# 2016 5-Year Review: Summary & Evaluation of Ozette Lake Sockeye

National Marine Fisheries Service
West Coast Region
Portland, OR

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# 5-Year Review: Ozette Lake Species

| Species Reviewed | Evolutionarily Significant Unit |
|---|---|
| **Sockeye Salmon** (*Oncorhynchus nerka*) | Ozette Lake Sockeye |

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# 1 · General Information

## 1.1 Introduction

Many West Coast salmon and steelhead (*Oncorhynchus* spp.) stocks have declined substantially from their historic numbers and now are at a fraction of their historical abundance. There are several factors that contributed 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 review for ESA-listed Ozette Lake sockeye 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.

Artificial propagation programs (hatcheries) are common throughout the range of ESA-listed West Coast salmon and steelhead. Prior to 2005, our policy was to include in the listed ESU or DPS only those hatchery fish deemed "essential for conservation" of the species. We revised that approach in response to a court decision and on June 28, 2005, announced a final policy addressing the role of artificially propagated Pacific salmon and steelhead in listing determinations under the ESA (70 FR 37204) (hatchery listing policy). This policy establishes criteria for including hatchery stocks in ESUs and DPSs. In addition, it (1) provides direction for considering hatchery fish in extinction risk assessments of ESUs and DPSs; (2) requires that hatchery fish determined to be part of the ESU or DPS be included in any listing of an 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 updated 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 reinitiation 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 new information on the composition of the ESUs and DPSs. 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 that ended, or have been newly implemented, and if any changes have occurred in the operation of existing programs. Taking these into consideration, they reviewed any scientific data relevant to the degree of divergence of hatchery fish from naturally spawning fish in the same area. They produced a report (Jones 2015) describing their findings. Finally, we consulted biologists and other salmon management specialists 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); 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 the Ozette Lake sockeye ESU under the ESA and classified it as a threatened species (Table 1). In 2005, hatchery-origin sockeye from the Umbrella Creek and Big River Hatchery programs were determined to be part of the ESU and listed with natural-origin sockeye as protected under the ESA (70 FR 37160).

**Table 1. Summary of the listing history under the Endangered Species Act for the Ozette Lake sockeye salmon ESU**

| Salmonid Species | ESU Name | Original Listing | Revised Listing |
|---|---|---|---|
| **Sockeye Salmon** (*Oncorhynchus nerka*) | Ozette Lake Sockeye Salmon | **FR notice:** 64 FR 14528<br>**Date listed:** 3/25/1999<br>**Classification**: Threatened | **FR notice:** 70 FR 37160<br>**Date:** 6/28/2005<br>**Re-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 Ozette Lake sockeye salmon in 2005 (70 FR 52630, September 2, 2005) (Table 2).

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 (Table 2). 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 Ozette Lake Sockeye Salmon.**

| Salmonid Species | ESU Name | 4(d) Protective Regulations | Critical Habitat Designations |
|---|---|---|---|
| **Sockeye Salmon** (*O. nerka*) | Ozette Lake Sockeye Salmon | **FR notice:** 65 FR 42422<br>**Date:** 7/10/2000<br>**Revised:** 6/28/2005 (70 FR 37160) | **FR notice:** 70 FR 52630<br>**Date:** 9/2/2005 |

### 1.3.4 Review History

Table 3 lists the scientific assessments of the status of the Ozette Lake sockeye salmon ESU. These assessments include status reviews conducted by our Northwest Fisheries Science Center and technical reports prepared in support of recovery planning for this ESU.

**Table 3. Summary of previous scientific assessments for the Ozette Lake Sockeye Salmon ESU.**

| Salmonid Species | ESU Name | Document Citation |
|---|---|---|
| **Sockeye Salmon** (*O. nerka*) | Ozette Lake Sockeye Salmon | NWFSC 2015<br>Ford et al. 2011<br>Currens et al. 2009<br>Rawson et al. 2009<br>Good et al. 2005<br>PSTRT and SSSG 2003<br>NMFS 1998<br>Gustafson et al. 1997 |

### 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 2009b). 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 the Ozette Lake sockeye salmon ESU.**

| Salmonid Species | ESU Name | Recovery Priority Number | Recovery Plans/Outline |
|---|---|---|---|
| **Sockeye Salmon** *(O. nerka)* | Ozette Lake Sockeye Salmon | **9** | **Title:** Recovery Plan For Lake Ozette Sockeye Salmon (*Oncorhynchus nerka*)<br>Available at: http://www.westcoast.fisheries.noaa.gov/publications/recovery_planning/salmon_steelhead/domains/puget_sound/lake_ozette/lakeozetterecoveryplan.pdf<br>**Date:** 5/29/2009<br>**Type:** Final<br>**FR Notice:** 74 FR 25706 |

The revision of Lake Ozette Sockeye's priority from 1 (highest priority) to 9 (moderately low priority) recognized that the magnitude of threat to species' recovery is relatively low, based on overall stability in the species' viability parameters and stability in the condition of primary constituent elements of critical habitat, and its ranking as a threatened species rather than an endangered species. The recovery potential for this ESU is good, and conflicts with development projects and other economic activity are limited, given the location of Ozette Lake within a national park.

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# 2 · Review Analysis

In this section, we review new information to determine whether the Ozette Lake sockeye salmon ESU's delineation remains appropriate.

## 2.1 Delineation of species under the Endangered Species Act

**Is the species under review a vertebrate?**

| ESU Name | YES | NO |
|---|---|---|
| Ozette Lake Sockeye Salmon | X | |

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

| ESU Name | YES | NO |
|---|---|---|
| Ozette Lake Sockeye Salmon | X | |

**Was the ESU listed prior to 1996?**

| ESU Name | YES | NO | Date Listed if Prior to 1996 |
|---|---|---|---|
| Ozette Lake Sockeye Salmon | | X | n/a |

### 2.1.1 Summary of relevant new information regarding delineation of Ozette Lake sockeye salmon ESU

**ESU/DPS Composition**

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

The Ozette Lake Sockeye salmon ESU includes naturally spawned sockeye salmon originating from the Ozette River and Ozette Lake and its tributaries. Also, sockeye salmon from two artificial propagation programs: the Umbrella Creek Hatchery Program; and the Big River Hatchery Program (78 FR 20802). The Puget Sound TRT considers the Ozette Lake sockeye salmon ESU to be composed of one historical population (Currens et al. 2009), with substantial substructuring of individuals into multiple spawning aggregations. The primary existing spawning aggregations occur in two beach locations— Allen's and Olsen's beaches, and in two tributaries, Umbrella Creek and Big River, where adult returns have been established through a hatchery reintroduction program. The hatchery program in Umbrella Creek has produced a self-sustaining spawning aggregation with a significant percentage of natural origin returns. The Northwest Fisheries Science Center team found no new information since the last status review

that would justify a change in composition of the Ozette Lake sockeye salmon ESU (NWFSC 2015).

**Membership of Hatchery Programs**

In preparing this report, our NMFS West Coast Region biologists reviewed the available information regarding hatchery membership of this ESU (Jones 2015). The Makah Tribe's hatchery program established adult sockeye salmon returns to the tributaries using beach spawning sockeye salmon as the donor stock for artificial propagation. The hatchery program is now self-sustaining, supported by adult sockeye salmon returns to Umbrella Creek established through the reintroduction effort. Because of their native Ozette Lake sockeye salmon stock origin, the hatchery-origin sockeye salmon produced by the Umbrella Creek and Big River programs were included as part of the ESU and listed with natural-origin sockeye as protected under the ESA (70 FR 37160, June 28, 2005). There have been no substantial operation or production changes in the Ozette Lake tributary hatchery program since the last status review. In response to low adult returns to the tributaries for two sockeye salmon brood cycle lines, in 2015, the Makah Tribe requested, and NMFS granted, an extension in the duration of the NMFS-approved hatchery-based tributary sockeye salmon reintroduction effort (NMFS 2015b). The purpose of the extension was to help ensure that total adult returns to Umbrella Creek and Big River were bolstered to the extent that the tributary spawning aggregations would be highly likely to become self-sustaining over all brood cycle lines after the hatchery program was terminated.

The Ozette Lake sockeye salmon tributary reintroduction programs on Umbrella Creek and the Big River have continued to operate, consistent with actions and practices described in the Makah Tribe's hatchery and research, monitoring, and evaluation resource management plan (MFM 2000). The plan was approved by NMFS in 2003 under Limit 6 of the ESA 4(d) rule for the listed ESU (NMFS 2003), as the plan was found to be adequate for the conservation of listed Ozette Lake sockeye salmon. Annual operational and stock status reports submitted to NMFS by the Makah Tribe indicate that practices and management actions applied to minimize genetic and other hatchery-related risks to listed sockeye salmon remain as originally authorized under the ESA 4(d) approval. The hatchery program was originally authorized for a 12-year duration unless stock status evaluations indicate a need to continue the program. As mentioned above, an extension in the duration of the program was authorized in 2015 to help ensure the tributary reintroduction effort was successful in creating self-sustaining adult returns. These hatchery programs are the only artificial propagation efforts functioning in the basin, and there are no new programs requiring consideration for membership to the ESU.

For the reasons stated, hatchery-origin sockeye produced through the Umbrella Creek and Big River hatchery programs should continue to be included in the ESU hatchery populations and considered for their contribution to the status of the ESU. The Ozette Lake sockeye hatchery program has not changed substantially from the previous ESA status review to suggest that its level of divergence relative to the local natural populations has changed. Therefore, we do not recommend any change in ESU hatchery membership.

## 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 Does the species have a final, approved recovery plan containing objective, measurable criteria?

| ESU Name | YES | NO |
|---|---|---|
| Ozette Lake Sockeye Salmon | X | |

### 2.2.2 Adequacy of recovery criteria

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

| ESU Name | YES | NO |
|---|---|---|
| Ozette Lake Sockeye Salmon | X | |

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

| ESU Name | YES | NO |
|---|---|---|
| Ozette Lake Sockeye Salmon | X | |

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

For the purposes of reproduction, salmon typically exhibit a metapopulation structure (Schtickzelle and Quinn 2007; McElhany et al. 2000). Rather than interbreeding as one large aggregation, ESUs typically 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. For the purpose of recovery planning, NMFS appointed a Puget Sound Technical Recovery Team (PSTRT) to identify independent populations and develop biological viability criteria for the ESA listed salmon and steelhead species in Puget Sound and Ozette Lake.

The Ozette Lake Sockeye salmon ESU includes naturally spawned sockeye salmon originating from the Ozette River and Ozette Lake and its tributaries. Also, sockeye salmon from two artificial propagation programs: the Umbrella Creek Hatchery Program; and the Big River Hatchery Program (78 FR 20802; Figure 1). The PSTRT determined that unlike most salmon ESUs, the Ozette Lake sockeye salmon ESU was historically made up of only one independent population (Currens et al. 2009). The extant spawning aggregations located on two beaches on Ozette Lake—Allen's and Olsen's beaches—and in two tributaries (Umbrella Creek and Big River) to Ozette Lake are considered subpopulations. The two remaining beach-spawning aggregations are probably fewer than the number of aggregations that occurred historically, but

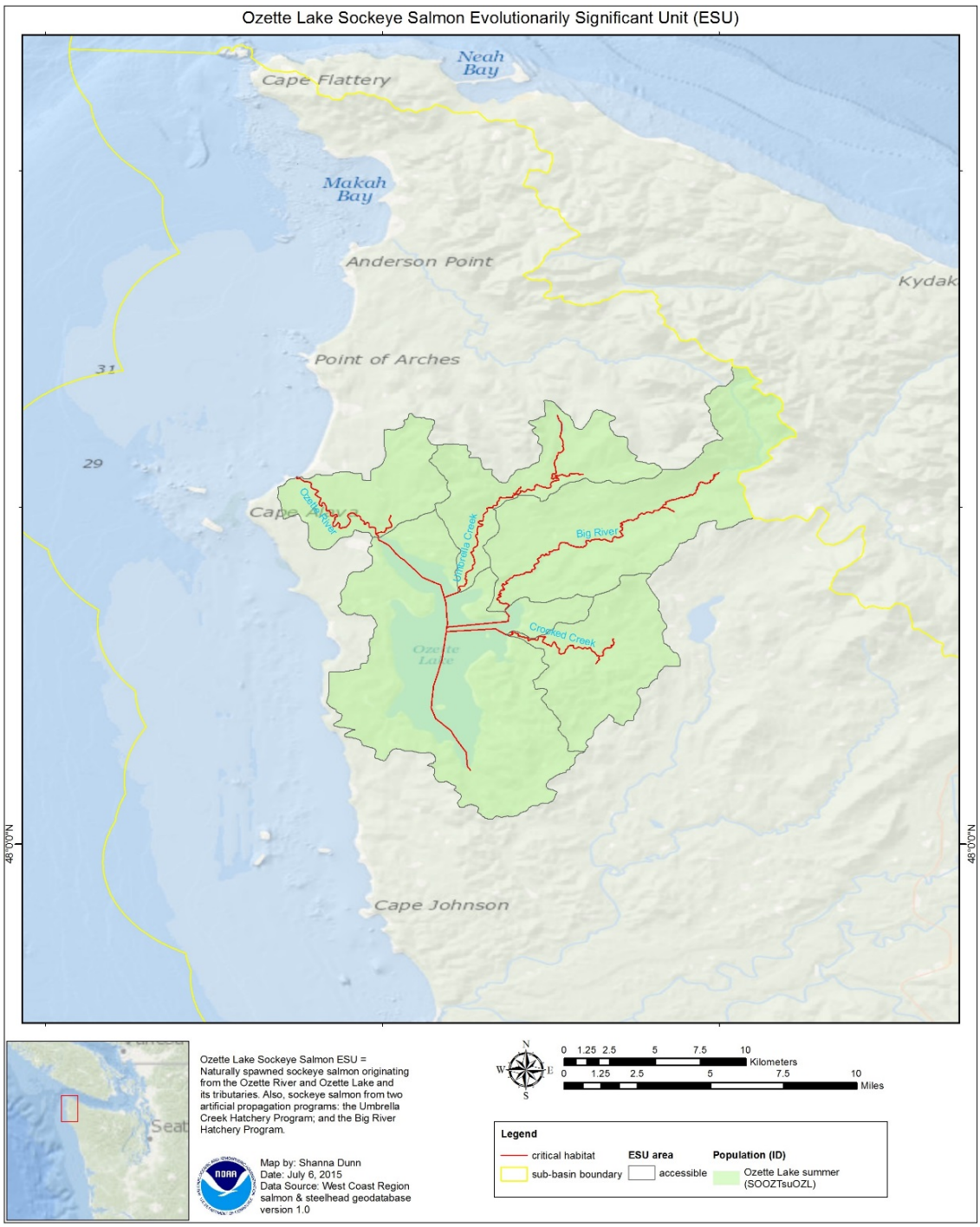


**Figure 1. Ozette Lake sockeye salmon population structure**[1]

[1] The map above generally shows the accessible and historically accessible areas for the Ozette Lake sockeye salmon ESU. The area displayed is consistent with the regulatory description of the composition of the Ozette Lake sockeye salmon ESU 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.

there is insufficient evidence to determine how many subpopulations occurred in the ESU historically (Currens et al. 2009). A few sockeye salmon, likely strays from beach spawning aggregations, were sporadically observed in during spawning ground surveys in past years in Umbrella Creek and Big River. The low number of sockeye observed was not indicative of self-sustaining adult returns, and, the extant tributary-spawning aggregations that are now predominately natural-origin fish were initiated through a hatchery-based introduction program.

For the Lake Ozette Sockeye Salmon Recovery Plan (NMFS 2009a), NMFS used the population structure and biological viability criteria identified by the PSTRT (Ruckelshaus et al. 2002; Currens et al. 2006).

The PSTRT used biological principles for developing their ESU and population criteria described in NMFS' VSP concept technical memorandum (McElhany et al. 2000). The viability of the ESU is based on the characteristics and their distribution throughout the ESU's geographic range. The Lake Ozette Sockeye Recovery Plan (NMFS 2009a) provides the following biological viability recovery criteria for naturally self-sustaining adults in the Ozette Lake sockeye ESU (Rawson et al. 2009):

- Abundance: 31,250 – 121,000 spawners, over a number of years
- Productivity: Population growth rate stable or increasing
- Spatial Structure: Multiple spatially distinct and persistent spawning aggregations across the historical range of the population
- Diversity: One or more persistent spawning aggregations from each major genetic and life history group historically present within the population.

## 2.3 Updated Information and Current Species' Status

Ozette Lake sockeye salmon were originally listed as a threatened species in 1999. The first 5-year status review (Good et al. 2005) found little evidence of an increasing trend in population abundance since the listing in 1999 and emphasized that the available data was very uncertain and hampered efforts to assess tends and status in the VSP criteria: abundance, spatial structure and diversity. They recommended that the threatened status remain unchanged. Similarly, Ford et al. (2011) concluded that estimates of population abundance for Ozette Lake sockeye remained highly variable and uncertain, making it impossible to detect changes in abundance trends or in productivity. It was clear, though, that population levels remained very low compared to historical levels when harvest on these stocks was plentiful. That review noted that assessment methods must improve in order to evaluate the status of this population/ESU and its responses to recovery actions. Again, information considered in 2011 did not indicate a change in the biological risk category.

The NMFS's Northwest Fisheries Science Center (NWFSC) has again reviewed updated information to inform this 5-year review, rating the population against the biological criteria identified in the recovery plan, to assign the current viability rating. New data available for this

review includes run size estimates based on expanded weir counts that have been extended from 2004 to 2012 in a report prepared for the National Marine Fisheries Service (Haggerty 2015), and updated information on the hatchery program, tributary spawners and beach spawners included in the Lake Ozette Sockeye Hatchery Genetics Management Plan Extension Request and its supporting tables (MFM 2015). This updated information includes estimates of total run size and brood stock take for Umbrella Creek from 2000 to 2013, and estimates of proportion hatchery origin spawners (pHOS) during the same period for Umbrella Creek, Big River, and Allen's and Olsen's beaches.

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

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

#### Updated Biological Risk Summary

Abundance of Ozette Lake sockeye has not changed substantially from the last status review. The quality of data continues to hamper efforts to assess more recent trends and spatial structure and diversity although this situation is improving. Based on this review, there is no evidence to suggest a change in the biological risk category (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

Habitat restoration and protection actions at the Federal, state, and local levels have been implemented to improve degraded habitat conditions and restore fish passage. While these efforts are expected to benefit the survival and productivity of the targeted Ozette Lake sockeye population, we do not yet have evidence demonstrating that improvements in habitat conditions have led to improvements in population viability. Improvements in monitoring, evaluation, and reporting of habitat metrics and fish population response will allow us to document the effectiveness of habitat restoration actions and progress toward the viability criteria for the Ozette Lake sockeye ESU in the future. Generally, it takes one to five decades to demonstrate such increases in viability. Below, we summarize several noteworthy restoration and protection

actions that have been implemented since the last review. We also note areas where concerns remain about the habitat conditions for this ESU.

### Current Status and Trends in Habitat

Below, we summarize information on the **current status and trends in habitat** conditions since our last 2010-2011 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; (2) **specific areas** where concerns about this DPS habitat condition remain; (3) **key protective measures and major restoration actions** leading toward achieving the recovery plan viability criteria established by the NMFS Science Centers as efforts 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

Although numerous commitments and actions to improve habitat conditions in the Ozette Lake area have been implemented, monitoring data and evaluation of such actions demonstrating a positive impact to the viability of the Ozette Lake sockeye is not yet available. Notably, Ozette Lake beach spawning habitat continues to decline as the upper beaches are narrowed by vegetation recruitment, and several other habitat factors remain unaddressed for a variety of reasons:

- Water quality is of key concern for Ozette Lake as mercury and PCB levels are among the highest in Washington State, despite the remote location of the lake (WDOE 2008). With regards to effects on the ESU, tissue samples taken from adult sockeye show mercury levels that were considerably lower than in lake-resident species (WDOE 2011). Adult sockeye salmon would be expected to have lower mercury and PCB concentrations because the vast majority of growth over their life cycle occurs in the ocean, where contaminant levels are low. Juvenile sockeye salmon that are exposed only to lake conditions for their two year rearing period would be expected to have elevated mercury and PCB concentrations, at levels similar to lake resident species; juvenile mercury levels are lower than those of juvenile sockeye found in Lake Washington, and are mid-range relative to juvenile sockeye values recorded in Alaska (WDOE 2011).

- Water quantity and hydrologic patterns are also a concern as restoration of normative hydrologic function to Ozette Lake watershed, as appropriate, is key to the long-term viability of the Ozette Lake sockeye ESU (Haggerty 2009).

- Action to enhance and restore spawning beaches has not been adequately pursued (Haggerty 2009; LOSSC 2012-2015).

- Predation continues to appear to be a significant factor limiting productivity (Haggerty 2009; LOSSC 2012-2015).

Detrimental habitat shifts associated with climate change are an emerging concern, particularly as rain dominant watersheds, such as the Ozette Lake watershed, are sensitive to drought. Hatchery-based introduction of Ozette Lake Sockeye aggregations into lake tributaries has expanded the range of habitat utilized by naturally spawning fish that are part of the ESU, and Makah tribal biologists report that natural spawning is occurring further upstream in the two tributaries that have been the focus of introduction efforts, which suggests that habitat values are becoming re-established in these tributaries. This expansion may be diminished by climatic changes, however, if stream flow and temperature levels become less hospitable to sockeye salmon survival and productivity. For example, in 2015, warmer than normal winter temperatures lead to maturation of eggs at the Makah hatchery several weeks earlier than usual, and drier than normal conditions in spring required release of juveniles from the hatchery several weeks earlier than usual. Early summer flows reduced the lake level so significantly that it was difficult, given dynamic depth and low flow conditions and the limited availability of tribal resources, to effectively operate the ARIS array in the upper Ozette River for the purposes of counting sockeye entering the lake. Further, ponded conditions and low flows in Ozette River impaired migration and aggravated predation, as otters took advantage of the sockeye pooling in cooler pockets of water. Mid-summer conditions saw flows at very low levels with temperatures so warm that disease risk increased at the tributary hatchery program rearing location.

### 2) Specific Areas of Concern

Significant habitat concerns remain, particularly regarding spawning beach conditions, hydrologic patterns that are legacy effects of streamside timber practices and large wood removal, which will take decades to ameliorate without affirmative restoration activities. The low productivity of the beach spawning aggregation(s) is a continuing concern that will require corrective habitat measures on the part of the co-managers and the Olympic National Park in order for viability benefits to accrue. Climate change also portends increasing frequency of detrimental conditions similar to those experienced throughout 2015.

### 3) Key Protective Measures and Major Restoration Actions

Implementation of the 2009 Lake Ozette Sockeye Recovery Plan is still in relatively early stages. Since the 2011 status review, Federal land managers, Tribes, and local partners have pursued several actions from the Recovery Plan to improve and restore habitat within the Ozette Lake watershed. These include:

- Tributary land acquisition
- Invasive weed control
- Fish habitat improvements
- HCP-associated Road Maintenance and Abandonment (RMAP) implementation and road cross drain installation
- Big River floodplain restoration

The largest change in practices systemically affecting habitat conditions has been the Washington State Forest Practices Habitat Conversation Plan (FPHCP) and Washington Department of Natural Resources State Land Habitat Conservation Plan (WDNR State Land HCP) for private and state forestland, as roughly 70 percent of the watershed is in private holdings, and the bulk of that is timber land (WDNR 2005). The HCPs' implementation has carried forward improvements to fish passage and road management via plans to properly abandon or stabilize existing forest roads, and improve standards on how new roads are to be built. Timber harvest practices that increased stream buffers, together with improved road management, have reduced the amount of sediment load to streams and rivers, and allowed better riparian conditions, all of which serve Ozette Lake Sockeye.

Both the Olympic National Park (ONP) and the Olympic Coast National Marine Sanctuary (OCNMS) have adopted Management Plans that contain elements consistent with Recovery Plan goals. The ONP plan includes several habitat improvement actions for Ozette Lake. The OCNMS plan of 2011 has elements to improve and protect nearshore areas.

The Makah Tribe is currently evaluating imaging sonar to estimate the total abundance of adult sockeye salmon entering Ozette Lake each year. These abundance estimates can be used with other data to estimate survival and productivity of each brood line cycle. The sonar-based census method is being evaluated because the video-based method of enumerating adults migrating into the lake using a full river-spanning weir is believed to impede fish movement, leading to elevated predation-related mortality. The change in abundance data collection practices is intended to allow removal and replacement of the weir used to record video images with a less restrictive deflection weir required for the sonar-based program. Removal of the full river-spanning weir will allow free upstream sockeye salmon adult sockeye salmon passage. Continued use of video fish counts using the full river-spanning weir is expected for no more than two additional years, at which point the less restrictive weir will be installed, re-establishing unimpeded fish passage and reducing a predation point in the upper Ozette River.

#### 4) Key Regulatory Mechanisms

Tributary habitat falls largely within the framework of federal land management, as Ozette Lake and proximate portion of its tributaries are predominantly within in the Olympic National Park. Tributary reaches outside the park are largely within private industrial timber holdings, with some reaches in Washington State Department of Natural Resources holdings. Given this unique geographical context, the largest determinant of tributary habitat outside of the Olympic National Park's land management practices, is the regulatory framework governing timber harvest. This framework includes Road Maintenance and Abandonment Plans intended to reduce significant sediment loads to streams and rivers, and is applicable to both small and large forest landowners. Within the Ozette Lake watershed, two large forest landowners, Merrill Ring, and Green Crow, have each met their RMAP obligations on time, improving water quality and river sediment conditions in Ozette Lake tributaries. Additionally state forest practice regulations have increased restrictions on timber harvest within riparian buffers based on stream type, allowing canopy cover, detrital input, shade, and large wood recruitment, to slowly re-establish natural habitat characteristics in and adjacent to fish bearing tributaries. Unfortunately, stream-typing

protocols in Washington State have been specifically noted by NMFS and the USFWS to be inaccurate, and thus under-identify streams as fish habitat. This signifies that protective value of the regulations is not carried forward adequately across the state, including in the Ozette Lake watershed, calling the effectiveness of the Forest Practices HCP into question.

#### 5) Recommended Future Actions

There have been some systemic improvements, as well as some discrete and site specific restorative actions to improve freshwater habitat conditions, and a general expansion of habitat areas as a result of supplementation practices. Improvements in stream-typing to correctly identify fish habitat and corollary forest practices consistent with the Forest Practices HCP will require continued attention.

### Listing Factor A Conclusion

Given that hatchery supplementation has shown success in expanding population spatial structure, and stream spawner productivity and abundance are performing well, we therefore conclude that there is a slight decline in the level of the risk to the species' persistence based on habitat destruction or modification since the last status review. However, the improvements will need to be safeguarded with additional protective measures and restorative actions, particularly with regard beach spawning, and predation factors. Until such measures are established and successes are documented, the previous risk level finding for this category should not be revised.

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

### Harvest

Changes in harvest management were implemented in the 1980s and no commercial or recreational harvest of Ozette Lake sockeye has been authorized since 1982. There have been no commercial salmon fisheries allowed in the Ozette Lake Basin since 1982. Incidental take from other fisheries (e.g., ocean harvest) is not likely a risk factor (NMFS 2009a; Haggerty et al. 2009).

Within the Olympic National Park several fishing restrictions to reduce incidental take of Ozette Lake Sockeye have been in place since 2004. These include:

- Anglers may only use a single, barbless hook with no bait.
- Recreational fisheries for salmonids other than sockeye in the Ozette River are only open from Aug. 1 - Feb 28, and closed the remainder of the year to avoid the late-winter and spring juvenile and adult sockeye migration periods in the river. This truncated fishing season minimizes the risk of incidental capture, injury, and mortality of listed sockeye salmon.
- Fisheries directed at other fish species in Ozette Lake are restricted to opening from the last Saturday of April to October 31. This restriction reduces the risk of incidental capture, injury and mortality of adult sockeye spawning in beach spawning areas, and on adult fish staging to enter Umbrella Creek and Big River.

- There are no recreational fishery harvest limits in the Ozette River and Ozette Lake when open on bass, perch, bullhead, or pikeminnow. This measure is implemented to maximize removal of potential sockeye predator and competitor species, and reduce the abundance of the species for the benefit of juvenile sockeye survival in the basin.

While the legacy of prior overutilization in fisheries, habitat alteration, and habitat degradation, combined with current habitat conditions, continues to be expressed as overall low abundance, given these restrictions and conditions of NMFS' biological opinion minimizing take associated with the Makah resource management plan, NMFS believes overutilization is not currently an active factor limiting productivity of the ESU. Harvest restrictions and restrictions to reduce incidental take are expected to be kept in place while efforts continue to improve habitat values, and this combination is likely to result in improved viability of the Ozette Lake sockeye ESU.

### Research and Monitoring

A community representative on the Lake Ozette Sockeye Steering Committee, which oversees implementation of the Lake Ozette Recovery Plan, has suggested that research be carried forward to determine Ozette Lake Sockeye migration patterns, and evaluate the degree to which they are impacted by harvest of other species. This suggestion remains a low priority item, and no action is pending on research or monitoring of take related to overutilization.

Much of the scientific research and monitoring being conducted for Ozette Lake sockeye salmon is intended to fulfill state agency obligations under the ESA and the Clean Water Act. In 2014, researchers were approved to take up to 26 naturally produced juvenile Ozette Lake sockeye salmon with three indirect mortalities. All of the requested nonlethal juveniles were taken by electrofishing units (NMFS APPS database; https://apps.nmfs.noaa.gov/). Backpack and boat electrofishing are being used to capture juvenile fish for absence/presence surveys and tissue samples for toxicology tests.

The quantity of permits issued over the past five years has been mostly consistent with the prior five years; therefore, the overall effect on the listed population 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 Ford et al. 2011 status review.

### Listing Factor B Conclusion

The legacy of prior overutilization in fisheries, habitat alteration, and habitat degradation, combined with current habitat conditions, continues to be expressed as overall low abundance. However, given these restrictions and conditions of NMFS' biological opinion minimizing take associated with the Makah resource management plan, and fishing restrictions that prevent target harvest of Ozette Lake Sockeye, NMFS believes overutilization is not currently an active factor limiting productivity of the ESU. Harvest restrictions and restrictions to reduce incidental take are expected to be kept in place while efforts continue to improve habitat values, and this combination is likely to retain the current level of viability of the Ozette Lake sockeye ESU.

## Listing Factor C: Disease or Predation

Fishing regulations implemented in 2004 removed catch limits on the harvest of non-native predator fish species such as largemouth bass, yellow perch and yellow bullhead, which may result in lower rates of piscivorous fish predation on juvenile sockeye. In July 2012, an error was remedied by striking northern pikeminnow from the list of non-native predator fish species. Although a native species, the most recent fishing regulations issued by NPS included northern pikeminnow with non-native fish species in removal of harvest catch limits as a measure to help reduce predation risks to listed sockeye salmon rearing in Ozette Lake.

Current operation and management of the weir at Ozette Lake currently constrains sockeye migration and delays both upstream and downstream fish passage, which results in increased fish and mammal predation by northern pikeminnow, harbor seal, and river otter on migrating juvenile and/or adult sockeye as they encounter the weir. ARIS based monitoring has been implemented as an alternative means to census adult sockeye salmon, and is expected to allow partial to full removal of the channel-spanning weir. The Co-managers expect to run both the ARIS and the weir-based adult fish counting methods for a maximum of two additional years to calibrate the data, and then retire the full river-spanning weir, and replace it with a less restrictive weir. At that time, predation at the site on both adult and juvenile sockeye would be expected to decline, improving productivity by reducing pre-spawn mortality, and increasing spawner abundance, as the rate of juvenile to adult survival increases.

The increasing pinniped population along the Pacific coast may lead to increased harbor seal and sea lion predation, although the effects in nearshore areas merit further evaluation to inform the development of management alternatives. The impact on the beach spawning population of sockeye salmon resulting from predation by harbor seals is also uncertain.

Additionally, sediment deposition and the non-natural hydrograph likely increase water temperatures, and may thereby exacerbate disease risks. Warmer and drier conditions associated with climate change also aggravate the risk of disease, particularly where hatchery supplementation is involved. The continuing concern of predation, especially by marine mammals, is also further amplified when drought conditions impair riverine migration habitat. Methods to address sediment and hydrology in non-drought conditions needs further investigation as identified in the Recovery Plan.

### Listing Factor C Conclusion

At this time, we do not have information available that would allow us to quantify the change in extinction risk, nor a complete understanding of the predation dynamics. The Lake Ozette Sockeye Steering Committee, via contribution from NMFS and ONP will hold a workshop with predation experts to improve our understanding of sockeye predation, and from there, develop additional strategies to reduce predation on the ESU. We, therefore, conclude that the risk to the species' persistence because of predation or disease has neither increased nor decreased since the last status review.

## Listing Factor D: Inadequacy of existing regulatory mechanisms

Information available since the last status review indicates that most regulatory mechanisms have not significantly changed, and adequacy of these regulatory mechanisms to provide protection for the ESU and its habitat needs remains largely static. The regulatory mechanisms that have improved since the last review include:

- Implementation of ESA-approved sockeye salmon status monitoring, evaluation, and research actions associated with the Ozette Lake Sockeye Salmon Hatchery and Genetics Management Plan.
- The Washington Department of Ecology has mapped riverine channel migration zones throughout Clallam County, which may be a foundation to regulatory measures that reduce development impacts adjacent to rivers throughout the watershed.

However, NMFS is also is on record with concerns that DNR stream-typing protocols associated with the Forest Practices HCP are being carried out in a manner inadequate to provide sufficient protection of stream habitat.

### Listing Factor D Conclusion:

These programs are discussed in detail in other sections of this report. However, as a general matter, environmental regulations serve as a method to limit but not prevent resource degradation at a project by project scale. When considered programmatically, we conclude that the risk to the species' persistence because of the inadequacy of existing regulatory mechanisms persists, despite the improvements noted above. Although the adequacy of regulatory programs has slightly improved relative to the last review, additional monitoring is needed to determine whether the additional protection is resulting in improved habitat quality and improved viability of the Ozette Lake sockeye ESU.

## 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 adult migrants, such as coho 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% of adult Redfish Lake sockeye 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, pink, coho, sockeye and steelhead, they predicted contractions in suitable marine habitat of 30-50% by the 2080s, with an even larger contraction (86-88%) for Chinook salmon under the medium and high emissions scenarios (A1B and A2) (NWFSC 2015).

Over the past 40 years, climate change has degraded environmental conditions for Pacific Northwest salmon and steelhead. In summer 2015, warm winter temperatures precipitated early maturation of sockeye eggs at the Makah supplementation hatchery, which in turn required earlier in season release of fry. The Olympic Peninsula has been in drought conditions since February 17, 2015, with tributaries currently at unseasonably low flows, and warm temperatures. These conditions are likely to negatively impact rearing juveniles, and if drought conditions continue into the fall, impair return migration and spawning conditions. The modeled climate change impacts appear to be borne out by current conditions, and it is likely that similar conditions will occur with increasing frequency over time, with likely negative impacts on the abundance and productivity of this species.

### 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% 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 downwelling, 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 during periods of low natural abundance. They also can help preserve genetic resources until limiting factors can be addressed. However, the long-term use of artificial propagation may pose risks to natural productivity and diversity. The magnitude and type of the risk depends on the status of the affected populations and on specific practices in the hatchery program.

Implementation of the Umbrella Creek and Big River sockeye salmon aggregation introduction programs is expected to result in positive contributions to spatial structure, abundance, and diversity for the ESU. These programs provide an essential safety net for the core beach spawning population while habitat concerns are being addressed. Since the previous status review, these programs have demonstrated effectiveness in producing increased levels of natural-origin adult fish recruitment and smolt production in Ozette Lake tributaries (Peterschmidt and Hinton 2005; Peterschmidt and Hinton 2006; Peterschmidt et al. 2007; Hinton et al. 2010; Haggerty 2015). Monitoring of tributary hatchery program sockeye salmon straying to spawning beaches over 10 years indicate that introgression is not a substantial concern at this time. However, spawning ground interactions between the beach and tributary-origin aggregates should continue to be monitored.

### 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 Effects

Based on the new information that has become available since the last ESA status review, we concluded that the tributary hatchery reintroduction programs have reduced risks to the Ozette Lake sockeye ESU by increasing abundance, productivity, diversity, and spatial structure of the species. The total abundance of natural-origin sockeye salmon spawning in the tributaries has increased from zero fish to an annual average of nearly two thousand fish commensurate with implementation of the hatchery effort. The productivity of the ESU in total has benefited from the introduction of natural spawning and creation of natural-origin returns to the tributaries. Spatial structure of the population has benefited from the extension of annual adult returns, natural spawning, and fry production in the tributaries. With regards to diversity, demographic diversity has improved with spatial structure and broadening age class, meanwhile best management practices applied through the ESA-approved tributary hatchery programs, and demonstrated very low stray rate levels of hatchery-origin fish to beach spawning sockeye areas, lend support to a finding that the tributary introduction effort will not impart substantial genetic diversity reduction or fitness loss effects on the core beach spawning aggregation, or on the population in total, as a result of past and continued implementation of the tributary sockeye salmon introduction programs.

## Other Recommendations

### Research, Monitoring, and Evaluation

While the Lake Ozette Recovery Plan identifies multiple research, monitoring, and evaluation needs and activities, with the exception of actions specified in the NMFS-approved Resource Management Plan implemented by the Makah Tribe, these are primarily unfunded and unperformed to date.

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

The updated status review completed by our Northwest Fisheries Science Center indicates that the ESU is not currently meeting the viability criteria in the Lake Ozette Sockeye Salmon Recovery Plan. Current abundance for natural origin spawning escapement to the known beach areas and the tributaries is 2,679 sockeye salmon, which is well below the PSTRT's minimum abundance planning goal of 31,250 fish. The fraction of abundance composed by beach spawning sockeye salmon appears to be declining, even while the tributary spawning aggregation is increasing in abundance and becoming well established. These relative statuses for the two aggregations suggest that risk to ESU spatial structure has only moderately ameliorated since the last status review. Estimating spawners has improved with the use of imaging sonar, but equipment failures, technical calibration difficulties, and extreme habitat conditions that complicated effective operation of the ARIS system for available tribal staff during certain periods have made it difficult to determine with certainty if significant viability improvements are likely to occur over time for this ESU. A small improvement in ESU viability has been observed over the last five years, and there is no new information to indicate that the extinction risk has increased significantly. The Science Center concluded, after reviewing the available new information that the biological risk category for this ESU has not changed since the time of the last status review.

Our analysis of the ESA section 4(a)(1) factors indicates that the collective risk to the Ozette Lake sockeye salmon ESU's persistence has decreased slightly since our listing determination in 2005. There have been improvements to habitat condition and the risks from overutilization have decreased due to the adoption of more conservative fishery management practices. The risk to the species' persistence because of the inadequacy of existing regulatory mechanisms has decreased slightly and existing hatchery programs help reduce extinction risks to this ESU. However, predation from an increase in pinniped populations and significant avian impacts remain a concern, as do the impacts that climate change poses to long-term recovery.

After considering the biological viability of the Ozette Lake sockeye salmon ESU and the current status of its ESA section 4(a)(1) factors, we conclude that the status of this ESU has not improved significantly since the updated ESA listing for the ESU in 2005. Although some of the risks posed by the 4(a)(1) factors have decreased, no commensurate improvement in ESU viability has been observed. Full benefits from the habitat restoration and protection efforts implemented during the last five years will likely take another five to 20 years to be realized. By continuing to implement actions that address the factors limiting ESU survival and monitoring the effects of the actions over time, we will ensure that restoration efforts meet the biological needs of the ESU and, in turn, contribute to the recovery of this species. The Lake Ozette Sockeye Salmon Recovery Plan is the primary guide for identifying future actions to target and address ESU limiting factors and threats. Over the next five years, it will be important continue to implement these actions and monitor our progress. Future improvements in data collection methods and analysis are also essential to better assess ESU abundance and productivity.

### 2.4.1 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 the composition of the Ozette Lake sockeye salmon ESU.

The West Coast Regional Office's review of new information to inform the ESU/DPS membership status of various hatchery programs (Jones 2015) found that the Ozette Lake Sockeye Salmon ESU hatchery programs have not changed substantially from the previous 2011 ESA status review. The two listed hatcheries – Umbrella Creek Hatchery and Big River Hatchery – have been combined into one hatchery – Umbrella Creek/Big River Hatcheries (Jones 2015).

### 2.4.2 ESU/DPS Viability and Statutory Listing Factors

- The Northwest Fisheries Science Center's review of updated information does not indicate a change in the biological risk category since the time of the last ESA status review (NWFSC 2015).
- Our analysis of the 4(a)(1) factors indicates that the collective risk to the Ozette Lake sockeye salmon ESU's persistence has decreased slightly since our final listing determination in 2005. Some concerns remain, particularly regarding climate change, degraded beach habitat, and increased pinniped predation.

# 3 · Results

## 3.1 Classification

### Listing status:

Based on the information identified above, we determine that no reclassification is appropriate, and therefore:

- The Ozette Lake sockeye salmon ESU should remain listed as threatened.

### ESU Delineation:

Based on the information identified above, we conclude that the current species delineation for the Ozette Lake sockeye salmon ESU is accurate and needs no adjustment.

### Hatchery Membership:

Jones 2015 reports only one change to the Ozette Lake sockeye salmon hatchery program since the previous 2011 review. The two listed hatcheries – Umbrella Creek Hatchery and Big River Hatchery – have been combined into one hatchery – Umbrella Creek/Big River Hatcheries (Jones 2015).

## 3.2 New Recovery Priority Number

Since the previous 2011 five-year review, NMFS revised the recovery priority number from one (NMFS 2009) to new recovery priority number of nine for the Ozette Lake sockeye salmon ESU (NMFS 2015a) as listed in Table 4 of this document.

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# 4 · Recommendations for Future Actions

Continued coordination and cooperation of Federal, state, tribal and local partners, such as the Ozette Lake Sockeye Steering Committee, is critical to the successful implementation of these the Recovery Plan for Ozette Lake sockeye (NMFS 2009a) – the Habitat Conservation Plans, Olympic National Park's Master Plan, and provisions of the HGMP. In our review of the listing factors, we identified several actions that are critical to improving the status of the Ozette Lake sockeye salmon ESU. These include implementation of strategies and actions identified in Section 7.2.2, of the recovery plan, such as restoration of spawning beaches, and addressing the impacts of the existing weir, as among the most important actions to be taken over the next five years. Secondarily, efforts to implement new research, monitoring and evaluation actions to address critical uncertainties identified in the Recovery Plan, such as how to best address predation impacts, achieve additional habitat improvements, and increase the abundance of the beach spawning aggregate through supplementation should be pursued.

Recommendations:

- Improve estimates of total population size. This is necessary both for developing a population level abundance series and dividing the population into the different aggregates. Efforts should be directed towards adopting the imaging sonar for estimating the total sockeye salmon run size entering Ozette Lake. This approach would have a much smaller effect on fish movement relative to the channel-spanning weir placed each year to count sockeye salmon, and can be used in the early part of the run.

- Improve estimates of the tributary spawners. Specifically re-evaluate the mark-recapture methodology for Umbrella Creek estimates and develop a method for estimating run size in the other tributaries.

- Continue efforts to enumerate the beach spawning aggregates with the goal of moving from an index-based estimate to a total abundance estimate. Also an occasional spatially extensive survey would provide a more concrete picture of distribution.

- Continue to implement regular sampling to estimate hatchery fraction and age structure for each of the aggregates. Also investigate alternative approaches for estimating overall hatchery origin contribution to the total ESU and population age structure.

- Increase technical support to Makah Tribe to improve ARIS use and performance in tracking of adult sockeye returns

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# 5 · References

## 5.1 Federal Register Notices

June 15, 1990 (55 FR 24296). Notice: Endangered and Threatened Species; Listing and Recovery Priority Guidelines.

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

March 25, 1999 (64 FR 14528). Final Rule: Endangered and Threatened Species: Threatened Status for Ozette Lake Sockeye Salmon in Washington.

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

June 28, 2005 (70 FR 37160). Final Rule: Endangered and Threatened Species: Final Listing Determinations for 16 ESUs of West Coast Salmon, and Final 4(d) Protective Regulations for Threatened Salmonid ESUs.

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

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

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

May 29, 2009 (74 FR 25706). Notice of Availability: Endangered and Threatened Species; Recovery Plans.

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

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

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

## 5.2 Literature Cited

Abdul-Aziz, O.I., N.J. Mantua, and K.W. Myer. 2011. Potential climate change impacts on thermal habitats of Pacific salmon (*Oncorhynchus spp.*) in the North Pacific Ocean and adjacent seas. Canadian Journal of Fisheries and Aquatic Sciences. 68:1660-1680.

Beechie, T., E. Buhle, M. Ruckelshaus, A. Fullerton, and L. Holsinger. 2006. Hydrologic regime and the conservation of salmon life history diversity. Biological Conservation. 130:560-572.

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

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

Crozier, L., R.W. Zabel, S. Achord, and E.E. Hockersmith. 2010. Interacting effects of density and temperature on body size in multiple populations of Chinook salmon. Journal of Animal Ecology. 79:342-349.

Currens, K.P., R. Fuerstenberg, W. Graeber, K Rawson, Ruckelshaus, M., N.J. Sands, and J. Scott. 2006. Independent populations of sockeye salmon in Lake Ozette. Puget Sound Technical Recovery Team document. March 21, 2006. 20 p. Available at: http://www.nwfsc.noaa.gov/trt/puget_docs

Currens, K.P., R.R. Fuerstenberg, W.H. Graeber, K. Rawson, M.H. Ruckelshaus, N.J. Sands, and J.B. Scott. 2009. Identification of an Independent Population of Sockeye Salmon in Lake Ozette, Washington. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-96, 18 p.

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

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

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

Gustafson, R. G., T. C. Wainwright, G. A. Winans, F. W. Waknitz, L. T. Parker, and R. S. Waples. 1997. Status review of sockeye salmon from Washington and Oregon. U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC-33.

Haggerty, M., A. Ritchie, J. Shellberg, M. Crewson, and J. Jalonen. 2009. Lake Ozette Limiting Factors Analysis. Prepared for The Makah Indian Tribe and NOAA Fisheries, in Cooperation With the Lake Ozette Sockeye Steering Committee.

Haggerty, M.J. 2015. A summary of Lake Ozette sockeye salmon run-size estimates for return years 2004 through 2012. Unpublished report prepared for NMFS, in coordination with Makah Fisheries Management.

Healey, M. 2011. The cumulative impacts of climate change on Fraser River sockeye salmon (*Oncorhynchus nerka*) and implications for management. Canadian Journal of Fisheries and Aquatic Sciences. 68:718-737.

Hinton, J., J. Gilman, and L. Cooke. 2010. 2009 Lake Ozette Sockeye Resource Management Plan Final Report. Makah Fisheries Management. P.O. Box 115, Neah Bay, WA 98357, 24 p.

IPCC (Intergovernmental Panel on Climate Change). 2013. Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press. Available from: http://www.climatechange2013.org/ Cambridge, United Kingdom and New York, NY, USA.

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

Klos, P.Z., T.E. Link, and J.T. Abatzoglou. 2014. Extent of the rain-snow transition zone in the western U.S. under historic and projected climate. Geophysical Research Letters. 41: 4560-4568.

LOSSC (Lake Ozette Sockeye Steering Committee) 2012-2015. Information presented and discussed among steering committee membership at quarterly meetings in furtherance of Recovery Plan implementation.

Mantua, N.J., S.R. Hare, Y. Zhang, J.M. Wallace, and R.C. Francis. 1997. A Pacific interdecadal climate oscillation with impacts on salmon production. Bulletin of the American Meteorological Society. 78:1069-1079.

Melillo, J.M., T.C Richmond, and G.W. Yohe. 2014. Climate Change Impacts in the United States: The Third National Climate Assessment. U.S. Global Change Research Program.

MFM (Makah Fisheries Management). 2000. Lake Ozette Sockeye Hatchery and Genetic Management Plan. Biological Assessment, Section 7 Consultation, October 23, 2000. Prepared by Makah Fisheries Management for Bureau of Indian Affairs, Makah Indian Tribe, Neah Bay, WA. 219 p.

MFM (Makah Fisheries Management). 2015. Appendix Lake Ozette Sockeye Hatchery Genetics Management Plan Extension Request supporting tables. Prepared by Joseph Hinton, Makah Fisheries Hatchery Manager. Makah Fisheries Management, Neah Bay, WA.

McElhany, P., M. Ruckleshaus, M. J. Ford, T. Wainwright, and E. Bjorkstedt. 2000. Viable Salmon Populations and the Recovery of Evolutionarily Significant Units. U. S. Department of Commerce, National Marine Fisheries Service, Northwest Fisheries Science Center, NOAA Technical Memorandum NMFS-NWFSC-42. 156 p. http://www.nwfsc.noaa.gov/assets/25/6190_06162004_143739_tm42.pdf

NMFS (National Marine Fisheries Service). 1998. Conclusions Regarding the Updates Status of Ozette Lake and Baker River ESUs of West Coast Sockeye Salmon. December 17, 1998, NMFS-NWFSC Status Review Update Memo.

NMFS (National Marine Fisheries Service). 2003. A Joint State/Tribal Resource Management Plan provided by the Makah Tribe and the Washington Department of Fish and Wildlife for Artificial Propagation, Research, Monitoring and Evaluation of Ozette Lake Sockeye Salmon. Under Limit 6 of the Endangered Species Act 4(d) Rule. (50 CFR 223.203(6)) (65 FR 42422, July 10, 2000) – DECISION MEMORANDUM. July 15, 2003. National Marine Fisheries Service. Northwest Region. Portland, Oregon.

NMFS (National Marine Fisheries Service). 2009a. Final Recovery Plan for Lake Ozette Sockeye Salmon. May 2009. NMFS Portland, Oregon

NMFS (National Marine Fisheries Service). 2009b. Biennial Report to Congress on the Recovery Program for Threatened and Endangered Species – October 1, 2006 - September 30, 2008. 184 pp. Available at: http://www.nmfs.noaa.gov/pr/pdfs/laws/esabiennial2008.pdf

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

NMFS (National Marine Fisheries Service). 2015b. National Marine Fisheries Service (NMFS) Evaluation of the Ozette Lake Sockeye Hatchery and Genetic Management Plan under Limit 6 of the Endangered Species Act Section 4(d) Rule (Reinitiation 2015). WCR-2015-2484. National Marine Fisheries Service, West Coast Region, Sustainable Fisheries Division. Portland, Oregon.

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

Peterschmidt, C. and J. Hinton. 2005. Resource Management Plan Report for Lake Ozette Sockeye 2004. Makah Fisheries Management Report, June 2005. 10p.

Peterschmidt, C. and J. Hinton. 2006. Resource Management Plan Report for Lake Ozette Sockeye 2005. Makah Fisheries Management Report 2006. 11p.

Peterschmidt, C., J. Hinton, and C. Eggleston. 2007. Resource Management Plan Report for Lake Ozette Sockeye 2006. Makah Fisheries Management Report 2007. 10p.

PSTRT (Puget Sound Technical Recovery Team) and SSSG (Shared Strategy Staff Group). 2003. Integrated Recovery Planning for Listed Salmon: Technical Guidance for Watershed Groups in Puget Sound. Draft February 3, 2003

Quinn, T.P. 2005. The Behavior and Ecology of Pacific Salmon and Trout. University of Washington Press. Seattle, Washington.

Rawson, K., N.J. Sands, K.P. Currens, W.H. Graeber, M.H. Ruckelshaus, R.R. Fuerstenberg, and J.B. Scott. 2009. Viability Criteria for the Lake Ozette Sockeye Salmon Evolutionarily Significant Unit. U.S. Department of Commerce. NOAA Technical Memorandum NMFS-NWFSC-99, 38 p.

Ruckelshaus, M., K.P. Currens, R. Fuerstenberg, W. Graeber, K. Rawson, N.J. Sands, and J. Scott. 2002. Planning ranges and preliminary guidelines for the delisting and recovery of the Puget Sound Chinook Salmon Evolutionarily Significant Unit. Puget Sound Technical Recovery Team document. April 30, 2002. 17 p. Available at: http://www.nwfsc.noaa.gov/trt/puget_docs/trtpopesu.pdf

Rykaczewski, R.R., J.P. Dunne, W.J. Sydeman, M. Garcia-Reyes, B.A. Black, and S.J. Bograd. 2015. Poleward displacement of coastal upwelling-favorable winds in the ocean's eastern boundary currents through the 21st century. Geophysical Research Letters. 42:6424-6431.

Salathe, E.P., A.F. Hamlet, C.F. Mass, S.Y. Lee, M. Stumbaugh, and R. Steed. 2014. Estimates of Twenty-First-Century Flood Risk in the Pacific Northwest Based on Regional Climate Model Simulations. Journal of Hydrometeorology. 15:1881-1899.

Sawaske, S.R. and D.L. Freyberg. 2014. An analysis of trends in baseflow recession and low-flows in rain-dominated coastal streams of the Pacific coast. Journal of Hydrology. 519:599-610.

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

Wade, A.A., T.J. Beechie, E. Fleishman, N.J. Mantua, H.Wu, J.S. Kimball, D.M. Stoms, and J.A. Stanford. 2013. Steelhead vulnerability to climate change in the Pacific Northwest. Journal of Applied Ecology. 50:1093-1104.

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

WDOE (Washington Department of Ecology). 2008. Measuring Mercury Trends in Freshwater Fish in Washington State: 2007 Sampling Results. Publication No. 08-03-027.

WDOE (Washington Department of Ecology). 2011. Mercury Concentrations in Lake Ozette Sockeye. Publication No. 11-03-017. March 2011. Available at www.ecy.wa.gov/biblio/1103017.html

WDNR (Washington Department of Natural Resources). 2005. Final Forest Practices Habitat Conservation Plan. Olympia, Washington. 335 p.

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# National Marine Fisheries Service 5-Year Review
# Ozette Lake Sockeye Salmon

**Conclusion:**
Based on the information identified above, we conclude:

- The Ozette Lake sockeye salmon ESU should remain listed as threatened

**REGIONAL OFFICE APPROVAL**

Approve: _____ Date: 13 May 2016

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