, as well as land use (lack of recharge arising from impervious surfaces). The Washington State Department of Ecology has a list of critical watersheds where instream flows are thought to be a contributing factor to "critical" or "depressed" fish status, as identified by the Washington Department of Fish and Wildlife. There are 16 basins identified as critical, affecting the following counties: Asotin, Garfield, Whitman, Columbia, Walla Walla, Benton, Yakima, Kittitas, Chelan, Pierce, King, Snohomish, Whatcom, Okanogan, and Clallam/Jefferson. Okanogan and Chelan Counties are home to UCR listed species. According to Washington State's instream flow status as of November 2016, (Figure 8) the Pre-1990 Rule is operative for the Methow and Okanogan basins, and the Post-2001 Rule is operative for the Entiat and Wenatchee basins. No new instream flows have been set in the Upper Columbia region since the last 5-year review.

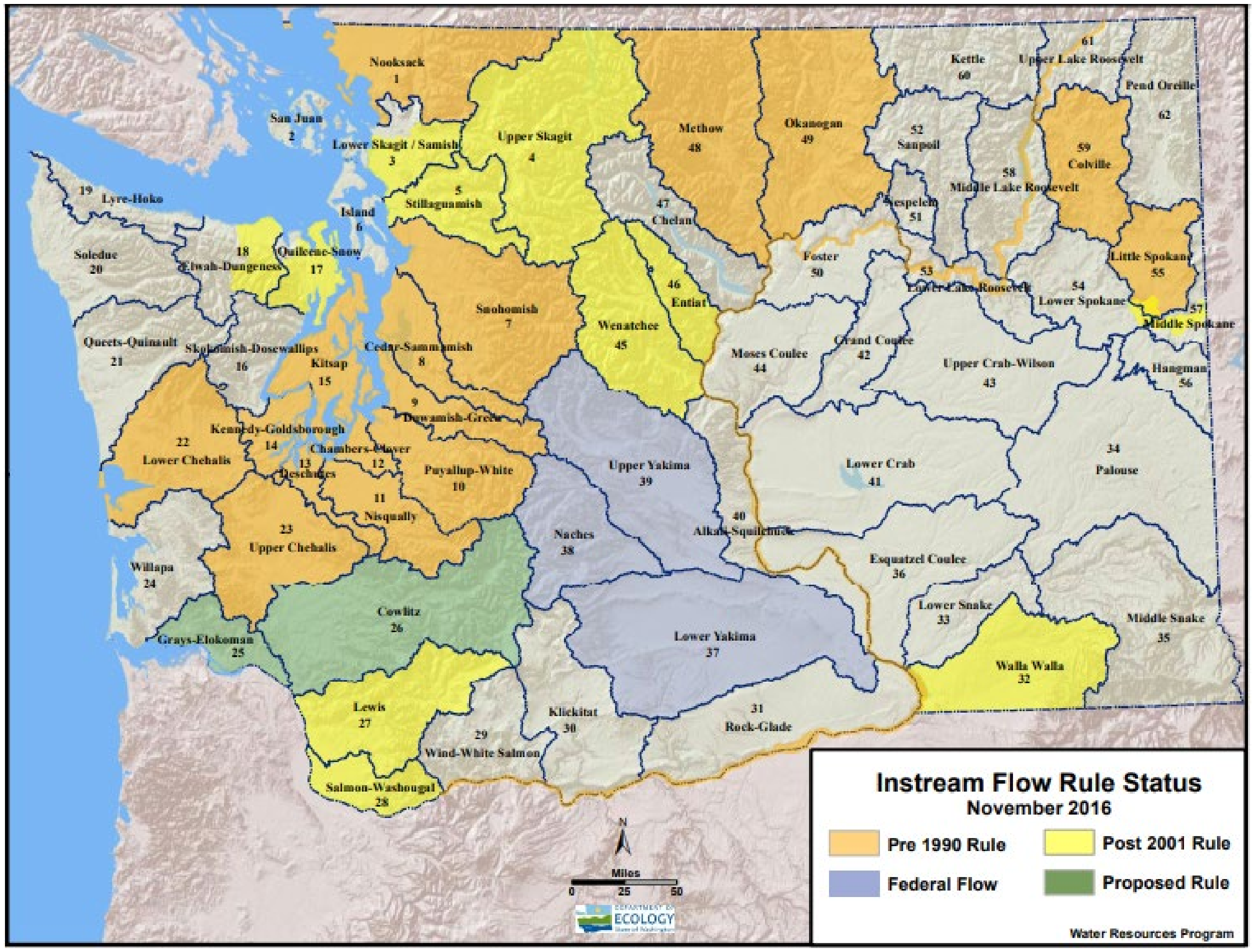

Figure 8. Basins in Washington State with Instream Flow Requirements.

Washington Water Rights – 1917 Water Code and the 1945 Groundwater Act govern how much water reaches or remains in streams. The 1917 Water Code is based on the common-law prior appropriations doctrine, and establishes a “first in time, first in rights” allocation for out of stream “beneficial uses” of surface water. Those with adjudicated older “senior” water rights may exert their allocation against junior water right holders in dry years when water supply is low. Beneficial uses did not include leaving water in streams, and many streams are legally allowed to go dry in drought years because senior appropriated amounts may exceed the volume of available water. The 1945 Groundwater Act, as updated in 1973, established a similar senior water rights and permitting system with the growing understanding that subsurface water was hydrologically connected to streams and rivers. Many uses are exempt from permitting requirements, however, including livestock watering, non-commercial lawn or garden watering less than ½ acre, domestic uses and small industrial uses (under 5000 gallons/day). Collectively, the unregulated uses cause a significant cumulative effect on stream recharge, reducing cool water and base flows necessary for summer and early fall survival of listed fish. Some uses of water, particularly during low flow, can have direct impacts to fish, by preventing upstream passage and even survival if water temperatures are too high.

Harvest

Pacific Salmon Treaty

Ocean fisheries in Southeast Alaska, British Columbia, and off the coasts of Washington and most of Oregon are managed under the Pacific Salmon Treaty (PST), which was initially ratified by the United States and Canada in 1985. The PST is implemented by the Pacific Salmon Commission, which negotiates, facilitates, and monitors the implementation of fishing regimes developed under the treaty. In the United States south of the Canadian border, the PFMC is responsible for regulating regimes agreed to by the Pacific Salmon Commission, while the North Pacific Fishery Management Council (NPFMC) has jurisdiction for ocean fisheries off Alaska.

Pacific Fishery Management Council

Since 1977, salmon fisheries in the exclusive economic zone (EEZ) (3 to 200 nautical miles offshore) off Washington, Oregon, and California have been managed under salmon Fishery Management Plans (FMPs) of the PFMC. While all species of salmon fall under the jurisdiction of the current plan (PFMC 2021), the FMP currently contains fishery management objectives only for Chinook salmon, coho, pink (odd-numbered years only), and any salmon species listed under the ESA that is measurably impacted by PFMC fisheries.

The effects of the salmon fisheries on ESA listed salmonids is limited by fishery management measures implemented under the Magnuson-Stevens Fishery Conservation and Management Act, as well as terms and conditions and reasonable and prudent alternatives developed by NMFS through consultations under ESA section 7. These measures take a variety of forms including FMP conservation objectives, limits on the time and area during which fisheries may be open, ceilings on fishery impact rates, and reductions from base period impact rates. NMFS annually issues a guidance letter to the PFMC reflecting the most current information for developing management objectives (e.g., Thom 2020).

North of Falcon

Ocean fisheries between Cape Falcon (on the north Oregon coast) and the Canadian border are coordinated with fisheries in the Columbia River, Puget Sound, and coastal rivers through the North of Falcon (NOF) process. This process was established by the states and the Northwest Indian Fisheries Commission member tribes; it occurs largely coincident with the PFMC process. In the NOF process, co-managers develop pre-season fishing plans that are coordinated between ocean and in-river fisheries to ensure that conservation and various allocation objectives are met. Allocation objectives include treaty/non-treaty tribal allocations and allocations between various non-treaty user groups, such as commercial and recreational fisheries.

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

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

Tributary Fisheries

Recreational fisheries in the tributaries of the Columbia and Snake Rivers are managed by Idaho, Washington, and Oregon for their respective waters. Tribes also regulate the tributary fisheries under their respective jurisdiction. NMFS has reviewed and approved various terminal-area state and tribal fisheries under the ESA.

Marine Mammal Protection Act

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

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

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

Listing Factor D Conclusion

Based on the information noted above for regulations in the Columbia River basin (Oregon, Washington and Idaho), we conclude that the risk to the species' persistence because of the adequacy of existing regulatory mechanisms has remained the same. Despite improvement in the adequacy of some regulatory mechanisms within the UCR ESU and DPS, there remain 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.
- Continued Federal and state water use policies that promote out of stream uses to the detriment of stream flows providing sufficient habitat for salmon and steelhead.
- Failure of Federal and state clean water laws to safeguard stream temperature regimes necessary to sustain levels of salmon and steelhead abundance and productivity that promote recovery.
- Federal and state programs that prioritize maintaining current infrastructure such as roads and levees in current condition and alignments without regard to habitat restoration and recovery needs, thus limiting the capacity of the DPS and ESU to reach abundance and productivity goals.

Recommended Actions:

- Future U.S. Forest Service and BLM plan reviews need to continue to address how forest practices and other Federal land management activities can support recovery of salmon and steelhead.
- Consistent with the Congressional intent of the Endangered Salmon Predation Prevention Act,[7] the MMPA section 120(f) permit Eligible Entities[8] are encouraged to develop and implement a long-term management strategy to deter the future recruitment of sea lions into the MMPA 120(f) geographic area.[9]

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[7] Public Law 115-329, the Endangered Salmon Predation Prevention Act.

[8] Eligible Entities: Oregon Department of Fish and Wildlife, the Washington Department of Fish and Wildlife, the Idaho Department of Fish and Game, on behalf of their respective states; the Nez Perce Tribe, the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes of the Warm Springs Reservation of Oregon, the Confederated Tribes and Bands of the Yakama Nation; and the Willamette Committee.

[9] MMPA 120(f) geographic area is defined by statute as the main stem of the Columbia River between river mile 112 (I-205 Bridge) and river mile 292 (McNary Dam), or in any tributary to the Columbia River that includes spawning habitat of threatened or endangered salmon or steelhead.

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

Climate Change

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

Climate change has negative implications for UCR spring-run Chinook salmon and UCR steelhead salmon survival and recovery, and for their designated critical habitat (Climate Impacts Group 2004; Scheuerell and Williams 2005; Zabel et al. 2006; ISAB 2007), characterized by the Independent Scientific Advisory Board (ISAB) as follows:

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

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

Impacts on Salmon

Range of effects caused by a changing climate

Climate change is predicted to cause a variety of impacts to Pacific salmon and their ecosystems (Mote et al. 2003; Crozier et al. 2008a; Martins et al. 2012; Wainwright and Weitkamp 2013; OCCRI 2019, 2021). The complex life cycles of anadromous fishes, including salmon, rely on productive freshwater, estuarine, and marine habitats for growth and survival, making them particularly vulnerable to environmental variation. Ultimately, the effects of climate change on salmon and steelhead across the Columbia Basin will be determined by the specific nature, level, and rate of change and the synergy among interconnected terrestrial/freshwater, estuarine, nearshore, and ocean environments. Climate change and anthropogenic factors continue to reduce adaptive capacity in Pacific salmon as well as altering life history characteristics and simplifying population structure.

The primary effects of climate change on Pacific Northwest salmon and steelhead are (Crozier 2016, 2021):

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

Effects caused by changing flows and temperatures

While all habitats used by Pacific salmon will be affected, the impacts and certainty of the change vary by habitat type. Some effects (e.g., increasing temperature) affect salmon at all life stages in all habitats, while others are habitat-specific, such as stream-flow variation in freshwater, sea-level rise in estuaries, and upwelling in the ocean. How climate change will affect each stock or population of salmon also varies widely depending on the level or extent of change, the rate of change, and the unique life history characteristics of different natural populations (Crozier et al. 2008b). For example, a few weeks difference in migration timing can have large differences in the thermal regime experienced by migrating fish (Martins et al. 2011). This occurred in 2015, when about 475,000 adult sockeye salmon (all ESUs) passed Bonneville Dam in the Columbia River, but only 2 to 15 percent of these adult sockeye, depending upon the population, survived to their spawning grounds. Most died in the lower Columbia River beginning in June when the water warmed to above 68°F, the temperature at which sockeye salmon begin to die. Water temperatures rose to 73°F in July, when the area experienced a combination of continued high summer temperatures and lower than average flows (due to the lower snowpack from the previous winter and drought conditions exacerbated due to increased occurrences of warm weather patterns) (NMFS 2016b). In 2015, only 14 percent of adult SR sockeye salmon survived from Bonneville to McNary Dam, and only 4 percent survived from Bonneville to Lower Granite Dam (NMFS 2016b).

Like most fishes, salmon are poikilotherms (cold-blooded animals); therefore, increasing temperatures in all habitats can have pronounced effects on their physiology, growth, and development rates (see review by Whitney et al. 2016). Increases in water temperatures beyond their thermal optima will likely be detrimental through a variety of processes, including increased metabolic rates (and therefore food demand), decreased disease resistance, increased physiological stress, and reduced reproductive success. All of these processes are likely to reduce fitness of salmonids, including UCR spring-run Chinook salmon and UCR steelhead (Beechie et al. 2013; Wainwright and Weitkamp 2013; Whitney et al. 2016).

By contrast, increased temperatures at ranges well below thermal optima (i.e., when the water is cold) can increase growth and development rates. Examples of this include accelerated emergence timing during egg incubation stages, or increased growth rates during fry stages (Crozier et al. 2008a; Martins et al. 2011). Temperature is also an important behavioral cue for migration (Sykes et al. 2009), and elevated temperatures may result in earlier-than-normal migration timing. While there are situations or stocks where this acceleration in processes or behaviors is beneficial, there are others where it is detrimental (Sykes et al. 2009; Whitney et al. 2016).

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

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

New Information

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

Marine Effects

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

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

Freshwater Effects

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

Streams with intact riparian corridors and that lie in mountainous terrain are likely to be more resilient to changes in air temperature. These areas may provide refuge from climate change for a number of species, including Pacific salmon. Krosby et al. (2018) identified potential stream refugia throughout the Pacific Northwest based on a suite of features thought to reflect the ability of streams to serve as such refuges. Analyzed features include large temperature gradients, high canopy cover, large relative stream width, low exposure to solar radiation, and low levels of human modification. They created an index of refuge potential for all streams in the region, with mountain area streams scoring highest. Flat lowland areas, which commonly contain migration corridors, were generally scored lowest, and thus were prioritized for conservation and restoration.

Marine survival

Variation in marine productivity and prey quality can greatly impact the marine survival of salmon populations. The specific ocean habitat use of different salmon populations is poorly defined. Recent work by Espinasse et al. (2019) used carbon and nitrogen stable isotopes derived from an extensive time-series of salmon scales to examine aspects of the marine environment used by Rivers Inlet (British Columbia) sockeye salmon. The authors were able to identify likely rearing areas before sampling. This work as well as other research cited in Siegel and Crozier (2020) are improving our understanding of how marine productivity impacts salmon growth and survival, particularly during the early marine period. While we understand that sea surface temperature is tightly linked to marine survival, we do not yet understand the mechanism involved. The work described above are important steps in increasing our understanding.

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

Climate Vulnerability Assessment

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

Crozier et al. (2019) concluded that both species have a high risk of overall climate vulnerability based on their high risk for biological sensitivity, high risk for climate exposure, and moderate capacity to adapt. Life-stage sensitivity attributes for UCR spring-run Chinook salmon scored high for both juvenile and adult freshwater stages. UCR steelhead scored high in the adult freshwater stage. Ocean survival is well predicted by environmental climate indices, particularly upwelling and the Pacific Northwest Index (Williams et al. 2014). However, the impact of climate change specifically on marine survival is uncertain, leading to a moderate score for the marine stage.

Both UCR spring-run Chinook salmon and UCR steelhead scored low in estuary stage sensitivity because of their rapid migration from fresh water to the early marine stage (Crozier et al. 2019). Risk during early life history was also scored low because of the high elevation and relatively stable flows that influence the egg stage. Scores for the juvenile freshwater rearing stage for both species were high because of the year-around reliance on freshwater habitat and sensitivity to changes in summer flows and stream temperatures.

UCR Chinook salmon may have sufficient adaptive capacity to shorten the juvenile freshwater residence period, but the consequences of such a shift for population viability are unknown. Deemed unlikely to shift upstream migration timing substantially, this ESU’s overall rank for adaptive capacity was moderate. UCR steelhead may have some latitude to shift timing of adult migrations to avoid peak late summer temperatures (Robards and Quinn 2002), but the consequences of such timing shifts are not known. In each river population, individuals occupying the mid-to-lower reaches are subject to annual high stream temperatures and summer water deficits, and there are limited opportunities to shift juvenile rearing patterns. Anadromous *O. mykiss* may have some opportunities to expand summer rearing and overwintering to habitat areas upstream, but the amount of suitable habitat is limited compared to the potential loss of habitat in downstream reaches. This DPS ranked moderate for adaptive capacity overall.

Lower Columbia River Estuary Modifications

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

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

Wildfires

A major emergent habitat concern since the 2016 5-year review is the increased frequency and severity of large (>20,000 acres) wildfires throughout the UCR spring-run Chinook salmon and UCR steelhead. As a general matter, extensive wildfires have affected habitat quality in burned areas, which are likely to incorporate areas of or near salmonid habitat, with a range of potential effects. While fires are natural disturbances that promote healthy ecological conditions for salmon and steelhead, larger and more intense fires are expected to have increasingly adverse effects on aquatic habitats and at much larger geographic scales.

As described in USFS 2018, intense fire can produce extensive areas of water repellant soils which combine with widespread vegetation loss to reduce water infiltration and create an elevated runoff response to precipitation events. This sudden increase in overland and stream flow renders channels vulnerable to fine sediment delivery through erosion and large hillslope failures. Existing culverts may be overwhelmed by debris jams with flow eventually eroding through the road prism. Freshly excavated roads and fire breaks cut by bulldozers to access and stop the fire's movement remove vegetation and expose soil. If these excavations are not rehabilitated prior to the rainy season, they may confine runoff and promote rill erosion. Damage to riparian habitat may significantly reduce stream shading and long term large woody material input as well as decrease upslope filtering of mobilized sediments by organic material. Water quality and fisheries habitat are ultimately degraded by accelerated surface runoff and erosional processes (surface erosion and increased landslide risk) that produce elevated nutrients, suspended sediment, turbidity, and accumulation of fines in pool habitat and spawning beds. High intensity wildfire has the greatest potential to damage aquatic habitat through increased surface erosion and increased risk of landslides that deliver large quantities of sediment to streams.

Hatchery Effects

The effects of hatchery fish on the status of an ESU or DPS depends upon which of the four key attributes – abundance, productivity, spatial structure, and diversity – are currently limiting the ESU/DPS, and how the hatchery fish within the ESU/DPS affect each of the attributes (70 FR

37204). Hatchery programs can provide short-term demographic benefits such as increases in abundance during periods of low natural abundance. They also can help preserve genetic resources until limiting factors can be addressed. However, the long-term use of artificial propagation may pose risks to natural productivity and diversity. The magnitude and type of the risk depends on the status of affected populations and on specific practices in the hatchery program.

UCR Spring-run Chinook Salmon

Hatchery managers have continued to implement and monitor changes in hatchery management since the last 5-year review for the hatchery programs within this ESU (Table 5 below). Although several measures have been implemented to reduce risk, the proportion of hatchery fish on the spawning grounds (pHOS) remains high in the Wenatchee and Methow Basins. However, a better measure of hatchery genetic risk is the proportionate natural influence (PNI) within the population, which balances the incorporation of natural-origin fish into the broodstock with pHOS. For example, in the Methow River Basin, specific pHOS goals and genetically linking the two spring Chinook salmon programs in the basin have shown improvement in the estimated PNI for the program (Table 6). We conclude that hatchery effects continue to present risks to the persistence of the UCR spring-run Chinook salmon ESU, but they are likely less of a risk compared to the last 5-year review because several additional reform measures have been implemented, such as terminating the Entiat National Fish Hatchery (NFH) spring Chinook salmon hatchery program and genetically linking the two spring Chinook salmon programs in the Methow River subbasin.

Table 5. ESA Status of hatchery programs within the UCR Spring Chinook Salmon ESU; NFH = National Fish Hatchery; HGMP = Hatchery and Genetic Management Plan; TRMP = Tribal Resource Management Plan; C = Review under the ESA is complete; U = undergoing ESA review; M = HGMP has not been submitted or is being modified by the applicant.

Program Stock Origin	Program	Run	Watershed Location of Release (State)	Currently Listed?	HGMP/ TRMP Status
Twisp	Twisp River	Spring	Methow River (WA)	Yes	C
Methow Composite	Methow Conservation	Spring	Methow River (WA)	Yes	C
	Winthrop NFH	Spring	Methow River (WA)	Yes	C
	Chief Joseph Hatchery	Spring	Okanogan River (WA)	Yes	C
Nason Creek	Nason Creek	Spring	Wenatchee River (WA)	Yes	C
Chiwawa	Chiwawa River	Spring	Wenatchee River (WA)	Yes	C
White	White River[4]	Spring	Wenatchee River (WA)	Yes	C
Carson stock	Leavenworth NFH	Spring	Wenatchee River (WA)	No	C
	Chief Joseph Hatchery	Spring	Mainstem Columbia River (WA)	No	C

[1]Program on hiatus.

Table 6. Methow Spring Chinook salmon spawning ground gene flow metrics, including PNI and program partial pHOS (ppHOS) (Humling et al. 2019).

Year	Methow Subbasin Escapement[1]				Program partial pHOS estimate[1]			
	Total Spawner Escapement	Combined pHOS	PNI[2,3]	PNI 5-yr moving Avg.[4]	WNFH	NOR-based ppHOS target[5]	MFH	Out-of-basin strays
2003	1,138	0.95	0.30	0.27	0.19	<0.20	0.76	0.01
2004	1,497	0.67	0.09	0.22	0.12	<0.20	0.54	0.01
2005	1,376	0.62	0.42	0.2	0.07	<0.20	0.52	0.02

Year	Methow Subbasin Escapement[1]				Program partial pHOS estimate[1]			
	Total Spawner Escapement	Combined pHOS	PNI[2,3]	PNI 5-yr moving Avg.[4]	WNFH	NOR-based ppHOS target[5]	MFH	Out-of-basin strays
2006	1,748	0.81	0.06	0.21	0.18	<0.20	0.58	0.05
2007	1,079	0.75	0.24	0.24	0.28	<0.20	0.33	0.14
2008	1,002	0.70	0.24	0.17	0.27	<0.20	0.38	0.05
2009	2,641	0.79	0.22	0.19	0.31	<0.20	0.45	0.03
2010	2,369	0.75	0.09	0.20	0.25	<0.20	0.49	0.01
2011	2,936	0.67	0.18	0.22	0.16	<0.20	0.43	0.08
2012	1,298	0.80	0.25	0.25	0.05	<0.20	0.71	0.03
2013	1,089	0.78	0.37	0.30	0.05	<0.20	0.72	0.01
2014	2,063	0.75	0.38	0.33	0.14	<0.20	0.60	0.01
2015	1,353	0.71	0.34	0.36	0.17	<0.20	0.51	0.02
2016	697	0.54	0.30	0.40	0.27	<0.20	0.25	0.02
2017	464	0.62	0.40	0.40	0.19	<0.20	0.35	0.08
2018	500	0.47	0.57	0.42	0.10	<0.20	0.20	0.17
AVG.	1,592	0.74	0.24	0.24	0.18	N/A	0.54	0.02

[1] Escapement estimates and derivatives from Snow et al. (2019) data (cited in Humling et al. 2019).

[2] PNI estimates re-calculated using Snow et al. (2019) data and NOAA 3-pop PNI tool (Busack 2015) (cited in Humling et al. 2019).

[3] PNI values differ slightly from Snow et al. (2019) estimates due to exclusion of out-of-basin strays in this analysis (cited in Humling et al. 2019).

[4] 5-yr moving average data for early and late years are based on nearest available years' data.

[5] Program ppHOS target from NOAA biological opinion, based on estimated NOR run size; red indicates exceedance.

UCR Steelhead

The proportions of hatchery-origin returns in natural spawning areas remain high across the DPS, especially in the Methow and Okanogan river populations (NWFSC 2015), but the management of the fish being propagated at the various programs (Table 7) has changed recently to focus production on individual populations using only fish from within that population (NMFS 2016a, 2017b, 2017d, 2017e).

Table 7. ESA Status of hatchery programs within the UCR Steelhead DPS; NFH = National Fish Hatchery; HGMP = Hatchery and Genetic Management Plan; TRMP = Tribal Resource Management Plan; C = Review under the ESA is complete; U = undergoing ESA review; M = HGMP has not been submitted or is being modified by the applicant.

Program Stock Origin	Program	Run	Watershed Location of Release (State)	Currently Listed	HGMP /TRMP Status
Wenatchee	Wenatchee River	Summer	Wenatchee River (WA)	Yes	C
Okanogan	Okanogan River	Summer	Okanogan River (WA)	Yes	C
Methow	Wells Complex	Summer	Methow River (WA)	Yes	C
Methow	Wells Complex	Summer	Okanogan River (WA)	Yes	C
Methow	Winthrop NFH	Summer	Methow River (WA)	Yes	C
Wells stock	Wells Complex	Summer	Columbia River (WA)	No	C
	Ringold Hatchery	Summer	Middle Columbia River (WA)	Yes	C

Listing Factor E Conclusion

Climate Change

UCR spring-run Chinook salmon and UCR steelhead have a high risk of overall climate vulnerability based on its high risk for biological sensitivity, high risk for climate exposure, and moderate capacity to adapt. Life-stage sensitivity attributes for UCR spring-run Chinook salmon scored high for both juvenile and adult freshwater stages. UCR steelhead scored high in the adult freshwater stage. Ocean survival is well predicted by environmental climate indices, particularly upwelling and the Pacific Northwest Index (Williams et al. 2014). However, the impact of climate change specifically on marine survival is uncertain, leading to a moderate score for the marine stage.

Hatchery Effects

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

UCR Spring-run Chinook Salmon

The hatchery programs that affect the UCR spring-run Chinook salmon ESU have changed over time, and these changes have likely reduced adverse effects on ESA-listed species. Specifically, the hatchery programs funded by the PUDs were reduced in size starting in 2012 because of a revised calculation of their mitigation responsibility based on increased survival through the PUD dams. Reducing hatchery production has reduced the number of natural-origin fish used for broodstock, as well as the proportion of hatchery fish on the spawning grounds and associated genetic risk. Furthermore, as a result of completed ESA section 7 consultations (NMFS 2014, 2015, 2016b, 2017a, 2017b), several additional reform measures have been implemented, such as terminating the Entiat NFH spring Chinook salmon hatchery program and genetically linking the two spring Chinook salmon programs in the Methow River subbasin.

UCR Steelhead

For UCR steelhead, the high-risk ratings for diversity are largely driven by chronic high levels of hatchery spawners within natural spawning areas and lack of genetic diversity among the populations. The basic major life history patterns (summer A-run type, tributary and mainstem spawning/rearing patterns, and the presence of resident populations and subpopulations) appear to be present. All of the populations were rated at high risk for current genetic characteristics by the ICTRT. Genetic samples from the 1980s indicated little differentiation within populations in the UCR steelhead DPS. Hatchery operations are now aligned with the ESA recovery plan (UCSRB 2007) and are meant to ensure that levels of genetic effects will still allow natural populations to improve in productivity, abundance, and diversity and adapt to both current and changing environments (NMFS 2017d). Recent changes include a reduction in the hatchery programs funded by the PUDs starting in 2012 because of a revised calculation of their mitigation responsibility based on increased survivals through the PUD-owned dams. Reduced hatchery production has also reduced the number of hatchery-origin fish on the spawning grounds, potentially decreasing the genetic risk to the natural-origin populations. The programs have implemented the following additional reform measures:

- The Methow component of the Wells Complex steelhead program made changes in its broodstock by developing a genetically linked program with Winthrop National Fish Hatchery to better link its hatchery fish to natural-origin steelhead. This is a critical step to recovery as these hatchery releases are responsible for a large proportion of the hatchery fish on spawning grounds in the Methow River (NMFS 2017d).

- Changes were made in the management of adult hatchery-origin steelhead returning to the Wenatchee River basin, which reduced pHOS and the resulting genetic risk to that population (NMFS 2016a).

NMFS has consulted on all the steelhead hatchery programs in the upper Columbia River basin (NMFS 2016a, 2017b, 2017d, 2017e) (and has concluded that they are not likely to appreciably reduce the likelihood of survival and recovery of the UCR steelhead DPS.

2.4 Synthesis

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

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

- *Updated Biological Risk Summary*: Our Northwest Fisheries Science Center completed an updated biological viability assessment for the UCR spring-run Chinook salmon ESU and for the UCR steelhead DPS (Ford 2022). They concluded that the viability ratings for UCR spring-run Chinook salmon and UCR steelhead remain at high risk and do not meet the viability criteria recommended by the ICTRT and adopted in the 2007 recovery plan. For UCR spring-run Chinook, all three populations remain below viability thresholds, and for UCR steelhead, all four populations remain below viability thresholds (Ford 2022). The Northwest Fisheries Science Center concluded, after reviewing the available new information, that the biological risk category for the UCR spring-run Chinook salmon ESU and for the UCR steelhead DPS has not changed since the time of the previous 2016 5-year review – both remain at high risk of extinction.
- *Listing Factor A (Habitat):* Conservation partners have implemented many tributary habitat restoration projects across the ESU and DPS since the last 5-year review, improving habitat conditions for both salmon and steelhead spawning, rearing, and

migration in many reaches. However, widespread areas of degraded habitat persist across the basin, with simplified stream channels, disconnected floodplains, impaired instream flow, loss of cold water refugia, and other limiting factors. Therefore, we conclude that since the last 5-year review, the risk to UCR spring Chinook salmon and UCR steelhead persistence because of habitat conditions has remained unchanged since the 2016 5-year review.

- *Listing Factor B (Overutilization):* The risk to the species' persistence because of overutilization remains essentially unchanged since the 2016 5-year review. New information available since the last 5-year review indicates harvest impacts have remained relatively constant (TAC 2015, 2016, 2017, 2018, 2019, 2020). Scientific research impacts authorized through the West Coast Region have remained relatively unchanged (non-lethal impacts increased while lethal impacts decreased) compared to the past 5 years (NMFS APPS database; https://apps.nmfs.noaa.gov/).
- *Listing Factor C (Disease and Predation*): Information available since the last 5-year review suggests that pinnipeds are consuming a large percentage of adult spring Chinook salmon migrating up the Lower Columbia River (e.g., Rub et al. 2019). The information available since the last 5-year review clearly indicates that predation by pinnipeds poses an adverse impact on the recovery of this ESU. This is less of an issue with the UCR steelhead DPS. Therefore, we conclude that since the last 5-year review, the risk to UCR spring Chinook salmon and UCR steelhead persistence because of predation has slightly increased.
- *Listing Factor D (Regulatory Mechanisms*): New information available since the last 5-year review indicates that the adequacy of a number of regulatory mechanisms has stayed the same on average, with some mechanisms showing the potential for some improvement whereas others made it more challenging to protect and recover our species.
- *Listing Factor E (Other Natural and Manmade Factors*): Climate change poses a major risk to both UCR species. Recent life cycle modeling suggests that increases in smolt survival are needed to overcome the negative impacts of climate change for Chinook salmon populations in this ESU; and that changing ocean conditions put these populations at high risk of extinction (Crozier et al. 2021). The year-long freshwater juvenile rearing stage makes both these species vulnerable to low stream flow and high stream temperatures. The hatchery programs that affect the UCR spring-run Chinook salmon ESU and UCR steelhead DPS have changed over time, and these changes have likely reduced adverse effects on ESA-listed species.

After considering the biological viability of the UCR ESU/DPS and the current status of their ESA section 4(a)(1) factors, we conclude that the status of the UCR spring-run Chinook salmon ESU and steelhead DPS has not improved significantly since the final listing determinations in 2005 and 2006, respectively. The implementation of sound management actions in hydropower, habitat, hatcheries, and harvest are essential to the recovery of the UCR ESU/DPS and must continue. The biological benefits of habitat restoration and protection efforts, in particular habitat restoration, have yet to be fully expressed and will likely take another ten to 40 years 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 actions over time, we will ensure that restoration efforts meet the biological needs of each population and, in turn, contribute to the recovery of these species. The UCR recovery plan and updated prioritization strategy is the primary guide for identifying future actions to target and address UCR spring-run Chinook salmon and UCR steelhead limiting factors and threats. Over the next 5 years, it will be important to continue to implement these actions and monitor our progress.

2.4.1 Upper Columbia River ESU and DPS Delineation and Hatchery Membership

The Northwest Fisheries Science Center's review (Ford 2022) found that no new information had become available that would justify a change in the delineation of the UCR spring-run Chinook salmon ESU and UCR steelhead DPS.

The West Coast Regional Office's review of new information since the previous 2016 5-year review regarding the ESU/DPS membership status of various hatchery programs indicates no changes in the UCR spring-run Chinook ESU membership are warranted. However, the Ringold Hatchery Program and the Okanogan component of the Wells Complex Program that are currently included in the UCR steelhead DPS should be removed because the Wells Hatchery stock is considered sufficiently divergent from the UCR steelhead populations that it is not included as part of the DPS (85 FR 81822), and because the Ringold Hatchery Program is solely dependent on the Wells Hatchery stock (NMFS 2017c). The inclusion of the Ringold Hatchery Program in the UCR steelhead DPS is no longer consistent with the Hatchery Listing Policy (70 FR 37204).

2.4.2 ESU/DPS Viability and Statutory Listing Factors

The Northwest Fisheries Science Center's review of updated information (Ford 2022) does not indicate a change in the biological risk category for either UCR species since the time of the last 5-year review (NWFSC 2015).

Our analysis of the ESA section 4(a)(1) factors indicates that the collective risk to the UCR salmon and steelhead's persistence has not changed significantly since our previous 5-year review for the UCR spring-run Chinook salmon ESU and the UCR steelhead DPS.

3. Results

3.1 Classification

Listing status:

Based on the information identified above, we determine that no reclassification for either of the two species is appropriate, and therefore:

- The UCR spring-run Chinook salmon ESU should remain listed as endangered.
- The UCR steelhead DPS should remain listed as threatened.

ESU/DPS Delineation:

The Northwest Fisheries Science Center's review (Ford 2022) found that no new information has become available that would justify a change in the delineation of the UCR steelhead DPS or spring-run Chinook salmon ESU.

Hatchery Membership:

For the UCR spring-run Chinook salmon ESU, we do not recommend any changes to the hatchery program membership.

For the UCR steelhead DPS, we recommend removal of the Ringold Hatchery Program and the Okanogan Component of the Wells Complex Program from the DPS for the reasons explained above.

3.2 New Recovery Priority Number

Since the previous 2016 5-year review, NMFS revised the recovery priority number guidelines and twice evaluated the numbers (NMFS 2019a, 2022). Table 4 indicates the numbers in place at the beginning of the current review. In January 2022, the numbers remained unchanged 1C for the UCR spring-run Chinook salmon ESU and 3C for the UCR steelhead DPS (NMFS 2022).

As part of this 5-year review we reevaluated the numbers based on the best available information, including the new viability assessment (Ford 2022), and concluded that the current recovery priority number for both species remains unchanged.

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4. Recommendations for Future Actions

In our review of the listing factors, we identified several actions critical to improving the status of the UCR steelhead DPS and the spring-run Chinook salmon ESU. The most important actions to be taken over the next 5 years include implementation of the high priority strategies and actions identified in the 2007 UCR recovery plan, the *U.S. v. Oregon* (in-river harvest) Management Agreement for years 2018-2027, the 2020 Columbia River System biological opinion (NMFS 2020b), and biological opinions on hatchery operations within the ESU/DPS (citations).

Some of the greatest opportunities to advance recovery are to:

- Prioritize tributary habitat projects that improve habitat resiliency to climate change. Actions to restore riparian vegetation, streamflow, and floodplain connectivity and to re-aggrade incised stream channels can ameliorate temperature increases, base flow decreases, and peak flow increases, thereby improving population resilience to certain effects of climate change (Beechie et al. 2013).
- Implement habitat restoration at a watershed scale. Roni et al. (2010) found that, for a watershed, at least 20 percent of floodplain and in-channel habitat need to be restored to see a 25 percent increase in salmon smolt production. Most watersheds occupied by this species have not yet reached that level of floodplain and habitat restoration.
- Reconnect stream channels with their floodplains. Reintroduction of beaver (Pollock et al. 2017) and low-tech process-based methods (Wheaton et al. 2019) will facilitate widespread, low-cost floodplain restoration across the Upper Columbia basin, increasing the productivity of freshwater habitat for salmon and steelhead.
- Ensure that habitat improvement actions are implemented consistent with best practices for watershed restoration (Beechie et al. 2010; Hillman et al. 2015; Appendix A of NMFS 2020b).
- Develop and implement long-term management strategies to reduce pinniped predation on adult spring Chinook and steelhead returning to the Lower Columbia River.

Additional recommended actions include:

- Fisheries co-managers further evaluating the impacts of other hatchery releases (both anadromous and resident) on spring-run Chinook salmon and steelhead.
- Federal and state management agencies continue estimating sea lion population (and predation rates on salmonids) in the Lower Columbia River.
- Federal, state, tribal and private entities improving estimates of research, monitoring, and evaluation handling (electrofishing, weirs, catch and release, tagging, marking, trapping, sorting) impacts.

- Federal, state, tribal, and private entities identifying contributing factors for lower or greater hatchery fish reproductive success.
- Federal, state, tribal, and private entities continuing focus and prioritization of recovery actions on limiting factors.
- Federal, state, tribal and private entities implementing Research Monitoring and Evaluation (RME) actions to address critical uncertainties.
- Assessing options for restoring access to UCR steelhead in the Similkameen River above Enloe Dam.
- Implementing habitat restoration actions that address anthropogenic features limiting natural riverine processes (e.g., removal or modification of levees, roads, culverts, irrigation infrastructure, bank stabilization, etc.)
- Restoring fish passage in Eightmile Creek and Twenty-mile Creek, tributaries to the Chewuch River.
- Finalizing and implementing a long-term agreement between U.S. Bureau of Reclamation, OID, and CCT to maintain perennial stream flow in the lower 4.3 miles of Salmon Creek.
- Addressing issues relating to the fish screen, diversion structure, and fishway in Salmon Creek.
- Implementing additional RME designed to increase understanding of productivity and diversity risk from hatchery programs.

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5.1 Federal Register Notices

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

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

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NATIONAL MARINE FISHERIES SERVICE
5-YEAR REVIEW
Oncorhynchus tshawytscha: Upper Colum

Current Classification: Endangered

Recommendation resulting from the 5-Year Review

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

Review Conducted By (Name and Office):

West Coast Region Upper Columbia River Spring-run Chinook Salmon ESU and Upper Columbia River Steelhead DPS Evaluation Team

REGIONAL OFFICE APPROVAL:

Lead Regional Administrator, NOAA Fisheries

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

Cooperating Regional Administrator, NOAA Fisheries

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

Signature____ Date: _______

HEADQUARTERS APPROVAL:

Assistant Administrator, NOAA Fisheries

[x] Concur [ ] Do Not Concur

Signature RAUCH.SAMUEL.D.III.1365850948 Digitally signed by RAUCH.SAMUEL.D.III.1365850948 Date: 2022.08.05 16:20:11 -04'00' Date: _______