Science, Service, Stewardship

2016 5-Year Review: Summary & Evaluation of Upper Willamette River Steelhead Upper Willamette River Chinook

National Marine Fisheries Service
West Coast Region
Portland, OR

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5-Year Review: Upper Willamette River Species

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

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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 historical abundance. There are several factors that contribute to these declines, including: overfishing, loss of freshwater and estuarine habitat, hydropower development, poor ocean conditions, and hatchery practices. These factors collectively led to the National Marine Fisheries Service's (NMFS) listing of 28 salmon and steelhead stocks in California, Idaho, Oregon, and Washington under the Federal Endangered Species Act (ESA).

The ESA, under section 4(c)(2), directs the Secretary of Commerce to review the listing classification of threatened and endangered species at least once every five years. After completing this review, the Secretary must determine if any species should be: (1) removed from the list; (2) have its status changed from threatened to endangered; or (3) have its status changed from endangered to threatened. The most recent listing determinations for most salmon and steelhead occurred in 2005 and 2006. This document describes the results of the 2016 five-year reviews of the ESA-listed Upper Willamette River (UWR) steelhead and Chinook salmon.

1.1.1 Background on salmonid listing determinations

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

To identify DPSs of steelhead, we apply the joint U.S. Fish and Wildlife Service-National Marine Fisheries Service DPS policy (61 FR 4722) rather than the ESU policy. Under this policy, a DPS of steelhead must be discrete from other populations, and it must be significant to its taxon.

Artificial propagation programs (hatcheries) are common throughout the range of ESA-listed West Coast salmon and steelhead. Prior to 2005, our policy was to include in the listed ESU or DPS only those hatchery fish deemed "essential for conservation" of a species. We revised that approach in response to a court decision and on June 28, 2005, announced a final policy addressing the role of artificially propagated Pacific salmon and steelhead in listing determinations under the ESA (70 FR 37204) (hatchery listing policy). This policy establishes

criteria for including hatchery stocks in ESUs and DPSs. In addition, it (1) provides direction for considering hatchery fish in extinction risk assessments of ESUs and DPSs; (2) requires that hatchery fish determined to be part of an ESU or DPS be included in any listing of the ESU or DPS; (3) affirms our commitment to conserving natural salmon and steelhead populations and the ecosystems upon which they depend; and (4) affirms our commitment to fulfilling trust and treaty obligations with regard to the harvest of some Pacific salmon and steelhead populations, consistent with the conservation and recovery of listed salmon ESUs and steelhead DPSs.

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

Because the new hatchery listing policy changed the way we considered hatchery fish in ESA listing determinations, we completed new status reviews and ESA listing determinations for West Coast salmon ESUs on June 28, 2005 (70 FR 37160), and for steelhead DPSs on January 5, 2006 (71 FR 834). On August 15, 2011, we published our status reviews and listing determinations for 11 ESUs of Pacific salmon and 6 DPSs of steelhead from the Pacific Northwest (76 FR 50448).

1.2 Methodology used to complete the review

On February 6, 2015, we announced the initiation of five-year reviews for 17 ESUs of salmon and 11 DPSs of steelhead in Oregon, California, Idaho, and Washington (80 FR 6695). We requested that the public submit new information on these species that has become available since our original listing determinations or since the species' status was last updated. In response to our request, we received information from Federal and state agencies, Native American Tribes, conservation groups, fishing groups, and individuals. We considered this information, as well as information routinely collected by our agency, to complete these five year reviews.

To complete the reviews, we first asked scientists from our Northwest and Southwest Fisheries Science Centers to collect and analyze new information about ESU and DPS viability. To evaluate viability, our scientists used the Viable Salmonid Population (VSP) concept developed by McElhany et al. (2000). The VSP concept evaluates four criteria – abundance, productivity, spatial structure, and diversity – to assess species viability. Through the application of this concept, the science center considered new information on the four salmon and steelhead population viability criteria. They also considered any new information available on the composition of the ESU and DPS. At the end of this process, the science teams prepared reports detailing the results of their analyses (NWFSC 2015).

To further inform the reviews, we also asked 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 whether any hatchery programs have ended, new hatchery programs have started, changes in the operation of existing programs have occurred, and scientific data relevant to the degree of divergence of hatchery fish from naturally spawning fish in the same area. These biologists produced a report (Jones 2015) describing their findings. Finally, we consulted salmon management biologists from the West Coast Region who are familiar with hatchery programs, habitat conditions, hydropower operations, and harvest management. In a series of structured meetings, by geographic area, these biologists identified relevant information and provided their insights on the degree to which circumstances have changed for each listed entity.

In preparing this report, we considered the best available information, including the work of the Northwest Fisheries Science Center (NWFSC 2015); the report of the regional biologists regarding hatchery programs (Jones 2015); recovery plans for the species in question; technical reports prepared in support of recovery plans for the species in question; the listing record (including designation of critical habitat and adoption of protective regulations); recent biological opinions issued for UWR species; 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

80 FR 6695; February 6, 2015

1.3.2 Listing history

In 1999, NMFS listed UWR steelhead and Chinook salmon as threatened species (Table 1).

Table 1. Summary of the listing history under the Endangered Species Act for ESU and DPS in the upper Willamette River.

Salmonid Species	ESU/DPS Name	Original Listing	Revised Listing(s)
Steelhead (*O. mykiss*)	Upper Willamette River Steelhead	**FR Notice:** 64 FR 14517 **Date:** 3/25/1999 **Classification:** Threatened	**FR Notice:** 71 FR 834 **Date:** 1/5/2006 **Classification:** Threatened
Chinook Salmon (*O. tshawytscha*)	Upper Willamette River Chinook Salmon	**FR Notice:** 64 FR 14308 **Date:** 3/24/1999 **Classification:** Threatened	**FR Notice:** 70 FR 37160 **Date:** 6/28/2005 **Classification:** Threatened

1.3.3 Associated rulemakings

The ESA requires NMFS to designate critical habitat, to the maximum extent prudent and determinable, for species it lists under the ESA. Critical habitat is defined as: (1) specific areas within the geographical area occupied by the species at the time of listing, if they contain physical or biological features essential to conservation, and those features may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by the species at the time of listing if the agency determines that the area itself is essential for conservation. We designated critical habitat for the UWR steelhead DPS and Chinook salmon ESU 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, trap, capture, or collect, or attempt to engage in any such conduct. For threatened species, the ESA does not automatically prohibit take, but instead authorizes the agency to adopt regulations it deems necessary and advisable for species conservation including regulations that prohibit take (ESA section 4(d)). In 2000, NMFS adopted 4(d) regulations for threatened salmonids that prohibit take except in specific circumstances. In 2005, we revised our 4(d) regulations for consistency between ESUs and DPSs, and, to take into account our hatchery listing policy.

Table 2. Summary of rulemaking for 4(d) protective regulations and critical habitat for ESU and DPS in the upper Willamette River.

Salmonid Species	ESU/DPS Name	4(d) Protective Regulations	Critical Habitat Designations
Steelhead (*O. mykiss*)	Upper Willamette River Steelhead	**FR notice:** 65 FR 42422 **Date:** 7/10/2000 **Revised:** 6/28/2005 (70 FR 37160)	**FR notice:** 70 FR 52630 **Date:** 9/2/2005
Chinook Salmon (*O. tshawytscha*)	Upper Willamette River Chinook Salmon	**FR notice:** 65 FR 42422 **Date:** 7/10/2000 **Revised:** 6/28/2005 (70 FR 37160)	**FR Notice:** 70 FR 52630 **Date:** 9/2/2005

1.3.4 Review History

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

Table 3. Summary of previous scientific assessments for UWR Steelhead and Chinook Salmon.

Salmonid Species	ESU/DPS Name	Document Citation
Steelhead (*O. mykiss*)	Upper Willamette River Steelhead	NWFSC 2015 Ford et al. 2011 ODFW and NMFS 2011 McElhany et al. 2007 Myers et al. 2006 WLCTRT and ODFW 2006 NMFS 2005 Good et al. 2005 Maher et al. 2005 WLCTRT 2004 WLCTRT 2003 NMFS 1999a NMFS 1999b NMFS 1998a NMFS 1997a NMFS 1997b NMFS 1997c Busby et al. 1996
Chinook Salmon (*O. tshawytscha*)	Upper Willamette River Chinook Salmon	NWFSC 2015 Ford et al. 2011 ODFW AND NMFS 2011 McElhany et al. 2007 Myers et al. 2006 WLCTRT and ODFW 2006 NMFS 2005 Good et al. 2005 Maher et al. 2005 WLCTRT 2004 WLCTRT 2003 NMFS 1999b Myers et al. 1998 NMFS 1998b

1.3.5 Species' Recovery Priority Number at Start of 5-year Review Process

On June 15, 1990, NMFS issued guidelines (55 FR 24296) for assigning listing and recovery priorities. For recovery plan development, implementation, and resource allocation, we assess three criteria to determine a species' recovery priority number from 1 (high) to 12 (low): (1) magnitude of threat; (2) recovery potential; and (3) conflict with development projects or other economic activity (NMFS 2009). Table 4 lists the recovery priority numbers for the subject species, as reported in NMFS 2015a.

1.3.6 Recovery Plan or Outline

Table 4. Recovery Priority Number and Endangered Species Act Recovery Plans for UWR Steelhead and Chinook Salmon.

Salmonid Species	ESU/DPS Name	Recovery Priority Number	Recovery Plans/Outline
Steelhead (*O. mykiss*)	Upper Willamette River Steelhead	**9**	**Title:** Upper Willamette River Conservation and Recovery Plan for Chinook Salmon and Steelhead Available at: http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/willamette_river/upper_willamette_river_recovery_plan_for_chinook_salmon_steelhead.html **Date:** August 22, 2011 **Type:** Final **FR Notice:** 76 FR 52317
Chinook Salmon (*O. tshawytscha*)	Upper Willamette River Chinook Salmon	**9**	**Title:** Upper Willamette River Conservation and Recovery Plan for Chinook Salmon and Steelhead Available at: http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/willamette_river/upper_willamette_river_recovery_plan_for_chinook_salmon_steelhead.html **Date:** August 22, 2011 **Type:** Final **FR Notice:** 76 FR 52317

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2 · Review Analysis

In this section, we review new information to determine whether the UWR listed 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 Willamette River Steelhead	X	
Upper Willamette River Chinook Salmon	X	

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

ESU/DPS Name	YES	NO
Upper Willamette River Steelhead	X	
Upper Willamette River Chinook Salmon	X	

Was the ESU/DPS listed prior to 1996?

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

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

In 1991, NMFS issued a policy on how the agency would delineate DPSs of Pacific salmon for listing consideration under the ESA (56 FR 58612). Under this policy a group of Pacific salmon populations is considered an ESU if it is substantially reproductively isolated from other con-specific populations, and it represents an important component in the evolutionary legacy of the biological species. The 1996 joint NMFS-Fish and Wildlife Service (FWS) 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 UWR steelhead DPS under the DPS policy in 1999, we used the joint DPS policy to delineate the DPS under the ESA.

2.1.1 Summary of relevant new information regarding delineation of the UWR ESU/DPS

ESU/DPS Composition

This section provides a summary of information presented in NWFSC 2015: Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest.

We found no new information that would justify a change in the composition of the UWR steelhead DPS or the UWR spring-run Chinook salmon ESU (NWFSC 2015).

Membership of Hatchery Programs

In preparing this report, our management biologists reviewed the available information regarding hatchery membership of this ESU and DPS (Jones 2015). They considered changes in hatchery programs that occurred since the last status review (e.g., some have been terminated while others are new) and made recommendations about the inclusion or exclusion of specific programs. They also noted any errors and omissions in the existing descriptions of hatchery population membership. NMFS intends to address any needed changes and corrections via separate rulemaking subsequent to the completion of these five-year status reviews.

UWR Steelhead

The UWR steelhead DPS includes all naturally spawned anadromous winter-run *O. mykiss* (steelhead) originating below natural and manmade impassable barriers from the Willamette River and its tributaries upstream of Willamette Falls to and including the Calapooia River (79 FR 20802).

There is no change in the UWR steelhead hatchery programs since the previous ESA status review (Jones 2015). All hatchery winter-run steelhead programs were terminated in the late 1990s, and the current summer-run steelhead hatchery program within the geographic boundaries of the DPS is not part of the DPS because it was originally derived from a non-native, out of DPS Skamania broodstock (Jones 2015).

UWR Chinook Salmon

The UWR Chinook salmon ESU includes naturally spawned spring-run Chinook salmon originating from the Clackamas River and from the Willamette River and its tributaries above Willamette Falls. Also, spring-run Chinook salmon from six artificial propagation programs: the McKenzie River Hatchery Program (Oregon Department of Fish and Wildlife (ODFW) Stock #23); Marion Forks Hatchery/North Fork Santiam River Program (ODFW Stock #21); South Santiam Hatchery Program (ODFW Stock #24) in the South Fork Santiam River and Molalla River; Willamette Hatchery Program (ODFW Stock #22); and the Clackamas Hatchery Program (ODFW Stock #19) (79 FR 20802).

The UWR Chinook salmon hatchery programs have not changed substantially from the previous ESA status review to suggest that their level of divergence relative to the local natural populations has changed (Jones 2015).

2.2 Recovery Criteria

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

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

ESU/DPS Name	YES	NO
Upper Willamette River Steelhead	X	
Upper Willamette River Chinook Salmon	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 Willamette River Steelhead	X	
Upper Willamette River Chinook Salmon	X	

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

ESU/DPS Name	YES	NO
Upper Willamette River Steelhead	X	
Upper Willamette River Chinook Salmon	X	

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

For the purposes of reproduction, salmon ESUs and steelhead DPSs typically display a metapopulation structure (Schtickzelle and Quinn 2007, McElhany et al. 2000). Rather than interbreeding as one large aggregation, ESUs and DPSs function as a group of independent populations separated by areas of unsuitable spawning habitat. For conservation and management purposes, it is important to identify the independent populations that make up an ESU or DPS. For recovery planning and development of recovery criteria, the Willamette-Lower Columbia Technical Recovery Team (WLC TRT) identified independent populations within the UWR steelhead DPS and the UWR Chinook salmon ESU. The WLC TRT also recommended specific biological viability criteria at the scale of independent populations and ESUs/DPSs. Multiple specific combinations of populations in each ESU or DPS could achieve WLC TRT's criteria.

The 2011 Upper Willamette River Recovery Plan (ODFW and NMFS 2011) adopted the biological criteria for achieving delisting established by the WLC TRT (McElhany et al. 2003; McElhany et al. 2006) based on the concept of population 'viability.' A viable population is one with negligible risk of extinction over 100 years. The WLC TRT criteria are based on a scoring system to describe each population's probability of extinction, as categorized into 'extinction risk' classes. In order to meet the biological criteria for delisting, the UWR steelhead DPS must have three out of four viable populations, and the UWR spring-run Chinook salmon ESU must have four out of seven viable populations.

UWR Steelhead

The UWR steelhead DPS includes all naturally spawned anadromous winter-run *O. mykiss* (steelhead) originating below natural and manmade impassable barriers from the Willamette River and its tributaries upstream of Willamette Falls to and including the Calapooia River (79 FR 20802; Figure 1).

The WLC TRT identified four historical demographically independent populations for UWR winter-run steelhead: Molalla, North Santiam, South Santiam, and Calapooia (Myers et al. 2006). The WLC TRT delineated the populations on geography, migration rates, genetic attributes, life history patterns, phenotypic characteristics, population dynamics, and environmental and habitat characteristics (Myers et al. 2006).

UWR Chinook Salmon

The UWR Chinook salmon ESU includes naturally spawned spring-run Chinook salmon originating from the Clackamas River and from the Willamette River and its tributaries above Willamette Falls. Also, spring-run Chinook salmon from six artificial propagation programs: the McKenzie River Hatchery Program (ODFW Stock #23); Marion Forks Hatchery/North Fork Santiam River Program (ODFW Stock #21); South Santiam Hatchery Program (ODFW Stock #24) in the South Fork Santiam River and Molalla River; Willamette Hatchery Program (ODFW Stock #22); and the Clackamas Hatchery Program (ODFW Stock #19) (79 FR 20802; Figure 2).

The WLC TRT identified seven demographically independent populations of spring-run Chinook salmon in the UWR Chinook salmon ESU: Clackamas, Molalla, North Santiam, South Santiam, Calapooia, McKenzie, and the Middle Fork Willamette (Myers et al. 2006). The WLC TRT classified the Clackamas, North Santiam, McKenzie and Middle Fork Willamette populations as "core populations" and the McKenzie as a "genetic legacy population." All the populations are part of the Cascades Tributaries Stratum for the ESU. The WLC TRT delineated the populations based on geography, migration rates, genetic attributes, life history patterns, phenotypic characteristics, population dynamics, and environmental and habitat characteristics (Myers et al. 2006).

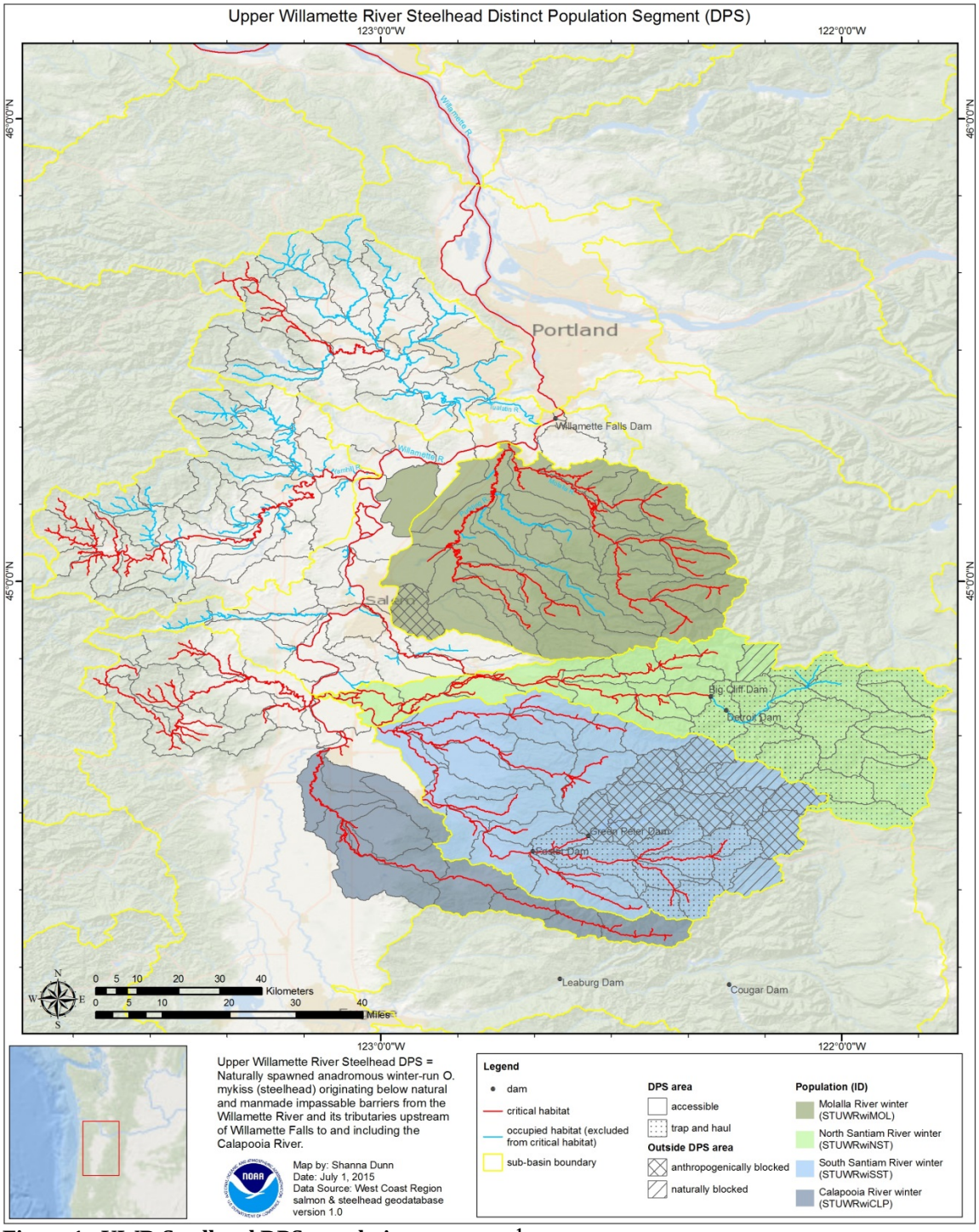

Figure 1. UWR Steelhead DPS population structure.[1]

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

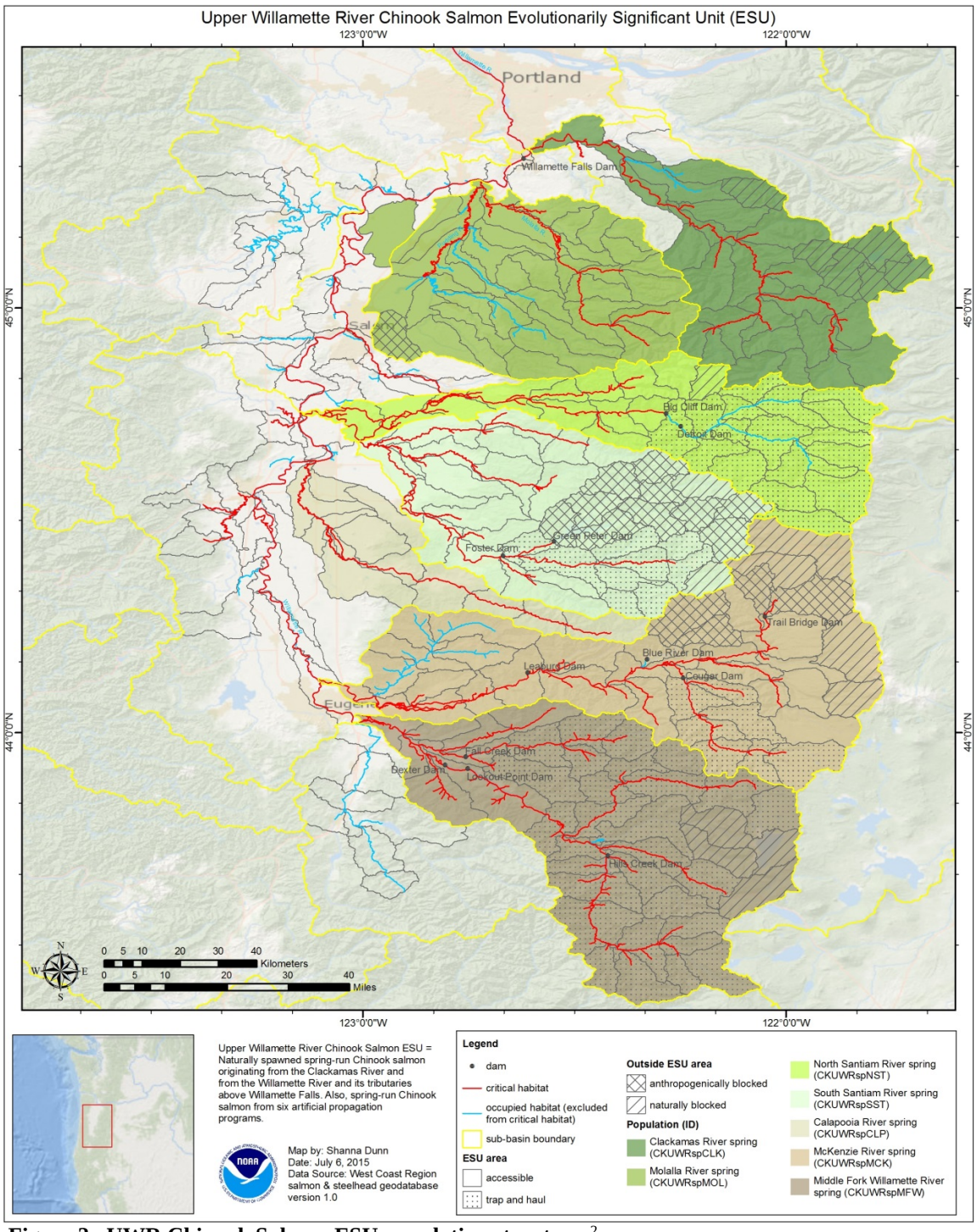

Figure 2. UWR Chinook Salmon ESU population structure.[2]

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

2.3 Updated Information and Current Species' Status

2.3.1 Analysis of Viable Salmonid Population (VSP) Status

Information provided in this section is summarized from NWFSC 2015—Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest.

UWR Steelhead DPS

Updated Risk Summary

Overall, the declines in abundance noted during the previous review (Ford et al. 2011) continued through the period 2010-2015. There is considerable uncertainty in many of the abundance estimates, except for perhaps the tributary dam counts. Radio-tagging studies suggest that a considerable proportion of winter-run steelhead ascending Willamette Falls do not enter the demographically independent populations (DIPs) that constitute this DPS; these fish may be non-native early winter-run steelhead that appear to have colonized the western tributaries, misidentified summer-run steelhead, or late winter-run steelhead that have colonized tributaries not historically part of the DPS. More definitive genetic monitoring of steelhead ascending Willamette Falls in tandem with radio-tagging work needs to be undertaken to estimate the total abundance of the DPS (NWFSC 2015).

The release of non-native summer-run steelhead continues to be a concern. Genetic analysis suggests that there is some level introgression among native late-winter-run steelhead and summer-run steelhead (Van Doornik et al. 2015). Accessibility to historical spawning habitat is still limited, especially in the North Santiam River. Much of the accessible habitat in the Molalla, Calapooia, and lower reaches of North and South Santiam rivers is degraded and under continued development pressure. Although habitat restoration efforts are underway, the time scale for restoring functional habitat is considerable (NWFSC 2015).

UWR Chinook Salmon ESU

Updated Risk Summary

In evaluating the status of UWR spring-run Chinook salmon there are number of general considerations that affect some or all of the populations. In addition to the pre-spawning mortalities monitored in the specific population basins, there is a shortfall in abundance between Willamette Falls and East side tributary census points due to pre-spawning mortality or spawning in the unsurveyed lower reaches of east or west-side tributaries (Jepson et al. 2013; Jepson et al. 2014) where spawning and incubation conditions are less well-suited to spring-run Chinook salmon. Radio-tagging results from 2014 suggest that few fish strayed into west-side tributaries (no detections) and relatively fewer fish were unaccounted for between Willamette Falls and the tributaries, 12.9 percent of clipped fish and 5.3 percent of unclipped fish (Jepson et al. 2015). Access to historical spawning and rearing areas is restricted by large dams in the four historically most productive tributaries, and in the absence of effective passage programs will continue to be confined to more lowland reaches where land development, water temperatures, and water quality may be limiting. Pre-spawning mortality levels are generally high in the lower tributary

reaches where water temperatures and fish densities are generally the highest. Areas immediately downstream of high head dams may also be subject to high levels of total dissolved gas (TDG). While the relationship between TDG levels and mortality is related to a complex interaction of fish species, age, depth, and history of exposure (Beeman and Maule 2006), the relative risks are quite high in some reaches. For example, natural origin Chinook salmon and steelhead are passed above the barrier dam at the Minto fish facility into a short reach immediately below the Detroit/Big Cliff Dam complex. At certain times of the year, water spilled over Detroit and Big Cliff dams on the North Santiam River has the potential to produce high levels of TDG, which could affect a significant portion of the incubating embryos, in-stream juveniles, and adults in the basin, although the effect of this impact has not been quantified (NWFSC 2015).

The apparent decline in the status of the McKenzie River DIP in the last 10 years is a source of concern given that this population was previously seen as a stronghold of natural production in the ESU. In contrast to most of the other populations in this ESU, McKenzie River Chinook salmon have access to much of their historical spawning habitat, although access to historically high quality habitat above Cougar Dam (South Fork McKenzie River) is still limited by poor downstream juvenile passage. Additionally, the installation of a temperature control structure in Cougar Dam in 2008 was thought to benefit downstream spawning and rearing success. Similarly, natural-origin returns to the Clackamas River have remained flat, despite adults having access to much of their historical spawning habitat. Although returning adults have access to most of the Calapooia and Molalla basin, habitat conditions are such that the productivity of these systems is very low. Natural-origin spawners in the Middle Fork Willamette River in the last 10 years consisted solely of adults returning to Fall Creek. While these fish contribute to the DIP and ESU, at best the contribution will be minor. Finally, improvements were noted in the North and South Santiam DIPs. The increase in abundance in both DIPs was in contrast to the other DIPs and the counts at Willamette Falls. While spring-run Chinook salmon in the South Santiam DIP have access to some of their historical spawning habitat, natural origin spawners in the North Santiam are still confined to below Detroit Dam and subject to relatively high pre-spawning mortality rates (NWFSC 2015).

Although there has likely been an overall decrease in the VSP status of the ESU since the last review, the magnitude of this change in not sufficient to suggest a change in risk category. Given current climatic conditions and the prospect of long-term climatic change, the inability of many populations to access historical headwater spawning and rearing areas may put this ESU at greater risk in the near future (NWFSC 2015).

2.3.2 Five-Factor Analysis

Section 4(a)(1)(b) of the ESA directs us to determine whether any species is threatened or endangered because of any of the following factors: (A) the present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; or (E) other natural or human-made factors affecting its

continued existence. Section 4(b)(1)(A) requires us to make listing determinations after conducting a review of the status of the species and taking into account efforts to protect such species. Below we discuss new information relating to each of the five factors as well as efforts being made to protect the species.

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

Significant habitat restoration and protection actions at the Federal, state, tribal, and local levels have been implemented to improve degraded habitat conditions and restore fish passage. While these efforts are expected to improve survival and productivity of the targeted populations, they do not constitute a comprehensive implementation of recommendations in the recovery plan. At this point we do not yet have information 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 be monitored and evaluated with the aid of new reporting techniques. Generally, it takes one to five decades to demonstrate such increases in viability.

Current Status and Trends in Habitat

Below, we summarize information for UWR spring-run Chinook salmon and UWR steelhead regarding current **status and trends in habitat** conditions for these two species since our last 2011 status 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 viability (NWFSC 2015); (2) **specific geographic areas of concern** where issues about this ESU/DPS habitat condition remain; (3) **key protective measures and major restoration actions** leading toward achieving the recovery plan viability criteria that substantially address a key concern noted above, or that represent a noteworthy conservation strategy; (4) **key regulatory measures** that are inadequate and contributing substantially to the key concerns summarized above; (5) **recommended future actions**, including: key near-term restoration actions that would address the key concerns summarized above; projects to address monitoring and research gaps; fixes or initiatives to address inadequate regulatory mechanisms, and addressing priority habitat areas when sequencing restoration actions.

1) Key Emergent or Ongoing Habitat Concerns

UWR Steelhead

- Lack of accessibility to historical spawning habitat, especially in the North Santiam River.
- Degraded accessible habitat under continued development pressure in the Molalla, Calapooia, and lower reaches of North and South Santiam rivers.
- Lack of high quality habitat below Detroit Dam on the North Santiam River.
- Lack of accessibility to historical spawning and rearing habitat above the Green Peter Dam (Quartzville Creek and Middle Santiam River).

- Juvenile downstream passage at Foster Dam for the South Santiam River population.

UWR Chinook Salmon

- Restricted access to historical spawning and rearing areas due to large dams (Bennett, Big Cliff, Detroit, Foster, Green Peter, Dexter, Fall Creek, Lookout Point, Cougar) in the four historically most productive tributaries for UWR spring-run Chinook salmon (North Santiam, South Santiam, Middle Fork Willamette, and McKenzie rivers). In the absence of effective passage programs, access will continue to be confined to more lowland reaches where land development, water temperatures, and water quality may be limiting. Pre-spawning mortality levels are generally high in the lower tributary reaches where water temperatures and fish densities[3] are generally the highest. Areas immediately downstream of high head dams may also be subject to high levels of TDG.

- Access to historically high quality habitat above Cougar Dam (South Fork McKenzie River) continues to be limited by poor downstream juvenile passage for the McKenzie River population, in spite of the fact that the installation of a temperature control structure in Cougar Dam in 2008 was thought to benefit downstream spawning and rearing success of this population.

- Loss of flood plain habitat (e.g., from levees and other bank armoring) and habitat-forming flows; reduced shallow water habitat, velocity refuge in winter in UWR tributaries and the lower mainstem Willamette River (especially in heavily developed areas including the Portland Harbor) has resulted in degraded juvenile rearing habitat as described in the ODFW and NMFS 2011 recovery plan and is an ongoing concern for UWR spring-run Chinook salmon.

2) Specific Geographic Areas of Concern

- Dams and reservoirs in the Santiam, McKenzie, and Middle Fork Willamette rivers for both the UWR steelhead and spring-run Chinook salmon populations (NWFSC 2015).

- In-stream and riparian reaches in the mainstem Willamette River, especially below Willamette Falls, the Portland Harbor, and other highly developed areas where shallow water and flood plain habitat has been lost or degraded.

3) Key Protective Measures and Major Restoration Actions

- Efforts have been underway since the 2011 status review to implement actions recommended in the UWR Recovery Plan (ODFW and NMFS 2011) relating to habitat limiting factors. These include numerous projects for habitat acquisition, easements, and restoration funded by the Oregon Watershed Enhancement Board (OWEB), Meyer Memorial Trust, and the City of Portland. Efforts to address habitat issues related to regulatory measures such as the Willamette Project and Federal Energy Regulatory Commission (FERC) long-term relicensing settlement

[3] Reaches downstream of fish hatcheries contain relatively large numbers of hatchery fish, which may also be more susceptible to pre-spawning mortality.

agreements are addressed under Listing Factor D: Adequacy & Inadequacy of Regulatory Mechanisms, and Protective Efforts in this document.

- OWEB (OWEB 2016): From 2010 to 2015, most funds were spent on acquisition of fee title property or conservation easements and the planning and design of restoration projects. By 2013, some of the restoration work had begun with more following in 2014-2015. It is still premature to see any results from most of these although data collected in the channels restored in gravel pits have shown lower temperatures.
    - Acquisitions and habitat restoration in the upper reaches of the Willamette River, above Albany at river mile 120.
    - Purchasing or restoring former gravel pits, primarily in the Middle Fork Willamette River near its confluence with the mainstem Willamette River at river mile 190.
    - Reconnecting the floodplain on Green Island (river mile 174) at the confluence of the McKenzie and Willamette rivers, conversion of over 1200 acres of farmland to riparian forest, swales, and oak savannah at Harkens Lake (river miles 153-155), and similar work on 198 acres of farmland in the Little Willamette area (river mile 124).
    - Restoration on publically owned land at Snag Boat Bend and Sam Daws (at river miles 144-147) reconnecting 61 acres, with 55 acres slated for replanting in 2016. Also underway are several smaller acquisitions of private lands, and floodplain forest restoration projects on public lands.
- Meyer Memorial Trust[4]: In 2008, the Meyer Memorial Trust established the Willamette River Initiative (WRI), a 10-year program to help improve ecological outcomes for the Willamette River and its tributaries through better knowledge, practice, and coordination of agency and nonprofit restoration efforts. WRI, designed with science-driven goals, has provided approximately $900,000 each year to more than 25 grantees from volunteer-based watershed councils to conservation groups and to university researchers.[5]
- City of Portland: The City of Portland continues to fund projects that directly support salmon recovery such as habitat restoration to reduce flood risks in Johnson Creek[6] and Crystal Springs.[7]

4) Key Regulatory Mechanisms

Various federal, state, county and tribal regulatory mechanisms are in place to reduce habitat degradation caused by human use and development. Many of these mechanisms have been

[4] http://mmt.org/our-portfolios/environment
[5] http://willametteinitiative.org/
[6] https://www.portlandoregon.gov/bes/article/214367 and http://www.portlandoregon.gov/bes/article/286175
[7] https://www.portlandoregon.gov/article/315581

improved and updated in the past five years, however, the implementation and effectiveness of regulatory mechanisms has not been adequately documented. See Listing Factor D: Adequacy & Inadequacy of Regulatory Mechanisms, and Protective Efforts in this document for details.

5) Recommended Future Actions

- Implement effective passage programs and revision of reservoir operations that will promote access to historical spawning and rearing areas currently blocked by the large dams in the four historically most productive tributaries (North and South Santiam, Middle Fork Willamette, and McKenzie rivers), described above under Key Emergent or Ongoing Habitat Concerns.
- NMFS and ODFW should convene the Willamette River Coordination Team described in Subsection 9.1 (Action Details – Priority, Locations, Schedule, Costs, and Implementers) of the UWR Recovery Plan (ODFW and NMFS 2011) and develop 1- and 3-year implementation plans to include as high priority action items:
    - Protection and restoration of floodplain connection and function, off-channel habitat, and channel migration processes to improve rearing habitat.
    - Habitat restoration implementation in the lower Willamette River, especially Portland Harbor.
    - Removal of non-essential levees and other bank armoring structures along the Willamette River that reduce habitat complexity and therefore rearing habitat.
- Systematically review and analyze the amount of habitat addressed against those high priority upper Willamette River mainstem and tributary areas identified in the ODFW and NMFS 2011 Upper Willamette River Recovery Plan.

Listing Factor A Conclusion

New information available since the last status review indicates that a number of restoration and protection actions have been implemented in freshwater and estuary habitat throughout the range of UWR salmon and steelhead. However, at this time we do not have information that would reveal improvements in habitat quality, quantity, and function. Future status assessments would benefit from a systematic review and analysis of the amount of habitat addressed against those high priority upper Willamette River mainstem and tributary areas identified in the ODFW and NMFS 2011 Recovery Plan. We remain concerned about degraded habitat conditions throughout the range of the steelhead DPS and spring-run Chinook salmon ESU, particularly with regard to land use and development activities that affect the quality and accessibility of habitats and habitat-forming processes such as riparian condition and floodplain function as well as water quality. Overall, we conclude that the risk to the species' persistence because of habitat destruction or modification has not changed since the last status review.

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

Harvest

UWR Steelhead

There is no directed fishery for winter-run steelhead in the upper Willamette River. Due to differences in return timing between native winter-run steelhead, introduced hatchery summer-run steelhead, and hatchery spring-run Chinook salmon the encounter rates for winter-run fish in the recreational fishery are thought to be low. Steelhead were historically taken in tribal and non-tribal gillnet fisheries, and in recreational fisheries in the mainstem Columbia River and in tributaries. In the 1970s, retention of steelhead in non-tribal commercial fisheries was prohibited, and in the mid-1980s, tributary recreational fisheries in Washington adopted mark-selective regulations. Sport fishery mortality rates were estimated at 0-3 percent (ODFW and NMFS 2011). There is additional incidental mortality in the commercial net fisheries for Chinook salmon and steelhead in the lower Columbia River. Tribal fisheries occur above Bonneville Dam and do not impact UWR steelhead (NWFSC 2015).

UWR Chinook Salmon

UWR spring-run Chinook salmon are taken in ocean fisheries primarily in Canada and Alaska. They are also taken in lower mainstem Columbia River commercial gillnet fisheries, and in recreational fisheries in the mainstem Columbia River and the Willamette River. These fisheries are directed at hatchery production, but historically could not discriminate between natural and hatchery fish. In the late 1990s, ODFW began mass-marking the hatchery production, and recreational fisheries within the Willamette River switched over to retention of only hatchery fish, with mandatory release of unmarked fish. Overall exploitation rates reflect this change in fisheries dropping from the 50-60 percent range in the 1980s and early 1990s to around 30 percent since 2000, with difference observed in both ocean and freshwater fisheries. Hooking mortalities are generally estimated at 10 percent, although river temperatures likely influence this rate. Illegal take of unmarked fish is thought to be low (NWFSC 2015).

Research and Monitoring

Much of the scientific research and monitoring being conducted for UWR steelhead and UWR Chinook salmon is intended to fulfill managers' obligations under the ESA to ascertain the status of the species. For authorized scientific research and monitoring throughout the Pacific Northwest (PNW), authorized mortality rates are capped at no greater than 0.5 percent of any PNW ESA-listed salmonid ESU/DPS. In 2014, researchers were approved to take up to 6,291 naturally produced juvenile UWR steelhead with a 1.68 percent mortality rate and 78,033 naturally produced juvenile UWR Chinook salmon with a 2.86 percent mortality rate. For the vast majority of scientific research permits, history has shown that researchers generally take far fewer salmonids than the allotted number of salmonids every year (12.35 percent of requested take and 11.07 percent of requested mortalities were used in PNW Section 10(a)(1)(A) permits from 2008 to 2014). The majority of the requested nonlethal take of juvenile steelhead have

been and are expected to continue to be captured with beach seines (40.2 percent), dam bypass (23.7 percent), screw traps (11.9 percent), electrofishing units (8.8 percent), and minnow traps (3.4 percent) (NMFS APPS database; https://apps.nmfs.noaa.gov/). Our records from the past nine years indicate that mortality rates for beach seines and screw traps are typically less than 1 percent and backpack electrofishing typically less than 3 percent. Researchers deploy screw traps from late winter through early summer to capture juvenile salmon and steelhead during their annual outmigration. Managers use the data collected from screw traps to derive estimates of outmigration abundance. Backpack electrofishing is used to capture juvenile fish for abundance estimates, tagging and marking, and tissue samples. However, a small number of the naturally produced adult fish may die as an unintended result of the research.

Because the majority of fish that researchers capture and release recover shortly after handling with no long-term ill effects, the effect of the action we consider here is the potential mortality. When compared to the abundance of the ESU/DPS, the potential mortality levels are typically low. These effects would be spread out over various channels and tributaries of the Willamette River basin. Thus, no population is likely to experience a disproportionate amount of these losses. Therefore, the research would likely have only a very small impact on abundance, a similarly small impact on productivity, and no measureable effect on spatial structure or diversity.

Listing Factor B Conclusion

Harvest-related impacts on natural-origin spring-run Chinook salmon and steelhead remain low on all populations in the ESU and DPS. For UWR steelhead, there is no directed fishery for winter-run steelhead in the upper Willamette River. In the mainstem Columbia River, sport fishery mortality rates were estimated at 0-3 percent (ODFW and NMFS 2011). Further, there is additional incidental mortality in the commercial net fisheries for Chinook salmon and steelhead in the lower Columbia River. The UWR spring-run Chinook salmon are taken in the lower mainstem Columbia River commercial gillnet fisheries and the recreational fisheries in the mainstem Columbia River and the Willamette River. Although these fisheries are directed at hatchery production, hooking mortalities are generally estimated at 10 percent and river temperatures likely influence this rate (NWFSC 2015).

For research, the quantity of permits issued over the past five years has been mostly consistent with the prior five years and the overall effect on listed populations has not changed substantially. Therefore, we conclude that the risk to the species' persistence because of utilization related to scientific studies remains essentially unchanged since the 2011 status review.

Listing Factor C: Disease or Predation

Predation

A Columbia River Basin-wide assessment of avian predation on juvenile salmonids indicates that the most significant impacts to smolt survival occur in the Columbia River estuary (Collis et al. 2009). Although actions to reduce avian predation in the Columbia River Basin have been

ongoing with implementation of the Federal Columbia River Power System (FCRPS) Biological Opinion (Opinion), high levels of avian predation by Caspian terns and double-crested cormorants continue to affect the UWR steelhead DPS and UWR Chinook salmon ESU. Further, predation remains a concern because of a general increase in pinniped populations along the West Coast. Non-indigenous fish affect salmon and their ecosystems through many mechanisms.

Caspian Terns

The NMFS' 2008 FCRPS Opinion recommended that the Action Agencies implement the Caspian Tern Management Plan [Reasonable and Prudent Alternative (RPA) Action 45] to substantially reduce this species' nesting habitat and salmonid predation rates in the Columbia River estuary by 2018. The plan calls for reductions in nesting habitat for Caspian terns at East Sand Island in the lower estuary, concurrent with the development of alternative nesting habitat elsewhere in the interior Northwest and along the California coast (i.e., outside the Columbia River basin) (NMFS 2014a). To date, nine alternative nesting habitat islands totaling 8.3 acres have been constructed at interior locations, but no coastal sites have been developed. Tern nesting habitat on East Sand Island has been reduced from 6 acres down to a current 1.58 acres, which has reduced the colony from a pre-management level of about 9,000 pairs to 6,000 to 6,500 pairs. However, this is short of the reduction to 3,500 to 4,000 pairs that was anticipated by the management plan and assessed in the 2008 Opinion's analysis (NMFS 2014a).

Double-crested Cormorants

The number of double-crested cormorants nesting in the Columbia River estuary has increased from about 150 pairs in the early 1980s to 11,000 to 13,500 pairs, with most of the increase occurring over the past 10 years (Appendix E in NMFS 2014a). Consumption rates of juvenile salmon and steelhead also increased during this period; in 2006, double-crested cormorants probably consumed more than 4 percent of the juvenile yearling Chinook salmon and about 13 percent of the juvenile steelhead in the lower Columbia River. In the 2014 FCRPS Supplemental Opinion, NMFS therefore recommended that the Action Agencies develop a cormorant management plan and implement actions to reduce cormorant numbers to no more than 5,380 to 5,939 nesting pairs on East Sand Island (RPA Action 46). The Corps completed a Cormorant Management Environmental Impact Statement and Management Plan in early 2015 and began implementation on East Sand Island in late May by culling adults and oiling eggs.

Pinnipeds

Status of Pinnipeds Populations in Oregon and Washington

Pinniped predation continues to remain a concern for listed species in Oregon and Washington due to a general increase in pinniped populations along the West Coast. For example, California sea lions have increased at a rate of 5.4 percent per year between 1975 and 2011 (NMFS 2015b), Steller sea lions have increased at a rate of 4.18 percent per year between 1979 and 2010 (Allen

and Angliss 2014), and harbor seals likely remain at or near carrying capacity in Washington and Oregon (Jefferies et al. 2003, Brown et al. 2005, respectively, as cited in NMFS 2014b).[8]

Columbia River Basin

In the Columbia River Basin, there has been a steady influx of pinnipeds (Figure 3), especially California sea lions, over the past 5 years with sharp increases in California sea lion presence in 2013 of 750 animals, 1,420 animals in 2014,[9] and 2,340 animals in 2015.[10]

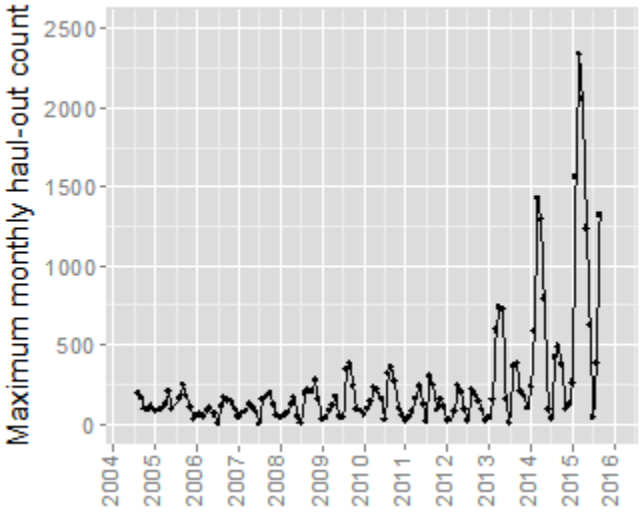

Figure 3. Estimated peak counts (spring and fall) of California sea lions in the East Mooring Basin in Astoria, Oregon, 2004 through 2015.[11]

As pinniped numbers have increased in the Columbia River Basin over the past 13 years (2002 through 2014), more than 40,000 fish from listed and non-listed salmon and steelhead stocks (listed stocks: Upper Columbia River spring-run Chinook salmon, Snake River spring/summer-run Chinook salmon, Upper Columbia River steelhead, Snake River Basin steelhead, Middle Columbia River steelhead; non-listed stocks: Middle Columbia River spring-run Chinook salmon, Upper Columbia River summer-run Chinook salmon, Deschutes River summer-run Chinook salmon) have been consumed by California sea lions in the vicinity of Bonneville Dam (Stansell et al. 2014). Most, but not all, California sea lions leave Bonneville Dam by the end of May, and there have been a handful that have taken residence in the area between Bonneville Dam forebay and The Dalles Dam. All up-river stocks are subject to pinniped predation in the vicinity of Bonneville Dam, although it is the spring-run Chinook salmon stocks that are at greatest risk because of 'run' timing.

[8] The last population estimates of harbor seals in Washington (coastal population) and Oregon was in 2003 and 2005 (Jefferies et al. 2003, Brown et al. 2005, respectively, as cited in NMFS 2014b), when the population growth rate was estimated at 7 percent (NMFS 2014b).
[9] E-mail to Robert Anderson, NMFS, from Bryan Wright, ODFW, October 28, 2015.
[10] E-mail to Robert Anderson, NMFS, from Bryan Wright, ODFW, October 28, 2015.
[11] E-mail to Robert Anderson, NMFS, from Bryan Wright, ODFW, October 28, 2015.

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

Ongoing research in the Columbia River (Wargo Rub et al. 2014)[12] suggests that 10 to 45 percent of the returning adult salmon are unaccounted for during the 146 mile migration between the Columbia River estuary and the Bonneville Dam, at the time when the California sea lions are present in the Columbia River in large numbers. If California sea lions are in fact responsible for a substantial fraction of this estimated loss, then this additional source of pinniped predation (in addition to documented predation at Bonneville Dam) may represent a significant shift in the severity of pinniped predation to the recovery of listed Columbia River Basin salmon and steelhead stocks, in addition to anthropogenic threats (e.g., impacts from habitat loss, dams, etc.).

Additionally, California sea lions numbers over the past five years at Willamette Falls, 28 miles south of the confluence of the Willamette and Columbia rivers at Portland, Oregon, have been steadily increasing and their predation on listed salmonid stocks has reached significant levels (Brown et al. 2015). In the late winter and spring months of 2014 and 2015, some 25-50 California sea lions consumed between 8-14 percent of the listed spring-run Chinook salmon and winter-run steelhead, respectively, attempting to pass the falls to upriver spawning areas (Wright et al. 2015).

The effect of marine mammal predation on the productivity and abundance of Columbia River Basin salmon and steelhead stocks has not been quantitatively assessed at this time. The absolute number of animals preying upon salmon and steelhead throughout the lower Columbia River and Willamette River is not known. In addition to pinniped predation on salmonids, this steady influx of pinnipeds into the Columbia River may also represent a threat to other species, such as eulachon. For example, in 2015 Washington Department of Fish and Wildlife (WDFW)[13] estimated, based on biomass reconstruction for eulachon consumption, that harbor seals were consuming an estimated 2,700,000 eulachon per day in the Columbia River estuary.

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

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

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

reduce the severity of the threat, especially pinniped predation in the Columbia River estuary (river miles 1 to 145) and at Willamette Falls.

Recommendations

- Expand monitoring efforts in the Columbia River and Willamette River to assess predator-prey interactions between pinnipeds and listed species.
- Maintain predatory pinniped management actions at Bonneville Dam to reduce the loss of up-river listed salmon and steelhead stocks.
- Complete life-cycle/extinction risk modeling to quantify predation rates by predatory pinnipeds on listed salmon and steelhead stocks in the Columbia River and Willamette River.

Fish Predation

Several species of fish predators in the Upper Willamette River, especially non-indigenous bass and the native Northern pikeminnow, pose a threat to the recovery of the UWR ESU and DPS. 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).

The construction of dams, dredging of waterways, and gravel pits have created reservoirs and islands from dredged spoils that have facilitated population explosions of the native Northern pikeminnow (Waples et al. 2007). In 1990, a sport fishing reward program was implemented to reduce the numbers of Northern pikeminnow in the Columbia River basin to reduce predation upon juvenile salmon and steelhead (NMFS 2010). Further, NMFS' 2008 FCRPS Opinion recommended the Northern Pikeminnow Management Program (RPA Action 43) to continue the sport-reward fishery while evaluating its effectiveness (NMFS 2008a) that was further expanded in the 2014 FCRPS Supplemental Opinion (NMFS 2014a). Though present in the Willamette River watershed, there is no sport reward fishery for Northern pikeminnow; however, there is no bag limit for captures (http://www.eregulations.com/oregon/fishing/willamette-zone/).

Disease

Disease rates over the past five years are believed to be consistent with the previous review period. A strain of infectious haematopoietic necrosis virus (IHNV) was detected on along the Pacific Coast that originated in the Columbia River and was reported in the last status review but has not be detected on the Pacific Coast since 2011. There was concern that this strain of IHNV would be more virulent and increase the spread of the infection, but these concerns have not been borne out as IHNV reports in the basin have declined in the past few years. These fluctuations in disease rates are considered normal but current high water temperatures and low water flows, associated with climate change effects, could exacerbate conditions that can lead to increased disease rates, affecting upper Willamette River salmon and steelhead.

Listing Factor C Conclusion

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

Listing Factor D: Adequacy and Inadequacy of Regulatory Mechanisms & Protective Efforts

Various Federal, state, county, and tribal regulatory mechanisms are in place to reduce habitat loss and degradation caused by human use and development and harvest impacts. New information available since the last status review indicates that the adequacy of a number of regulatory mechanisms has improved slightly. Examples of regulatory mechanisms for **Habitat** and for **Harvest** are listed below followed by our conclusion and bulleted summary of concerns regarding the current adequacy of existing regulatory mechanisms.

Habitat

Mainstem Columbia River Hydrosystem Improvements

The implementation of the RPAs in the 2008 FCRPS Opinion (NMFS 2008a), as amended in 2010 (NMFS 2010) and supplemented in 2014 (NMFS 2014a), has provided a number of actions that are improving the survival and condition of upper Willamette River salmon and steelhead migrants through the mainstem Columbia River, including the reach that passes through the Columbia River Gorge and the estuary:

- Flow management from storage reservoirs
- Operations and maintenance activities to maintain biological performance
- Piscivorous fish, avian, and pinniped predation control measures

Changes in the life-cycle productivity of UWR salmonids, as updated in this status review, were affected by alterations to the FCRPS since about 2005. Juvenile and adult passage facilities at all of the mainstem FCRPS dams, including Bonneville, are the subject of ongoing testing for passage survival and behavioral responses with the results informing further changes to facility design and project operations under the principle of adaptive management.

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

Improvements under the Willamette River Basin Flood Control and Hydroelectric Project (Willamette Project) 2008 Biological Opinion

The federal Willamette River Basin Flood Control and Hydroelectric Project in the Willamette River subbasin (the Willamette Project) is operated and maintained by the U.S. Army Corps of Engineers (USACE) and includes 13 multipurpose dams and reservoirs, and about 43 miles of revetments in the upper Willamette River basin and subbasins. Bonneville Power Administration (BPA) markets power generated at some of the Willamette Project dams, and the U.S. Bureau of Reclamation (USBOR) sells a portion of the water stored in Willamette Project reservoirs for irrigation purposes. In 2008, NMFS issued a Biological Opinion (NMFS 2008b) on the impact of the Willamette Project on species listed for protection under the Endangered Species Act and proposed an RPA with additional measures which, combined with the Proposed Action, would allow for survival of the species with an adequate potential for recovery, and avoid destruction or modification of critical habitat. These RPA measures include coordination, flow management, a water contract program, fish passage, water quality, hatcheries, habitat, and research, and a temperature control tower at Cougar Dam (USACE 2014). Implementation of these measures since our previous 2011 status review is ongoing and includes the following short-term and longer-term passage and temperature control measures:

- Transportation of adult spring-run Chinook salmon above dams in the North Santiam River, South Santiam River, South Fork McKenzie River, and Fall Creek using hatchery fish producing natural-origin returns expanding access to previously blocked, relatively high quality habitat (Sharp et al. 2013).
- Installation of a temperature control structure in Cougar Dam in 2008 to benefit downstream spawning and rearing success (USACE 2014).
- USACE operational changes addressing stream temperatures below Detroit Dam (USACE 2014).
- USACE implementation of operational measures at Fall Creek Dam and reservoir beginning in 2011 improving downstream passage of juvenile UWR Chinook salmon (Nesbit et al. 2014; Taylor et al. 2012).

Willamette Wildlife Mitigation Program

Implementation of the 25-year 2010 Memorandum of Agreement (MOA) between the State of Oregon and the Bonneville Power Administration to permanently settle wildlife mitigation responsibilities for the Willamette Project. Implementation of the MOA under which BPA agreed to acquire at least an additional 16,880 acres of wildlife mitigation property and to protect 26,537 acres (or more) by the end of 2025 is currently underway.

Improvements under Federal Energy Regulatory Commission (FERC) Hydropower Facilities and Dams

FERC long-term relicensing settlement agreements implemented in several Willamette River tributaries since our previous 2011 status review include:

- Improved fish passage at the Leaburg-Walterville Hydroelectric Project (Janos and McLaughlin 2013).
- Improved fish passage, habitat improvements, and water releases at the Carmen-Smith Hydroelectric Projects (Janos and McLaughlin 2013).
- Passing only unmarked fish above North Fork Dam and screening the intake for downstream migrants at the Clackamas River Hydroelectric Projects (Ackerman 2016).
- Removal of several small dams at the FERC-licensed Thompson's Mill Facility on the Calapooia River (RDG 2011).

Estuary Habitat Research, Monitoring, and Evaluation

The FCRPS Action Agencies are also implementing a Research, Monitoring, and Evaluation (RME) program in the estuary (the Columbia River below Bonneville Dam) under the 2008 FCRPS Opinion and its 2010 and 2014 supplements (NMFS 2008a; NMFS 2010; NMFS 2014a). This includes two primary components: action effectiveness monitoring and critical uncertainties research.

The habitat restoration project sponsors have been implementing the Action Agencies' Action Effectiveness Monitoring and Research (AEMR) plan (Johnson et al. 2013a) in an effort to document the ecological success of their efforts. The AEMR monitoring program addresses the following types of questions:

- Are habitat restoration projects in the lower Columbia River estuary improving:
    - Juvenile salmon access into and from the site?
    - Juvenile salmon performance (body condition? growth? life history diversity?)
    - Prey production?
    - Flux of prey, macro-detritus from restoring areas to the mainstem?
- Are listed Chinook and sockeye salmon and steelhead from the interior Columbia River basin using the site?
- Have hydrological processes been improved (e.g., tidal influence and flood regime) and are they self-maintaining?
- Has connectivity with the mainstem Columbia River been improved and is it self-maintaining?
- Is the rate of sediment accretion at the site at an expected level post-restoration and is the restored land elevation likely to be able to maintain itself over time?
- Is the channel cross-sectional area at the restored site likely to maintain itself over time?

- Is the percent cover of native (versus non-native, invasive) plant species increasing?
- Are water temperatures appropriate for shallow water rearing habitats of juvenile salmon (i.e., relative to surrounding riverine/estuarine areas and/or reference sites)?

The AEMR plan includes three levels of sampling:

- Level 1—intensive monitoring of both habitat and fish indicators. Level 1 is performed at a subset of the habitat restoration sites at the following intervals after construction: 1-3, 5, and 10 years. Indicators include juvenile salmon density, condition, growth, genetic stock, diet, residence time, prey production, and macrodetritus export.
- Level 2—extensive monitoring of a set of core habitat metrics at a larger number of the sites at 1, 3, and 5 years after construction. Core habitat metrics include vegetation percent cover, plant biomass, dissolved oxygen, water velocity, and channel cross-sections.
- Level 3—monitoring of key (controlling) habitat factors at all of the restoration sites at intervals of 1 and 5 years after construction. These include standard photo points, water surface elevation (a predictor of juvenile salmonid access from and materials flux to the mainstem), water temperature, and sediment accretion.

During 2014, ten sites received level 3 and five sites received level 2 monitoring. Three sites were chosen for the most intensive, level 1 monitoring in 2016. Results to date are preliminary, but generally show positive effects from restoration actions. This program will continue at least through 2018, the end of the term of the 2008 FCRPS Opinion.

The second type of RME in the estuary, critical uncertainties research, focuses on information requested by the Expert Regional Technical Group (ERTG), a group of scientists that evaluates the benefits of proposed estuary habitat improvement actions. Questions posed by the ERTG that are under investigation include:

- What is the ecological role of large, woody debris (LWD) in tidal marshes, river floodplains, and floodplain lakes and ponds?
- What is the ecological role and impact of pilings (treated wood structures used to slow the river along its banks) on salmon? Do they need to be removed?
- Do constructed or created habitats provide similar benefits to juvenile salmon as analogous natural habitats in the Columbia River estuary?
- How do juvenile salmon use floodplain lakes and ponds?
- Do juvenile fish penetrate into and shelter within the emergent wetlands, upland meadows, shrub vegetation, and forests that fringe the lower Columbia River estuary?

- Does the spatial organization of restoration projects have non-linear (e.g., cumulative) effects on salmon use, survival, production, and life history diversity?
- How do hatchery-produced stocks affect the benefit of estuary restoration projects to natural stocks?

One recent project (Roegner et al. 2015) investigated the contribution of floodplain habitats to the recovery of Columbia River basin Chinook salmon. By characterizing the genetic stocks using shallow water habitats in eight reaches below Bonneville Dam, the project is assisting strategic planning for the restoration of habitats used by lower Columbia River basin populations.

Federal Land Management

According to NMFS 2015 Geographic Information System (GIS) database,[14] the majority of the upper Willamette River basin is in private ownership (61 percent), with the remaining 39 percent under Federal ownership [approximately 33 percent U.S. Forest Service (USFS) and 5 percent Bureau of Land Management (BLM) with small percentage ownership by the Bureau of Indian Affairs, Bureau of Reclamation, Department of Defense, and FWS]. Most of the landscape in Federal ownership is high quality USFS headwater habitats located in the higher elevations of the Cascade and Coast ranges and vital to the conservation of the UWR spring-run Chinook salmon ESU and UWR steelhead DPS.

Significant opportunities exist for conservation on federally managed forests, since land use protocols by the USFS and the BLM continue to affect functional attributes of stream channel formation, riparian connectivity, and magnitude and frequency of contact with floodplains, as well as watershed processes. These two Federal land managers recognize the need for active watershed restoration and stewardship as essential towards the recovery and protection of the UWR salmon ESU and the steelhead DPS habitat as evidenced by their implementation of a variety of restoration actions listed below under the Aquatic Habitat Restoration Activities Biological Opinion II programmatic (NMFS 2013):

- Culvert replacements to provide fish passage.
- Road decommissioning.
- Large wood and gravel placement projects.
- Channel reconstruction and floodplain reconnection.
- Weir/small dam removals.

[14] www.westcoast.fisheries.noaa.gov/maps_data/maps_and_gis_data.html

Additionally, through coordination and collaboration with NMFS through ESA consultations,[15] timber harvest within riparian buffers has decreased significantly on Federal Lands within the upper Willamette River basin, protecting cool stream temperatures, large wood loading, and decreased sediment inputs. The establishment of no-cut buffers along stream corridors and a change in timber harvest prescriptions from clear-cut to thinning continue to advance the protection of upper Willamette River fish and their habitats.

Given this, there remains uncertainty over the future conservation of UWR salmon and steelhead on Federal lands. The level of protection afforded to the UWR ESU and DPS and their habitat will be determined on Federal lands by land management plans currently under development by the USFS and BLM. The content of these management plans and the manner in which they are implemented and integrated with the ODFW and NMFS 2011 recovery plan will help determine the extent to which Federal land management will continue contributing to recovery of the UWR ESU and DPS.

Significant opportunities continue to exist for recovery and/or conservation actions on Federal lands because of the responsibilities of these land management agencies under ESA section 7(a)(1). NMFS will continue to work with the USFS and BLM to identify opportunities for restoration actions on Federal lands. We will also work with these agencies, to the degree possible, to provide technical assistance for projects that benefit UWR salmon and steelhead species. Initiation and completion of consultation by USFS and BLM on all actions where consultation is required is also a conservation priority.

Clean Water Act

The Federal Clean Water Act addresses the development and implementation of water quality standards, the development of Total Maximum Daily Loads (TMDLs),[16] filling of wetlands, point source permitting, the regulation of stormwater, and other provisions related to protection of U.S. waters. The Clean Water Act is administered in the States of Oregon and Washington with oversight by the U. S. Environmental Protection Agency (EPA). State water quality standards are set to protect beneficial uses, which include several categories of salmonid use.

Each state has a water quality certification program under which it reviews projects that will discharge dredged or fill materials into waters of the U.S. and issues certifications that the proposed action meets State water quality standards and other aquatic protection regulations, if appropriate. Each state also issues National Pollution Discharge Elimination System (NPDES) permits for discharges from industrial point sources, waste-water treatment plants, construction sites, and municipal stormwater conveyances to allow for the discharge of constituents into the lower Columbia River, with established parameters for the allowance of mixing zones if the

[15] See http://www.blm.gov/or/esa/Examples_BA.htm

[16] A TMDL is a pollution budget and includes a calculation of the maximum amount of a pollutant that can occur in a waterbody and allocates the necessary reductions to one or more pollutant sources. A TMDL serves as a planning tool and potential starting point for restoration or protection activities with the ultimate goal of attaining or maintaining water quality standards.

discharged constituent(s) do(es) not meet existing water quality standards at the 'end of the pipe.' TMDLs are prepared to develop actions to reduce concentrations of specific contaminants or natural constituents recognized within a waterbody[17] that fail to meet water quality standards in repeated testing. These constituents may be pesticides such as dieldrin which is regulated under the Federal Insecticide, Fungicide and Rodenticide Act, industrial chemicals such as polychlorinated biphenyls (PCBs) regulated under the Toxic Substances Control Act,[18] or physical measures of water such as temperature for which numeric water quality standards have been developed. TMDLs have been developed for only dioxin and total dissolved gas in the lower Columbia River, but there are numerous toxicants that have yet to be addressed in a TMDL. The need for TMDLs to address these issues has been identified and TMDLs will eventually be developed.

Both UWR Chinook salmon and steelhead pass through the mainstem Columbia and lower Willamette rivers as they migrate up or down the river. Toxic contamination through the production, use, and disposal of numerous chemicals from multiple sources including industrial, agricultural, medical and pharmaceutical, and common household uses that enter the Columbia and Willamette rivers in wastewater treatment plant effluent, stormwater runoff, and nonpoint source pollution is a growing concern (Morace 2012; Nilsen and Morace 2014). Data collected by the Washington State Department of Ecology (WDOE), Oregon Department of Environmental Quality (DEQ), and the Columbia River Contaminants and Habitat Characterization Project (ConHab) indicates contaminants are present at levels of concern (Alvarez et al. 2014; Counihan et al. 2013; Nilsen and Morace 2014; Nilsen et al. 2014a and 2014b). Most of these chemicals have been identified as needing a TMDL. TMDLs are either underway or planned in the future.

- DEQ submitted Oregon's 2010 Integrated Report and 303(d) list to EPA in May 2011. The Integrated Report was approved by EPA and finalized in December 2012. The 2012 Integrated Report and 303(d) list to the EPA was submitted in November 2014, but the EPA has not taken final action on that document (http://www.deq.state.or.us/wq/assessment/assessment.htm).

- Washington State Use-based (e.g., aquatic life use) Surface Water Quality Standards, Washington Administrative Code (WAC) 173-201A. The EPA approved the Washington State's updated Water Quality Assessment 305(b) report and 303(d) list in 2012 (http://www.ecy.wa.gov/programs/Wq/303d/index.html).

[17] Under section 303(d) of the Clean Water Act, states, territories and authorized tribes (included in the term State here) are required to submit lists of impaired waters. These are waters that are too polluted or otherwise degraded to meet water quality standards. A TMDL is only issued if a contaminant is on the 303(d) list for the specific water body.

[18] The Toxic Substances Control Act (TSCA) of 1976 provides EPA with authority to require reporting, record-keeping and testing requirements, and restrictions relating to chemical substances and/or mixtures. Certain substances are generally excluded from TSCA, including, among others, food, drugs, cosmetics, and pesticides.

Non-Federal Tributary Land Management

Oregon's Integrated Water Resource Strategy

In August 2012, Oregon's Water Resources Department initiated a new statewide program to further restore and protect streamflow throughout the state (OWRD 2012).

Oregon's Statewide Planning Guidelines

Since 1973, Oregon has maintained a strong statewide program for land use planning, managed and implemented by the Department of Land Conservation and Development. The foundation of that program is a set of 19 Statewide Planning Goals addressing land use and related topics, such as citizen involvement, housing, and natural resources. Most of the goals are accompanied by *guidelines* that are suggestions about how a goal may be applied. Oregon´s statewide goals are achieved through local comprehensive planning. State law requires each city and county to adopt a comprehensive plan and the zoning and land-division ordinances needed to put the plan into effect. The local comprehensive plans must be consistent with the Statewide Planning Goals. Plans are reviewed for such consistency by the state´s Land Conservation and Development Commission (LCDC). When LCDC officially approves a local government´s plan, the plan is said to be *acknowledged*. It then becomes the controlling document for land use in the area covered by that plan. Oregon´s planning laws apply not only to local governments but also to special districts and state agencies. The laws strongly emphasize coordination -- keeping plans and programs consistent with each other, with the goals, and with acknowledged local plans.

Oregon's Aquatic Invasive Species Prevention Program

Since 2011, Oregon has implemented HB 2220 that created an Aquatic Invasive Species (AIS) Prevention Program and established a new user fee to boaters; "Aquatic Invasive Species Prevention Permit." The AIS Prevention Program is co-managed by ODFW and Oregon State Marine Board.

Harvest

Pacific Fisheries Management Council Harvest Management

Salmon fisheries in the exclusive economic zone (three to 200 miles offshore) of Washington, Oregon, and California have been managed under salmon Fishery Management Plans (FMPs) of the Pacific Fishery Management Council (PFMC) since 1977. While all species of salmon fall under the jurisdiction of the current plan (PFMC 2014), the FMP currently contains fishery management objectives only for Chinook salmon, coho salmon, pink salmon (odd-numbered years only), and any salmon species listed under the ESA measurably impacted by PFMC fisheries. The PFMC does have an FMP for steelhead. Incidental catches of steelhead in harvests targeting other species are inconsequential (low hundreds of fish each year) to very rare (PFMC 2014). In the event this situation should change, management objectives for steelhead could be developed and incorporated by plan amendment.

The constraints on take of ESA-listed species authorized under incidental take statements and reasonable and prudent alternatives are collectively referred to as consultation standards. These

constraints 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 may periodically revise consultation standards and annually issues a guidance letter reflecting the most current information (e.g., Stelle 2015). Even though the current FMP does not manage for steelhead because they are so rarely caught in ocean fisheries and retention of steelhead in non-treaty fisheries is currently prohibited, based on currently available information, NMFS has concluded that ocean fishery management actions beyond those already in place that seek to shape fisheries to minimize impacts to steelhead are not necessary (Stelle 2015).

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

Harvest impacts on UWR salmon and steelhead in mainstem Columbia River fisheries in mainstem commercial, mainstem recreational, and mainstem treaty fisheries continue to be managed under the 2008-2017 *U.S. v. Oregon* Management Agreement.[19] The parties to the agreement are the United States, the states of Oregon, Washington, and Idaho, and four Columbia River Treaty Tribes: Warm Springs, Yakama, Nez Perce, and Umatilla. The agreement sets harvest rate limits on fisheries impacting lower Columbia River salmonids, and these harvest limits continue to be annually managed by the fisheries co-managers (TAC 2011-14). Treaty tribes, states, and federal fisheries managers have begun discussions on the development of a new *U.S. v. Oregon* Management Agreement to replace the current agreement prior to 2019. The current *U.S. v. Oregon* Management Agreement (2008-2017) has, on average, maintained reduced impacts of fisheries on the MCR steelhead DPS (TAC 2011-14), and we expect that to continue with the abundance based framework incorporated into the current regulatory regime.

Listing Factor D Conclusion

Based on the improvements noted above, we conclude that the risk to the species' persistence because of the adequacy of existing regulatory mechanisms has decreased slightly. Despite this improvement, there remain concerns regarding existing regulatory mechanisms, including:

- Lack of documentation or analysis of the effectiveness of existing land-use regulatory mechanisms, land-use management plans, and fisheries harvest management regulations.
- NMFS notes that certain Federal, state, and local land and water use decisions continue to occur without the benefit of ESA review. State and local decisions have no Federal nexus to trigger the ESA Section 7 consultation requirement, and thus certain permitting actions allow direct and indirect species and/or habitat effects. An example of a state action falling in this gray area is NPDES permitting, which can allow discharges of detrimental effluent within aquatic habitat, diminishing conservation potential and causing death or injury among listed fishes.

[19] http://www.westcoast.fisheries.noaa.gov/fisheries/salmon_steelhead/united_states_v_oregon.html

- With regard to Federal actions, there continues to be confusion among some entities as to the relationship between ESA mandates, federal preemption, and the primacy of regulatory obligations, that impairs the consultation process or even prevents consultation from occurring. An example of this is found in the intertwined roles of U.S. Army Corps of Engineers who consults on Federal Navigation Channel dredging and deepening to accommodate larger vessels (NMFS 2012a; NMFS 2012b; NMFS 2015c); but these consultations do not include a related consultation by the U.S. Coast Guard who have authority to regulate the large vessel traffic that the deepening intends to accommodate in the Columbia River. Thus, ship wake fish stranding (Pearson and Skalski 2011), a phenomenon that increases with vessel size and vessel speeds, continues to be a significant regulatory concern in the lower Columbia River that needs to be addressed.

- Contradictory policies and/or implementation of regulations by Federal agencies. For example, one agency may take actions to improve riparian vegetation and instream habitat in one area while a short distance away, another Federal authority requires removal of vegetation and instream structures.

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

Climate Change (NWFSC 2015)

The Intergovernmental Panel on Climate Change (IPCC) and U.S. Global Change Research Program recently published updated assessments of anthropogenic influence on climate, as well as projections of climate change over the next century (IPCC 2013; Melillo et al. 2014). Reports from both groups document ever increasing evidence that recent warming bears the signature of rising concentrations of greenhouse gas emissions. There is moderate certainty that the 30-year average temperature in the Northern Hemisphere is now higher than it has been over the past 1,400 years. In addition, there is high certainty that ocean acidity has increased with a drop in pH of 0.1 (NWFSC 2015).

Projected Climate Change

Trends in warming and ocean acidification are highly likely to continue during the next century (IPCC 2013). In winter across the west, the highest elevations (e.g. in the Rocky Mountains) will shift from consistent longer (>5 months) snow-dominated winters to a shorter period (3-4 months) of reliable snowfall (Klos et al. 2014); lower, more coastal or more southerly watersheds will shift from consistent snowfall over winter to alternating periods of snow and rain ("transitional"); lower elevations or warmer watersheds will lose snowfall completely, and rain-dominated watersheds will experience more intense precipitation events and possible shifts in the timing of the most intense rainfall (e.g., Salathe et al. 2014). Warmer summer air temperatures will increase both evaporation and direct radiative heating. When combined with reduced winter water storage, warmer summer air temperatures will lead to lower minimum flows in many watersheds. Higher summer air temperatures will depress minimum flows and raise maximum stream temperatures even if annual precipitation levels do not change (e.g., Sawaske and Freyberg 2014) (NWFSC 2015).

Higher sea surface temperatures and increased ocean acidity are predicted for marine environments in general (IPCC 2013). However, regional marine impacts will vary, especially in relation to productivity. The California Current is strongly influenced by seasonal upwelling of cool, deep, water that is high in nutrients and low in dissolved oxygen and pH. An analysis of 21 global climate models found that most predicted a slight decrease in upwelling in the California Current, although there is a latitudinal cline in the strength of this effect, with less impact toward the north (Rykaczewski et al. 2015; NWFSC 2015).

Impacts on Salmon

Studies examining the effects of long term climate change to salmon populations have identified a number of common mechanisms by which climate variation is likely to influence salmon sustainability. These include direct effects of temperature such as mortality from heat stress, changes in growth and development rates, and disease resistance. Changes in the flow regime (especially flooding and low flow events) also affect survival and behavior. Expected behavioral responses include shifts in seasonal timing of important life history events, such as the adult migration, spawn timing, fry emergence timing, and the juvenile migration (NWFSC 2015).

Climate impacts in one life stage generally affect body size or timing in the next life stage and can be negative across multiple life stages (Healey 2011; Wade et al. 2013; Wainwright and Weitkamp 2013). Changes in winter precipitation will likely affect incubation and/or rearing stages of most populations. Changes in the intensity of cool season precipitation could influence migration cues for fall- and spring-run adult migrants, such as coho salmon and steelhead. Egg survival rates may suffer from more intense flooding that scours or buries redds. Changes in hydrological regime, such as a shift from mostly snow to more rain, could drive changes in life history, potentially threatening diversity within an ESU (Beechie et al. 2006). Changes in summer temperature and flow will affect both juvenile and adult stages in some populations, especially those with yearling life histories and summer migration patterns (Quinn 2005; Crozier and Zabel 2006; Crozier et al. 2010). Adults that migrate or hold during peak summer temperatures can experience very high mortality in unusually warm years. For example, in 2015 only 4 percent of adult Redfish Lake sockeye salmon survived the migration from Bonneville to Lower Granite Dam after confronting temperatures over 22°C in the lower Columbia River. Marine migration patterns could also be affected by climate induced contraction of thermally suitable habitat. Abdul-Aziz et al. (2011) modeled changes in summer thermal ranges in the open ocean for Pacific salmon under multiple IPCC warming scenarios. For chum salmon, pink salmon, coho salmon, sockeye salmon, and steelhead, they predicted contractions in suitable marine habitat of 30-50 percent by the 2080s, with an even larger contraction (86-88 percent) for Chinook salmon under the medium and high emissions scenarios (A1B and A2) (NWFSC 2015).

Terrestrial and Ocean Conditions and Marine Survival (NWFSC 2015)

Environmental conditions in both fresh and marine waters inhabited by Pacific Northwest salmon are influenced, in large part, by two ocean-basin scale drivers, the Pacific Decadal Oscillation (PDO; Mantua et al. 1997) and the El Niño-Southern Oscillation (ENSO). Starting in late 2013, however, abnormally warm conditions in the Central NE Pacific Ocean known as the

"warm blob" (Bond et al. 2015) has also had a strong influence on both terrestrial and marine habitats (NWFSC 2015).

The Warm Blob

Marine waters in the North Pacific Ocean have been warmer than average since late fall 2013, when the "warm blob" first developed in the central Gulf of Alaska (Bond et al. 2015). The warm blob was caused by lower than normal heat loss from the ocean to the atmosphere and of relatively weak mixing of the upper ocean, due to unusually high and persistent sea level pressure. Temperature anomalies of the near-surface (upper ~100 m) waters exceeded 3°C in January 2014, or 4 standard deviations (Freeland and Whitney 2014). These anomalies were the greatest observed in this region and season since at least the 1980s and possibly as early as 1900 (Bond et al. 2015; NWFSC 2015).

Pacific Decadal Oscillation

The PDO describes the most prominent mode of variability in the North Pacific sea surface temperature (SST) field (Mantua et al. 1997). Positive PDO values are characterized by warm SSTs along the West Coast of North America and cold SSTs in the central North Pacific and are associated with warm and dry PNW winters (especially for the interior Columbia River Basin) and low snowpack. Negative PDO value have the opposite pattern (cold along the coast and warm in the central North Pacific) and are associated with cold wet winters throughout the PNW (high snowpack) (Mantua et al. 1997). Because the PDO is a measure of SSTs and the eastern North Pacific Ocean has been extremely warm, it has been positive since January 2014 (NWFSC 2015).

El Niño-Southern Oscillation

El Niño-Southern Oscillation (ENSO) is a tropical phenomenon that influences climate patterns around the globe. Much like the PDO, the warm phase (El Niño) is characterized by warm SSTs along the West Coast of North America, while negative values (La Niña) produce cold SSTs along the coast. Like the PDO, ENSO also influences terrestrial environments, and PNW winter snowpack is low during warm El Niño events and high during cool La Niña years. The latest ENSO forecasts point to a strong to very strong El Niño persisting into spring 2016, with some models predicting that this event will be comparable to the exceptional 1997/98 event (NWFSC 2015).

Freshwater environments

Sea surface temperatures across the Northeast Pacific Ocean are anomalously warm which has contributed to above average terrestrial temperatures in the PNW (Bond et al. 2015). Mean air temperatures for Washington, Oregon, and Idaho were the warmest on record for the 24-month period ending in August 2015 (from a 120-year record starting in 1895). In contrast, precipitation in the PNW was slightly above average during 2014. Since January 2015, however, precipitation has been below average and the 8-month period from January to August was the 11th driest on record. The exceptionally warm air during the winter of 2014/2015 and below

average precipitation from January-April resulted in anomalously low snow pack conditions in the Olympic and Cascade Mountains, with most areas having less than 25 percent of average snow pack in April 2015 (compared to the 1981-2010 record). The combined effects of low flows and high air temperatures are expected to result in higher than normal stream temperatures and reports of fish kills of salmon and sturgeon in the Willamette and mainstem Columbia rivers in late June and July 2015 (NWFSC 2015).

Marine survival

Ocean conditions important for PNW salmon became unusually warm early in 2014, and are currently at or near record warm temperatures for much of the northeast Pacific Ocean. There is an abundance of evidence highlighting impacts on coastal marine ecosystems, including sea bird die offs, range shifts for subtropical fish and plankton, etc. Juvenile salmon entering the coastal ocean in 2015 may have experienced especially poor ocean conditions. The expected impacts of the 2015/16 El Niño include intense winter down welling, increased northward moving currents, increased upper ocean stratification, and overall reduced productivity. These conditions will likely prime the PNW's coastal ocean for very poor productivity in spring 2016. Combining the expected El Niño effects over the next 6 to 8 months with existing warm ocean conditions will likely lead to poor or perhaps very poor early marine survival for PNW salmon going to sea in spring 2016 (NWFSC 2015).

Pacific salmon are a cold water species: they flourish in cold streams and cold and productive marine ecosystems, such as those present in the early 2010s, resulting in record returns for many ESUs. The exceptionally warm marine waters in 2014 and 2015 (and associated warm-water food webs) and warm stream temperatures observed during 2015 were unfavorable for high marine or freshwater survival. West Coast salmon entering the ocean in 2016 will likely encounter subtropical foodwebs that do not promote high survival. The full impact of these unusual environmental conditions will not be known until adults return beginning this fall and continuing for the next few years (NWFSC 2015).

Hatchery Impacts

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

UWR steelhead

Winter-run steelhead hatchery programs were terminated in the late 1990s. Currently, the only steelhead programs in the upper Willamette River release Skamania Hatchery-origin summer-run steelhead. Annual total releases have been relatively stable at around 600,000 from (2009-2014), although the distribution has changed some with fewer fish being released in the North Santiam and corresponding increases in the South Santiam and Middle Fork Willamette rivers. There has been some concern regarding the effect of introduced summer-run steelhead on native late

winter-run steelhead. There is some overlap in the spawn timing for summer-run and late-winter-run steelhead, and genetic analysis has identified approximately 10 percent of the juvenile steelhead as summer x winter-run hybrids at Willamette Falls and in the Santiam River Basin (Johnson et al. 2013b). Early winter-run steelhead, derived from earlier (now discontinued) releases of non-native Big Creek Hatchery steelhead have established themselves in tributaries draining the west side of the Willamette Valley. Based on the results of Johnson et al. (2013b), approximately 10.5 percent of the juveniles sampled at Willamette Falls were early x late winter-run steelhead hybrids, with similar proportions detected in the North and South Santiam rivers, 11.1 percent and 14.8 percent, respectively. While not directly determining the presence of hybrids, Van Doornik et al. (2015) concluded that late winter-run (eastern tributary) steelhead had largely maintained their genetic distinctiveness over time. Even in the absence of long-term introgression, there are still concerns that hybridization will decrease the overall productivity of the native population. The presence of hatchery-reared and feral hatchery-origin fish may also affect the growth and survival of juvenile late winter-run steelhead. In the North and South Santiam rivers, juveniles are largely confined below much of their historical spawning and rearing habitat. Releases of large numbers of hatchery-origin summer-run steelhead may temporarily exceed rearing capacities and displace winter-run juvenile steelhead (NWFSC 2015).

UWR Chinook salmon

Hatchery production has remained relatively stable since the initial status review (Myers et al. 1998). In general, production levels are based on mitigation agreements related to the construction of dams in the Willamette River Basin. There have been a number of operational changes at hatcheries. Mass marking of hatchery-origin Chinook salmon began in 1997, with all returning adults being marked by 2002. Off-station releases within some basins have been curtailed in an effort to limit natural spawning by hatchery-origin fish. Releases of juvenile Chinook salmon into the Coast Fork, a West side tributary that does not support a Chinook salmon population, have been made in an effort to maintain a harvestable hatchery return, but reduce hatchery x natural adult interaction on the natural spawning grounds in Eastside tributaries. Some of these returning adults have returned to their hatchery of origin rather than the Coast Fork release site. A review of hatchery operations by the Hatchery Science Review Group (HSRG) in 2009 identified a number of modifications to improve the status of Chinook salmon. Foremost was an increase in the proportion of naturally-produced fish into the hatchery broodstock; however, in many basins the abundance of naturally-produced Chinook salmon was critically low precluding their use as broodstock (HSRG 2009). Recent improvements at the Cougar (2010), Minto (2012), and Foster (2014) fish collection facilities offer the potential for collecting more hatchery origin adults and removing them from the natural-spawning component of the populations. Increased collection efficiency has been observed at the Cougar and Minto facilities, while the recently completed Foster facility appears to require further modifications. Ultimately, these facilities should be able to reduce the proportion of hatchery origin spawners (pHOS) in both the North and South Santiam populations. Plans are being developed for improvements in the facilities at Fall Creek and Dexter Dam (NWFSC 2015).

Listing Factor E Conclusion

Climate Change

Trends in warming and ocean acidification are highly likely to continue during the next century (IPCC 2013). Analysis of ESU specific vulnerabilities to climate change by life stage will be available in the near future, upon completion of the West Coast Salmon Climate Vulnerability Assessment. In summary, both freshwater and marine productivity tend to be lower in warmer years for most populations considered in this status review. These trends suggest that many populations might decline as mean temperature rises. However, the historically high abundance of many southern populations is reason for optimism and warrants considerable effort to restore the natural climate resilience of these species (NWFSC 2015).

Terrestrial and Ocean Conditions and Marine Survival

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

On a positive note, after previous strong El Niño events (e.g., 1982/83 and 1997/98), there was a rapid transition from warm to cold conditions along the West Coast, which resulted in greatly improved marine survival for Pacific salmon for several years following the El Niño. Whether a similar rapid transition to cold conditions will occur with this El Niño is not known or presently forecast, but is within the realm of possibility (NWFSC 2015).

Pacific salmon are a cold water species: they flourish in cold streams and cold and productive marine ecosystems, such as those present in the early 2010s, resulting in record returns for many ESUs. The exceptionally warm marine waters in 2014 and 2015 (and associated warm-water food webs) and warm stream temperatures observed during 2015 were unfavorable for high marine or freshwater survival. West Coast salmon entering the ocean in 2016 will likely encounter subtropical foodwebs that do not promote high survival. The full impact of these unusual environmental conditions will not be known until adults return beginning this fall and continuing for the next few years (NWFSC 2015).

Hatchery Impacts

For UWR steelhead, the diversity goals are partially achieved through the closure of winter-run steelhead hatchery programs in the upper Willamette River. However, there is some concern that the summer-run steelhead releases in the South Santiam River may be influencing the viability of native steelhead in the North and South Santiam rivers. For UWR spring-run Chinook salmon,

hatchery production has remained relatively stable since the initial status review. However, recent improvements at the Cougar (2010), Minto (2012) and Foster (2014) fish collection facilities offer the potential for collecting more hatchery origin adults and removing them from the natural-spawning component of the populations. Ultimately, these facilities should be able to reduce the pHOS in both the North and South Santiam populations (NWFSC 2015).

Efforts being made to protect the Species

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

In the final listing determinations for salmon (70 FR 37160) and steelhead (71 FR 834), we noted that while many of the ongoing protective efforts are likely to promote the conservation of listed salmonids, most efforts are relatively recent, have yet to indicate their effectiveness, and few address conservation needs at scales sufficient to conserve entire ESUs. Therefore, NMFS concluded that existing protective efforts lack the certainty of implementation and effectiveness to preclude listing several ESUs of salmon and several DPSs of steelhead.

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

2.4 Synthesis

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

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

The Northwest Fisheries Science Center updated status review (NWFSC 2015) notes that although there has likely been an overall decrease in the VSP status of the UWR Chinook salmon ESU since the previous Ford et al. 2011 review, the magnitude of this change is not sufficient to suggest a change in risk category. Given current climatic conditions and the prospect of long-term climatic change, the inability of many populations to access historical headwater spawning and rearing areas may put this ESU at greater risk in the near future.

For the UWR steelhead DPS, the declines in abundance noted during the previous review (Ford et al. 2011) continued through the period 2010-2015, and accessibility to historical spawning habitat remains limited, especially in the North Santiam River. Although the recent magnitude of these declines is relatively moderate, the NWFSC (2015) notes that continued declines would be a cause for concern. Much of the accessible habitat in the Molalla, Calapooia, and lower reaches of North and South Santiam rivers is degraded and under continued development pressure. Although habitat restoration efforts are underway, the time scale for restoring functional habitat is considerable (NWFSC 2015).

Our analysis of the ESA section 4(a)(1) factors indicates that the collective risk to the persistence of the UWR Chinook salmon and steelhead has not changed significantly since our previous 2011 status review. Improvements have been made in operations and fish passage at tributary dams, and numerous habitat restoration projects have been completed in many upper Willamette River tributaries and we expect that these actions eventually will provide benefit to the UWR Chinook salmon ESU and steelhead DPS. However, the scale of habitat improvements needed is greater than the scale of habitat actions implemented to date, and we remain concerned about impaired passage at multiple dams and degraded habitat through-out the watershed. Most land in the upper Willamette River is in private ownership, making successful efforts to protect and restore habitat on private lands key to recovery in the upper Willamette, particularly in the face of continuing development. There are also substantial portions of Federal land in the upper Willamette, so the protection and restoration of salmon and steelhead habitat on Federal lands is also crucial to recovery.

Harvest rates on UWR Chinook salmon and steelhead have remained stable and relatively low since the last status review. Research impacts on both species have also remained relatively low. However, pinniped predation on upper Willamette River salmon and steelhead has increased, although we are unable to quantify the resulting change in extinction risk. The impacts that hatcheries and climate change pose to long-term recovery also remain a concern.

After considering the biological viability of the UWR Chinook salmon ESU and steelhead DPS and the current status of the ESA section 4(a)(1) factors, we conclude that the status of the UWR ESU and DPS has not changed significantly since the last status review. However, the implementation of sound recovery actions in each “H”—hydropower, habitat, hatcheries, and harvest—is underway and must continue to achieve recovery. In addition, the biological benefits of some actions, habitat restoration and protection efforts, in particular, have yet to be fully expressed and will likely take another five to 20 years to result in measurable improvements to

population viability. By continuing to implement actions that address the factors limiting population viability and monitoring the effects of the actions over time, we will ensure that recovery efforts meet the biological needs of each population and, in turn, contribute to the recovery of the UWR ESU and DPS. The ODFW and NMFS 2011 Upper Willamette River Conservation and Recovery Plan for Chinook Salmon and Steelhead is the primary guide for identifying future actions to target and address limiting factors and threats for the UWR ESU and DPS. Over the next five years, it is crucial to continue to implement recovery actions and monitor our progress.

2.4.1 ESU/DPS Delineation and Hatchery Membership

The Northwest Fisheries Science Center's review (NWFSC 2015) found that no new information has become available that would justify a change in composition of the UWR ESU and DPS.

The West Coast Regional Office reviewed new information regarding the ESU/DPS membership status of various hatchery programs in the Jones 2015 report. For the UWR steelhead DPS, there were no recommended program changes (added/removed from the DPS) since the previous 2011 review; however, two hatchery programs in the UWR Chinook salmon ESU were changed – (1) Marion Forks Hatchery/North Fork Santiam River was renamed North Santiam River and (2) South Santiam Hatchery in the Molalla River was renamed Molalla River (Jones 2015).

2.4.2 ESU/DPS Viability and Statutory Listing Factors

- The Northwest Fisheries Science Center's review of updated information (NWFSC 2015) does not indicate a change in the biological risk category for either UWR species since the time of the last status review (Ford et al. 2011).

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

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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 Upper Willamette River steelhead DPS should remain listed as threatened.
- The Upper Willamette River Chinook salmon ESU should remain listed as threatened.

ESU/DPS Delineation:

The Northwest Fisheries Science Center's review (NWFSC 2015) found that no new information has become available that would justify a change in composition of the UWR steelhead DPS or UWR Chinook salmon ESU.

Hatchery Membership:

Jones 2015 reports a few changes to UWR steelhead and UWR Chinook salmon hatchery programs since the previous 2011 review. For the UWR steelhead, no changes were noted. For the UWR Chinook salmon, two hatchery programs changed their names – (1) Marion Forks Hatchery/North Fork Santiam River was changed to North Santiam River and (2) South Santiam Hatchery in the Molalla River was changed to Molalla River (Jones 2015).

3.2 New Recovery Priority Number

Since the previous five-year review, NMFS revised the recovery priority numbers from one (NMFS 2009) to new recovery priority numbers of nine for both the UWR steelhead DPS and the UWR Chinook salmon ESU (NMFS 2015a) as listed in Table 4 of this document.

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4 · Recommendations for Future Actions

In our review of the listing factors, we found most important actions to be taken over the next five years include implementation of the high priority strategies and actions identified in the 2011 UWR Recovery Plan, with the most important being Willamette Project (NMFS 2008b). We are currently in the process of reviewing actions that address the factors contributing to the existing high risk rating for each population, since such actions have the greatest potential to improve VSP parameters for the species. NMFS will continue to coordinate with the Federal, state, tribal, and local implementing entities to ensure that risk factors and actions identified in the recovery plan are addressed. Specifically, we recommend:

- Build and operate downstream passage facilities, spillways, and other outlets at Willamette Project dams to increase juvenile survival (Cougar, Detroit, Foster, and Lookout Point dams).
- Revise reservoir operations to increase productivity of salmon.
- Develop a short-term implementation plan to prioritize habitat protection and restoration projects/programs in the ODFW and NMFS 2011 recovery plan using the NOAA Fisheries Recovery Action Mapping Tool.20 This should include improving juvenile rearing habitat including restoration of Portland Harbor and removal or modification of non-essential levees and other bank armoring structures.
- Quantitatively analyze net habitat loss and restoration/protective efforts and evaluate the effectiveness of existing land-use regulatory mechanisms, land-use management plans, and fisheries harvest management regulations.
- Repair or replace Willamette Falls fish ladder to ensure continued passage.
- Complete FERC relicensing for Carmen-Smith (McKenzie River) to provide upstream and downstream passage for Chinook salmon.
- Implement comprehensive actions to reduce pre-spawn mortality.
- Continue to seek avenues to reduce pinniped predation in the mainstem Willamette and Columbia rivers.
- Increase outreach and public messaging regarding recovery of salmon and steelhead in the Willamette River.

[20] http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/recovery_action_mapping_tool.html

Research, Monitoring, and Evaluation

- Continue analyses to identify the causes of the apparent decline in the status of the McKenzie River spring-run Chinook salmon population.
- Steelhead monitoring: evaluate steelhead genetics (including designation of the Clackamas population), population structure, adult and juvenile migration timing, introgression with non-DPS stocks, and role of steelhead in west-side tributaries.
- Juvenile Chinook salmon monitoring: gain better understanding of survival in reservoirs and early life history in the Willamette and lower Columbia rivers.
- Steelhead and Chinook salmon: assess population abundance and survival, evaluation of success of implemented projects, identification of factors limiting fish production, and assess the extent of habitat restoration needed to reach viability. This is extremely important for the Calapooia and Molalla populations which are at highest risk.
- Assess operational strategies at dams to increase productivity, including managing for water temperature and flows.

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

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National Marine Fisheries Service
5-Year Review

Upper Willamette River Steelhead
Upper Willamette River Chinook Salmon

Conclusion:

Based on the information identified above, we conclude:

- The Upper Willamette River steelhead DPS should remain listed as threatened.
- The Upper Willamette River Chinook salmon ESU should remain listed as threatened.

REGIONAL OFFICE APPROVAL

Approve: _____ Date: 26 APRIL 2016

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Oregon/Washington Coastal Office
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