CHAPTER 8

STATUS OF SPECIES AND CRITICAL HABITAT LIKELY TO BE ADVERSELY AFFECTED SALMONIDS

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8 STATUS OF SPECIES AND CRITICAL HABITAT LIKELY TO BE ADVERSELY AFFECTED

8.1 Introduction

The purpose of this section is to characterize the condition and status of the 28 species[1] that are likely to be adversely affected by the action, and to describe the status, conservation role and function of their respective critical habitats.

The status of species includes the existing level of risk that the Endangered Species Act (ESA)-listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. The species status section helps to inform the description of the species' current "reproduction, numbers, or distribution," which is part of the jeopardy determination as described in 50 C.F.R. §402.02.

This section also examines the condition of critical habitat throughout the designated area (such as various watersheds and coastal and marine environments that make up the designated area), and discusses the condition and current function of designated critical habitat, including the essential physical and biological features that contribute to that conservation value of the critical habitat.

The following species and critical habitat designations may occur in the action area (Table 1). More detailed information on the status of these species and critical habitat are found in a number of published documents including recent recovery plans, status reviews, stock assessment reports, and technical memorandums. Many are available on the Internet at http://www.nmfs.noaa.gov/pr/species/.

Table 1. Listed Species and Critical Habitat in the Action Area.

Common Name (Distinct Population Segment (DPS) or Evolutionarily Significant Unit (ESU))	Scientific Name	Status
Chum salmon , Columbia River ESU	Oncorhynchus keta	THREATENED
Chum salmon, Hood Canal summer-run ESU		THREATENED
Chinook salmon, California coastal ESU	Oncorhynchus tshawytscha	THREATENED
Chinook salmon, Central Valley spring-run ESU		THREATENED
Chinook salmon, Lower Columbia River ESU		THREATENED
Chinook salmon, Puget Sound ESU		THREATENED
Chinook salmon, Sacramento River winter-run ESU		ENDANGERED
Chinook salmon, Snake River fall-run ESU		THREATENED

[1] We use the word "species" as it has been defined in section 3 of the ESA, which include "species, subspecies, and any distinct population segment (DPS) of any species of vertebrate fish or wildlife which interbreeds when mature (16 U.S.C 1533)." Pacific salmon other than steelhead that have been listed as endangered or threatened were listed as "evolutionarily significant units" (ESU), which NMFS uses to identify distinct population segments of Pacific salmon. Any ESU or DPS is a "species" for the purposes of the ESA.

Common Name (Distinct Population Segment (DPS) or Evolutionarily Significant Unit (ESU))	Scientific Name	Status
Chinook salmon, Snake River spring/summer run ESU		THREATENED
Chinook salmon, Upper Columbia River spring-run ESU		ENDANGERED
Chinook salmon, Upper Willamette River ESU		THREATENED
Coho salmon, Central California coast ESU	Oncorhynchus kisutch	ENDANGERED
Coho salmon, Lower Columbia River ESU		THREATENED
Coho salmon, Oregon coast ESU		THREATENED
Coho salmon, S. Oregon and N. Calif coasts ESU		THREATENED
Sockeye, Ozette Lake ESU	Oncorhynchus nerka	THREATENED
Sockeye, Snake River ESU		ENDANGERED
Steelhead, California Central Valley DPS	Oncorhynchus mykiss	THREATENED
Steelhead, Central California coast DPS		THREATENED
Steelhead, Lower Columbia River DPS		THREATENED
Steelhead, Middle Columbia River DPS		THREATENED
Steelhead, Northern California DPS		THREATENED
Steelhead, Puget Sound DPS		THREATENED
Steelhead, Snake River Basin DPS		THREATENED
Steelhead, South-Central California coast DPS		THREATENED
Steelhead, Southern California DPS		ENDANGERED
Steelhead, Upper Columbia River DPS		THREATENED
Steelhead, Upper Willamette River DPS		THREATENED

In assessing the status of the listed species NMFS made use of the viable salmonid population (VSP) concept and its four criteria. A VSP is an independent population (a population of which extinction probability is not substantially affected by exchanges of individuals with other populations) with a negligible risk of extinction, over a 100-year period, when threats from random catastrophic events, local environmental variation, demographic variation, and genetic diversity changes are taken into account (McElhany et al. 2000b). The four factors defining a viable population are a population's: (1) spatial structure, their distribution and utilization of their range; (2) abundance; (3) annual growth rate, including trends and variability of annual growth rates; and (4) diversity (McElhany et al. 2000b).

A population's tendency to increase in abundance and its variation in annual population growth and distribution defines a viable population (McElhany et al. 2000b; Morris and Doak 2002). A negative long-term trend in average annual population growth rate will eventually result in extinction. Further, a weak positive long-term growth rate will increase the risk of extinction as it maintains a small population at low abundances over a longer time frame. A large variation in the growth rates also increases the likelihood of extinction (Lande 1993; Morris and Doak 2002). Thus, in our status reviews of each listed species, we provide information on population abundance and annual growth rate of extant populations.

The action area for this consultation contains designated critical habitat for all 28 listed Pacific Salmon listed in Table 1. Critical habitat is defined as the specific areas within the geographical area occupied by the species, at the time it is listed, on which are found those physical or biological features that are essential to the conservation of the species, and which may require special management considerations or protection. Critical habitat can also include specific areas outside the geographical area occupied by the species at the time it is listed that are determined by the Secretary to be essential for the conservation of the species (ESA of 1973, as amended, section 3(5)(A)).

The primary purpose in evaluating the status of critical habitat is to identify for each Evolutionarily Significant Unit (ESU) or Distinct Population Segment (DPS) the function of the critical habitat to support the intended conservation role for each species. Such information is important for an adverse modification analysis as it establishes the context for evaluating whether the proposed action results in negative changes in the function and role of the critical habitat for species conservation. NMFS bases its critical habitat analysis on the areas of the critical habitat that are affected by the proposed action and the area's physical or biological features that are essential to the conservation of a given species, and not on how individuals of the species will respond to changes in habitat quantity and quality.

In evaluating the status of designated critical habitat, we consider the current quantity, quality, and distribution of the physical or biological features (PBFs[2]) that are essential for the conservation of the species. NMFS has identified PBFs of critical habitat for each life stage (*e.g.*, migration, spawning, rearing, and estuary) common for a number of species. To fully understand the conservation role of these habitats, specific physical and biological habitat features (*e.g.*, water temperature, water quality, forage, natural cover, etc.) were identified for each life stage.

Besides potential toxicity, water free of contaminants is important as contaminants can disrupt normal behavior necessary for successful migration, spawning, and juvenile rearing. Sufficient forage is necessary for juveniles to maintain growth that reduces freshwater predation mortality, increases overwintering success, initiates smoltification, and increases ocean survival. Natural cover such as submerged and overhanging large wood and aquatic vegetation provides shelter from predators, substrates for aquatic and terrestrial invertebrates (salmonid prey), shades freshwater to prevent increase in water temperature, and creates important side channels. A description of the past, ongoing, and continuing activities that threaten the functional condition of PBFs and their attributes are described in the *Environmental Baseline* section of this Biological Opinion (Opinion).

[2] Some of the critical habitat designations used the term "primary constituent elements" or PCEs, a regulatory that is no longer in effect. PCEs are generally the same as PBFs, and we will use the terms interchangeably based on the description in the species' critical habitat designation.

The information from the Status of the Species section may be used as a “risk modifier” in the Integration and Synthesis section (Chapters 13 and 16). Factors which have the potential to “modify” the risk of the action jeopardizing the species are those which are able to interact with the effects of the action. While many of the factors described in this section have the potential to modify the risk, and were thus considered, three of the factors within the status of the species were consistently found to have a high potential to modify the risk. Those three factors are: 1) trends in abundance, spatial distribution, and productivity; 2) listing status; and 3) achievement of recovery goals. We therefore developed three key questions to guide our synthesis of the information within the Status of the Species section:

1. Are abundance, spatial distribution, and productivity trends increasing, decreasing or stable?

2. Is the species listed as threatened or endangered?

3. Have recovery goals been met or are they on a sustained positive trajectory toward recovery?

Each status section concludes with a table providing a brief response to each of these questions.

Within the Integration and Synthesis section we characterize the overall magnitude of influence of the species status as either “low” or “high”. This characterization includes directionality (i.e. positive influence which equates to less risk or negative influence which equates to more risk) as well as confidence. The magnitude, directionality, and confidence of the influence are determined primarily by answers provided to the three key questions outlined above. We acknowledge that the magnitude, and directionality of these three factors varies on a species-by-species basis (for example, the significance of the attainment of recovery goals are relative to the specifics of the recovery goals themselves). We further acknowledge that the quantitative data (e.g. estimates of population growth rates) are incomplete without considering the more qualitative data often provided in recovery plans, status reports and listing documents. Therefore, we characterized magnitude and directionality with the following guidelines: 1) If the listing status of the species is “endangered”, the magnitude is high and the directionality is negative; 2) If the listing status is “threatened” and both of the other two factors indicates stability and/or recovery and/or uncertainty, the magnitude is low and the directionality is negative; 3) if the listing status is “threatened” and the other two factors indicate population decline and failure to meet recovery goals, the magnitude is high and the directionality is negative. It is conceivable directionality could also be positive. For example, if the listing status is “threatened” and the population’s growth rate, abundance, and spatial distribution has been consistently increasing between status reports, the direction could be positive. This is the case of threatened Hood Canal summer-run chum, where the population’s growth rate and abundance has been increasing in recent years.

The overall confidence in the magnitude and directionality is then characterized as either “low” or “high”. Confidence is determined by assessing the amount of evidence provided, as well as by further considering the species specific implications of the three factors. It is important to note that the key-question framework (described above) is a tool to help guide our risk assessors in making transparent and consistent determinations. However, the ultimate consideration of increased or decreased risk attributable to the status of the species is not restricted to the consideration of the key questions alone. All information relevant to the status of the species is considered in the risk assessment.

With but a few exceptions (discussed below) ESA listed salmon and steelhead are doing poorly throughout their Washington, Idaho, Oregon and California range. In most of Washington State, according to the state’s biennial report on salmon (stateofsalmon.wa.gov), ESA listed salmon are below recovery goals (see Table *2*). While some species such as Snake River fall-run Chinook and Hood Canal summer-run chum are demonstrating large successes and continue upward trends towards recovery, others species, such as the Puget Sound Chinook and the upper Columbia River spring-run Chinook continue to diminish.

In Idaho, with the exception of the Snake River fall-run Chinook, species are not making progress or are showing only slight signs of progress toward recovery goals. For example, in 2018, only thirteen wild sockeye returned to Idaho, the recovery goal is 2,500.

Oregon salmon species include Oregon Coast Coho. The 2017 adult returns reached only 8.5 percent of the abundance goal. In 2016, the lower Columbia River coho salmon spawner abundance increased from 2015, but was still the fourth lowest observed in the past 15 years of monitoring (ODFW 2016). Lower Columbia River Chinook returns are far below abundance goals and in recent years have shown no progress toward improving in numbers. Upper Willamette River Chinook and steelhead abundance has remained steady in recent years but far below recovery targets.

California returns of all listed salmon continue to decline (Table 3). For example, in total 237,000 salmon and steelhead returned to monitored California rivers to spawn in 2016/2017. This amounts to a 30 percent reduction from the 2015/2016 returns.

Table 2. Washington StateESA-listed salmon progress toward recovery.

Below Goal (ESA listed salmon in Washington)			Near Goal
Getting Worse	Not Making Progress	Showing Signs of Progress	Approaching Goal
Upper Columbia River Spring Chinook	Upper Columbia River Steelhead	Mid-Columbia River Steelhead	Hood Canal Summer Chum
Puget Sound Chinook	Lower Columbia River Chum	Lake Ozette Sockeye	Snake River Fall Chinook

	Lower Columbia River Coho	Lower Columbia River Steelhead	
	Lower Columbia River Fall Chinook	Snake River Steelhead	
	Lower Columbia River Spring Chinook	Puget Sound Steelhead[3]	
	Snake River Spring and Summer Chinook		

Table 3. Total Salmon and steelhead returning to California rivers 2013 – 2017.

Monitoring year	Total Salmon and Steelhead Abundance
2016/2017	237,000
2015/2016	335,000
2014/2015	520,000
2013/2014	680,000

The following narratives summarize the biology and ecology of threatened and endangered species that are likely to be adversely affected by the Environmental Protection Agency's (EPA) proposed action. The summaries include a description of the timing and duration of each life stage (e.g. adult river entry, spawning, egg incubation, freshwater rearing, smolt outmigration, and ocean migration). We also highlight information related to the viability of populations and the physical or biological features essential for the conservation of the species (PBFs) of designated critical habitats. These summaries provide a foundation for NMFS' evaluation of the effects of the proposed action on these listed species.

[3] Recovery goals for Puget Sound Steelhead are under development. NOAA draft recovery goals are available at www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/puget_sound/puget _sound_salmon_recovery_domain.html

8.2 Chum salmon, Columbia River ESU

Table 4. Chum salmon, Columbia River ESU; overview table

Species	Common Name	Distinct Population Segment	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus keta	Chum Salmon	Columbia River ESU	Threatened	2016	70 FR 37160	78 FR 41911	70 FR 52630

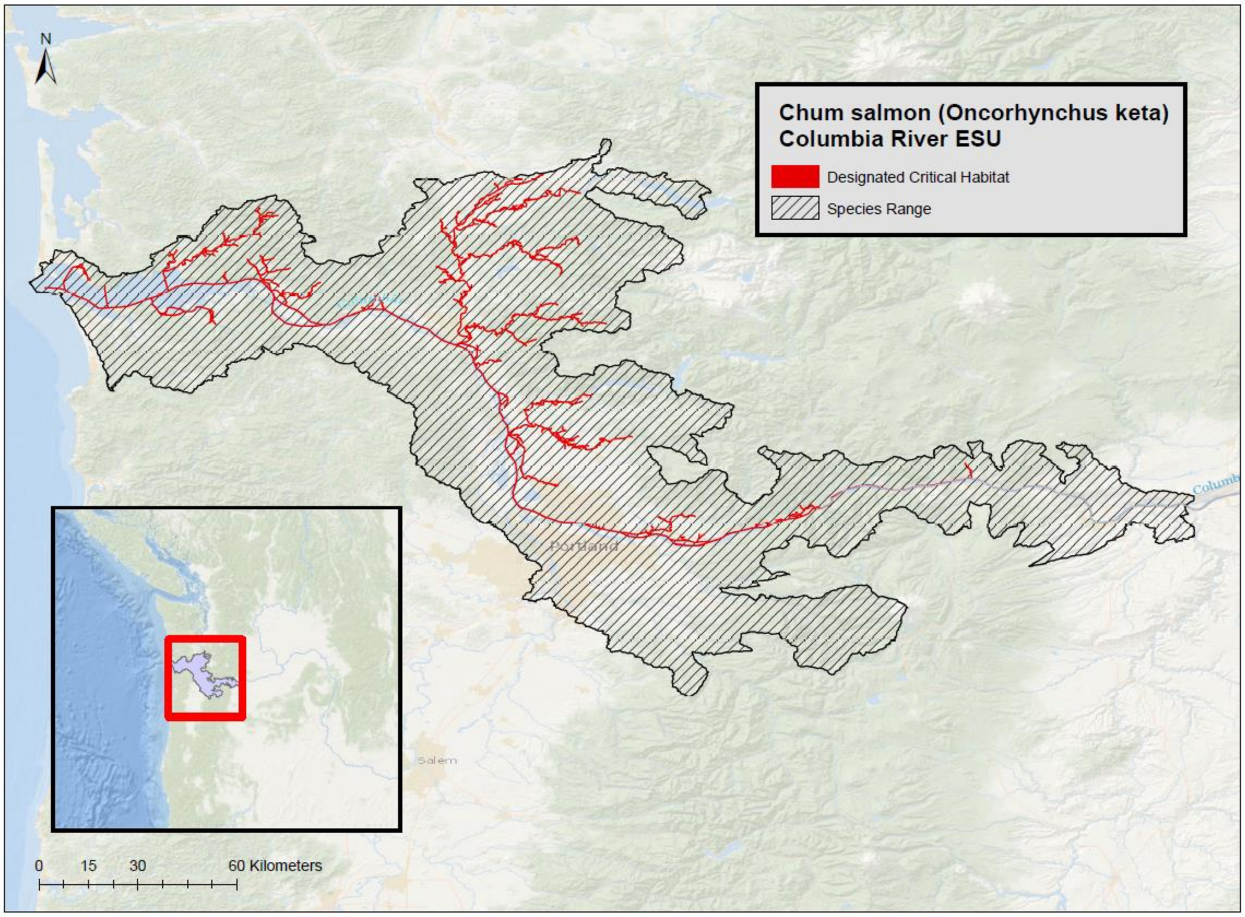

Figure 1. Chum salmon, Columbia River ESU range and designated critical habitat

Species Description. Chum salmon are an anadromous (i.e., adults migrate from marine to freshwater streams and rivers to spawn) and semelparous (i.e., they spawn once and then die) fish species. Adult chum salmon are typically between eight and fifteen pounds, but they can get as large as 45 pounds and 3.6 feet long. Males have enormous canine-like fangs and a striking calico pattern body color (front two-thirds of the flank marked by a bold, jagged, reddish line and the posterior third by a jagged black line) during spawning. Females are less flamboyantly colored and lack the extreme dentition of the males. Ocean stage chum salmon are metallic greenish-blue along the back with black speckles. Chum salmon have the widest natural geographic and spawning distribution of the Pacific salmonids. Chum salmon have been documented to spawn from Korea and the Japanese island of Honshu, east around the rim of the North Pacific Ocean to Monterey Bay, California. Historically, chum salmon were distributed throughout the coastal regions of western Canada and the U.S. At present, major spawning populations occur as far south as Tillamook Bay on the northern Oregon coast. On March 25, 1999, NMFS listed the Hood Canal Summer-run ESU and the Columbia River ESU of chum salmon as threatened (64 FR 14508). NMFS reaffirmed the status of these two ESUs as threatened on June 28, 2005 (70 FR 37160).

Status. The majority of the populations within the Columbia River chum salmon ESU are at high to very high risk, with very low abundances (NWFSC 2015b). These populations are at risk of extirpation due to demographic stochasticity and Allee effects. One population, Grays River, is at low risk, with spawner abundances in the thousands and demonstrating a recent positive trend. The Washougal River and Lower Gorge populations maintain moderate numbers of spawners and appear to be relatively stable. The life history of chum salmon is such that ocean conditions have a strong influence on the survival of emigrating juveniles. The potential prospect of poor ocean conditions for the near future may put further pressure on the Columbia River chum salmon ESU (NWFSC 2015b). Freshwater habitat conditions may be negatively influencing spawning and early rearing success in some basins, and contributing to the overall low productivity of the ESU. Columbia River chum salmon were historically abundant and subject to substantial harvest until the 1950s (Johnson et al. 1997). There is no directed harvest of this ESU and the incidental harvest rate has been below one percent for the last five years (NWFSC 2015b). Land development, especially in the low gradient reaches that chum salmon prefer, will continue to be a threat to most chum salmon populations due to projected increases in the population of the greater Vancouver-Portland area and the Lower Columbia River overall (Metro 2015). The Columbia River chum salmon ESU remains at a moderate to high risk of extinction (NWFSC 2015b).

Life history. Most chum salmon mature and return to their birth stream to spawn between three and five years of age, with 60 to 90 percent of the fish maturing at four years of age. Age at maturity appears to follow a latitudinal trend (i.e., greater in the northern portion of the species' range). Chum salmon typically spawn in the lower reaches of rivers, with redds usually dug in the mainstem or in side channels of rivers from just above tidal influence to 100 km from the sea. Juveniles out-migrate to seawater almost immediately after emerging from the gravel covered redds ((Salo 1991). This ocean-type migratory behavior contrasts with the stream-type behavior of some other species in the genus Oncorhynchus (e.g., coastal cutthroat trout, steelhead, Coho salmon, and most types of Chinook and sockeye salmon), which usually migrate to sea at a larger size, after months or years of freshwater rearing. This means that survival and growth in juvenile chum salmon depend less on freshwater conditions (unlike stream-type salmonids which depend heavily on freshwater habitats) than on favorable estuarine conditions. Another behavioral difference between chum salmon and species that rear extensively in freshwater is that chum salmon form schools, presumably to reduce predation (Pitcher 1986), especially if their movements are synchronized to swamp predators (Miller and Brannon 1982).

Chum salmon spend two to five years in feeding areas in the northeast Pacific Ocean, which is a greater proportion of their life history compared to other Pacific salmonids. Chum salmon distribute throughout the North Pacific Ocean and Bering Sea, although North American chum salmon (as opposed to chum salmon originating in Asia), rarely occur west of 175 E longitude (Johnson et al. 1997). North American chum salmon migrate north along the coast in a narrow band that broadens in southeastern Alaska, although some data suggest that Puget Sound chum, including Hood Canal summer-run chum, may not make extended coastal migrations into northern British Columbian and Alaskan waters, but instead may travel directly offshore into the north Pacific Ocean (Johnson et al. 1997).

Table 5. Temporal distribution of Chum salmon, Columbia River ESU

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="4">Present</td></tr>
<tr><td>Spawning</td><td>Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Present</td></tr>
<tr><td>Incubation (eggs)</td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Present</td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td></td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td></td><td colspan="4">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Population Dynamics

Abundance / Productivity. Chum populations in the Columbia River historically reached hundreds of thousands to a million adults each year (NMFS 2017b). In the past 50 years, the average has been a few thousand a year. The majority of populations in the Columbia River chum ESU remain at high to very high risk, with very low abundances (NWFSC 2015b). Ford (2011b) concluded that 14 out of 17 of chum populations in this ESU were either extirpated or nearly extirpated. The very low persistence probabilities or possible extirpations of most chum salmon populations are due to low abundance, productivity, spatial structure, and diversity. Only one population (Grays River) is at low risk, with spawner abundances in the thousands, and demonstrating a recent positive trend. Two other populations (Washougal River and Lower Gorge) maintain moderate numbers of spawners and appear to be relatively stable (NWFSC 2015b).

Genetic Diversity. There are currently four hatchery programs in the Lower Columbia River releasing juvenile chum salmon: Grays River Hatchery, Big Creek Hatchery, Lewis River Hatchery, and Washougal Hatchery (NMFS 2017b). Total annual production from these hatcheries has not exceeded 500,000 fish. All of the hatchery programs in this ESU use integrated stocks developed to supplement natural production. Other populations in this ESU persist at very low abundances and the genetic diversity available would be very low (NWFSC

2015b). Although, hatchery production of Columbia River chum salmon has been limited and hatchery effects on diversity are thought to have been relatively small, diversity has been greatly reduced at the ESU level because of presumed extirpations and low abundance in the remaining populations (fewer than 100 spawners per year for most populations) (LCFRB 2010a; NMFS 2013a).

Distribution. The Columbia River chum salmon ESU includes all natural-origin chum salmon in the Columbia River and its tributaries in Washington and Oregon. The ESU consists of three populations: Grays River, Hardy Creek and Hamilton Creek in Washington State. Chum salmon from four artificial propagation programs also contribute to this ESU.

Designated Critical Habitat. NMFS designated critical habitat for the Columbia River chum salmon ESU in 2005 (70 FR 52630). Sixteen of the 19 subbasins reviewed in NMFS' assessment of critical habitat for the CR chum salmon ESU were rated as having a high conservation value. The remaining three subbasins were given a medium conservation value. Washington's federal lands were rated as having high conservation value to the species. PBFs considered essential for the conservation of the Columbia River ESU of Chum salmon are shown in Table 6.

Table 6 Primary Bioligical Features of critical habitats desigated for ESA-listed salmon and steelhead species considered in the opinion (except SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, SR

sockeye salmon, SONCC coho salmon, Sacramento River winter-run Chinook salmon, and Central California Coast coho salmon – see Table 31) and corresponding species life history events.

Primary Biological Features Site Type	Primary Biological Features Site Attribute	Species Life History Event
Freshwater spawning	Substrate Water quality Water quantity	Adult spawning Embryo incubation Alevin growth and development
Freshwater rearing	Floodplain connectivity Forage Natural cover Water quality Water quantity	Fry emergence from gravel Fry/parr/smolt growth and development
Freshwater migration	Free of artificial obstruction Natural cover Water quality Water quantity	Adult sexual maturation Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration
Estuarine areas	Forage Free of artificial obstruction Natural cover Salinity Water quality Water quantity	Adult sexual maturation and "reverse smoltification" Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration
Nearshore marine areas	Forage Free of artificial obstruction Natural cover Water quantity Water quality	Adult growth and sexual maturation Adult spawning migration Nearshore juvenile rearing

Limited information exists on the quality of essential habitat characteristics for CR chum salmon. However, migration PBF has been significantly impacted by dams obstructing adult migration and access to historic spawning locations. Water quality and cover for estuary and rearing PBFs have decreased in quality to the extent that the PBFs are not likely to maintain their intended function to conserve the species.

Recovery Goals. The ESU recovery strategy for Columbia River chum salmon focuses on improving tributary and estuarine habitat conditions, reducing or mitigating hydropower impacts, and reestablishing chum salmon populations where they may have been extirpated (NMFS 2013a). The goal of the strategy is to increase the abundance, productivity, diversity, and spatial structure of chum salmon populations such that the Coast and Cascade chum salmon strata are restored to a high probability of persistence, and the persistence probability of the two Gorge populations improves. For details on Columbia River chum salmon ESU recovery goals, including complete down-listing/delisting criteria, see the NMFS 2013 recovery plan (NMFS 2013a).

Table 7. Summary of status; Chum salmon, Columbia River ESU

Criteria	**Description**
Abundance / productivity trends	Most populations have very low abundances and productivity, low genetic diversity, high risk of extinction
Listing status	Threatened
Attainment of recovery goals	criteria not yet met
Condition of PBFs	Rearing PBFs (water quality and cover) are degraded; Migration PBFs significantly impacted by dams; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; All 19 watersheds of high or medium conservation value

8.3 Chum salmon, Hood Canal summer-run ESU

Table 8. Chum salmon, Hood Canal summer-run ESU; overview table

Species	Common Name	Distinct Population Segment	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus keta	Chum salmon	Hood Canal summer-run	Threatened	2011	70 FR 37160	2005	70 FR 52630

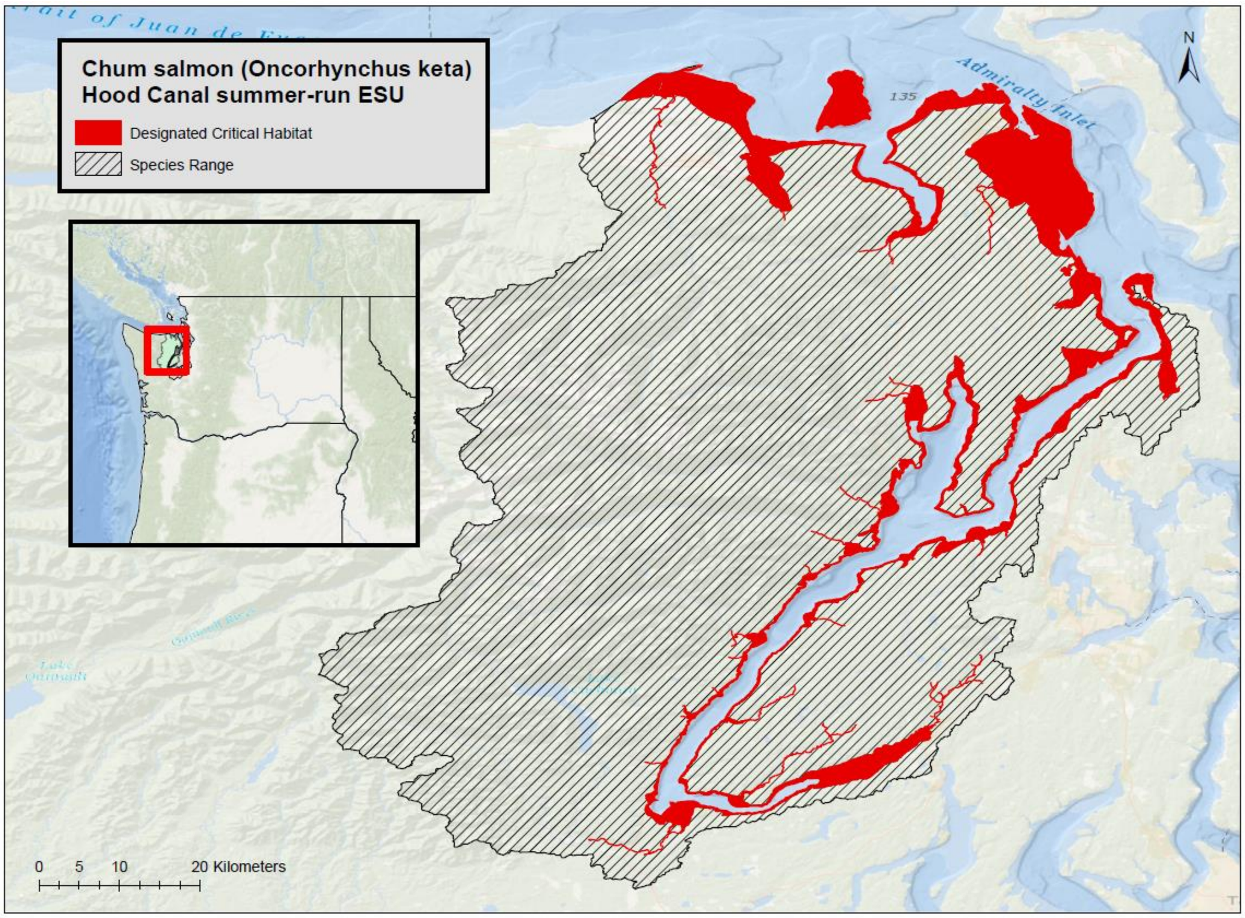

Figure 2. Chum salmon, Hood Canal summer-run ESU range and designated critical habitat

Species Description. Chum salmon are an anadromous (i.e., adults migrate from marine to freshwater streams and rivers to spawn) and semelparous (i.e., they spawn once and then die) fish species. Adult chum salmon are typically between eight and fifteen pounds, but they can get as large as 45 pounds and 3.6 feet long. Males have enormous canine-like fangs and a striking calico pattern body color (front two-thirds of the flank marked by a bold, jagged, reddish line and the posterior third by a jagged black line) during spawning. Females are less flamboyantly colored and lack the extreme dentition of the males. Ocean stage chum salmon are metallic greenish-blue along the back with black speckles. Chum salmon have the widest natural geographic and spawning distribution of the Pacific salmonids. Chum salmon have been documented to spawn from Korea and the Japanese island of Honshu, east around the rim of the North Pacific Ocean to Monterey Bay, California. Historically, chum salmon were distributed throughout the coastal regions of western Canada and the U.S. At present, major spawning populations occur as far south as Tillamook Bay on the northern Oregon coast. On March 25, 1999, NMFS listed the Hood Canal Summer-run ESU and the Columbia River ESU of chum salmon as threatened (64 FR 14508). NMFS reaffirmed the status of these two ESUs as threatened on June 28, 2005 (70 FR 37160).

Status. The two most recent status reviews (2011 and 2015) indicate some positive signs for the Hood Canal summer-run chum salmon ESU. Diversity has increased from the low levels seen in the 1990s due to both the reintroduction of spawning aggregates and the more uniform relative abundance between populations; considered a good sign for viability in terms of spatial structure and diversity (Ford 2011b). Spawning distribution within most streams was also extended further upstream with increased abundance. At present, spatial structure and diversity viability parameters for each population nearly meet the viability criteria (NWFSC 2015b). Spawning abundance has remained relatively high compared to the low levels observed in the early 1990's (Ford 2011b). Natural-origin spawner abundance has shown an increasing trend since 1999, and spawning abundance targets in both populations were met in some years (NWFSC 2015b). Despite substantive gains towards meeting viability criteria in the Hood Canal and Strait of Juan de Fuca summer chum salmon populations, the ESU still does not meet all of the recovery criteria for population viability at this time (NWFSC 2015b). Overall, the Hood Canal Summer-run chum salmon ESU remains at a moderate risk of extinction.

Life history. Most chum salmon mature and return to their birth stream to spawn between three and five years of age, with 60 to 90 percent of the fish maturing at four years of age. Age at maturity appears to follow a latitudinal trend (i.e., greater in the northern portion of the species' range). Chum salmon typically spawn in the lower reaches of rivers, with redds usually dug in the mainstem or in side channels of rivers from just above tidal influence to 100 km from the sea. Juveniles out-migrate to seawater almost immediately after emerging from the gravel covered redds ((Salo 1991). This ocean-type migratory behavior contrasts with the stream-type behavior of some other species in the genus *Oncorhynchus* (e.g., coastal cutthroat trout, steelhead, Coho salmon, and most types of Chinook and sockeye salmon), which usually migrate to sea at a larger size, after months or years of freshwater rearing. This means that survival and growth in juvenile chum salmon depend less on freshwater conditions (unlike stream-type salmonids which depend heavily on freshwater habitats) than on favorable estuarine conditions. Another behavioral difference between chum salmon and species that rear extensively in freshwater is that chum salmon form schools, presumably to reduce predation (Pitcher 1986), especially if their movements are synchronized to swamp predators (Miller and Brannon 1982).

Chum salmon spend two to five years in feeding areas in the northeast Pacific Ocean, which is a greater proportion of their life history compared to other Pacific salmonids. Chum salmon distribute throughout the North Pacific Ocean and Bering Sea, although North American chum salmon (as opposed to chum salmon originating in Asia), rarely occur west of 175 E longitude (Johnson et al. 1997). North American chum salmon migrate north along the coast in a narrow band that broadens in southeastern Alaska, although some data suggest that Puget Sound chum, including Hood Canal summer-run chum, may not make extended coastal migrations into northern British Columbian and Alaskan waters, but instead may travel directly offshore into the north Pacific Ocean (Johnson et al. 1997).

Table 9. Temporal distribution of Chum salmon, Hood Canal summer-run ESU

<table>
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<tr><td>Spawning</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Present</td><td></td><td></td></tr>
<tr><td>Incubation (eggs)</td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="4">Present</td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td></td><td colspan="4">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td></td><td colspan="5">Present</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Population Dynamics

Abundance / Productivity. Of the sixteen populations that comprise the Hood Canal Summer-run chum ESU, seven are considered “functionally extinct” (Skokomish, Finch Creek, Anderson Creek, Dewatto, Tahuya, Big Beef Creek and Chimicum). The remaining nine populations are well distributed throughout the ESU range except for the eastern side of Hood Canal (Johnson et al. 1997). Two independent major population groups have been identified for this ESU: (1) spawning aggregations from rivers and creeks draining into the Strait of Juan de Fuca, and (2) spawning aggregations within Hood Canal proper (Sands 2009). NMFS examined average escapements (geometric means) for five-year intervals and estimated trends over the intervals for all natural spawners and for natural-origin only spawners. For both populations, abundance was relatively high in the 1970s, lowest for the period 1985-1999, and high again for the most recent 10 years (NWFSC 2015b). The overall trend in spawning abundance is generally stable for the Hood Canal population (all natural spawners and natural-origin only spawners) and for the Strait of Juan de Fuca population (all natural spawners). Only the Strait of Juan de Fuca population’s natural-origin only spawners shows a significant positive trend. NMFS determined the abundance trends that appear to be positive occurs during a short time span between 1995-2009, and again recently from 2011 - 2015 is the Juan de Fuca population (NWFSC 2015b). Productivity rates, which were quite low during the five-year period from 2005-2009 (Ford 2011b), increased from 2011-2015 and were greater than replacement rates from 2014-2015 for both major population groups (NWFSC 2015b). However, productivity of individual spawning aggregates still shows only two of eight aggregates have viable performance. While overall population abundance goals are being met, sub-population abundance goals for Hood Canal summer-run chum have not been met for six of the eight surviving sub-populations, and the species has not achieved spatial structure goals.

Genetic Diversity. There were likely at least two ecological diversity groups within the Strait of Juan de Fuca population and at least four ecological diversity groups within the Hood Canal population. With the possible exception of the Dungeness River aggregation within the Strait of Juan de Fuca population, Hood Canal ESU summer chum spawning groups exist today that represent each of the ecological diversity groups within the two populations (NMFS 2017a). NMFS measured spatial distribution of the Hood Canal chum salmon ESU using the Shannon diversity index (NWFSC 2015b). Higher diversity values indicate a more uniform distribution of the population among spawning sites, which provides greater robustness to the population. Diversity values were generally lower in the 1990s for both independent populations within the ESU, indicating that most of the abundance occurred at a few spawning sites. Although the overall linear trend in diversity appears to be negative, the last five-year interval shows the highest average value for both populations within the Hood Canal ESU. This results in part from the addition of one reintroduced spawning aggregation in the Strait of Juan de Fuca population and two reintroduced spawning aggregations in the Hood Canal population (NMFS 2017a).

Distribution. The Hood Canal summer-run chum salmon ESU includes all naturally spawned populations of summer-run chum salmon in Hood Canal and its tributaries as well as populations in Olympic Peninsula rivers between Hood Canal and Dungeness Bay, Washington. This ESU also includes three artificial propagation programs: Hamma Hamma Fish Hatchery, Lilliwaup Creek Fish Hatchery, and the Jimmycomelately Creek Fish Hatchery (five other Hood Canal summer chum hatchery programs were terminated between 2005 and 2010 and are no longer part of the ESU).

Designated Critical Habitat. NMFS designated critical habitat for Hood Canal Summer-run chum salmon in 2005 (70 FR 52630). There are 12 watersheds within the range of this ESU. Three watersheds received a medium rating and nine received a high rating of conservation value to the ESU (NMFS 2005a). Five nearshore marine areas also received a rating of high conservation value. Habitat areas for the Hood Canal Summer-run chum salmon include 88 mi (142 km) of stream and 402 mi (647 km) of nearshore marine areas. PBFs considered essential for the conservation of the Hood Canal ESU of Chum salmon are shown in Table 6:

The spawning PBF is degraded by excessive fine sediment in the gravel, and the rearing PBF is degraded by loss of access to sloughs in the estuary and nearshore areas and excessive predation. Low river flows in several rivers also adversely affect most PBFs. In the estuarine areas, both migration and rearing PBFs of juveniles are impaired by loss of functional floodplain areas necessary for growth and development of juvenile chum salmon. These degraded conditions likely maintain low population abundances across the ESU.

Recovery Goals. The recovery strategy for Hood Canal Summer-run chum salmon focuses on habitat protection and restoration throughout the geographic range of the ESU, including both freshwater habitat and nearshore marine areas within a one-mile radius of the watersheds' estuaries (NMFS 2007). The recovery plan includes an ongoing harvest management program to reduce exploitation rates, a hatchery supplementation program, and the reintroduction of naturally spawning summer chum aggregations to several streams where they were historically present. The Hood Canal plan gives first priority to protecting the functioning habitat and major production areas of the ESU's eight extant stocks, keeping in mind the biological and habitat needs of different life-history stages, and second priority to restoration of degraded areas, where recovery of natural processes appears to be feasible (HCCC 2005). For details on Hood Canal Summer-run chum salmon ESU recovery goals, including complete down-listing/delisting criteria, see the Hood Canal Coordinating Council 2005 recovery plan (HCCC 2005) and the NMFS 2007 supplement to this recovery plan (NMFS 2007). Both independent populations (Strait of Juan de Fuca, Hood Canal) must have enough fish returning to meet abundance goals, distributed across the ESU to meet spatial structure goals in order to be considered recovered and removed from ESA listing.

Table 10. Summary of status; Chum salmon, Hood Canal summer-run ESU

Criteria	**Description**
Abundance / productivity trends	stable to increasing abundance trend, increasing population productivity
Listing status	threatened
Attainment of recovery goals	some criteria met
Condition of PBFs	Spawning and rearing PBFs are degraded; Migration and rearing PBFs are impaired by loss of floodplain habitat necessary for juvenile growth and development; Elevated temperatures and environmental mixtures anticipated in freshwater habitats ; All 12 watersheds of high or medium conservation value

8.4 Chinook salmon, California coastal ESU

Table 11. Chinook salmon, California coastal ESU; overview table

Species	Common Name	Distinct Population Segment	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus tshawytscha	Chinook salmon	California Coastal	Threatened	2016	70 FR 37160	2016	70 FR 52488

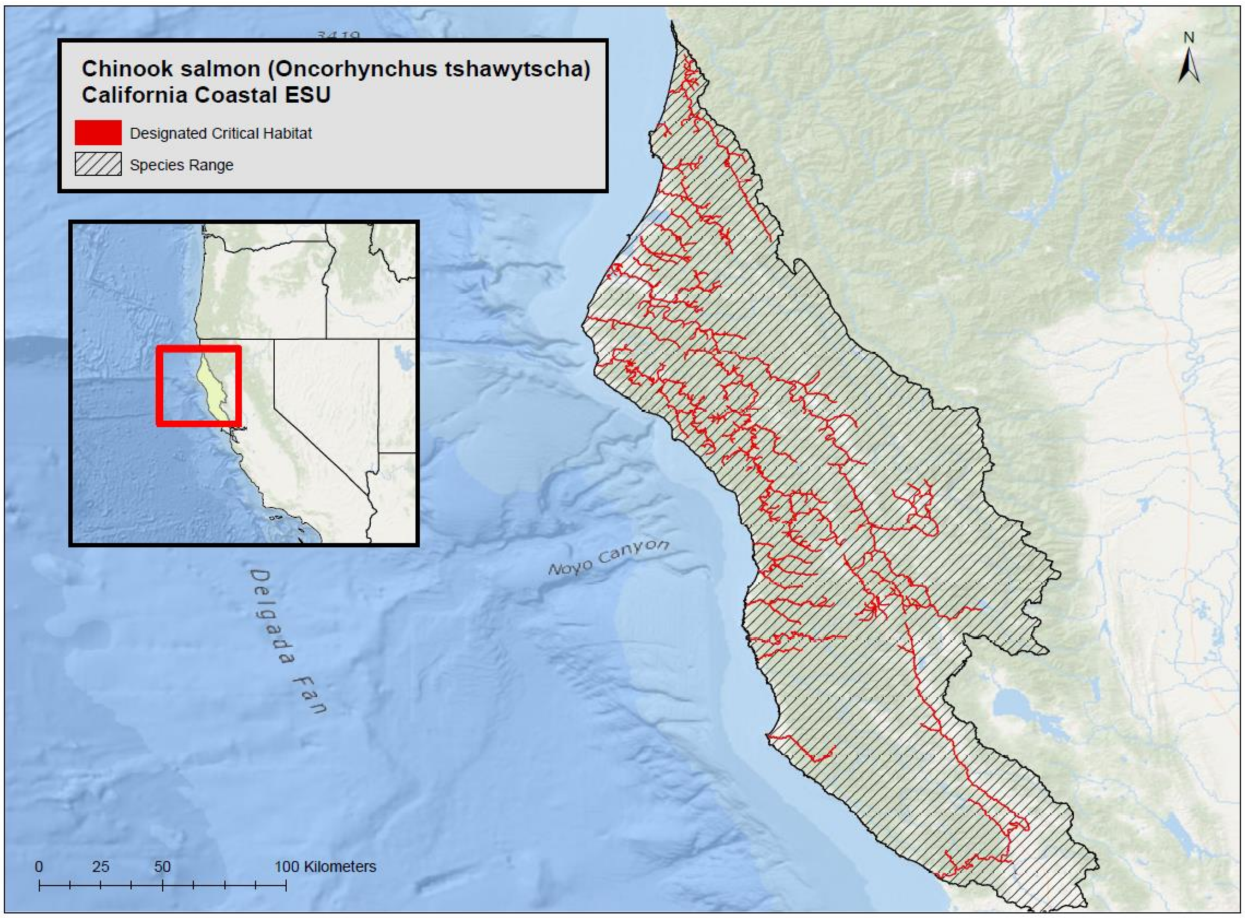

Figure 3. Chinook salmon, California coastal ESU range and designated critical habitat

Species Description. Chinook salmon, also referred to as king salmon in California, are the largest of the Pacific salmon. Spawning adults are olive to dark maroon in color, without conspicuous streaking or blotches on the sides. Spawning males are darker than females, and have a hooked jaw and slightly humped back. They can be distinguished from other spawning salmon by the color pattern, particularly the spotting on the back and tail, and by the dark, solid black gums of the lower jaw (Moyle 2002a). On September 16, 1999, NMFS listed the California coastal ESU of Chinook salmon as a "threatened" species (FR 64 50394). On June 28, 2005, NMFS confirmed the listing of CC Chinook salmon as threatened under the ESA and also added seven artificially propagated populations from the following hatcheries or programs to the listing. The California Coastal (CC) Chinook salmon ESU includes all naturally spawned populations of Chinook salmon from rivers and streams south of the Klamath River (Humboldt County, CA.) to the Russian River (Sonoma County, CA) (70 FR 37160).

Status. The ESU was historically comprised of 38 populations which included 32 fall-run populations and 6 spring-run populations across four Diversity Strata (Spence et al. 2008b). All six of the spring-run populations were classified as functionally independent, but are considered extinct (Williams et al. 2011). Good et al. (2005a) cited continued evidence of low population sizes relative to historical abundance, mixed trends in the few available time series of abundance indices available, and low abundance and extirpation of populations in the southern part of the ESU. In addition, the apparent loss of the spring-run life history type throughout the entire ESU as a significant diversity concern. The 2016 recovery plan determined that the four threats of greatest concern to the ESU are channel modification, roads and railroads, logging and wood harvesting, and both water diversion and impoundments and severe weather patterns.

Life history. California coastal Chinook salmon are a fall-run, ocean-type fish. Although a spring-run (river-type) component existed historically, it is now considered extinct (Bjorkstedt et al. 2005). The different populations vary in run timing depending on latitude and hydrological differences between watersheds. Entry of California coastal Chinook salmon into the Russian River depends on increased flow from fall storms, usually in November to January. Juveniles of this ESU migrate downstream from April through June and may reside in the estuary for an extended period before entering the ocean.

The length of time required for embryo incubation and emergence from the gravel is dependent on water temperature. For maximum embryo survival, water temperatures reportedly must be between 41°F and 55.4°F and oxygen saturation levels must be close to maximum. Under those conditions, embryos hatch in 40 to 60 days and remain in the gravel as alevins (the life stage between hatching and egg sack absorption) for another 4 to 6 weeks before emerging as fry. Juveniles may reside in freshwater for 12 to 16 months, but some migrate to the ocean as young-of-the- year in the winter or spring months within eight months of hatching.

Juvenile Chinook salmon forage in shallow areas with protective cover, such as tidally influenced sandy beaches and vegetated zones (Healey et al. 1991). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson et al. 1982b; MacFarlane and Norton 2002; Sommer et al. 2001). Upon reaching the ocean, juvenile Chinook salmon feed voraciously on larval and juvenile fishes, plankton, and terrestrial insects (Healey et al. 1991; MacFarlane and Norton 2002). Chinook salmon grow rapidly in the ocean environment, with growth rates dependent on water temperatures and food availability.

Table 12. Temporal distribution of Chinook salmon, California coastal ESU

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td>Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td></tr>
<tr><td>Spawning</td><td>Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Present</td></tr>
<tr><td>Incubation (eggs)</td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Present</td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td></td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td></td><td colspan="5">Present</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Population Dynamics

Abundance. Comparison of historical and current abundance information indicates that independent populations of Chinook salmon are depressed in many basins (Bennet 2005; Good et al. 2005b; NMFS 2008); only the Russian River currently has a run of any significance (Bjorkstedt et al. 2005). The 2000 to 2007 median observed (at Mirabel Dam) Russian River Chinook salmon run size is 2,991 with a maximum of 6,103 (2003) and a minimum of 1,125 (2008) adults (Cook 2008; Sonoma County Water Agency (SCWA) 2008).

Productivity / Population Growth Rate. The available data, a mixture of short-term (6-year or less) population estimates or expanded redd estimates and longer-term partial population estimates and spawner/red indexes, provide no indication that any of the independent populations (likely to persist in isolation) are approaching viability targets. Overall, there is a lack of compelling evidence to suggest that the status of these populations has improved or deteriorated appreciably since the previous status review (Williams et al. 2011).

Genetic Diversity. At the ESU level, the loss of the spring-run life history type represents a significant loss of diversity within the ESU, as has been noted in previous status reviews (Good et al. 2005b; Williams et al. 2011). Concern remains about the extremely low numbers of Chinook salmon in most populations of the North-Central Coast and Central Coast strata, which diminishes connectivity across the ESU. However, the fact that Chinook salmon have regularly been reported in the Ten Mile, Noyo, Big, Navarro, and Garcia rivers represents a significant improvement in our understanding of the status of these populations in watersheds where they were thought to have been extirpated. These observations suggest that spatial gaps between extant populations are not as extensive as previously believed.

Distribution. The California Coastal Chinook ESU includes all naturally spawned populations of Chinook salmon from rivers and streams south of the Klamath River to the Russian River, California (64 FR 50394; September 16, 1999). Seven artificial propagation programs are considered to be part of the ESU: The Humboldt Fish Action Council (Freshwater Creek), Yager Creek, Redwood Creek, Hollow Tree, Van Arsdale Fish Station, Mattole Salmon Group, and Mad River Hatchery fall-run Chinook hatchery programs. These artificially propagated stocks are no more divergent relative to the local natural population(s) than what would be expected between closely related natural populations within the ESU (NMFS 2005a).

Designated Critical Habitat. NMFS designated critical habitat for the California coastal Chinook salmon on September 2, 2005 (70 FR 52488). It includes multiple CALWATER hydrological units north from Redwood Creek and south to Russian River. The total area of critical habitat includes 1,500 miles of stream habitat and about 25 square miles of estuarine habitat, mostly within Humboldt Bay. PBFs considered essential for the conservation of the California coastal ESU of Chinook salmon are shown in Table 6:

There are 45 occupied CALWATER Hydrologic Subarea watersheds within the freshwater and estuarine range of this ESU. Eight watersheds received a low rating, 10 received a medium rating, and 27 received a high rating of conservation value to the ESU (70 FR 52488). Two estuarine habitat areas used for rearing and migration (Humboldt Bay and the Eel River Estuary) also received a high conservation value rating. Critical habitat in this ESU consists of limited quantity and quality summer and winter rearing habitat, as well as marginal spawning habitat. Compared to historical conditions, there are fewer pools, limited cover, and reduced habitat complexity. The current condition of PBFs of the California coastal Chinook salmon critical habitat indicates that PBFs are not currently functioning or are degraded; their conditions are likely to maintain a low population abundance across the ESU.

Recovery Goals. Recovery goals, objectives and criteria for the Central Valley spring-run Chinook are fully outlined in the 2016 Recovery Plan. Recovery plan objectives are to: 1. Reduce the present or threatened destruction, modification, or curtailment of habitat or range; 2. Ameliorate utilization for commercial, recreational, scientific, or educational purposes; 3. Abate disease and predation; 4. Establish the adequacy of existing regulatory mechanisms for protecting CC Chinook salmon now and into the future (i.e., post-delisting); 5. Address other natural or manmade factors affecting the continued existence of CC Chinook salmon; and 6. Ensure the status of CC Chinook salmon is at a low risk of extinction based on abundance, growth rate, spatial structure and diversity.

Table 13. Summary of status; Chinook salmon, California coastal ESU

Criteria	**Description**
Abundance / productivity trends	At considerable risk from population fragmentation and reduced spatial diversity. Comparisons to historical abundance is depressed in many basin. Only one population has had consistent run exceeding 1,000 spawning fish.
Listing status	threatened
Attainment of recovery goals	some criteria met
Condition of PBFs	Spawning PBFs are degraded by timber harvest; Rearing and migration PBFs impacted by dams and invasive species; Estuarine PBFs degraded by water quality and saltwater mixing; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; Of 45 watersheds, 27 are of high and 10 are of medium conservation value.

8.5 Chinook salmon, Central Valley spring-run ESU

Table 14. Chinook salmon, Central Valley spring-run ESU; overview table

Species	Common Name	Distinct Population Segments (DPS)	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus tshawytscha	Chinook Salmon	Central Valley Spring-run	Threatened	2016	1999 64 FR 50394 2014 79 FR 20802	2014	2005 70 FR 52488

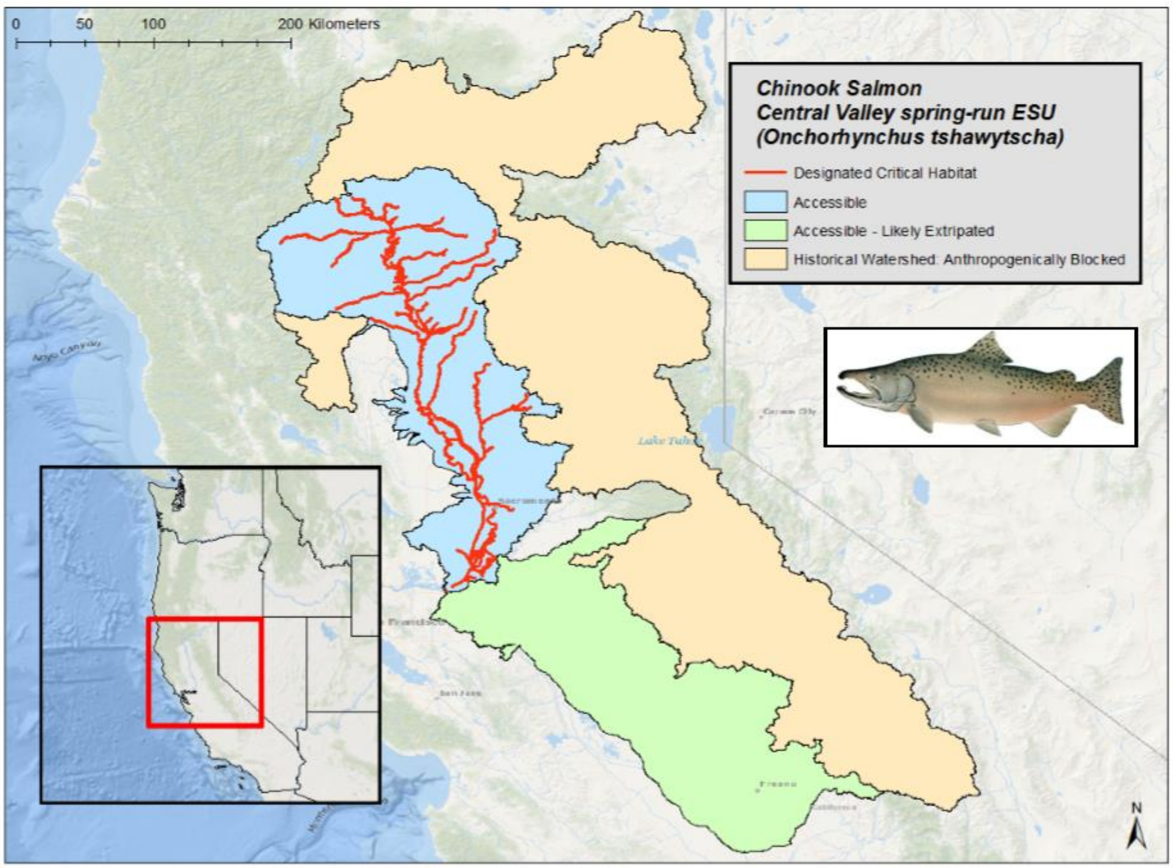

Figure 4. Chinook salmon, Central Valley spring-run ESU range and designated critical habitat

Species Description. Chinook salmon, also referred to as king salmon in California, are the largest of the Pacific salmon. Spawning adults are olive to dark maroon in color, without conspicuous streaking or blotches on the sides. Spawning males are darker than females, and have a hooked jaw and slightly humped back. They can be distinguished from other spawning salmon by the color pattern, particularly the spotting on the back and tail, and by the dark, solid black gums of the lower jaw (Moyle 2002a). On September 16, 1999, NMFS listed the Central Valley ESU of spring-run Chinook salmon as a “threatened” species (FR 64 50394). Historically, spring-run Chinook salmon occurred in the headwaters of all major river systems in the Central Valley where natural barriers to migration were absent. The only known streams that currently support self-sustaining populations of non-hybridized spring-run Chinook salmon in the Central Valley are Mill, Deer and Butte creeks. Each of these populations is small and isolated (NMFS 2014b).

Status. Although spring-run Chinook salmon were probably the most abundant salmonid in the Central Valley, this ESU has suffered the most severe declines of any of the four Chinook salmon runs in the Sacramento River Basin (Fisher 1994). The ESU is currently limited to independent populations in Mill, Deer, and Butte creeks, persistent and presumably dependent populations in the Feather and Yuba rivers and in Big Chico, Antelope, and Battle creeks, and a few ephemeral or dependent populations in the Northwestern California region (e.g., Beegum, Clear, and Thomes creeks). The Central Valley spring-run Chinook salmon ESU is currently faced with three primary threats: (1) loss of most historic spawning habitat; (2) degradation of the remaining habitat; and (3) genetic introgression with the Feather River fish hatchery spring-run Chinook salmon strays. The potential effects of climate change are likely to adversely affect spring-run Chinook salmon and their recovery (NMFS 2014b).

Life history. Adult Central Valley spring-run Chinook salmon leave the ocean to begin their upstream migration in late January and early February, and enter the Sacramento River between March and September, primarily in May and June (Moyle 2002a; Yoshiyama et al. 1998). Spring-run Chinook salmon generally enter rivers as sexually immature fish and must hold in freshwater for up to several months before spawning. While maturing, adults hold in deep pools with cold water. Spawning normally occurs between mid- August and early October, peaking in September (Moyle 2002a).

The length of time required for embryo incubation and emergence from the gravel is dependent on water temperature. For maximum embryo survival, water temperatures reportedly must be between 41°F and 55.4°F and oxygen saturation levels must be close to maximum. Under those conditions, embryos hatch in 40 to 60 days and remain in the gravel as alevins (the life stage between hatching and egg sack absorption) for another 4 to 6 weeks before emerging as fry. Spring-run fry emerge from the gravel from November to March (Moyle 2002a). Juveniles may reside in freshwater for 12 to 16 months, but some migrate to the ocean as young-of-the- year in the winter or spring months within eight months of hatching.

Juvenile Chinook salmon forage in shallow areas with protective cover, such as tidally influenced sandy beaches and vegetated zones (Healey et al. 1991). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson et al. 1982b; MacFarlane and Norton 2002; Sommer et al. 2001). Upon reaching the ocean, juvenile Chinook salmon feed voraciously on larval and juvenile fishes, plankton, and terrestrial insects (Healey et al. 1991; MacFarlane and Norton 2002). Chinook salmon grow rapidly in the ocean environment, with growth rates dependent on water temperatures and food availability.

Table 15. Temporal distribution of Chinook salmon, Central Valley spring-run ESU

<table>
<tr><td>Life History phase</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td></tr>
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<tr><td>Incubation (eggs)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="5">Present</td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Present</td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Population Dynamics

Abundance. The Central Valley as a whole is estimated to have supported spring-run Chinook salmon runs as large as 600,000 fish between the late 1880s and 1940s. The only known streams that currently support self-sustaining populations of nonhybridized spring-run Chinook salmon in the Central Valley are Mill, Deer and Butte creeks. Abundance and trend estimates for these streams as well as streams supporting dependent populations are provided in Table 16 (NMFS 2014b).

Table 16. Viability metrics for Central Valley spring-run ESU Chinook salmon populations.

Population	N	$\hat{S}$	10-year trend (95% CI)	Recent Decline (%)
Antelope Creek	8.0	2.7	-0.375 (-0.706, -0.045)	87.8
Battle Creek	1836	61	0.176 (0.033, 0.319)	9.0
Big Chico Creek	0.0	0.0	-0.358 (-0.880, 0.165)	60.7
Butte Creek	20169	6723	0.353 (-0.061, 0.768)	15.7
Clear Creek	822	27	0.010 (-0.311, 0.330)	63.3
Cottonwood Creek	4	1.3	-0.343 (-0.672, -0.013)	87.5
Deer Creek	2272	757.3	-0.089 (-0.337, 0.159)	83.8
Feather River Fish Hatchery	10808	3602.7	0.082 (-0.015, 0.179)	17.1
Mill Creek	2091.	697.0	-0.049 (-0.183, 0.086)	58.0
Sacramento River[a]	-	-	-	-
Yuba River	6515	2170.7	0.67 (-0.138, 0.272)	9.0

N: Total population size (N) is estimated as the sum of estimated run sizes over the most recent three years for Core 1 populations (bold) and Core 2 populations.
Ŝ: The mean population size (Ŝ) is the average of the estimated run sizes for the most recent 3 years (2012 to 2014).
Population growth/decline rate (10 year trend) is estimated from the slope of log-transformed estimated run size.
The catastrophic metric (recent decline) is the largest year-to-year decline in total population size (N) over the most recent 10 such ratios.
[a] Beginning in 2009, estimates of spawning escapement of Upper Sacramento River spring chinook were no longer monitored.

Productivity / Population Growth Rate. Cohort replacement rates (CRR) are indications of whether a cohort is replacing itself in the next generation. The majority of Central Valley (CV) spring-run Chinook salmon are found to return as three-yearolds, therefore looking at returns every three years is used as an estimate of the CRR. In the past the CRR has fluctuated between just over 1.0 to just under 0.5, and in the recent years with high returns (2012 and 2013), CRR jumped to 3.84 and 8.68 respectively. CRR for 2014 was 1.85, and the CRR for 2015 with very low returns was a record low of 0.14. Low returns in 2015 were further decreased due to high temperatures and most of the CV spring-run Chinook salmon tributaries experienced some pre-spawn mortality. Butte Creek experienced the highest prespawn mortality in 2015, resulting in a carcass survey CRR of only 0.02.

Genetic Diversity. Threats to the genetic integrity of spring-run Chinook salmon was identified as a serious concern to the species when it was listed in 1999 (FR 64 50394; Myers et al. 1998a). Three main factors compromised the genetic integrity of spring-run Chinook salmon: (1) the lack of reproductive isolation following dam construction throughout the Central Valley resulting in introgression with fall-run Chinook salmon in the wild; (2) within basin and inter-basin mixing between spring and fall broodstock for artificial propagation, resulting in introgression in hatcheries; and (3) releasing hatchery-produced juvenile Chinook salmon in the San Francisco estuary, which contributes to the straying of returning adults throughout the Central Valley (NMFS 2014b).

Distribution. The Central Valley Technical Recovery Team delineated 18 or 19 historic independent populations of CV spring-run Chinook salmon, and a number of smaller dependent populations, that are distributed among four diversity groups (southern Cascades, northern Sierra, southern Sierra, and Coast Range) (Lindley et al. 2004). Of these independent populations, only three are extant (Mill, Deer, and Butte creeks) and they represent only the northern Sierra Nevada diversity group. Of the dependent populations, CV spring-run Chinook salmon are found in Battle, Clear, Cottonwood, Antelope, Big Chico, and Yuba creeks, as well as the Sacramento and Feather rivers and a number of tributaries of the San Joaquin River including Mokelumne, Stanislaus, and Tuolumne rivers. The 2005 listing determination concluded that the Feather River Fish Hatchery spring-run Chinook salmon production should be included in the Central Valley spring-run Chinook salmon ESU (79 FR 20802; NMFS 2016a).

Designated Critical Habitat NMFS published a final rule designating critical habitat for Central Valley spring-run Chinook on September 2, 2005 (70 FR 52488). The designated critical habitat includes 1,853 km (1,158 mi) of streams and 655 km2 (254 km2) of estuarine habitat. PBFs considered essential for the conservation of the Central Valley spring-run ESU of Chinook salmon are shown in Table 6.

The current condition of PBFs of the CV Spring-run Chinook salmon critical habitat indicates that PBFs are not currently functioning or are degraded; their conditions are likely to maintain a low population abundance across the ESU. Spawning and rearing PBFs are degraded by high water temperature caused by the loss of access to historic spawning areas in the upper watersheds which maintained cool and clean water throughout the summer. The rearing PBF is degraded by floodplain habitat being disconnected from the mainstem of larger rivers throughout the Sacramento River watershed, thereby reducing effective foraging. Migration PBF is degraded by lack of natural cover along the migration corridors. Juvenile migration is obstructed by water diversions along Sacramento River and by two large state and federal water-export facilities in the Sacramento-San Joaquin Delta.

Recovery Goals. Recovery goals, objectives and criteria for the Central Valley spring-run Chinook are fully outlined in the 2014 Recovery Plan (NMFS 2014b). The ESU delisting criteria for the spring-run Chinook are: 1) One population in the Northwestern California Diversity Group at low risk of extinction; 2) Two populations in the Basalt and Porous Lava Diversity Group at low risk of extinction; 3) Four populations in the Northern Sierra Diversity Group at low risk of extinction; 4) Two populations in the Southern Sierra Diversity Group at low risk of extinction; and 5) Maintain multiple populations at moderate risk of extinction.

Table 17. Summary of status; Chinook salmon, Central Valley spring-run ESU

Criteria	**Description**
Abundance / productivity trends	Stable to declining trends, low abundances, low genetic diversity, fragmented populations
Listing status	Threatened
Attainment of recovery goals	Criteria not yet met
Condition of PBFs	Spawning and rearing PBFs are degraded by elevated temperatures, lost access to historic spawning sites, and loss of floodplain habitat; Migration PBFs degraded by loss of cover and water diversions; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; Of 38 watersheds, 28 are of high and 3 are of medium conservation value

8.6 Chinook salmon, Lower Columbia River ESU

Table 18. Chinook salmon, Lower Columbia River ESU; overview table

Species	Common Name	Distinct Population Segment	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus tshawytscha	Chinook Salmon	Lower Columbia River ESU	Threatened	2016	70 FR 37160	2013	70 FR 52630

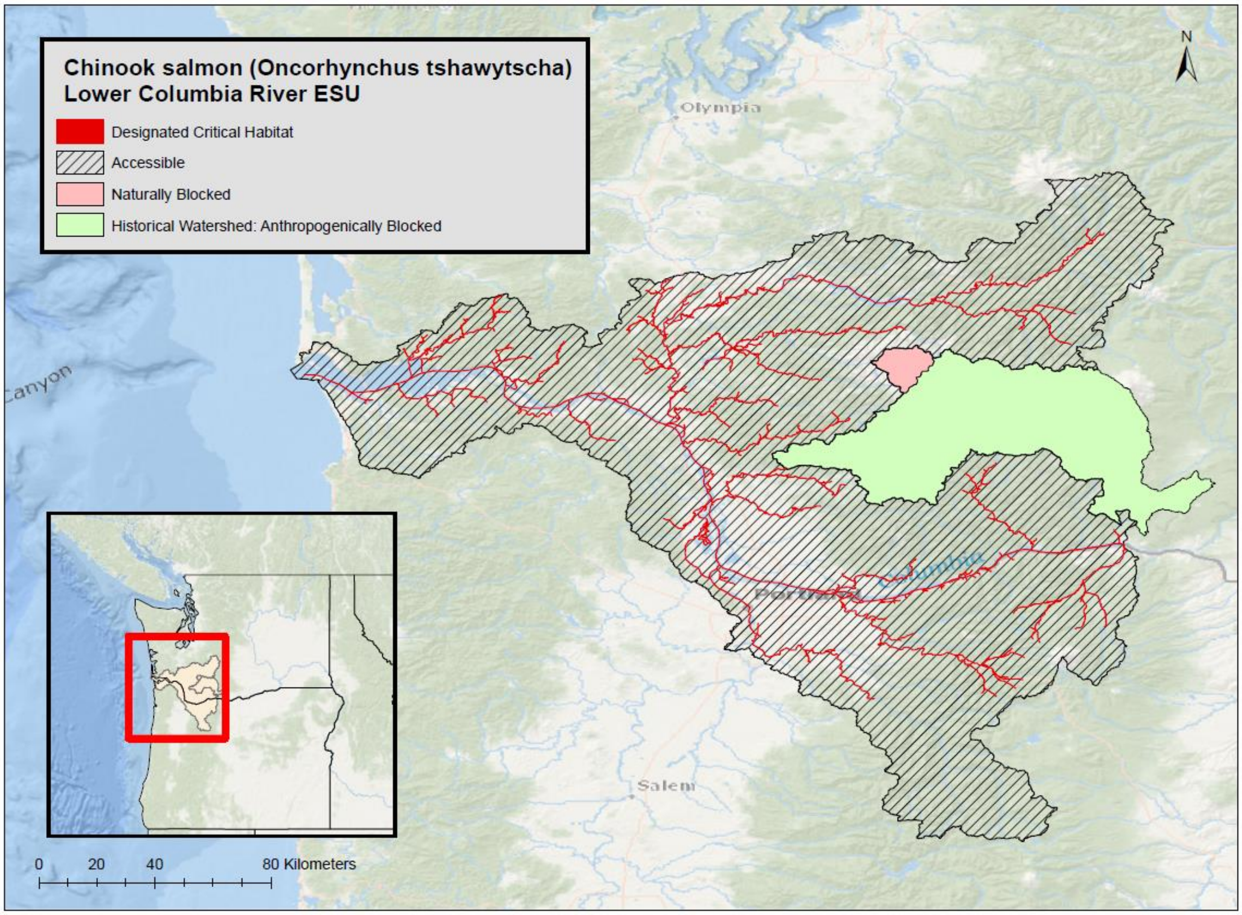

Figure 5. Chinook salmon, Lower Columbia River ESU range and designated critical habitat

Species Description. Chinook salmon, also referred to as king salmon in California, are the largest of the Pacific salmon. Spawning adults are olive to dark maroon in color, without conspicuous streaking or blotches on the sides. Spawning males are darker than females, and have a hooked jaw and slightly humped back. They can be distinguished from other spawning salmon by the color pattern, particularly the spotting on the back and tail, and by the dark, solid black gums of the lower jaw (Moyle 2002a). On March 24, 1999, NMFS listed the Lower

Columbia River ESU of Chinook salmon as a "threatened" species (64 FR 14308). The listing was revisited and confirmed as "threatened" in 2005 (70 FR 37160). The Lower Columbia River Chinook salmon ESU includes all naturally-spawned populations of fall-run and spring-run Chinook salmon from the Columbia River and its tributaries from its mouth at the Pacific Ocean upstream to a transitional point between Oregon and Washington, east of the Hood River and the White Salmon River and any such fish originating from the Willamette River and its tributaries below Willamette Falls. Twenty artificial propagation programs are included in the ESU (70 FR 37160).

Status. Populations of Lower Columbia River Chinook salmon have declined substantially from historical levels. Out of the 32 populations that make up this ESU, only the two late-fall runs (the North Fork Lewis and Sandy) are considered viable. Most populations (26 out of 32) have a very low probability of persistence over the next 100 years and some are extirpated or nearly so. Five of the six strata fall significantly short of the recovery plan criteria for viability. Low abundance, poor productivity, losses of spatial structure, and reduced diversity all contribute to the very low persistence probability for most Lower Columbia River Chinook salmon populations. Hatchery contribution to naturally-spawning fish remains high for a number of populations, and it is likely that many returning unmarked adults are the progeny of hatcheryorigin parents, especially where large hatchery programs operate. Continued land development and habitat degradation in combination with the potential effects of climate change will present a continuing strong negative influence into the foreseeable future.

Life history. Lower Columbia River Chinook salmon display three run types including early fall-runs, late fall-runs, and spring-runs. Presently, the fall-run is the predominant life history type. Spring-run Chinook salmon were numerous historically. Fall-run Chinook salmon enter fresh water typically in August through October. Early fall-run spawn within a few weeks in large river mainstems. The late fall-run enters in immature conditions, has a delayed entry to spawning grounds, and resides in the river for a longer time between river entry and spawning. Spring-run Chinook salmon enter fresh water in March through June to spawn in upstream tributaries in August and September.

Offspring of fall-run spawning may migrate as fry to the ocean soon after yolk absorption (*i.e.*, ocean-type), at 30–45 mm in length (Healey 1991). In the Lower Columbia River system, however, the majority of fall-run Chinook salmon fry migrate either at 60-150 days post-hatching in the late summer or autumn of their first year. Offspring of fall-run spawning may also include a third group of yearling juveniles that remain in fresh water for their entire first year before emigrating. The spring-run Chinook salmon migrates to the sea as yearlings (stream-type) typically in spring. However, the natural timing of Lower Columbia River (LCR) spring-run Chinook salmon emigration is obscured by hatchery releases (Myers et al. 2006). Once at sea, the ocean-type LCR Chinook salmon tend to migrate along the coast, while stream-type LCR Chinook salmon appear to move far off the coast into the central North Pacific Ocean

(Healey 1991; Myers et al. 2006). Adults return to tributaries in the lower Columbia River predominately as three- and four-year-olds for fall-run fish and four- and five-year-olds for spring-run fish.

Juvenile Chinook salmon forage in shallow areas with protective cover, such as tidally influenced sandy beaches and vegetated zones (Healey et al. 1991). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson et al. 1982b; MacFarlane and Norton 2002; Sommer et al. 2001). Upon reaching the ocean, juvenile Chinook salmon feed voraciously on larval and juvenile fishes, plankton, and terrestrial insects (Healey et al. 1991; MacFarlane and Norton 2002). Chinook salmon grow rapidly in the ocean environment, with growth rates dependent on water temperatures and food availability.

Table 19. Temporal distribution of Chinook salmon, Lower Columbia River ESU

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td></td><td></td><td colspan="10">Present</td></tr>
<tr><td>Spawning</td><td>Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="5">Present</td></tr>
<tr><td>Incubation (eggs)</td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td colspan="5">Present</td></tr>
<tr><td>Emergence (alevin to fry phases</td><td colspan="4">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Population Dynamics

Abundance. Populations of Lower Columbia River Chinook salmon have declined substantially from historical levels. Many of the ESU’s populations are believed to have very low abundance of natural-origin spawners (100 fish or fewer), which increases genetic and demographic risks. Other populations have higher total abundance, but several of these also have high proportions of hatchery-origin spawners (Table 20).

Table 20. Lower Columbia River Chinook salmon population structure, abundances, and hatchery contributions (Good et al. 2005; Myers et al. 2006).

Run	Population	Historical Abundance	Mean* Number of Spawners	Hatchery Abundance Contributions
F-R	Grays River (WA)	2,477	99	38%
	Elochoman River (WA)	Unknown	676	68%
	Mill, Abernathy, and German Creeks (WA)	Unknown	734	47%
	Youngs Bay (OR)	Unknown	Unknown	Unknown
	Big Creek (OR)	Unknown	Unknown	Unknown
	Clatskanie River (OR)	Unknown	50	Unknown
	Scappoose Creek (OR)	Unknown	Unknown	Unknown
F-R	Lower Cowlitz River (WA)	53,956	1,562	62%
	Upper Cowlitz River (WA)	Unknown	5,682	Unknown
	Coweeman River (WA)	4,971	274	0%

Run	Population	Historical Abundance	Mean* Number of Spawners	Hatchery Abundance Contributions
	Toutle River (WA)	25,392	Unknown	Unknown
	Salmon Creek and Lewis River (WA)	47,591	256	0%
	Washougal River (WA)	7,518	3,254	58%
	Kalama River (WA)	22,455	2,931	67%
	Clackamas River (OR)	Unknown	40	Unknown
	Sandy River (OR)	Unknown	183	Unknown
LF-R	Lewis R-North Fork (WA)	Unknown	7,841	13%
	Sandy River (OR)	Unknown	504	3%
S-R	Upper Cowlitz River (WA)	Unknown	Unknown	Unknown
	Tilton River (WA)	Unknown	Unknown	Unknown
	Cispus River (WA)	Unknown	1,787*	Unknown
	Toutle River (WA)	2,901	Unknown	Unknown
	Kalama River (WA)	4,178	98	Unknown
	Lewis River (WA)	Unknown	347	Unknown
	Sandy River (OR)	Unknown	3,085	3%
F-R	Upper Columbia Gorge (WA)	2,363	136	13%
	Big White Salmon R (WA)	Unknown	334	21%
	Lower Columbia Gorge (OR)	Unknown	Unknown	Unknown
	Hood River (OR)	Unknown	18	Unknown
S-R	Big White Salmon R (WA)	Unknown	334	21%
	Hood River (OR)	Unknown	18	Unknown

**Arithmetic mean*
Recent 5-year spawner abundance (up to 2001) and historic abundance over more than 20 years is given as a geometric mean, and include hatchery origin Chinook salmon.
F-R is fall run, LF-R is late fall run, and S-R is spring run Chinook salmon.

Productivity / Population Growth Rate. Trend indicators for most populations are negative. The majority of populations for which data are available have a long-term trend of <1; indicating the population is in decline (Bennet 2005; Good et al. 2005b). Only the late-fall run population in Lewis River has an abundance and population trend that may be considered viable (McElhany et al. 2007a). The Sandy River is the only stream system supporting a natural production of spring-run Chinook salmon of any amount. However, the population is at risk from low abundance and negative to low population growth rates (McElhany et al. 2007a).

Genetic Diversity. The genetic diversity of all populations (except the late fall-run Chinook salmon) has been eroded by large hatchery influences and periodically by low effective population sizes. The near loss of the spring-run life history type remains an important concern for maintaining diversity within the ESU.

Distribution. The basin wide spatial structure has remained generally intact. However, the loss of about 35 percent of historic habitat has affected distribution within several Columbia River subbasins. Currently, only one population appears self-sustaining (Good et al. 2005b).

Designated Critical Habitat. NMFS designated critical habitat for LCR Chinook salmon on September 2, 2005 (70 FR 52630). It includes all Columbia River estuarine areas and river reaches proceeding upstream to the confluence with the Hood Rivers as well as specific stream reaches in a number of tributary subbasins. PBFs considered essential for the conservation of Chinook salmon, Lower Columbia River ESU are shown in Table 6.

Timber harvest, agriculture, and urbanization have degraded spawning and rearing PBFs by reducing floodplain connectivity and water quality, and by removing natural cover in several rivers. Hydropower development projects have reduced timing and magnitude of water flows, thereby altering the water quantity needed to form and maintain physical habitat conditions and support juvenile growth and mobility. Adult and juvenile migration PBFs are affected by several dams along the migration route.

Recovery Goals. NMFS has developed the following delisting criteria for the Lower Columbia River Chinook salmon ESU. For a complete description of the ESU recovery goals, including complete down-listing/delisting criteria, see the 2013 recovery plan.

1. All strata that historically existed have a high probability of persistence or have a probability of persistence consistent with their historical condition. High probability of stratum persistence is defined as:
    a. At least two populations in the stratum have at least a 95 percent probability of persistence over a 100-year time frame (i.e., two populations with a score of 3.0 or higher based on the Technical Recovery Team's (TRT) scoring system).
    b. Other populations in the stratum have persistence probabilities consistent with a high probability of stratum persistence (i.e., the average of all stratum population scores is 2.25 or higher, based on the TRT's scoring system). (See Section 2.6 for a brief discussion of the TRT's scoring system.)
    c. Populations targeted for a high probability of persistence are distributed in a way that minimizes risk from catastrophic events, maintains migratory connections among populations, and protects within-stratum diversity.

    A probability of persistence consistent with historical condition refers to the concept that strata that historically were small or had complex population structures may not have met Criteria A through C, above, but could still be considered sufficiently viable if they provide a contribution to overall ESU viability similar to their historical contribution.

2. The threats criteria described in Section 3.2.2 have been met.

Table 21. Summary of status; Chinook salmon, Lower Columbia River ESU

Criteria	**Description**
Abundance / productivity trends	Trends for most populations are declining. Only one population is self-sustaining. The near loss of the spring-run life history remains an important concern for maintaining genetic diversity.

Listing status	threatened
Attainment of recovery goals	criteria not yet met
Condition of PBFs	Spawning and rearing PBFs are degraded by timber harvest, agriculture, urbanization, loss of floodplain habitat, and reduced natural cover; Migration PBFs impacted by dams; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; Of occupied watersheds, 31 are of high and 13 are of medium conservation value.

8.7 Chinook salmon, Puget Sound ESU

Table 22. Chinook salmon, Puget Sound ESU; overview table

Species	Common Name	Distinct Population Segment	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus tshawytscha	Chinook salmon	Puget Sound ESU	Threatened	2011	70 FR 37160	2007	70 FR 52630

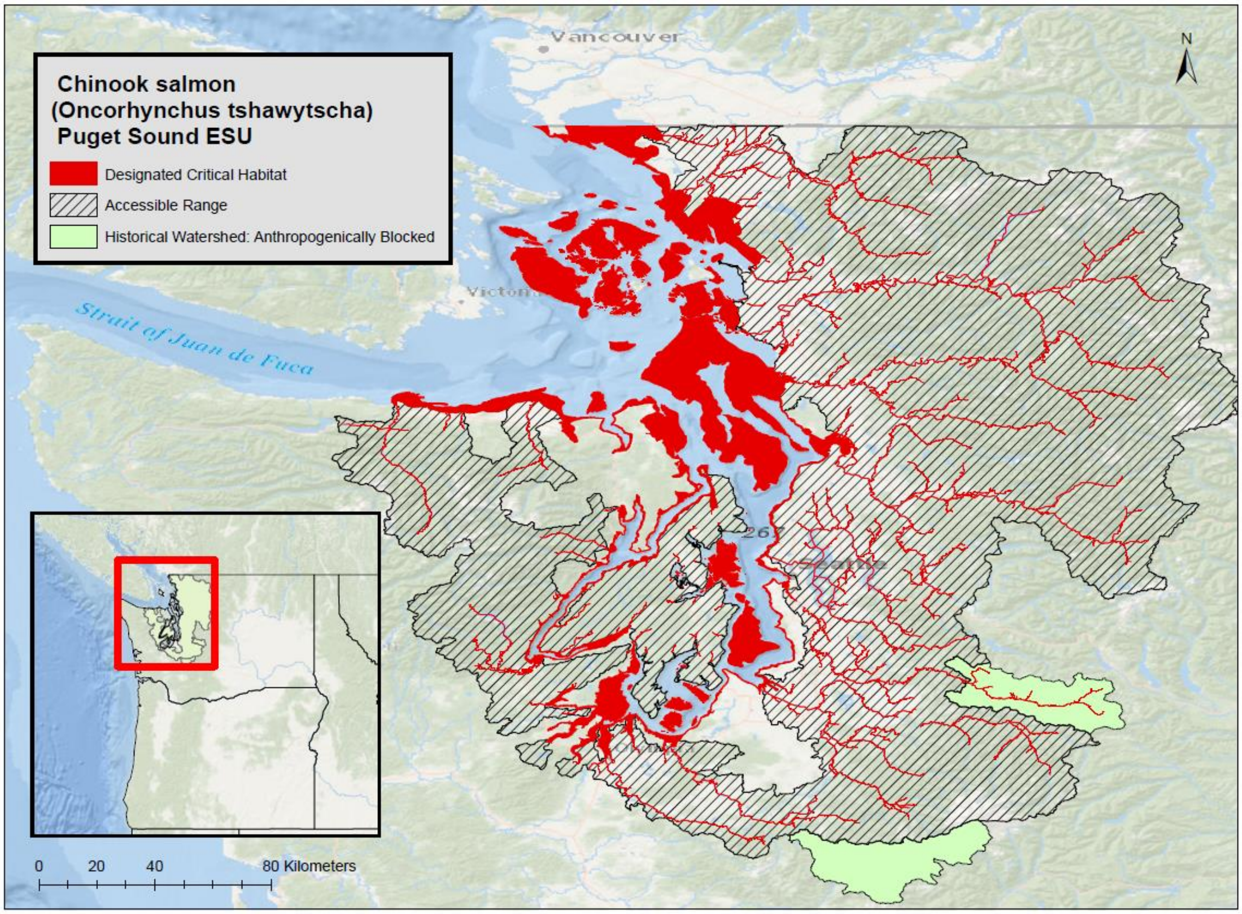

Figure 6. Chinook salmon, Puget Sound ESU range and designated critical habitat

Species Description Chinook salmon, also referred to as king salmon in California, are the largest of the Pacific salmon. Spawning adults are olive to dark maroon in color, without conspicuous streaking or blotches on the sides. Spawning males are darker than females, and have a hooked jaw and slightly humped back. They can be distinguished from other spawning salmon by the color pattern, particularly the spotting on the back and tail, and by the dark, solid black gums of the lower jaw (Moyle 2002a). On March 24, 1999, NMFS listed the Puget Sound ESU of Chinook salmon as a “threatened” species (64 FR 14308). The listing was revisited and confirmed as “threatened” in 2005 (70 FR 37160). The Puget Sound ESU includes naturally spawned Chinook salmon originating from rivers flowing into Puget Sound from the Elwha River (inclusive) eastward, including rivers in Hood Canal, South Sound, North Sound and the Strait of Georgia. Twenty-six artificial propagation programs are included as part of the ESU.

Status All Puget Sound Chinook salmon populations are well below escapement abundance levels identified as required for recovery to low extinction risk in the recovery plan. In addition, most populations are consistently below the productivity goals identified in the recovery plan as necessary for recovery. Although trends vary for individual populations across the ESU, most populations have declined in total natural origin recruit abundance since the last status review; and natural origin recruit escapement trends since 1995 are mostly stable. A few populations have reached goals but not consistently during the past 10 years (2018 Washington State of the Salmon Report). While some have met their high productivity goals, but never their low (minimum) productivity goals, none of the Puget Sound populations of Chinook salmon could be considered exceeding their abundance recovery goals. Several of the risk factors identified in the previous status review (Good et al. 2005b) are still present, including high fractions of hatchery fish in many populations and widespread loss and degradation of habitat. Although this ESU's total abundance is a greatly reduced from historic levels, recent abundance levels do not indicate that the ESU is at immediate risk of extinction. This ESU remains relatively well distributed over 22 populations in 5 geographic areas across the Puget Sound. Although current trends are concerning, the available information indicates that this ESU remains at moderate risk of extinction.

Life history Puget Sound Chinook salmon populations exhibit both early-returning (August) and late-returning (mid-September and October) Chinook salmon spawners (Healey 1991). Juvenile Chinook salmon within the Puget Sound generally exhibit an "ocean-type" life history. However, substantial variation occurs with regard to juvenile residence time in freshwater and estuarine environments. Hayman (Hayman et al. 1996) described three juvenile life histories for Chinook salmon with varying freshwater and estuarine residency times in the Skagit River system in northern Puget Sound. In this system, 20 percent to 60 percent of sub-yearling migrants rear for several months in freshwater habitats while the remaining fry migrate to rear in the Skagit River estuary and delta (Beamer et al. 2005). Juveniles in tributaries to Lake Washington exhibit both a stream rearing and a lake rearing strategy. Lake rearing fry are found in highest densities in nearshore shallow (<1 m) habitat adjacent to the opening of tributaries or at the mouth of tributaries where they empty into the lake (Tabor et al. 2006). Puget Sound Chinook salmon also has several estuarine rearing juvenile life history types that are highly dependent on estuarine areas for rearing (Beamer et al. 2005). In the estuaries, fry use tidal marshes and connected tidal channels including dikes and ditches developed to protect and drain agricultural land. During their first ocean year, immature Chinook salmon use nearshore areas of Puget Sound during all seasons and can be found long distances from their natal river systems (Brennan et al. 2004).

Juvenile Chinook salmon forage in shallow areas with protective cover, such as tidally influenced sandy beaches and vegetated zones (Healey et al. 1991). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson et al. 1981; MacFarlane and Norton 2002; Sommer et al. 2001a). Upon reaching the ocean, juvenile Chinook salmon feed voraciously on larval and juvenile fishes, plankton, and terrestrial insects (Healey et al. 1991; MacFarlane and Norton 2002). Chinook salmon grow rapidly in the ocean environment, with growth rates dependent on water temperatures and food availability.

Table 23. Temporal distribution of Chinook salmon, Puget Sound ESU

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td></td><td></td><td></td><td colspan="8">Present</td><td></td></tr>
<tr><td>Spawning</td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="6">Present</td></tr>
<tr><td>Incubation (eggs)</td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td colspan="6">Present</td></tr>
<tr><td>Emergence (alevin to fry phase)</td><td colspan="4">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Present</td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Population Dynamics

Abundance. Estimates of the historic abundance range from 1,700 to 51,000 potential Puget Sound Chinook salmon spawners per population. During the period from 1996 to 2001, the geometric mean of natural spawners in populations of Puget Sound Chinook salmon ranged from 222 to just over 9,489 fish. Thus, the historical estimates of spawner capacity are several orders of magnitude higher than spawner abundances currently observed throughout the ESU (Good et al. 2005b).

Table 24. Puget Sound Chinook salmon preliminary population structure, abundances, and hatchery contributions (Good et al. 2005).

Independent Populations	Historical Abundance	Mean Number of Spawners	Hatchery Abundance Contributions
Nooksack-North Fork	26,000	1,538	91%
Nooksack-South Fork	13,000	338	40%
Lower Skagit	22,000	2,527	0.2%
Upper Skagit	35,000	9,489	2%
Upper Cascade	1,700	274	0.3%
Lower Sauk	7,800	601	0%
Upper Sauk	4,200	324	0%
Suiattle	830	365	0%
Stillaguamish-North Fork	24,000	1,154	40%
Stillaguamish-South Fork	20,000	270	Unknown
Skykomish	51,000	4,262	40%
Snoqualmie	33,000	2,067	16%
Sammamish	Unknown	Unknown	Unknown
Cedar	Unknown	327	Unknown
Duwamish/Green			
Green	Unknown	8,884	83%

Independent Populations	Historical Abundance	Mean Number of Spawners	Hatchery Abundance Contributions
White	Unknown	844	Unknown
Puyallup	33,000	1,653	Unknown
Nisqually	18,000	1,195	Unknown
Skokomish	Unknown	1,392	Unknown
Mid Hood Canal Rivers			
Dosewallips	4,700	48	Unknown
Duckabush	Unknown	43	Unknown
Hamma Hamma	Unknown	196	Unknown
Mid Hood Canal	Unknown	311	Unknown
Dungeness	8,100	222	Unknown
Elwha	Unknown	688	Unknown

Productivity / Population Growth Rate. While natural origin recruit escapements have remained fairly constant during the most recent review period (1985-2009), total natural origin recruit abundance and productivity have continued to decline. Median recruits per spawner for the last five-year period (brood years 2002-2006) is the lowest over any of the five year intervals. However, results vary across populations in the ESU with some populations showing stronger trends than others. Long-term trends in abundance and median population growth rates for naturally spawning populations indicate that approximately half of the populations are declining and the other half are increasing in abundance over the length of available time series. However, the median overall long-term trend in abundance is close to 1 for most populations that have a lambda exceeding 1, indicating that most of these populations are barely replacing themselves.

Genetic Diversity / Spatial Distribution The Northwest Fisheries Science Center estimated the diversity index for five year time intervals over the 25 year time span of the available data. In general, a higher diversity value indicates a healthier distribution of salmon among the streams and rivers in the ESU. Current estimates of diversity show a decline over the past 25 years, indicating a decline of salmon in some areas and increases in others. Salmon returns to the Whidbey Region increased in abundance while returns to other regions declined. In aggregate, the diversity of the ESU as a whole has been declining over the last 25 years.

Designated Critical Habitat

Critical habitat was designated for this species on September 2, 2005 (70 FR 52630). It includes 1,683 km of stream channels, 41 square km of lakes, and 3,512 km of nearshore marine habitat. PBFs considered essential for the conservation of Chinook salmon, Puget Sound ESU are shown in Table 6.

Forestry practices have heavily impacted migration, spawning, and rearing PBFs in the upper watersheds of most rivers systems within critical habitat designated for the Puget Sound Chinook salmon. Degraded PBFs include reduced conditions of substrate supporting spawning, incubation and larval development caused by siltation of gravel; and degraded rearing habitat by removal of cover and reduction in channel complexity. Urbanization and agriculture in the lower alluvial valleys of mid- to southern Puget Sound and the Strait of Juan de Fuca have reduced channel function and connectivity, reduced available floodplain habitat, and affected water quality. Thus, these areas have degraded spawning, rearing, and migration PBFs. Hydroelectric development and flood control also obstruct Puget Sound Chinook salmon migration in several basins. The most functional PBFs are found in northwest Puget Sound: the Skagit River basin, parts of the Stillaguamish River basin, and the Snohomish River basin where federal land overlap with critical habitat designated for the Puget Sound Chinook salmon. However, estuary PBFs are degraded in these areas by reduction in the water quality from contaminants, altered salinity conditions, lack of natural cover, and modification and lack of access to tidal marshes and their channels.

Recovery Goals. The ESU-wide delisting and recovery criteria (PSTRT, 2002) provide flexibility in meeting the requirements of the Endangered Species Act, and preserve options for Puget Sound Chinook in the future. The recommendations by the TRT describe the biological characteristics that would constitute a viable ESU for Puget Sound Chinook. The ESU would have a high likelihood of persistence if:

1. All populations improve in status and at least some achieve a low risk status.
2. At least 2-4 viable Chinook populations are present in each of the 5 regions.
3. Each region has one or more viable populations from each major diversity group that was historically present within that region.
4. Freshwater tributary habitats in Puget Sound are providing sufficient function for ESU persistence. Ecological functioning occurs even in those habitats that do not currently support any of the 22 identified Chinook populations, since they affect nearshore processes and may provide future habitat options.
5. The production of Chinook salmon in Puget Sound tributaries is consistent with ESU recovery objectives, and contributes to the health of the overall ecosystem in the region.
6. None of the 22 remaining Chinook populations go extinct, and the direct and indirect effects of habitat, harvest and hatchery management actions are consistent with ESU recovery.

Table 25. Summary of status; Chinook salmon, Puget Sound ESU

Criteria	**Description**
Abundance / productivity trends	Abundance is several orders of magnitude below historic levels. Approximately half the populations are declining and half are increasing in abundance. Most of the populations that are increasing have lambda of close to 1 (barely replacing themselves).
Listing status	threatened
Attainment of recovery goals	criteria not yet met
Condition of PBFs	Spawning, rearing and migration PBFs are degraded by forestry, agriculture, urbanization, and loss of habitat;

	Estuarine PBFs degraded by water quality, altered salinity, and lack of natural cover; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; Of 61 watersheds, 40 are of high and 9 are of medium conservation value.

8.8 Chinook salmon, Sacramento River winter-run ESU

Table 26. Chinook salmon, Sacramento winter-run ESU; overview table

Species	Common Name	Distinct Population Segments (DPS)	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus tshawytscha	Chinook Salmon	Sacramento River winter-run	Endangered	2011	1990 54 FR 32085 1994 59 FR 440	2014	1993 58 FR 33212

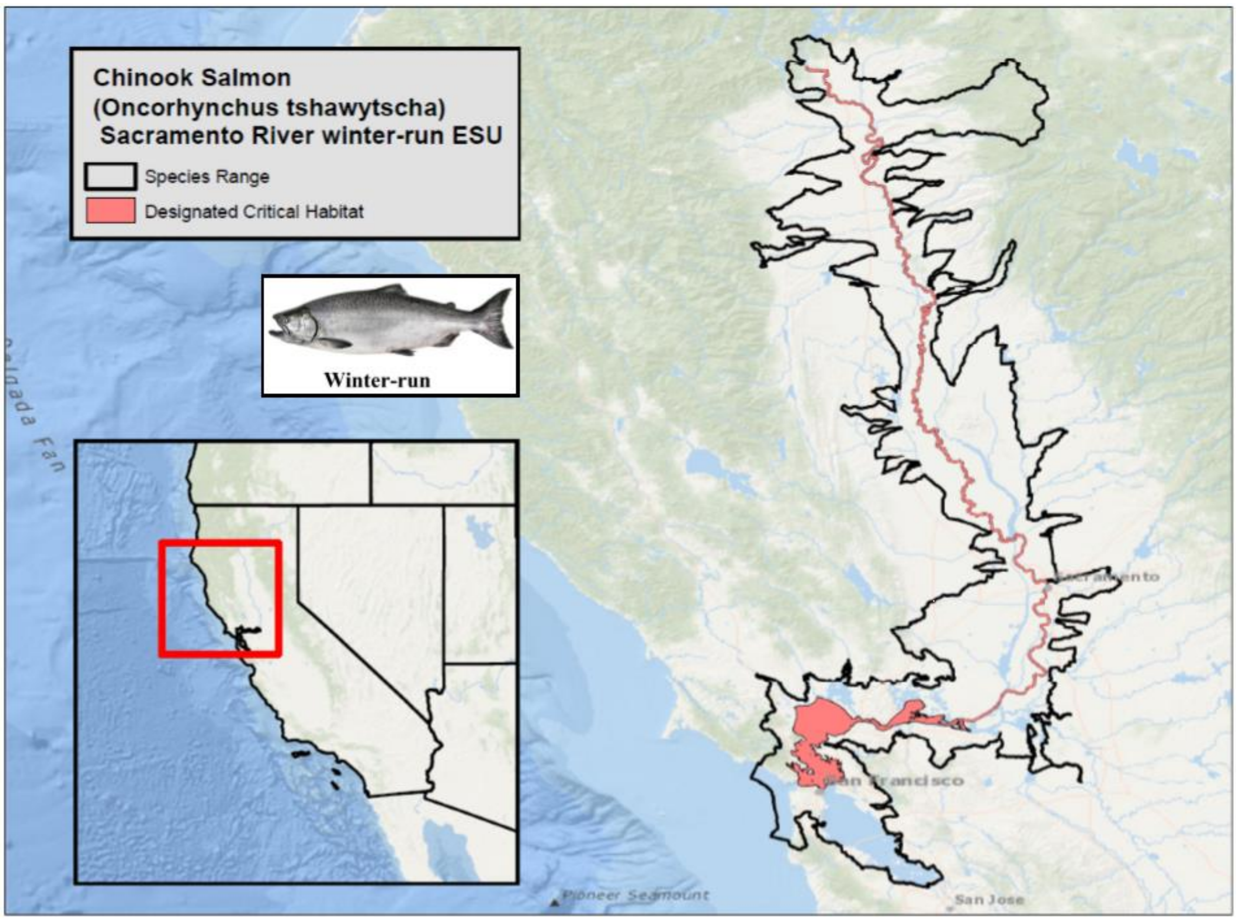

Figure 7. Chinook salmon, Sacramento winter-run ESU range and designated critical habitat

Species Description. Chinook salmon, also referred to as king salmon in California, are the largest of the Pacific salmon. Spawning adults are olive to dark maroon in color, without conspicuous streaking or blotches on the sides. Spawning males are darker than females, and have a hooked jaw and slightly humped back. They can be distinguished from other spawning salmon by the color pattern, particularly the spotting on the back and tail, and by the dark, solid black gums of the lower jaw (Moyle 2002a). On January 4, 1994, NMFS listed the Sacramento River winter-run ESU of Chinook salmon as Endangered (59 FR 440). The Sacramento River winter-run Chinook salmon ESU includes winter-run Chinook salmon spawning naturally in the Sacramento River and its tributaries, as well as winter-run Chinook salmon that are part of the conservation hatchery program at the Livingston Stone National Fish Hatchery (LSNFH). Winter-run Chinook salmon originally spawned in the upper Sacramento River system (Little Sacramento, Pit, McCloud and Fall rivers) and in Battle Creek (Yoshiyama et al. 1998; Yoshiyama et al. 2001). Currently, winter-run Chinook salmon spawning habitat is likely limited to the reach of the Sacramento River extending from Keswick Dam downstream to the Red Bluff Diversion Dam.

Status. The Sacramento River winter-run Chinook salmon ESU is composed of just one small population that is currently under severe stress caused by one of California's worst droughts on record. Over the last 10 years of available data (2003-2013), the abundance of spawning winter-run Chinook adults ranged from a low of 738 in 2011 to a high of 17,197 in 2007, with an average of 6,298. The population subsists in large part due to agency-managed cold water releases from Shasta Reservoir during the summer and artificial propagation from Livingston Stone National Fish Hatchery's winter-run Chinook salmon conservation program. Winter-run Chinook salmon are dependent on sufficient cold water storage in Shasta Reservoir, and it has long been recognized that a prolonged drought could have devastating impacts, possibly leading to the species' extinction. The probability of extended droughts is increasing as the effects of climate change continue(NMFS 2014b). In addition to the drought, another important threat to winter-run Chinook salmon is a lack of suitable rearing habitat in the Sacramento River and Delta to allow for sufficient juvenile growth and survival(NMFS 2016e).

Life history. Winter-run Chinook salmon are unique because they spawn during summer months when air temperatures usually approach their yearly maximum. As a result, winter-run Chinook salmon require stream reaches with cold water sources that will protect embryos and juveniles from the warm ambient conditions in summer. Adult winter-run Chinook salmon immigration and holding (upstream spawning migration) through the Delta and into the lower Sacramento River occurs from December through July, with a peak during the period extending from January through April (Fish and Service 1995). Winter-run Chinook salmon are sexually immature when upstream migration begins, and they must hold for several months in suitable habitat prior to spawning. Spawning occurs between late-April and mid-August, with a peak in June and July as reported by California Department of Fish and Wildlife (CDFW) annual escapement surveys (2000-2006).

Winter-run Chinook salmon embryo incubation in the Sacramento River can extend into October (Vogel et al. 1988). Winter-run Chinook salmon fry rearing in the upper Sacramento River exhibit peak abundance during September, with fry and juvenile emigration past Red Bluff Diversion Dam (RBDD) primarily occurring from July through November (Poytress and Carrillo 2010; Poytress and Carrillo 2011; Poytress and Carrillo 2012). Emigration of winter-run Chinook salmon juveniles past Knights Landing, located approximately 155.5 river miles downstream of the RBDD, reportedly occurs between November and March, peaking in December, with some emigration continuing through May in some years (Snider and Titus 2000).

Juvenile Chinook salmon forage in shallow areas with protective cover, such as tidally influenced sandy beaches and vegetated zones (Healey et al. 1991). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson et al. 1982a; MacFarlane and Norton 2002). Upon reaching the ocean, juvenile Chinook salmon feed voraciously on larval and juvenile fishes, plankton, and terrestrial insects (Healey et al. 1991; MacFarlane and Norton 2002). Chinook salmon grow rapidly in the ocean environment, with growth rates dependent on water temperatures and food availability.

Table 27. Temporal distribution of Chinook salmon, Sacramento winter-run ESU

<table>
<tr><td>Life History phase</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td colspan="6">Present</td><td></td><td></td><td></td><td></td><td colspan="2">Present</td></tr>
<tr><td>Spawning</td><td></td><td></td><td></td><td colspan="5">Present</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Incubation (eggs)</td><td></td><td></td><td></td><td colspan="6">Present</td><td></td><td></td><td></td></tr>
<tr><td>Emergence (alevin to fry phases</td><td></td><td></td><td></td><td></td><td></td><td colspan="4">Present</td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td colspan="5">Present</td></tr>
</table>

Population Dynamics

Abundance. Over the last 10 years of available data (2003-2013), the abundance of spawning winter-run Chinook adults ranged from a low of 738 in 2011 to a high of 17,197 in 2007, with an average of 6,298 (*Figure 8*).

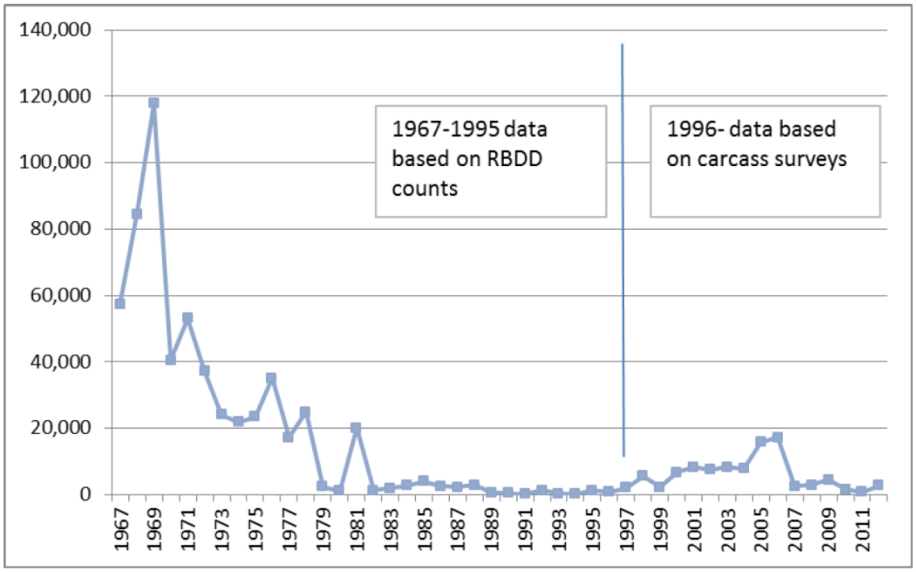

Figure 8. Estimated Sacramento River winter-run Chinook salmon run size (1967-2012)

Productivity / Population Growth Rate. The population declined from an escapement of near 100,000 in the late 1960s to fewer than 200 in the early 1990s (Good et al. 2005a). More recent population estimates of 8,218 (2004), 15,730 (2005), and 17,153 (2006) show a three-year average of 13,700 returning winter-run Chinook salmon (CDFW Website 2007). However, the run size decreased to 2,542 in 2007 and 2,850 in 2008. Monitoring data indicated that approximately 5.6 percent of winter-run Chinook salmon eggs spawned in the Sacramento River in 2014 survived to the fry life stage (three to nearly 10 times lower than in previous years). The ongoing drought has made 2015 another challenging year for winter-run Chinook salmon (NMFS 2016e).

Genetic Diversity. The rising proportion of hatchery fish among returning adults threatens to increase the risk of extinction. Lindley et al. (2007) recommend that in order to maintain a low risk of genetic introgression with hatchery fish, no more than five percent of the naturally-spawning population should be composed of hatchery fish. Since 2001, hatchery origin winter-run Chinook salmon have made up more than five percent of the run, and in 2005 the contribution of hatchery fish exceeded 18 percent (Lindley et al. 2007).

Distribution. The range of winter-run Chinook salmon has been greatly reduced by Keswick and Shasta dams on the Sacramento River and by hydroelectric development on Battle Creek. Currently, winter-run Chinook salmon spawning is limited to the main-stem Sacramento River between Keswick Dam (River Mile [RM] 302) and the RBDD (RM 243) where the naturally-spawning population is artificially maintained by cool water releases from the dams. Within the Sacramento River, the spatial distribution of spawners is largely governed by water year type and the ability of the Central Valley Project to manage water temperatures (NMFS 2014b).

Designated Critical Habitat. NMFS designated critical habitat for the Sacramento winter-run Chinook on June 16, 1993 (58 FR 33212). It includes: the Sacramento River from Keswick Dam, Shasta County (river mile 302) to Chipps Island (river mile 0) at the westward margin of the Sacramento-San Joaquin Delta, and other specified estuarine waters**.** Physical and biological features that are essential for the conservation of Sacramento winter-run Chinook salmon, based on the best available information, include (1) access from the Pacific Ocean to appropriate spawning areas in the upper Sacramento River; (2) the availability of clean gravel for spawning substrate; (3) adequate river flows for successful spawning, incubation of eggs, fry development and emergence, and downstream transport of juveniles; (4) water temperatures between 42.5 and 57.5 °F (5.8 and 14.1 degrees Celsius (°C)) for successful spawning, egg incubation, and fry development; (5) habitat and adequate prey free of contaminants; (6) riparian habitat that provides for successful juvenile development and survival; and (7) access of juveniles downstream from the spawning grounds to San Francisco Bay and the Pacific Ocean (58 FR 33212).

The current condition of PBFs for the Sacramento River Winter-run Chinook salmon indicates that they are not currently functioning or are degraded. Their conditions are likely to maintain low population abundances across the ESU. Spawning and rearing PBFs are especially degraded by high water temperature caused by the loss of access to historic spawning areas in the upper watersheds where water maintain lower temperatures. The rearing PBF is further degraded by floodplain habitat disconnected from the mainstems of larger rivers throughout the Sacramento River watershed. The migration PBF is also degraded by the lack of natural cover along the migration corridors. Rearing and migration PBFs are further affected by pollutants entering the surface waters and riverine sediments as contaminated stormwater runoff, aerial drift and deposition, and via point source discharges. Juvenile migration is obstructed by water diversions along Sacramento River and by two large state and federal water-export facilities in the Sacramento-San Joaquin Delta.

Recovery Goals. Recovery goals, objectives and criteria for the Sacramento River winter-run Chinook are fully outlined in the 2014 Recovery Plan (NMFS 2014b). In order to achieve the downlisting criteria, the species would need to be composed of two populations – one viable and one at moderate extinction risk. Having a second population would improve the species' viability, particularly through increased spatial structure and abundance, but further improvement would be needed to reach the goal of recovery. To delist winter-run Chinook salmon, three viable populations are needed. Thus, the downlisting criteria represent an initial key step along the path to recovering winter-run Chinook salmon.

Table 28. Summary of status; Chinook salmon, Sacramento winter-run ESU

Criteria	Description

Abundance / productivity trends	Only one small population, declining population trend hatchery-supported propagation, low genetic diversity
Listing status	Endangered
Attainment of recovery goals	Criteria not yet met
Condition of PBFs	Spawning and rearing PBFs are degraded by elevated temperatures and loss of habitat; Migration PBFs degraded by lack of natural cover and water diversions; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; The entire Sacramento river and delta are considered of high conservation value

8.9 Chinook salmon, Snake River fall-run

Table 29. Chinook salmon, Snake River fall-run ESU; overview table

Species	Common Name	Distinct Population Segments (DPS)	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus tshawytscha	Chinook Salmon	Snake River fall-run	Threatened	2011	2005 70 FR 37160 2014 79 FR 20802	Proposed 2015	1993 58 FR 68543

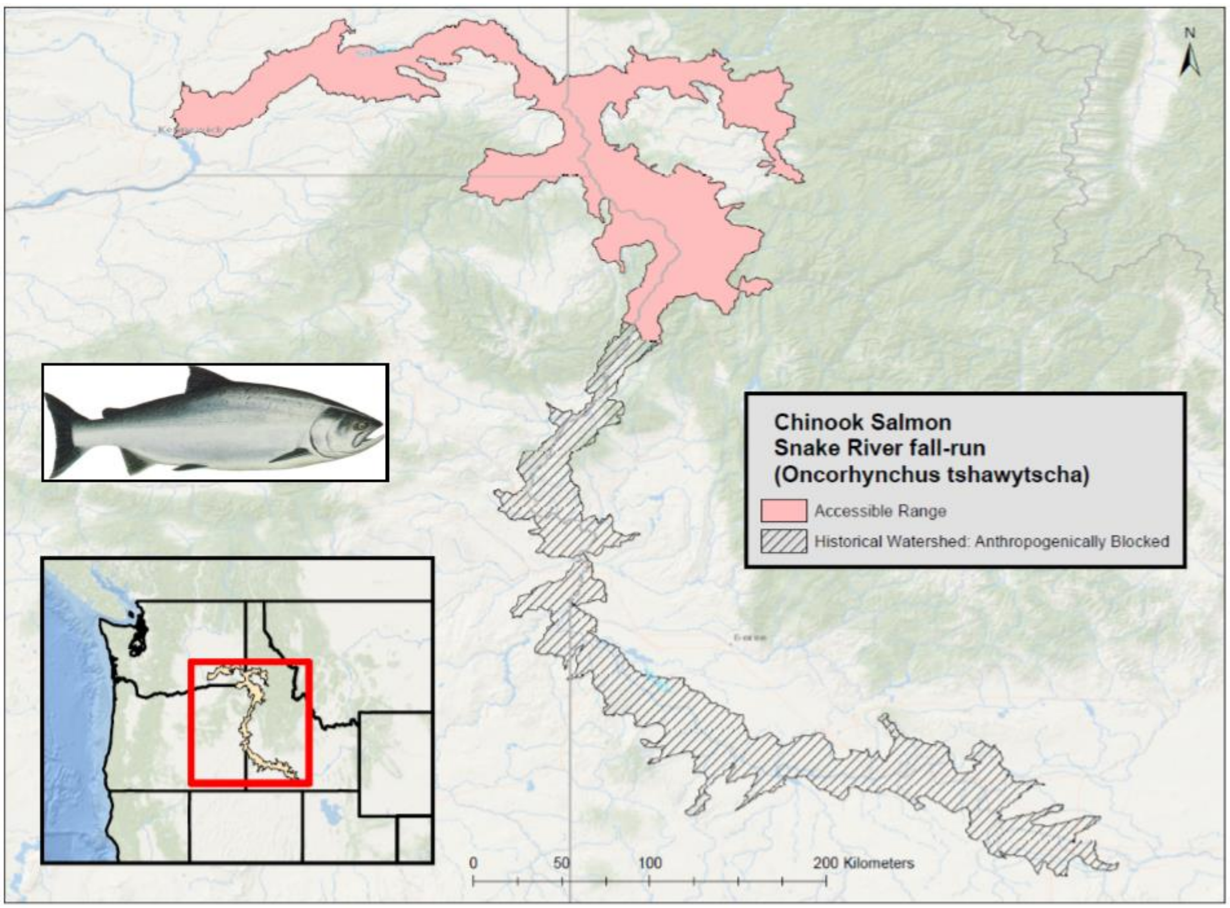

Figure 9. Chinook salmon, Snake River fall-run ESU range and designated critical habitat

Species Description. Chinook salmon are the largest of the Pacific salmon. Spawning adults are olive to dark maroon in color, without conspicuous streaking or blotches on the sides. Spawning males are darker than females, and have a hooked jaw and slightly humped back. They can be distinguished from other spawning salmon by the color pattern, particularly the spotting on the back and tail, and by the dark, solid black gums of the lower jaw (Moyle 2002b). NMFS first listed Snake River fall Chinook salmon as a threatened species under the ESA on April 22, 1992 (57 FR 14658). NMFS reaffirmed the listing status in June 28, 2005 (70 FR 37160), and reaffirmed the status again in its 2014 (79 FR 20802). Snake River fall Chinook salmon historically spawned throughout the 600-mile reach of the mainstem Snake River from its mouth upstream to Shoshone Falls, a 212-foot high natural barrier near Twin Falls, Idaho (RM 614.7). The listed ESU currently includes all natural-origin fall-run Chinook salmon originating from the mainstem Snake River below Hells Canyon Dam (the lowest of three impassable dams that form the Hells Canyon Complex) and from the Tucannon River, Grande Ronde River, Imnaha River, Salmon River, and Clearwater River subbasins. The listed ESU also includes fall-run Chinook salmon from four artificial propagation programs (NMFS 2011; NMFS 2015).

Status. As late as the late 1800s, approximately 408,500 to 536,180 fall Chinook salmon are believed to have returned annually to the Snake River. The run began to decline in the late 1800s and then continued to decline through the early and mid-1900s as a result of overfishing and other human activities, including the construction of major dams. Snake River fall Chinook salmon abundance has increased significantly since ESA listing in the 1990s. The overall current risk rating for the Lower Mainstem Snake River fall Chinook salmon population is viable (recovery plan). Nevertheless, while the number of natural-origin fall Chinook salmon has been high, substantial uncertainty remains about the status of the species' productivity and diversity. Threats posed by straying out-of-ESU hatchery fish have declined due to improved management. Still, large reaches of historical habitat remain blocked and inundated, and the mainstem Snake and Columbia River hydropower system, while less of a constraint than in the past, continues to cause juvenile and adult losses. The number of hatchery-origin fall Chinook salmon on the spawning grounds continues to threaten natural-origin fish productivity and genetic diversity. Further, the combined and relative effects of the different threats across the life cycle ─ including threats from climate change ─ remain poorly understood (NMFS 2011; NMFS 2015).

Life history. Snake River fall-run Chinook return to the Columbia River in August and September, pass Bonneville Dam from mid-August to the end of September, and enter the Snake River between early September and mid-October (DART 2013). Once they reach the Snake River, fall Chinook salmon generally travel to one of five major spawning areas and spawn from late October through early December (Connor et al. 2014).

Upon emergence from the gravel, most young fall Chinook salmon move to shoreline riverine habitat (recovery plan). Some fall Chinook salmon smolts sustain active migration after passing Lower Granite Dam and enter the ocean as subyearlings, whereas some delay seaward migration and enter the ocean as yearlings (Connor et al. 2005; McMichael et al. 2008; NMFS 2015). Snake River fall Chinook salmon can be present in the estuary as juveniles in winter, as fry from March to May, and as fingerlings throughout the summer and fall (Fresh et al. 2005; Roegner et al. 2012; Teel et al. 2014).

Once in the Northern California Current, dispersal patterns differ for yearlings and subyearlings. Subyearlings migrate more slowly, are found closer to shore in shallower water, and do not disperse as far north as yearlings (Fisher et al. 2014; Sharma and Quinn 2012; Trudel et al. 2009; Tucker et al. 2011). Snake River basin fall Chinook salmon spend one to four years in the Pacific Ocean, depending on gender and age at the time of ocean entry (Connor et al. 2005).

Juvenile Chinook salmon forage in shallow areas with protective cover, such as tidally influenced sandy beaches and vegetated zones (Healey et al. 1991). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson et al. 1982a; MacFarlane and Norton 2002). Upon reaching the ocean, juvenile Chinook salmon feed voraciously on larval and juvenile fishes, plankton, and terrestrial insects (Healey et al. 1991). Chinook salmon grow rapidly in the ocean environment, with growth rates dependent on water temperatures and food availability.

Table 30. Temporal distribution of Chinook salmon, Snake River fall-run ESU

Life History phase	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Entering Fresh Water (adults/jacks)								Present				
Spawning										Present		
Incubation (eggs)	Present									Present		
Emergence (alevin to fry phases	Present											Present
Rearing and migration (juveniles)	Present											

Population Dynamics

Abundance. The naturally spawning fall Chinook salmon in the lower Snake River have included both returns originating from naturally spawning parents and from returning hatchery releases. The geometric mean natural-origin adult abundance for the most recent 10 years of annual spawner escapement estimates (2005-2014) is 6,418, with a standard error of 0.19 (NMFS 2015)

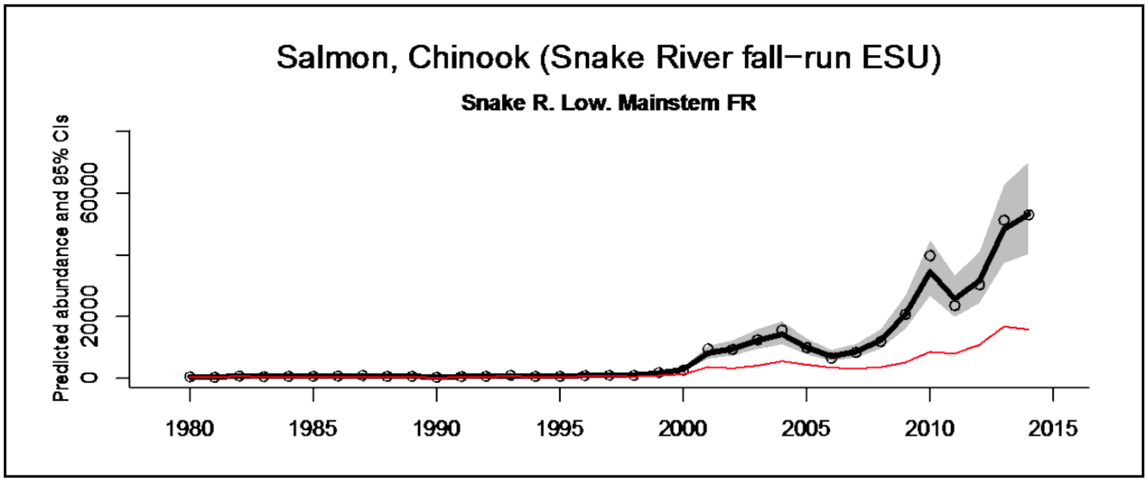

Figure 10. Smoothed trend in estimated total (thick black line) and natural (thin red line) population spawning abundance. Points show the annual spawning abundance estimates (from 2015 draft recovery plan).

Productivity / Population Growth Rate. The current estimate of productivity for this population (1990-2009 brood years) is 1.53 with a standard error of 0.18. This estimate of productivity, however, may be problematic for two reasons: (1) the increasingly small number of years that actually contribute to the productivity estimate means that there is increasing statistical uncertainty surrounding that estimate, and (2) the years contributing to the estimate are now far in the past and may not accurately reflect the true productivity of the current population (NMFS 2015)

Genetic Diversity. Genetic samples from the aggregate population in recent years indicate that composite genetic diversity is being maintained and that the Snake River Fall Chinook hatchery stock is similar to the natural component of the population, an indication that the actions taken to reduce the potential introgression of out-of-basin hatchery strays has been effective. Overall, the current genetic diversity of the population represents a change from historical conditions and, applying the Interior Columbia Technical Recovery Team (ICTRT) guidelines, the rating for this metric is moderate risk (NMFS 2015).

Distribution. The extant Lower Snake River Fall Chinook salmon population consists of a spatially complex set of five historical major spawning areas (Cooney et al. 2007), each of which consists of a set of relatively discrete spawning patches of varying size. The primary Major spawning area (MaSA) in the extant Lower Mainstem Snake River population is the 96-km Upper Mainstem Snake River Reach, extending upriver from the confluence of the Salmon River to the Hells Canyon Dam site, where the canyon walls narrow and strongly confine the river bed. A second mainstem Snake River MaSA, the Lower Mainstem Snake River Reach, extends 69 km downstream from the Salmon River confluence to the upper end of the contemporary Lower Granite Dam pool. The lower mainstem reaches of two major tributaries to the mainstem Snake River, the Grande Ronde and the Clearwater Rivers, were also identified by the ICTRT as

MaSAs. Both of these river systems currently support fall Chinook salmon spawning in the lower reaches. In addition, there is some historical evidence for production of late spawning Chinook salmon in spatially isolated reaches in upriver tributaries to each of these systems (NMFS 2015).

Designated Critical Habitat. NMFS designated critical habitat for SR Fall-run Chinook salmon on December 28, 1993 (58 FR 68543). PBFs considered essential for the conservation of Chinook salmon, Snake River fall-run ESU are shown in Table 31.

Table 31. Essential features of critical habitats designated for SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, SR sockeye salmon, SONC coho salmon, and corresponding species life history events.

Essential Features Site	Essential Features Site Attribute	Species Life History Event
Spawning and juvenile rearing areas	Access (sockeye) Cover/shelter Food (juvenile rearing) Riparian vegetation Space (Chinook, coho) Spawning gravel Water quality Water temp (sockeye) Water quantity	Adult spawning Embryo incubation Alevin growth and development Fry emergence from gravel Fry/parr/smolt growth and development
Adult and juvenile migration corridors	Cover/shelter Food (juvenile) Riparian vegetation Safe passage Space Substrate Water quality Water quantity Water temperature Water velocity	Adult sexual maturation Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration
Areas for growth and development to adulthood	Ocean areas – not identified	Nearshore juvenile rearing Subadult rearing Adult growth and sexual maturation Adult spawning migration

The major degraded PBFs within critical habitat designated for SR Fall-run Chinook salmon include: (1) safe passage for juvenile migration which is reduced by the presence of the Snake and Columbia River hydropower system within the lower mainstem; (2) rearing habitat water quality altered by influx of contaminants and changing seasonal temperature regimes caused by water flow management; and (3) spawning/rearing habitat PBF attributes (spawning areas with gravel, water quality, cover/shelter, riparian vegetation, and space to support egg incubation and larval growth and development) that are reduced in quantity (80 percent loss) and quality due to the mainstem lower Snake River hydropower system.

Water quality impairments in the designated critical habitat are common within the range of this ESU. Pollutants such as petroleum products, pesticides, fertilizers, and sediment in the form of turbidity enter the surface waters and riverine sediments from the headwaters of the Snake, Salmon, and Clearwater Rivers to the Columbia River estuary; traveling along with contaminated stormwater runoff, aerial drift and deposition, and via point source discharges. Some contaminants such as mercury and pentachlorophenol enter the aquatic food web after reaching water and may be concentrated or even biomagnified in the salmon tissue. This species also requires migration corridors with adequate passage conditions (water quality and quantity available at specific times) to allow access to the various habitats required to complete their life cycle.

Recovery Goals. Recovery goals, objectives and criteria for the Snake River fall-run Chinook are fully outlined in the 2015 Recovery Plan (NMFS 2015). ESA recovery goals should support conservation of natural fish and the ecosystems upon which they depend. Thus, the ESA recovery goal for Snake River fall Chinook salmon is that: the ecosystems upon which Snake River fall Chinook salmon depend are conserved such that the ESU is self-sustaining in the wild and no longer needs ESA protection.

Table 32. Summary of status; Chinook salmon, Snake River fall-run ESU

Criteria	**Description**
Abundance / productivity trends	Stable to increasing abundance trend, moderate extinction risk. Productivity of naturally spawned populations uncertain. Large proportion of hatchery-reared fish.
Listing status	Threatened
Attainment of recovery goals	Criteria not yet met
Condition of PBFs	Spawning, rearing and migration PBFs are degraded by loss of habitat, impaired stream flows, barriers to fish passage, and poor water quality; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; The entire river corridor is considered of high conservation value

8.10 Chinook salmon, Snake River spring/summer-run ESU

Table 33. Chinook salmon, Snake River spring/summer-run ESU; overview table

Species	Common Name	Distinct Population Segments (DPS)	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus tshawytscha	Chinook Salmon	Snake River Spring and Summer run	Threatened	2011	2005 70 FR 37160 2014 79 FR 20802	Proposed 2014	1999 64 FR 57399

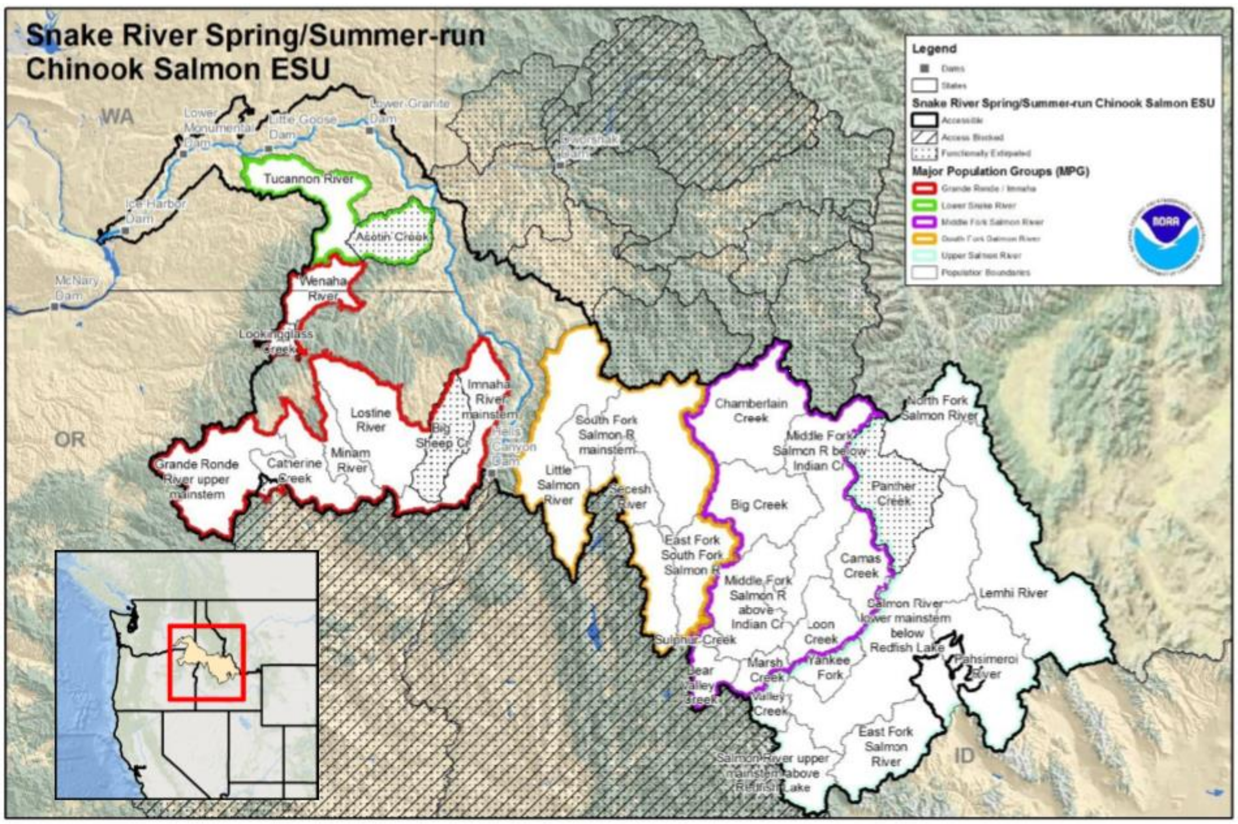

Figure 11. Chinook salmon, Snake River spring/summer-run ESU range and designated critical habitat

Species Description. Chinook salmon are the largest of the Pacific salmon. Spawning adults are olive to dark maroon in color, without conspicuous streaking or blotches on the sides. Spawning males are darker than females, and have a hooked jaw and slightly humped back. They can be distinguished from other spawning salmon by the color pattern, particularly the spotting on the back and tail, and by the dark, solid black gums of the lower jaw (Moyle 2002b). Snake River spring/summer-run Chinook salmon, an ESU was listed as a threatened species under the ESA on April 22, 1992 (57 FR 14658). NMFS reaffirmed the listing on June 28, 2005 (70 FR 37160) and made minor technical corrections to the listing on April 14, 2014 (79 FR 20802). The Snake River spring/summer Chinook salmon ESU includes all naturally spawned populations of spring/summer Chinook salmon in the mainstem Snake River and the Tucannon River, Grand Ronde River, Imnaha River, and Salmon River subbasins as well as spring/summer Chinook salmon from 11 artificial propagation programs (NMFS 2016c).

Status. The historical run of Chinook in the Snake River likely exceeded one million fish annually in the late 1800s, by the 1950s the run had declined to near 100,000 adults per year. The adult counts fluctuated throughout the 1980s but then declined further, reaching a low of 2,200 fish in 1995. Currently, the majority of extant spring/summer Chinook salmon populations in the Snake River spring/summer Chinook salmon ESU remain at high overall risk of extinction, with a low probability of persistence within 100 years. Factors cited in the 1991 status review as contributing to the species’ decline since the late 1800s include overfishing, irrigation diversions, logging, mining, grazing, obstacles to migration, hydropower development, and questionable management practices and decisions (Matthews and Waples 1991). In addition, new threats ─ such as those posed by toxic contamination, increased predation by non-native species, and effects due to climate change ─ are emerging (NMFS 2016a).

Life history. Adult spring-run Chinook salmon destined for the Snake River return to the Columbia River from the ocean in early spring and pass Bonneville Dam beginning in early March and ending May 31st. Snake River summer-run Chinook salmon return to the Columbia River from June through July. Adults from both runs hold in deep pools in the mainstem Columbia and Snake Rivers and the lower ends of the spawning tributaries until late summer, when they migrate into the higher elevation spawning reaches. Generally, Snake River spring-run Chinook salmon spawn in mid- through late August. Snake River summer-run Chinook salmon spawn approximately one month later than spring-run fish and tend to spawn lower in the tributary drainages, although their spawning areas often overlap with those of spring-run spawners

The eggs that Snake River spring and summer Chinook salmon deposit in late summer and early fall incubate over the following winter, and hatch in late winter and early spring. Juveniles rear through the summer, overwinter, and typically migrate to sea in the spring of their second year of life, although some juveniles may spend an additional year in fresh water. Depending on the tributary and the specific habitat conditions, juveniles may migrate extensively from natal reaches into alternative summer-rearing or overwintering areas. Most yearling fish are thought to spend relatively little time in the estuary compared to sub-yearling ocean-type fish however there is considerable variation in residence times in different habitats and in the timing of estuarine and ocean entry among individual fish (Holsman et al. 2012; McElhany et al. 2000a).

Snake River spring/summer-run Chinook salmon range over a large area in the northeast Pacific Ocean, including coastal areas off Washington, British Columbia, and southeast Alaska, the continental shelf off central British Columbia, and the Gulf of Alaska (NMFS 2016c). Most of the fish spend two or three years in the ocean before returning to tributary spawning grounds primarily as 4- and 5-year-old fish. A small fraction of the fish spend only one year in the ocean and return as 3-year-old “jacks,” heavily predominated by males (Good et al. 2005a).

Juvenile Chinook salmon forage in shallow areas with protective cover, such as tidally influenced sandy beaches and vegetated zones (Healey et al. 1991). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson et al. 1982a; MacFarlane and Norton 2002). Upon reaching the ocean, juvenile Chinook salmon feed voraciously on larval and juvenile fishes, plankton, and terrestrial insects (Healey et al. 1991; MacFarlane and Norton 2002). Chinook salmon grow rapidly in the ocean environment, with growth rates dependent on water temperatures and food availability.

Table 34. Temporal distribution of Chinook salmon, Snake River spring/summer-run ESU

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td></td><td></td><td colspan="5">Present</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Spawning</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td><td></td><td></td></tr>
<tr><td>Incubation (eggs)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="4">Present</td><td></td></tr>
<tr><td>Emergence (alevin to fry phases</td><td>Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Population Dynamics

Abundance / Productivity

Lower Snake River Major Population Group (MPG): Abundance and productivity remain the major concern for the Tucannon River population. Natural spawning abundance (10-year geometric mean) has increased but remains well below the minimum abundance threshold for the single extant population in this MPG. Poor natural productivity continues to be a major concern.

Grande Ronde/Imnaha MPG: The Wenaha River, Lostine/Wallowa River and Minam River populations showed substantial increases in natural abundance relative to the previous ICTRT review, although each remains below their respective minimum abundance thresholds. The Catherine Creek and Upper Grande Ronde populations each remain in a critically depressed state. Geometric mean productivity estimates remain relatively low for all populations in the MPG.

South Fork Salmon River MPG: Natural spawning abundance (10-year geometric mean) estimates increased for the three populations with available data series. Productivity estimates for these populations are generally higher than estimates for populations in other MPGs within the ESU. Viability ratings based on the combined estimates of abundance and productivity remain at high risk, although the survival/capacity gaps relative to moderate and low risk viability curves are smaller than for other ESU populations.

Middle Fork Salmon River MPG: Natural-origin abundance and productivity remains extremely low for populations within this MPG. As in the previous ICTRT assessment, abundance and productivity estimates for Bear Valley Creek and Chamberlain Creek (limited data series) are the closest to meeting viability minimums among populations in the MPG.

Upper Salmon River MPG: Abundance and productivity estimates for most populations within this MPG remain at very low levels relative to viability objectives. The Upper Salmon Mainstem has the highest relative abundance and productivity combination of populations within the MPG.

Genetic Diversity / Spatial Structure

Lower Snake River MPG: The integrated spatial structure/diversity risk rating for the Lower Snake River MPG is moderate.

Grande Ronde/Imnaha MPG: The Upper Grande Ronde population is rated at high risk for spatial structure and diversity while the remaining populations are rated at moderate.

South Fork Salmon River MPG: Spatial structure/diversity risks are currently rated moderate for the South Fork Mainstem population (relatively high proportion of hatchery spawners) and low for the Secesh River and East Fork South Fork populations.

Middle Fork Salmon River MPG: Spatial structure/diversity risk ratings for Middle Fork Salmon River MPG populations are generally moderate. This primarily is driven by moderate ratings for genetic structure assigned by the ICTRT because of uncertainty arising from the lack of direct genetic samples from within the component populations.

Upper Salmon River MPG: Spatial structure/diversity risk ratings vary considerably across the Upper Salmon River MPG. Four of the eight populations are rated at low or moderate risk for overall spatial structure and diversity and could achieve viable status with improvements in average abundance/productivity. The high spatial structure/diversity risk rating for the Lemhi population is driven by a substantial loss of access to tributary spawning/rearing habitats and the associated reduction in life-history diversity. High risk ratings for Pahsimeroi River, East Fork Salmon River, and Yankee Fork Salmon River are driven by a combination of habitat loss and diversity concerns related to low natural abundance combined with chronically high proportions of hatchery spawners in natural areas.

Distribution The Snake River spring/summer Chinook salmon ESU includes all naturally spawned populations of spring/summer Chinook salmon in the mainstem Snake River and the Tucannon River, Grand Ronde River, Imnaha River, and Salmon River subbasins. The ESU is broken into five major population groups (MPG). Together, the MPGs contain 28 extant independent naturally spawning populations, three functionally extirpated populations, and one extirpated population. The Upper Salmon River MPG contains eight extant populations and one extirpated population. The Middle Fork Salmon River MPG contains nine extant populations. The South Fork Salmon River MPG contains four extant populations. The Grande Ronde/Imnaha Rivers MPG contains six extant populations, with two functionally extirpated populations. The Lower Snake River MPG contains one extant population and one functionally extirpated population. The South Fork and Middle Fork Salmon Rivers currently support most of the natural spring/summer Chinook salmon production in the Snake River drainage (NMFS 2016c).

Designated Critical Habitat Critical habitat for Snake River spring/summer Chinook salmon was designated on December 28, 1993 (58 FR 68543) and revised slightly on October 25, 1999 (64 FR 57399). PBFs considered essential for the conservation of Chinook salmon, Snake River spring/summer-run ESU are shown in Table 31.

Spawning and juvenile rearing PBFs are regionally degraded by changes in flow quantity, water quality, and loss of cover. Juvenile and adult migrations are obstructed by reduced access that has resulted from altered flow regimes from hydroelectric dams. According to the ICBTRT, the Panther Creek population was extirpated because of legacy and modern mining-related pollutants creating a chemical barrier to fish passage (Chapman and Julius 2005).

Presence of cool water that is relatively free of contaminants is particularly important for the spring/summer run life history as adults hold over the summer and juveniles may rear for a whole year in the river. Water quality impairments are common in the range of the critical habitat designated for this ESU. Pollutants such as petroleum products, pesticides, fertilizers, and sediment in the form of turbidity enter the surface waters and riverine bottom substrate from the headwaters of the Snake, Salmon, and Clearwater Rivers to the Columbia River estuary as contaminated stormwater runoff, aerial drift and deposition, and via point source discharges. Some contaminants such as mercury and pentachlorophenol enter the aquatic food web after reaching water and may be concentrated or even biomagnified in the salmon tissue. This species also requires migration corridors with adequate passage conditions (water quality and quantity available at specific times) to allow access to the various habitats required to complete their life cycle.

Recovery Goals. Recovery goals, scenarios and criteria for the Snake River spring and summer-run Chinook salmon are fully outlined in the 2016 proposed recovery plan (NMFS 2016c). The status levels targeted for populations within an ESU or DPS are referred to collectively as the “recovery scenario” for the ESU or DPS. NMFS has incorporated the viability criteria into viable recovery scenarios for each Snake River spring/summer Chinook salmon and steelhead MPG. The criteria should be met for an MPG to be considered Viable, or low (5 percent or less) risk of extinction, and thus contribute to the larger objective of ESU or DPS viability. These criteria are:

- At least one-half the populations historically present (minimum of two populations) should meet viability criteria (5 percent or less risk of extinction over 100 years).
- At least one population should be highly viable (less than 1 percent risk of extinction).
- Viable populations within an MPG should include some populations classified as "Very Large'" or "Large," and "Intermediate" reflecting proportions historically present.
- All major life history strategies historically present should be represented among the populations that meet viability criteria.
- Remaining populations within an MPG should be maintained (25 percent or less risk of extinction) with sufficient abundance, productivity, spatial structure, and diversity to provide for ecological functions and to preserve options for ESU or DPS recovery.
- For MPGs with only one population, this population must be highly viable (less than 1 percent risk of extinction).

Table 35. Summary of status; Chinook salmon, Snake River spring/summer-run ESU

Criteria	**Description**
Abundance / productivity trends	Low abundances, high risk of extinction. Poor natural productivity with unknown rates. Several Salmon River populations have higher abundances, but still well below recovery criteria. Moderate genetic diversity.
Listing status	Threatened
Attainment of recovery goals	Criteria not yet met
Condition of PBFs	Spawning, rearing and migration PBFs are degraded by loss of habitat, altered stream flows, barriers to fish passage, dams, loss of cover, and poor water quality; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; The entire river corridor is considered of high conservation value

8.11 Chinook salmon, Upper Columbia River spring-run ESU

Table 36. Chinook salmon, Upper Columbia River spring-run ESU; overview table

Species	Common Name	Distinct Population Segment	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus tshawytscha	Chinook salmon	Upper Columbia River spring-run ESU	Endangered	2016	70 FR 37160	2007	70 FR 52630

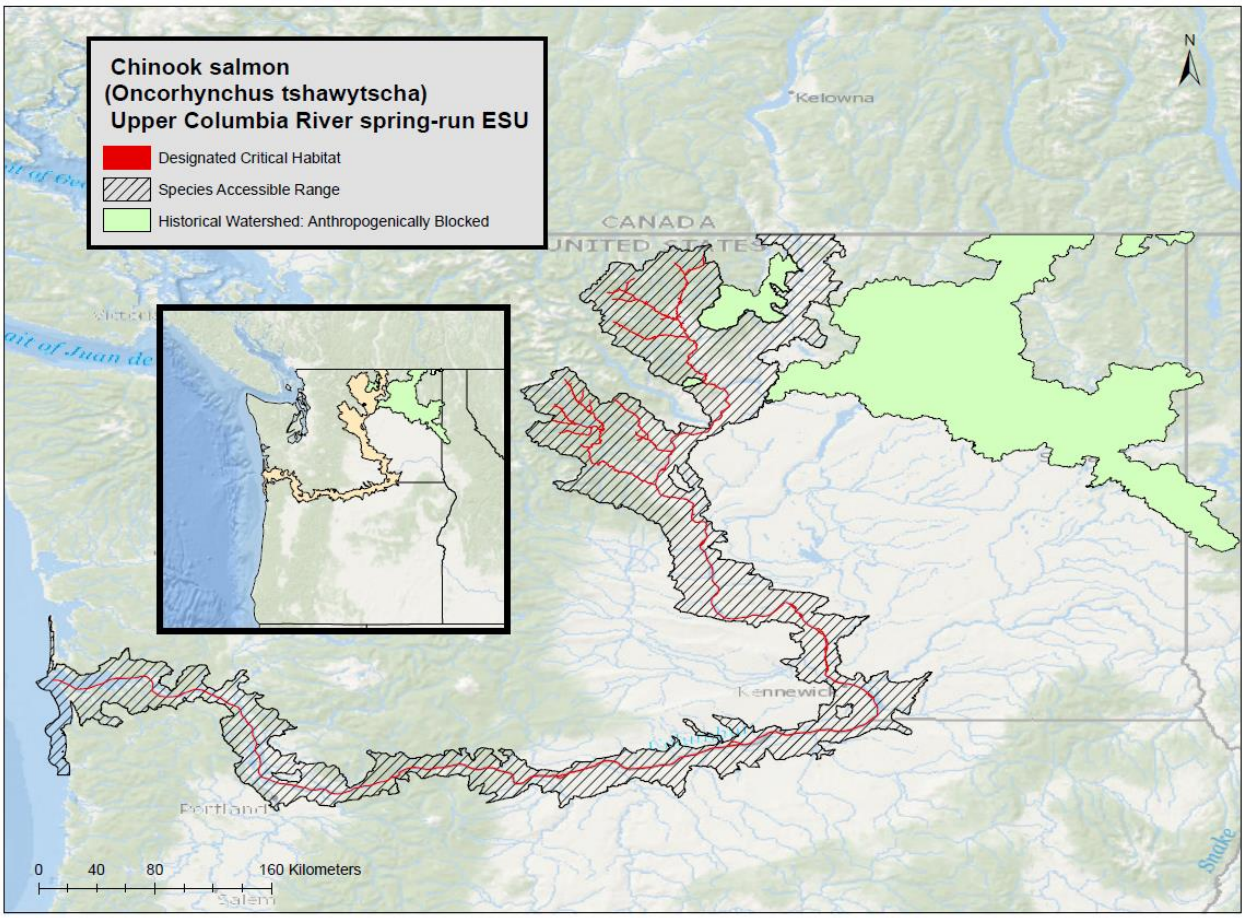

Figure 12. Chinook salmon, Upper Columbia River spring-run ESU range and designated critical habitat

Species Description. Chinook salmon are the largest of the Pacific salmon. Spawning adults are olive to dark maroon in color, without conspicuous streaking or blotches on the sides. Spawning males are darker than females, and have a hooked jaw and slightly humped back. They can be distinguished from other spawning salmon by the color pattern, particularly the spotting on the back and tail, and by the dark, solid black gums of the lower jaw (Moyle 2002b). Upper

Columbia River spring-run Chinook salmon, an ESU was listed as an endangered species under the ESA on March 24, 1999 (64 FR 14308). NMFS reaffirmed the listing on June 28, 2005 (70 FR 37160). The Snake River spring/summer Chinook salmon ESU includes all naturally spawned populations of spring/summer Chinook salmon in the mainstem Snake River and the Tucannon River, Grand Ronde River, Imnaha River, and Salmon River subbasins as well as spring/summer Chinook salmon from 11 artificial propagation programs (NMFS 2016c). This ESU includes naturally spawned spring-run Chinook salmon originating from Columbia River tributaries upstream of the Rock Island Dam and downstream of Chief Joseph Dam (excluding the Okanogan River subbasin). Also, spring-run Chinook salmon from six artificial propagation programs.

Status. The Upper Columbia spring Chinook ESU includes three extant populations (Wenatchee, Entiat, and Methow), as well as one extinct population in the Okanogan subbasin (ICBTRT 2003). All three populations continued to be rated at low risk for spatial structure but at high risk for diversity criteria. Large-scale supplementation efforts in the Methow and Wenatchee Rivers are ongoing, intended to counter short-term demographic risks given current average survival levels and the associated year-to-year variability. Under the current recovery plan, habitat protection and restoration actions are being implemented that are directed at key limiting factors. Although the status of the ESU is improved relative to measures available at the time of listing, all three populations remain at high risk (NWFSC 2015).

Life history. Adult Spring Chinook in the Upper Columbia Basin begin returning from the ocean in the early spring, with the run into the Columbia River peaking in mid-May. Spring Chinook enter the Upper Columbia tributaries from April through July. After migration, they hold in freshwater tributaries until spawning occurs in the late summer, peaking in mid to late August. Juvenile spring Chinook spend a year in freshwater before migrating to salt water in the spring of their second year of life. Most Upper Columbia spring Chinook return as adults after two or three years in the ocean. Some precocious males, or jacks, return after one winter at sea. A few other males mature sexually in freshwater without migrating to the sea. However, four and five year old fish that have spent two and three years at sea, respectively, dominate the run. Fecundity ranges from 4,200 to 5,900 eggs, depending on the age and size of the female.

Juvenile Chinook salmon forage in shallow areas with protective cover, such as tidally influenced sandy beaches and vegetated zones (Healey et al. 1991). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson et al. 1982a; MacFarlane and Norton 2002). Upon reaching the ocean, juvenile Chinook salmon feed voraciously on larval and juvenile fishes, plankton, and terrestrial insects (Healey et al. 1991; MacFarlane and Norton 2002). Chinook salmon grow rapidly in the ocean environment, with growth rates dependent on water temperatures and food availability.

Table 37. Temporal distribution of Chinook salmon, Upper Columbia River spring-run ESU

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td></td><td></td><td colspan="7">Present</td><td></td><td></td><td></td></tr>
<tr><td>Spawning</td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td><td></td><td></td><td></td></tr>
<tr><td>Incubation (eggs)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="5">Present</td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td colspan="4">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Present</td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Population Dynamics

Abundance For all populations, average abundance over the recent 10-year period is below the average abundance thresholds that the ICTRT identifies as a minimum for low risk (ICTRT 2008a; ICTRT 2008b; ICTRT 2008c). The geometric mean spawning escapements from 1997 to 2001 were 273 for the Wenatchee population, 65 for the Entiat population, and 282 for the Methow population. These numbers represent only 8 percent to 15 percent of the minimum abundance thresholds. The five-year geometric mean remained low as of 2003.

Productivity / Population Growth Rate. Based on 1980-2004 returns, the lambda for this ESU is estimated at 0.93 (meaning the population is not replacing itself) (Fisher and Hinrichsen 2006). The long-term trend for abundance and lambda for individual populations indicate a decline for all three populations (Good et al. 2005b). Short-term lambda values indicate an increasing trend for the Methow population, but not for the Wenatchee and Entiat populations (ICTRT 2008a; ICTRT 2008b; ICTRT 2008c).

Genetic Diversity. The ICTRT characterizes the diversity risk to all Upper Columbia River (UCR) Spring-run Chinook populations as “high”. The high risk is a result of reduced genetic diversity from homogenization of populations that occurred under the Grand Coulee Fish Maintenance Project in 1939-1943.

Distribution. Spring Chinook currently spawn and rear in the upper main Wenatchee River upstream from the mouth of the Chiwawa River, overlapping with summer Chinook in that area (Peven et al. 1994). The primary spawning areas of spring Chinook in the Wenatchee subbasin include Nason Creek and the Chiwawa, Little Wenatchee, and White rivers. (Hamstreet and Carie 2003) described the current spawning distribution for spring Chinook in the Entiat subbasin as the Entiat River (river mile 16.2 to 28.9) and the Mad River (river mile 32 1.5-5.0). Spring Chinook of the Methow population currently spawn in the mainstem Methow River and the Twisp, Chewuch, and 5 Lost drainages (Humling and Snow 2005; Scribner et al. 1993). A few also spawn in Gold, Wolf, 6 and Early Winters creeks.

Designated Critical Habitat. NMFS designated critical habitat for Upper Columbia River Spring-run Chinook salmon on September 2, 2005 (70 FR 52630). It includes all Columbia River estuarine areas and river reaches proceeding upstream to Chief Joseph Dam and several tributary subbasins. PBFs considered essential for the conservation of Chinook salmon, Upper Columbia River spring-run ESU are shown in Table 6.

Spawning and rearing PBFs are somewhat degraded in tributary systems by urbanization in lower reaches, grazing in the middle reaches, and irrigation and diversion in the major upper drainages. These activities have resulted in excess erosion of fine sediment and silt that smother spawning gravel; reduction in flow quantity necessary for successful incubation, formation of physical rearing conditions, and juvenile mobility. Moreover siltation further affects critical habitat by reducing water quality through contaminated agricultural runoff; and removing natural cover. Adult and juvenile migration PBFs are heavily degraded by Columbia River Federal dam projects and a number of mid-Columbia River Public Utility District dam projects also obstruct the migration corridor.

Recovery Goals. Recovery goals, objectives and detailed criteria for the Central Valley spring-run Chinook are fully outlined in the 2016 Recovery Plan. The general recovery objectives are:

- Increase the abundance of naturally produced spring Chinook spawners within each population in the Upper Columbia ESU to levels considered viable.
- Productivity 21 Increase the productivity (spawner:spawner ratios and smolts/redds) of naturally produced spring Chinook within each population to levels that result in low risk of extinction.
- Restore the distribution of naturally produced spring Chinook to previously occupied areas (where practical) and allow natural patterns of genetic and phenotypic diversity to be expressed.

Table 38. Summary of status; Chinook salmon, Upper Columbia River spring-run ESU

Criteria	Description
Abundance / productivity trends	All populations have low abundance and the long-term trend in growth rate of the ESU is declining (the population is not replacing itself).
Listing status	Endangered
Attainment of recovery goals	Criteria not yet met
Condition of PBFs	Spawning and rearing PBFs are degraded by urbanization and irrigation water diversions; Migration PBFs degraded by numerous dams; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; Of occupied watersheds, 26 are of high and 5 are of medium conservation value

8.12 Chinook salmon, Upper Willamette River ESU

Table 39. Chinook salmon, Upper Willamette River ESU; overview table

Species	Common Name	Distinct Population Segment	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus tshawytscha	Chinook salmon	Upper Willamette River ESU	Threatened	2016	70 FR 37160	2011	70 FR 52630

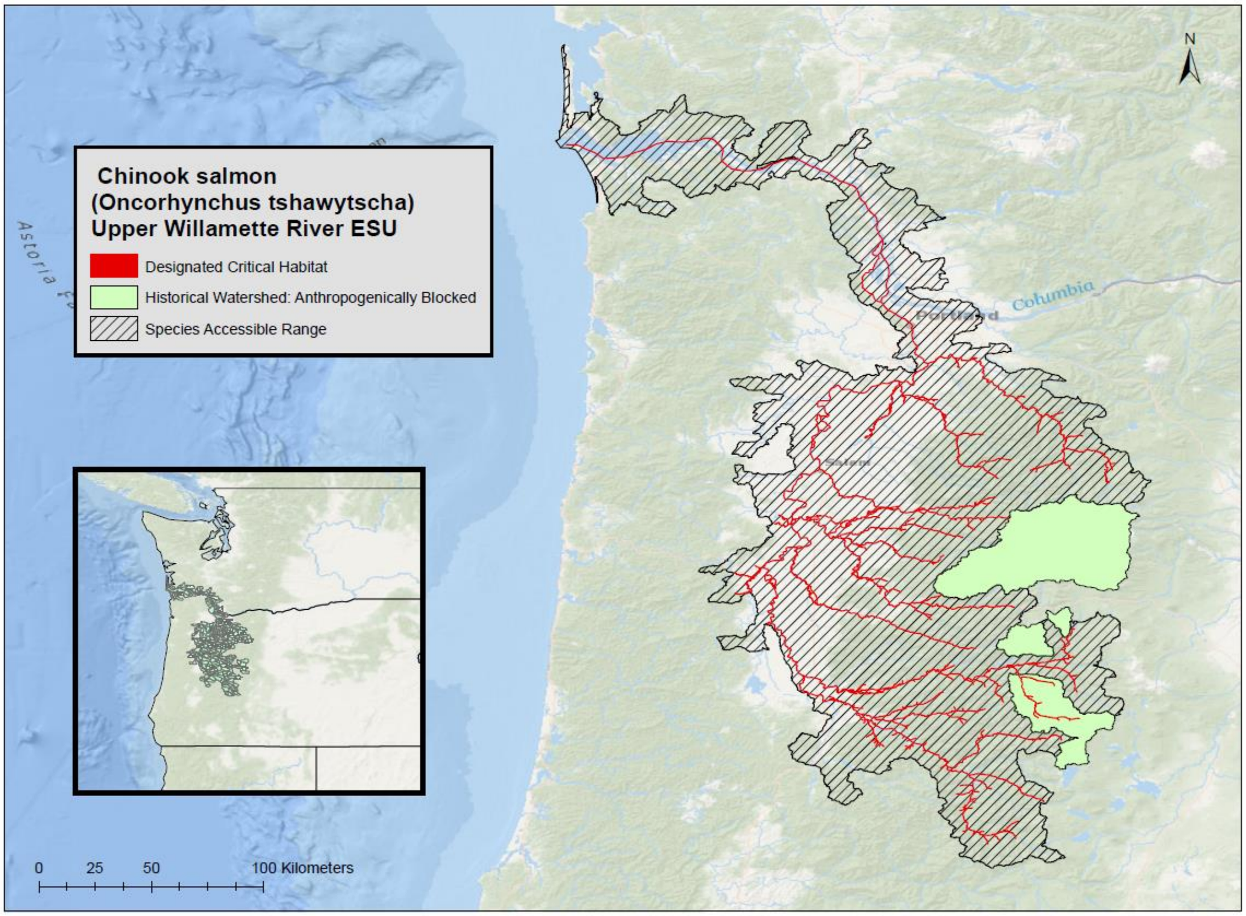

Figure 13. Chinook salmon, Upper Willamette River ESU range and designated critical habitat

Species Description. Chinook salmon are the largest of the Pacific salmon. Spawning adults are olive to dark maroon in color, without conspicuous streaking or blotches on the sides. Spawning males are darker than females, and have a hooked jaw and slightly humped back. They can be distinguished from other spawning salmon by the color pattern, particularly the spotting on the back and tail, and by the dark, solid black gums of the lower jaw (Moyle 2002b). Upper Willamette River Chinook salmon, an ESU was listed as an endangered species under the ESA on March 24, 1999 (64 FR 14308). NMFS reaffirmed the listing on June 28, 2005 (70 FR

37160). This 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.

Status. The Upper Willamette River Chinook ESU is considered to be extremely depressed, likely numbering less than 10,000 fish compared to a historical abundance estimate of 300,000 (Myers et al. 2003). There are seven demographically independent populations of spring-run Chinook salmon in the Upper Willamette River (UWR) Chinook salmon ESU: Clackamas, Molalla, North Santiam, South Santiam, Calapooia, McKenzie, and the Middle Fork Willamette (Myers et al. 2006). Currently, significant natural production occurs in only the Clackamas and McKenzie populations (McElhany et al. 2007a). Juvenile spring Chinook produced by hatchery programs are released throughout many of the subbasins and adult Chinook returns to the ESU are typically 80-90 percent hatchery origin fish. 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.

Life history. Upper Willamette River Chinook salmon exhibit an earlier time of entry into the Columbia River than other spring-run Chinook salmon ESUs (Myers et al. 1998b). Adults appear in the lower Willamette River in February, but the majority of the run ascends Willamette Falls in April and May, with a peak in mid- to late May. However, present-day salmon ascend the Willamette Falls via a fish ladder. Consequently, the migration of spring Chinook salmon over Willamette Falls extends into July and August (overlapping with the beginning of the introduced fall-run of Chinook salmon).

The adults hold in deep pools over summer and spawn in late fall or early winter when winter storms augments river flows. Fry may emerge from February to March and sometimes as late as June (Myers et al. 2006). Juvenile migration varies with three distinct juvenile emigration “runs”: fry migration in late winter and early spring; sub-yearling (0 yr +) migration in fall to early winter; and yearlings (1 yr +) migrating in late winter to spring. Sub-yearlings and yearlings rear in the mainstem Willamette River where they also use floodplain wetlands in the lower Willamette River during the winter-spring floodplain inundation period.

Juvenile Chinook salmon forage in shallow areas with protective cover, such as tidally influenced sandy beaches and vegetated zones (Healey et al. 1991). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson et al. 1982a; MacFarlane and Norton 2002). Upon reaching the ocean, juvenile Chinook salmon feed voraciously on larval and juvenile fishes, plankton, and terrestrial insects (Healey et al. 1991; MacFarlane and Norton 2002). Chinook salmon grow rapidly in the ocean environment, with growth rates dependent on water temperatures and food availability.

Table 40. Temporal distribution of Chinook salmon, Upper Willamette River ESU

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td></td><td></td><td></td><td></td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Spawning</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td><td></td><td></td></tr>
<tr><td>Incubation (eggs)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="4">Present</td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Present</td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Population Dynamics

Abundance. The UWR Chinook ESU is considered to be extremely depressed, likely numbering less than 10,000 fish compared to a historical abundance estimate of 300,000 (Myers et al. 2003). Currently, significant natural production occurs in only the Clackamas and McKenzie populations (McElhany et al. 2007a).

Table 41. Upper Willamette River Chinook salmon independent populations core (C) and genetic legacy (G) populations and hatchery contributions (Good et al. 2005).

Functionally Independent Populations	Historical Abundance	Most Recent Spawner Abundance	Hatchery Abundance Contributions
Clackamas River (C)	Unknown	2,910	64%
Molalla River	Unknown	52 redds	>93%
North Santiam River (C)	Unknown	~ 7.1 rpm	>95%
South Santiam River	Unknown	982 redds	>84%
Calapooia River	Unknown	16 redds	100%
McKenzie River (C,G)	Unknown	~2,470	26%
Middle Fork Willamette River (C)	Unknown	235 redds	>39%
Total	>70,000	~9,700	Mostly hatchery

Productivity / Population Growth Rate The spring Chinook salmon in the McKenzie River is the only remaining self-sustaining naturally reproducing independent population. The other natural-origin populations in this ESU have very low current abundances, and long- and short-term population trends are negative.

Genetic Diversity Access of fall-run Chinook salmon to the upper Willamette River and the mixing of hatchery stocks within the ESU have threatened the genetic integrity and diversity of the species. Much of the genetic diversity that existed between populations has been homogenized (Myers et al. 2006).

Distribution 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). 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. 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 Demographically Independent Populations (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 prespawning mortality rates (NWFSC 2015).

Designated Critical Habitat NMFS designated critical habitat for this species on September 2, 2005 (70 FR 52630). Designated critical habitat includes all Columbia River estuarine areas and river reaches proceeding upstream to the confluence with the Willamette River as well as specific stream reaches in a number of subbasins. PBFs considered essential for the conservation of Chinook salmon, Upper Willamette River ESU are shown in Table 6.

The current condition of PBFs of the UWR Chinook salmon critical habitat indicates that migration and rearing PBFs are not currently functioning or are degraded. These conditions impact their ability to serve their intended role for species conservation. The migration PBF is degraded by dams altering migration timing and water management altering the water quantity necessary for mobility and survival. Migration, rearing, and estuary PBFs are also degraded by loss of riparian vegetation and instream cover. Pollutants such as petroleum products, fertilizers, pesticides, and fine sediment enter the stream through runoff, point source discharge, drift during application, and non-point discharge where agricultural and urban development occurs. Degraded water quality in the lower Willamette River where important floodplain rearing habitat is present affects the ability of this habitat to sustain its role to conserve the species.

Recovery Goals. Recovery goals, objectives and detailed criteria for the Upper Willamette River Chinook are fully outlined in the 2011 Recovery Plan. The 2011 recovery plan outlines five potential scenario options for meeting the viability criteria for recovery. Of the five scenarios, scenario 1 reportedly represented the most balanced approach given limitations in some populations. The approach in this Plan to achieve ESU delisting of UWR Chinook salmon is to recover the McKenzie (core and genetic legacy population) and the Clackamas populations to an extinction risk status of very low risk (beyond minimal viability thresholds), to recover the North

Santiam and Middle Fork Willamette populations (core populations) to an extinction risk status of low risk, to recover the South Santiam population to moderate risk, and improve the status of the remaining populations from very high risk to high risk.

Table 42. Summary of status; Chinook salmon, Upper Willamette River ESU

Criteria	Description
Abundance / productivity trends	Only one of seven remaining naturally reproducing independent populations. Unknown historical abundance. Declining trends with a high hatchery-produced fraction.
Listing status	Threatened
Attainment of recovery goals	Criteria not yet met
Condition of PBFs	Migration, rearing, and estuary PBFs are degraded by dams, water management, loss of riparian vegetation, and quality of floodplain habitat; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; Of 59 assessed watersheds, 22 are of high and 18 are of medium conservation value

8.13 Coho salmon, Central California Coast ESU

Table 43. Coho salmon, central California coast ESU; overview table

Species	Common Name	ESU	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus kisutch	**Coho salmon**	**Central California Coast**	**Endangered**	2016	70 FR 37160	2012	64 FR 24049

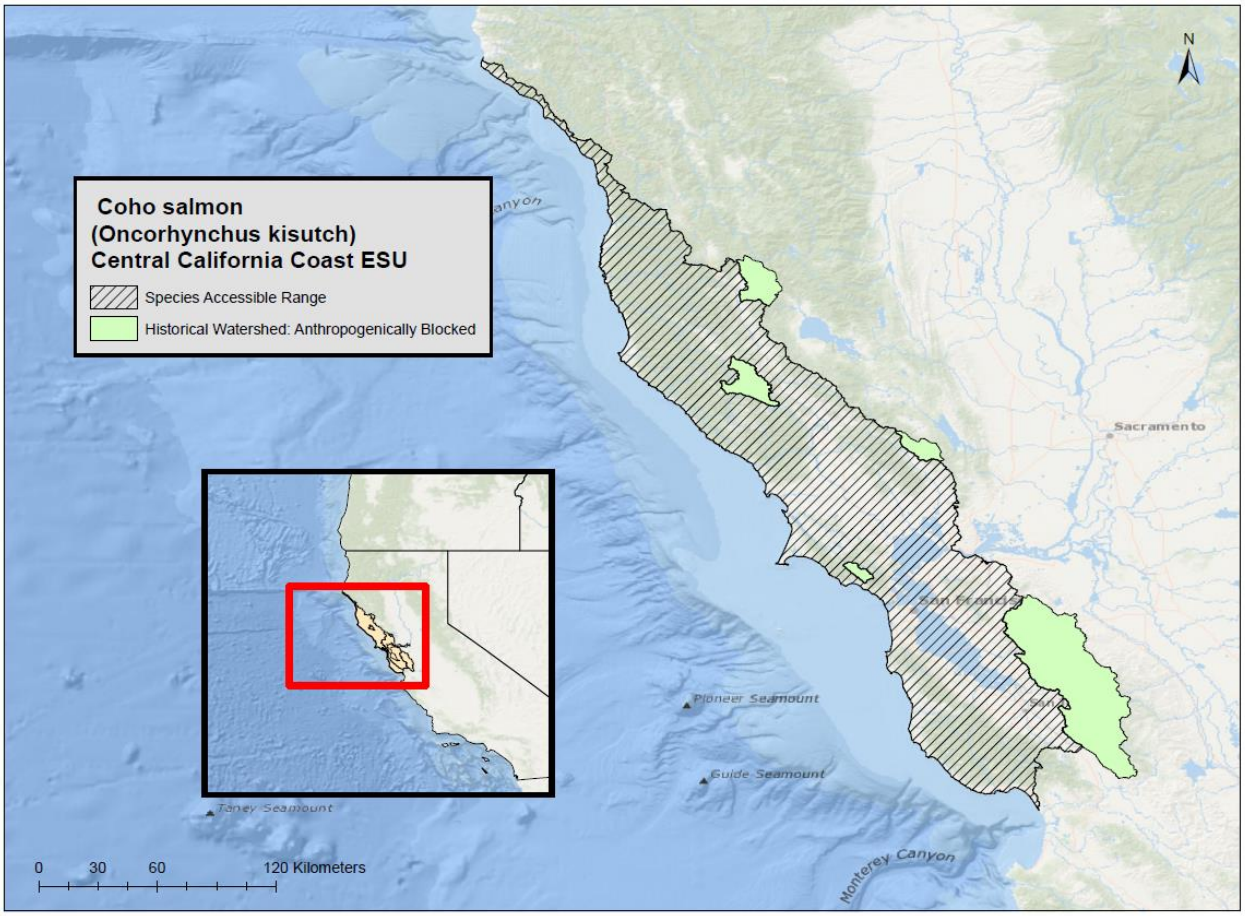

Figure 14. Coho salmon, central California coast ESU range

Species Description Coho salmon are an anadromous species (i.e., adults migrate from marine to freshwater streams and rivers to spawn). Adult coho salmon are typically about two feet long and eight pounds. Coho have backs that are metallic blue or green, silver sides, and light bellies; spawners are dark with reddish sides; and when coho salmon are in the ocean, they have small black spots on the back and upper portion of the tail. Central California coast coho salmon, an ESU was listed as threatened under the ESA on October 31, 1996 (64 FR 56138). NMFS re-classified the ESU as endangered on June 28, 2005 (70 FR 37160). This ESU includes naturally spawned coho salmon originating from rivers south of Punta Gorda, California to and including

Aptos Creek, as well as such coho salmon originating from tributaries to San Francisco Bay. Also, coho salmon from three artificial propagation programs.

Status The low survival of juveniles in freshwater, in combination with poor ocean conditions, has led to the precipitous declines of Central California Coast (CCC) coho salmon populations. Most independent CCC coho salmon populations remain at critically low levels, with those in the southern Santa Cruz Mountains strata likely extirpated. Data suggests some populations show a slight positive trend in annual escapement, but the improvement is not statistically significant. Overall, all CCC coho salmon populations remain, at best, a slight fraction of their recovery target levels, and, aside from the Santa Cruz Mountains strata, the continued extirpation of dependent populations continues to threaten the ESU's future survival and recovery. The evaluation of current habitat conditions and ongoing and future threats led to the conclusion that summer and winter rearing survival are very low due to impaired instream habitats. These impairments were due to a lack of complexity formed by instream wood, high sediment loads, lack of refugia habitats during winter, low summer flows and high instream temperatures. Additionally, populations throughout the ESU, but particularly at the southern end of the range, are likely to be significantly impacted by climate change in the future (NMFS 2012).

Life history Central California Coast coho salmon typically enter freshwater from November through January, and spawn into February or early March (Moyle 2002a). The upstream migration towards spawning areas coincides with large increases in stream flow (Hassler 1987). Coho salmon often are not able to enter freshwater until heavy rains have caused breaching of sand bars that form at the mouths of many coastal California streams. Spawning occurs in streams with direct flow to the ocean, or in large river tributaries (Moyle 2002b). Female coho salmon choose a site to spawn at the head of a riffle, just downstream of a pool where water flow changes from slow to turbulent, and where medium to small size gravel is abundant (Moyle 2002b).

Eggs incubate in redds from November through April, and hatch into "alevins" after a period of 35-50 days (Shapovalov and Taft 1954b). The period of incubation is inversely related to water temperature. Alevins remain in the gravel for two to ten weeks then emerge into the water column as young juveniles, known as "fry". Juveniles, or fry, form schools in shallow water along the undercut banks of the stream to avoid predation. The juveniles feed heavily during this time, and as they grow they set up individual territories. Juveniles are voracious feeders, ingesting any organism that moves or drifts over their holding area. The juvenile's diet is mainly aquatic insect larvae and terrestrial insects, but small fish are taken when available (Moyle 2002a).

After one year in freshwater juvenile coho salmon undergo physiological transformation into "smolts" for outmigration to the ocean. Smolts may spend time residing in the estuarine habitat prior to ocean entry, to allow for the transition to the saline environment. After entering the ocean, the immature salmon initially remain in the nearshore waters close to their natal stream. They gradually move northward, generally staying over the continental shelf (Brown et al. 1994). After approximately two years at sea, adult coho salmon move slowly homeward. Adults begin their freshwater migration upstream after heavy fall or winter rains breach the sandbars at the mouths of coastal streams (Sandercock 1991) and/or flows are sufficient to reach upstream spawning areas.

Table 44. Temporal distribution of Coho salmon, central California coast ESU

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
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<tr><td>Incubation (eggs)</td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Present</td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td></td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Present</td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Population Dynamics

Abundance. Limited information exists on abundance of coho salmon within the CCC coho salmon ESU. About 200,000 to 500,000 coho salmon were produced statewide in the 1940s (Good et al. 2005b). This escapement declined to about 99,000 by the 1960s with approximately 56,000 (56 percent) originating from streams within the CCC coho salmon ESU. The estimated number of coho salmon produced within the ESU in 2011 was between 2,000 and 3,000 wild adults (Gallagher et al. 2010).

Productivity / Population Growth Rate. Within the Lost Coast – Navarro Point stratum, current population sizes range from 4 percent to 12 percent of proposed recovery targets, with two populations (Albion River and Big River, respectively) at or below their high-risk depensation thresholds. Most independent populations show positive but non-significant population trends. Dependent populations within the stratum have declined significantly since 2011. Similar results were obtained immediately south within the Navarro Point – Gualala Point stratum, where two of the three largest independent populations, the Navarro and Garcia rivers, have averaged 257 and 46 adult returns, respectively, during the past six years (both populations are at or below their high-risk depensation threshold). Data from the three dependent populations within the stratum (Brush, Greenwood and Elk creeks) suggest little to no adult coho salmon escapement since 2011. In the Russian River and Lagunitas Creek watersheds, which are the two largest within the Central Coast strata, recent coho salmon population trends suggest limited improvement, although both populations remain well below recovery targets. Likewise, most dependent populations within the strata remain at very low levels, although excess broodstock adults from the Russian River and Olema Creek were recently stocked into Salmon Creek and the subsequent capture of juvenile fish indicates successful reproduction occurred. Finally, recent sampling within Pescadero Creek and San Lorenzo River, the only two independent populations within the Santa Cruz Mountains strata, suggest coho salmon have likely been extirpated within both basins. A bright spot appears to be the recent improvement in abundance and spatial distribution noted within the strata's dependent populations; Scott Creek experienced the largest coho salmon run in a decade during 2014/15, and researchers recently detected juvenile coho salmon within four dependent watersheds where they were previously thought to be extirpated (San Vincente, Waddell, Soquel and Laguna creeks

Genetic Diversity. Hatchery raised smolt have been released infrequently but occasionally in large numbers in rivers throughout the ESU (Bjorkstedt et al. 2005). Releases have included transfer of stocks within California and between California and other Pacific states as well as smolt raised from eggs collected from native stocks. However, genetic studies show little homogenization of populations, *i.e.*, transfer of stocks between basins have had little effect on the geographic genetic structure of CCC coho salmon (Sonoma County Water Agency (SCWA) 2002). The CCC coho salmon likely has considerable diversity in local adaptations given that the ESU spans a large latitudinal diversity in geology and ecoregions, and include both coastal and inland river basins.

Distribution. The TRT identified 11 "functionally independent", one "potentially independent" and 64 "dependent" populations in the CCC coho salmon ESU (Bjorkstedt *et al.*, 2005 with modifications described in Spence *et al.* 2008). The 75 populations were grouped into five Diversity Strata. ESU spatial structure has been substantially modified due to lack of viable source populations and loss of dependent populations. One of the two historically independent populations in the Santa Cruz mountains (*i.e.*, South of the Golden Gate Bridge) is extirpated (Good et al. 2005b; Spence et al. 2008a). Coho salmon are considered effectively extirpated from the San Francisco Bay (NMFS 2001; Spence et al. 2008a). The Russian River is of particular importance for preventing the extinction and contributing to the recovery of CCC coho salmon (NOAA 2013). The Russian River population, once the largest and most dominant source population in the ESU, is now at high risk of extinction because of low abundance and failed productivity (Spence et al. 2008a). The Lost Coast to Navarro Point to the north contains the majority of coho salmon remaining in the ESU.

Designated Critical Habitat. Critical habitat for the CCC coho salmon ESU was designated on May 5, 1999 (64 FR 24049). It encompasses accessible reaches of all rivers (including estuarine areas and tributaries) between Punta Gorda and the San Lorenzo River (inclusive) in California. Critical habitat for this species also includes two streams entering San Francisco Bay: Arroyo Corte Madera Del Presidio and Corte Madera Creek. PBFs considered essential for the conservation of Coho salmon, central California coast ESU are:

- Within the range of both ESUs, the species' life cycle can be separated into 5 essential habitat types:
    1. Juvenile summer and winter rearing areas;
    2. juvenile migration corridors;
    3. areas for growth and development to adulthood;

4. adult migration corridors; and
5. spawning areas.

- Essential features of coho critical habitat include adequate
  1. substrate,
  2. water quality,
  3. water quantity,
  4. water temperature,
  5. water velocity,
  6. cover/shelter,
  7. food,
  8. riparian vegetation,
  9. space, and
  10. safe passage conditions.

NMFS (2008) evaluated the condition of each habitat attribute in terms of its current condition relative to its role and function in the conservation of the species. The assessment of habitat for this species showed a distinct trend of increasing degradation in quality and quantity of all PBFs as the habitat progresses south through the species range, with the area from the Lost Coast to the Navarro Point supporting most of the more favorable habitats and the Santa Cruz Mountains supporting the least. However, all populations are generally degraded regarding spawning and incubation substrate, and juvenile rearing habitat. Elevated water temperatures occur in many streams across the entire ESU.

Recovery Goals See the 2012 Recovery Plan for complete down listing/delisting criteria for each of the following recovery goals (NMFS 2012):

1. Prevent extinction by protecting existing populations and their habitats;

2. Maintain current distribution of coho salmon and restore their distribution to previously occupied areas essential to their recovery;

3. Increase abundance of coho salmon to viable population levels, including the expression of all life history forms and strategies;

4. Conserve existing genetic diversity and provide opportunities for interchange of genetic material between and within meta populations;

5. Maintain and restore suitable freshwater and estuarine habitat conditions and characteristics for all life history stages so viable populations can be sustained naturally;

6. Ensure all factors that led to the listing of the species have been ameliorated; and

7. Develop and maintain a program of monitoring, research, and evaluation that advances understanding of the complex array of factors associated with coho salmon survival and recovery and which allows for adaptively managing our approach to recovery over time.

Table 45. Summary of status; Coho salmon, central California coast ESU

Criteria	Description
Abundance / productivity trends	Stable population trend, low abundances, fragmented populations, supported by hatchery propagation.
Listing status	Endangered
Attainment of recovery goals	Criteria not yet met
Condition of PBFs	Degradation in quality and quantity of PBFs, especially in southern end of range; Rearing PBFs degraded by loss of suitable incubation substrate and loss of habitat; Elevated temperatures anticipated in freshwater habitats; Environmental mixtures anticipated in freshwater habitats may impact PBFs

8.14 Coho salmon, Lower Columbia River ESU

Table 46. Coho salmon, lower Columbia River ESU; overview table

Species	Common Name	ESU	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus kisutch	**Coho salmon**	**Lower Columbia River**	**Threatened**	2016	70 FR 37160	2013	81 FR 9251

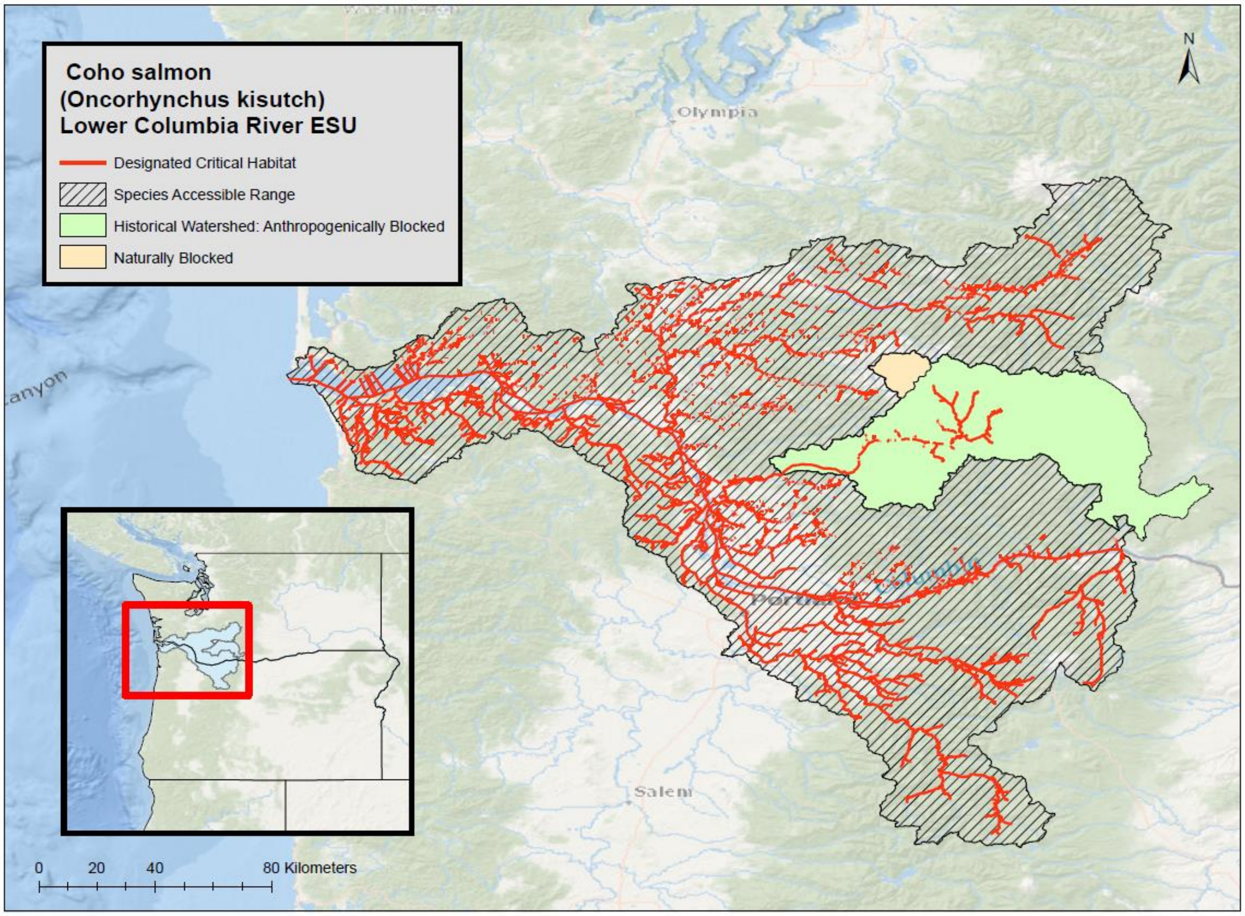

Figure 15. Coho salmon, lower Columbia River ESU range and designated critical habitat

Species Description Coho salmon are an anadromous species (i.e., adults migrate from marine to freshwater streams and rivers to spawn). Adult coho salmon are typically about two feet long and eight pounds. Coho have backs that are metallic blue or green, silver sides, and light bellies; spawners are dark with reddish sides; and when coho salmon are in the ocean, they have small black spots on the back and upper portion of the tail. Lower Columbia River coho salmon, an ESU was listed as threatened under the ESA on June 28, 2005 (70 FR 37160). This ESU includes naturally spawned coho salmon originating from the Columbia River and its tributaries downstream from the Big White Salmon and Hood Rivers (inclusive) and any such fish originating from the Willamette River and its tributaries below Willamette Falls. Also, coho salmon from 21 artificial propagation programs.

Status Recovery efforts have likely improved the status of a number of coho salmon demographically independent populations (DIPs), abundances are still at low levels and the majority of the DIPs remain at moderate or high risk. For the lower Columbia River region, land development and increasing human population pressures will likely continue to degrade habitat, especially in lowland areas. Although populations in this ESU have generally improved, especially in the 2013/14 and 2014/15 return years, recent poor ocean conditions suggest that population declines might occur in the upcoming return years. Regardless, this ESU is still considered to be at moderate risk (NWFSC 2015a).

Life history Lower Columbia River coho salmon are typically categorized into early- and late-returning stocks. Early-returning (Type S) adult coho salmon enter the Columbia River in mid-August and begin entering tributaries in early September, with peak spawning from mid-October to early November. Late-returning (Type N) coho salmon pass through the lower Columbia from late September through December and enter tributaries from October through January. Most spawning occurs from November to January, but some occurs as late as March (LCFRB 2010b).

Coho salmon typically spawn in small to medium, low- to-moderate elevation streams from valley bottoms to stream headwaters. Coho salmon construct redds in gravel and small cobble substrate in pool tailouts, riffles, and glides, with sufficient flow depth for spawning activity (NMFS 2013b). Eggs incubate over late fall and winter for about 45 to 140 days, depending on water temperature, with longer incubation in colder water. Fry may thus emerge from early spring to early summer (ODFW 2010). Juveniles typically rear in freshwater for more than a year. After emergence, coho salmon fry move to shallow, low-velocity rearing areas, primarily along the stream edges and inside channels. Juvenile coho salmon favor pool habitat and often congregate in quiet backwaters, side channels, and small creeks with riparian cover and woody debris. Side-channel rearing areas are particularly critical for overwinter survival, which is a key regulator of freshwater productivity (LCFRB 2010b).

Most juvenile coho salmon migrate seaward as smolts in April to June, typically during their second year. Salmon that have stream-type life histories, such as coho, typically do not linger for extended periods in the Columbia River estuary, but the estuary is a critical habitat used for feeding during the physiological adjustment to salt water. Juvenile coho salmon are present in the Columbia River estuary from March to August. Columbia River coho salmon typically range throughout the nearshore ocean over the continental shelf off of the Oregon and Washington coasts. Early-returning (Type S) coho salmon are typically found in ocean waters south of the Columbia River mouth. Late-returning (Type N) coho salmon are typically found in ocean waters north of the Columbia River mouth. Most coho salmon sexually mature at age three, except for a small percentage of males (called "jacks") who return to natal waters at age two, after only 5 to 7 months in the ocean (LCFRB 2010b).

Table 47. Temporal distribution of Coho salmon, lower Columbia River ESU

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="4">Present</td></tr>
<tr><td>Spawning</td><td colspan="4">Present</td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td></tr>
<tr><td>Incubation (eggs)</td><td colspan="4">Present</td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td></td><td></td><td colspan="5">Present</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Population Dynamics

Abundance. Although poor data quality prevents precise quantification, most populations are believed to have very low abundance of natural-origin spawners (50 fish or fewer, compared to historical abundances of thousands or tens of thousands).

Productivity / Population Growth Rate. Both the long- and short-term trend, and lambda for the natural origin (late-run) portion of the Clackamas River coho salmon are negative but with large confidence intervals (Good et al. 2005b). The short-term trend for the Sandy River population is close to 1, indicating a relatively stable population during the years 1990 to 2002 (Good et al. 2005b). The long-term trend (1977 to 2002) for this same population shows that the population has been decreasing (trend=0.54); there is a 43 percent probability that the median population growth rate (lambda) was less than one. More recent spawning surveys indicate short-term increases in natural production in the Clatskanie, Scappoose, and Mill/Abernathy/Germany populations (Ford 2011a; ODFW 2010).

Genetic Diversity. The spatial structure of some populations is constrained by migration barriers (such as tributary dams) and development in lowland areas. Low abundance, past stock transfers, other legacy hatchery effects, and ongoing hatchery straying may have reduced genetic diversity within and among coho salmon populations (LCFRB 2010a, ODFW 2010). It is likely that hatchery effects have also decreased population productivity.

Distribution. The Lower Columbia River coho salmon ESU historically consisted of a total of 24 independent populations (see Table 6-2). Because NMFS had not yet listed the ESU in 2003 when the WLC TRT designated core and genetic legacy populations for other ESUs, there are no such designations for Lower Columbia River coho salmon. However, the Clackamas and Sandy subbasins contain the only populations in the ESU that have clear records of continuous natural spawning (McElhany et al. 2007b).

Designated Critical Habitat. Critical habitat for the lower Columbia River coho salmon ESU was designated on February 24, 2016 (81 FR 9252). PBFs considered essential for the conservation of Coho salmon, lower Columbia River ESU are shown in Table 6.

•

Reduced complexity, connectivity, quantity, and quality of habitat used for spawning, rearing, foraging, and migrating continues to be a concern for all four lower Columbia River listed species. Loss of habitat from conversion to agricultural or urbanized uses continues to be a particular concern throughout the lower Columbia River region, especially the loss of habitat complexity in the lower tributary/mainstem Columbia River interface, and concomitant changes in water temperature (LCFRB 2010b; NMFS 2013b; ODFW 2010). 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 River in wastewater treatment plant effluent, stormwater runoff, and nonpoint source pollution is a growing concern (Morace 2012).

Recovery Goals NMFS has developed the following delisting criteria for the Lower Columbia River coho salmon ESU:

1. All strata that historically existed have a high probability of persistence or have a probability of persistence consistent with their historical condition. High probability of stratum persistence is defined as:
    a. At least two populations in the stratum have at least a 95 percent probability of persistence over a 100-year time frame (i.e., two populations with a score of 3.0 or higher based on the TRT’s scoring system).
    b. Other populations in the stratum have persistence probabilities consistent with a high probability of stratum persistence (i.e., the average of all stratum population scores is 2.25 or higher, based on the TRT’s scoring system). (See Section 2.6 for a brief discussion of the TRT’s scoring system.)
    c. Populations targeted for a high probability of persistence are distributed in a way that minimizes risk from catastrophic events, maintains migratory connections among populations, and protects within-stratum diversity.
    d. A probability of persistence consistent with historical condition refers to the concept that strata that historically were small or had complex population structures may not have met Criteria A through C, above, but could still be considered sufficiently viable if they provide a contribution to overall ESU viability similar to their historical contribution.
2. The threats criteria described in Section 3.2.2 of the 2013 recovery plan have been met.

Table 48. Summary of status; Coho salmon, lower Columbia River ESU

Criteria	Description
Abundance / productivity trends	90 percent reduction in abundance of all independent populations. Two of 25 populations have significant natural production. Long and short term lambda projections remain negative. Diversity of populations remain in the high risk category.

Listing status	Threatened
Attainment of recovery goals	Criteria not yet met
Condition of PBFs	Spawning and rearing PBFs are degraded by timber harvest, agriculture, urbanization, loss of floodplain habitat, and reduced natural cover; Migration PBFs impacted by dams; Elevated temperatures and environmental mixtures anticipated in freshwater habitats

8.15 Coho salmon, Oregon Coast ESU

Table 49. Coho salmon, Oregon coast ESU; overview table

Species	Common Name	ESU	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus kisutch	Coho salmon	Oregon Coast	Threatened	2016	76 FR 35755	2016	73 FR 7816

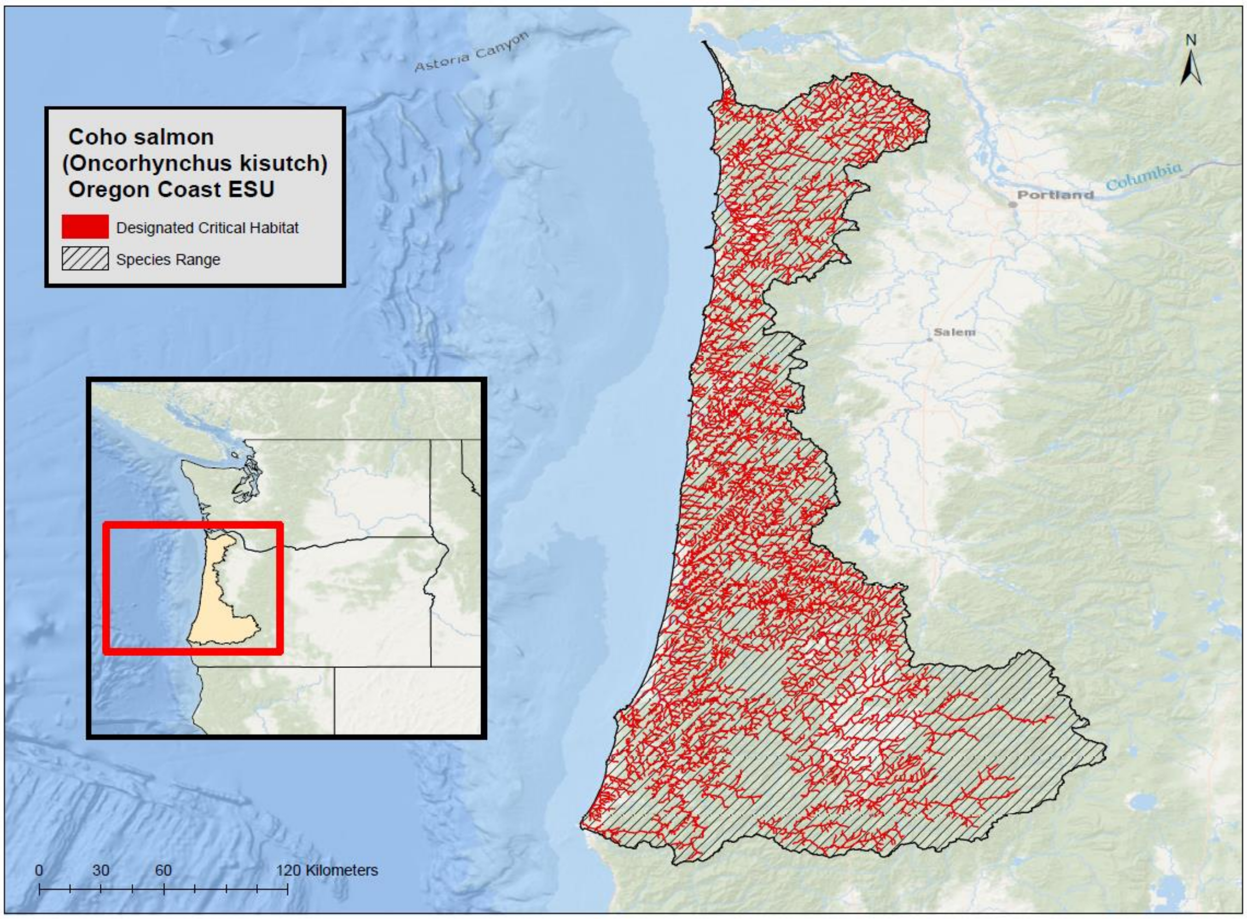

Figure 16. Coho salmon, Oregon coast ESU range and designated critical habitat

Species Description Coho salmon are an anadromous species (i.e., adults migrate from marine to freshwater streams and rivers to spawn). Adult coho salmon are typically about two feet long and eight pounds. Coho have backs that are metallic blue or green, silver sides, and light bellies; spawners are dark with reddish sides; and when coho salmon are in the ocean, they have small black spots on the back and upper portion of the tail. Oregon coast coho salmon, an ESU was listed as threatened under the ESA on August 10, 1998 (63 FR 42587). The listing was revisited and confirmed as threatened on June 20, 2011 (76 FR 35755). This ESU includes naturally spawned coho salmon originating from coastal rivers south of the Columbia River and north of

Cape Blanco, and also coho salmon from one artificial propagation program: Cow Creek Hatchery Program.

Status Findings by the NWFSC (2015a) and ODFW (2016) show many positive improvements to Oregon Coast coho salmon in recent years, including positive long-term abundance trends and escapement. Results from the NWFSC recent review show that while Oregon Coast coho salmon spawner abundance varies by time and population, the total abundance of spawners within the ESU has been generally increasing since 1999, with total abundance exceeding 280,000 spawners in three of the last five years. Overall, the NWFSC (2015a) found that increases in Oregon Coast coho salmon ESU scores for persistence and sustainability clearly indicate that the biological status of the ESU is improving, due in large part to management decisions (reduced harvest and hatchery releases). It determined, however, that Oregon Coast coho salmon abundance remains strongly correlated with marine survival rates.

Life history The anadromous life cycle of coho salmon begins in their home stream where they emerge from eggs as ‘alevins’ (a larval life stage dependent on food stored in a yolk sac). These very small fish require cool, slow moving freshwater streams with quiet areas such as backwater pools, beaver ponds, and side channels (Reeves et al. 1989) to survive and grow through summer and winter seasons. Current production of coho salmon smolts in the Oregon Coast coho salmon ESU is particularly limited by the availability of complex stream habitat that provides the shelter for overwintering juveniles during periods when flows are high, water temperatures are low, and food availability is limited (ODFW 2007).

The Oregon Coast coho salmon follow a yearling-type life history strategy, with most juvenile coho salmon migrating to the ocean as smolts in the spring, typically from as late as March into June . Coho salmon smolts outmigrating from freshwater reaches may feed and grow in lower mainstem and estuarine habitats for a period of days or weeks before entering the nearshore ocean environment. The areas can serve as acclimation areas, allowing coho salmon juveniles to adapt to saltwater. Research shows that substantial numbers of coho fry may also emigrate downstream from natal streams into tidally influenced lower river wetlands and estuarine habitat (Bass 2010; Chapman 1962; Koski 2009).

Oregon Coast coho salmon tend to make relatively short ocean migrations. Coho from this ESU are present in the ocean from northern California to southern British Columbia, and even fish from a given population can be widely dispersed in the coastal ocean, but the bulk of the ocean harvest of coho salmon from this ESU are found off the Oregon coast. The majority of coho salmon adults return to spawn as 3–year-old fish, having spent about 18 months in freshwater and 18 months in salt water (Sandercock 1991). The primary exceptions to this pattern are ‘‘jacks,’’ sexually mature males that return to freshwater to spawn after only 5 to 7 months in the ocean.

Table 50. Temporal distribution of Coho salmon, Oregon coast ESU

Life History phase	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Entering Fresh Water (adults/jacks)	Present									Present		
Spawning	Present									Present		
Incubation (eggs)	Present									Present		
Emergence (alevin to fry phases)	Present											Present
Rearing and migration (juveniles)	Present											

Population Dynamics

Abundance. Results from the NWFSC recent review show that while Oregon Coast (OC) coho salmon spawner abundance varies by time and population, the total abundance of spawners within the ESU has been generally increasing since 1999, with total abundance exceeding 280,000 spawners in three of the last five years (NWFSC 2015a).

Productivity / Population Growth Rate. Most independent populations in the ESU showed an overall increasing trend in abundance with synchronously high abundances in 2002-2003, 2009-2011, and 2014, and low abundances in 2007, 2009, and 2015. This synchrony suggests the overriding importance of marine survival to recruitment and escapement of Oregon Coast coho salmon (NWFSC 2015a).

Genetic Diversity. While the 2008 biological review team status review concluded that there was low certainty that ESU-level genetic diversity was sufficient for long-term sustainability in the ESU (Wainwright et al. 2008), the recent NWFSC review suggests this is an unlikely outcome. The observed upward trends in abundance and productivity and downward trends in hatchery influence make decreases in genetic or life history diversity or loss of dependent populations in recent years unlikely (NWFSC 2015a).

Distribution. The geographic setting for the Oregon Coast coho salmon ESU includes the Pacific Ocean and the freshwater habitat (rivers, streams, and lakes) along the Oregon Coast from the Necanicum River near Seaside on the north to the Sixes River near Port Orford on the south. The Oregon/Northern California Coasts Technical Recovery Team identified 56 historical populations that function collectively to form the Oregon Coast coho salmon ESU. The team classified 21 of the populations as independent because they occur in basins with sufficient historical habitat to have persisted through several hundred years of normal variations in marine and freshwater conditions (NMFS 2016d).

Designated Critical Habitat. NMFS designated critical habitat for Oregon Coast coho salmon on February 11, 2008 (73 FR 7816). PBFs considered essential for the conservation of Coho salmon, Oregon coast ESU are shown in Table 6.

- Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development.

The spawning PBF has been impacted in many watersheds from the inclusion of fine sediment into spawning gravel from timber harvest and forestry related activities, agriculture, and grazing. These activities have also diminished the channels' rearing and overwintering capacity by reducing the amount of large woody debris in stream channels, removing riparian vegetation, disconnecting floodplains from stream channels, and changing the quantity and dynamics of stream flows. The rearing PBF has been degraded by elevated water temperatures in 29 of the 80 HUC 5 watersheds; rearing PBF within the Nehalem, North Umpqua, and the inland watersheds of the Umpqua subbasins have elevated stream temperatures. Water quality is impacted by contaminants from agriculture and urban areas in low lying areas in the Umpqua subbasins, and in coastal watersheds within the Siletz/Yaquina, Siltcoos, and Coos subbasins. Reductions in water quality have been observed in 12 watersheds due to contaminants and excessive nutrition. The migration PBF has been impacted throughout the ESU by culverts and road crossings that restrict passage. As described above the PBFs vary widely throughout the critical habitat area designated for OC coho salmon, with many watersheds heavily impacted with low quality PBFs while habitat in other coho salmon bearing watersheds having sufficient quality for supporting the conservation purpose of designated critical habitat.

Recovery Goals. See the 2016 Recovery Plan for detailed descriptions of the recovery goals and delisting criteria (NMFS 2016d). In the simplest terms, NMFS will remove the Oregon Coast coho salmon from federal protection under the ESA when we determine that:

- The species has achieved a biological status consistent with recovery—the best available information indicates it has sufficient abundance, population growth rate, population spatial structure, and diversity to indicate it has met the biological recovery goals.
- Factors that led to ESA listing have been reduced or eliminated to the point where federal protection under the ESA is no longer needed, and there is reasonable certainty that the relevant regulatory mechanisms are adequate to protect Oregon Coast coho salmon sustainability.

Table 51. Summary of status; Coho salmon, Oregon coast ESU

Criteria	**Description**
Abundance / productivity trends	Drastic reductions in ESU abundance compared to historical estimates. Highly variable abundances with periods of severe declines followed by a year of increases. Long term trends remain negative due to low abundances in the 1990s.
Listing status	Threatened
Attainment of recovery goals	Criteria not yet met
Condition of PBFs	Rearing PBFs are degraded by elevated water temperature; All PBFs degraded by reduced water quality from contaminants and excess nutrients; Elevated temperatures and

	environmental mixtures anticipated in freshwater habitats; Of 80 assessed watersheds, 45 are of high and 27 are of medium conservation value

8.16 Coho salmon, Southern Oregon/Northern California Coast ESU

Table 52. Coho salmon, Southern Oregon/Northern California ESU ; overview table

Species	Common Name	ESU	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus kisutch	Coho salmon	Southern Oregon / Northern California	Threatened	2016	70 FR 37160	2014	64 FR 24049

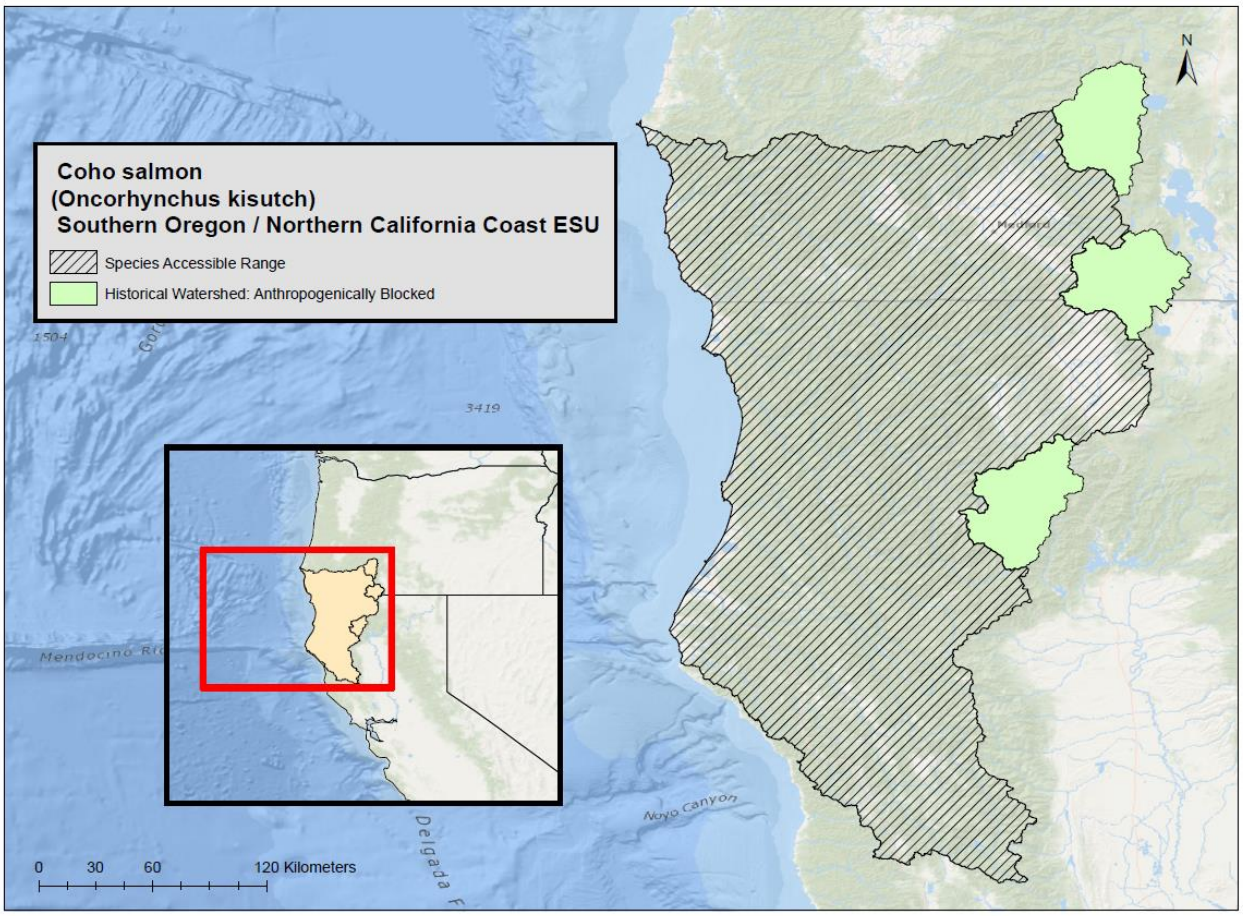

Figure 17. Coho salmon, Southern Oregon/Northern California ESU range and designated critical habitat

Species Description Coho salmon are an anadromous species (i.e., adults migrate from marine to freshwater streams and rivers to spawn). Adult coho salmon are typically about two feet long and eight pounds. Coho have backs that are metallic blue or green, silver sides, and light bellies; spawners are dark with reddish sides; and when coho salmon are in the ocean, they have small black spots on the back and upper portion of the tail. Southern Oregon / Northern California Coast (SONCC) coho salmon, an ESU was listed as threatened under the ESA on May 6, 1997 (62 FR 24588). The listing was revisited and confirmed as threatened on June 28, 2005 (70 FR

37160). This ESU includes naturally spawned coho salmon originating from coastal streams and rivers between Cape Blanco, Oregon, and Punta Gorda, California. Also, coho salmon from three artificial propagation programs.

Status Though population-level estimates of abundance for most independent populations are lacking, the best available data indicate that none of the seven diversity strata appears to support a single viable population as defined by the SONCC coho salmon technical recovery team's viability criteria (low extinction risk; Williams et al. (2008)). Further, 24 out of 31 independent populations are at high risk of extinction and 6 are at moderate risk of extinction. Based on the above discussion of the population viability parameters, and qualitative viability criteria presented in Williams et al. (2008), NMFS concludes that the SONCC coho salmon ESU is currently not viable and is at high risk of extinction. The primary causes of the decline are likely long-standing human-caused conditions (e.g., harvest and habitat degradation), which exacerbated the impacts of adverse environmental conditions (e.g., drought and poor ocean conditions) (60 FR 38011; July 25, 1995).

Life history Coho salmon is an anadromous fish species that generally exhibits a relatively simple 3-year life cycle. Adults typically begin their freshwater spawning migration in the late summer and fall, spawn by mid-winter, and then die. The run and spawning times vary between and within populations. Depending on river temperatures, eggs incubate in ''redds'' (gravel nests excavated by spawning females) for 1.5 to 4 months before hatching as ''alevins'' (a larval life stage dependent on food stored in a yolk sac). Once most of the yolk sac is absorbed, the 30 to 35 millimeter fish (then termed "fry") begin emerging from the gravel in search of shallow stream margins for foraging and safety (Council 2004). Coho salmon fry typically transition to the juvenile stage by about mid-June when they are about 50 to 60 mm, and both stages are collectively referred to as "young of the year." Juveniles develop vertical dark bands or "parr marks", and begin partitioning available instream habitat through aggressive agonistic interactions with other juvenile fish (Quinn 2005). Juveniles rear in fresh water for up to 15 months, then migrate to the ocean as ''smolts'' in the spring. Coho salmon typically spend 2 growing seasons in the ocean before returning to their natal stream to spawn as 3 year-olds. Some precocious males, called ''jacks,'' return to spawn after only 6 months at sea (NMFS 2014a).

Table 53. Temporal distribution of Coho salmon, Southern Oregon/Northern California ESU

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="4">Present</td></tr>
<tr><td>Spawning</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td></tr>
<tr><td>Incubation (eggs)</td><td>Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Present</td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Population Dynamics

Abundance. Population-level estimates of abundance for most independent populations are lacking. The best available data indicate that none of the seven diversity strata appears to support a single viable population (one at low risk of extinction) as defined by in the viability criteria. In fact, most of the 30 independent populations in the ESU are at high risk of extinction for abundance because they are below or likely below their depensation threshold (NMFS 2014a).

Productivity / Population Growth Rate. Available data show that the 95 percent confidence intervals for the slope of the regression line include zero for many populations, indicating that whether the slope is negative or positive cannot be determined. However, there is 95 percent confidence that the slope of the regression line is negative, indicating a decreasing trend, for Mill Creek in the Smith River and Freshwater Creek in Humboldt Bay Tributaries. In contrast, there is 95 percent confidence that the slope of the regression line is positive, indicating an increasing trend, at Gold Ray Dam in the Upper Rogue River(NMFS 2014a).

Genetic Diversity. The primary factors affecting the genetic and life-history diversity of SONCC coho salmon appear to be low population abundance and the influence of hatcheries and out-of-basin introductions. The ESU's current genetic variability and variation in life-history likely contribute significantly to long-term risk of extinction. Given the recent trends in abundance across the ESU, the genetic and life-history diversity of populations is likely very low and is inadequate to contribute to a viable ESU (NMFS 2014a).

Distribution. The SONCC Coho Salmon ESU includes all naturally spawned populations of coho salmon in coastal streams between Cape Blanco, Oregon and Punta Gorda, California, as well as coho salmon produced by three artificial propagation programs: Cole Rivers Hatchery, Trinity River Hatchery, and Iron Gate Hatchery. The ESU if comprised of 40 populations within seven diversity strata. Recent information for SONCC coho salmon indicates that their distribution within the ESU has been reduced and fragmented, as evidenced by an increasing number of previously occupied streams from which they are now absent. However, extant populations can still be found in all major river basins within the ESU (70 FR 37160; June 28, 2005).

Designated Critical Habitat NMFS designated critical habitat for the SONCC coho salmon on May 5, 1999 (64 FR 24049). PBFs considered essential for the conservation of Coho salmon, Southern Oregon/Northern California ESU are shown in Table 31.

Critical habitat designated for the SONCC coho salmon is generally of good quality in northern coastal streams. Spawning PBF has been degraded throughout the ESU by logging activities that has increased fines in spawning gravel. Rearing PBF has been considerably degraded in many inland watersheds from the loss of riparian vegetation resulting in unsuitably high water temperatures. Rearing and juvenile migration PBFs have been reduced from the disconnection of floodplains and off-channel habitat in low gradient reaches of streams, consequently reducing winter rearing capacity.

Recovery Goals See the 2014 recovery plan for complete down listing/delisting criteria for this ESU (NMFS 2014a).

Table 54. Biological recovery objectives and criteria for SONCC coho salmon. All Biological criteria must be met in a recovered ESU. Taken from (NMFS 2014a).

VSP Parameter	Population Role	Biological Recovery Objective	Biological Recovery Criteria[1]
Abundance	Core	Achieve a low risk of extinction[2]	The geometric mean of wild adults over 12 years meets or exceeds the "low risk threshold" of spawners for each core population[2,3,4]
	Non-Core 1	Achieve a moderate or low risk of extinction[2]	The annual number of wild adults is greater than or equal to four spawners per IP-km for each non-core population[2]
Productivity	Core and Non-Core 1	Population growth rate is not negative	Slope of regression of the geometric mean of wild adults over the time series ≥ zero[4]
Spatial Structure	Core and Non-Core 1	Ensure populations are widely distributed	Annual within-population juvenile distribution ≥ 80%[4] of habitat[5,6] (outside of a temperature mask[7])
	Non-Core 2 and Dependent	Achieve inter- and intra-stratum connectivity	≥ 80% of accessible habitat[4] is occupied in years[8] following spawning of cohorts that experienced high marine survival[9]
Diversity	Core and Non-Core 1	Achieve low or moderate hatchery impacts on wild fish	Proportion of hatchery-origin adults (pHOS) < 0.05
	Core and Non-Core 1	Achieve life-history diversity	Variation is present in migration timing, age structure, size and behavior. The variation in these parameters[10] is retained.

[1] All applicable criteria must be met for each population in order for the ESU to be viable.
[2] See Table 4-2 for specific spawner abundance requirements needed to meet this objective.
[3] In the Shasta River, Upper Trinity River, and Upper Rogue River populations, IP above some anthropogenic dams was excluded from the spawner target, so the low-risk threshold for these populations is based on the IP downstream of those dams.
[4] Assess for at least 12 years, striving for a coefficient of variation (CV) of 15% or less at the population level (Crawford and Rumsey 2011).
[5] Based on available rearing habitat within the watershed (Wainwright et al. 2008). For purposes of these biological recovery criteria, "available" means accessible. 80% of habitat occupied relates to a truth value of +1.0,(true: juveniles occupy a high proportion of the available rearing habitat within the watershed (p. 56, Wainwright et al. 2008).
[6] The average for each of the three year classes over the 12 year period used for delisting evaluation must each meet this criterion. Strive to detect a 15% change in distribution with 80% certainty (Crawford and Rumsey 2011).
[7] Williams et al. (2008) identified a threshold air temperature, above which juvenile coho salmon generally do not occur, and identified areas with air temperatures over this threshold. These areas are considered to be within the temperature mask.
[8] If young-of-year are sampled, sampling would occur the spring following spawning of the cohorts experiencing high marine survival. If 1+ juveniles are sampled, sampling would occur approximately 1.5 years after spawning of the cohorts experiencing high marine survival, but before outmigration to the estuary and ocean.
[9] High marine survival is defined as 10.2% for wild fish and 8% for hatchery fish; Sharr et al. 2000. If marine survival is not high, then this criterion does not apply.
[10] This variation is documented in the population profiles in Chapters 7 to 46 of this plan.

Table 55. Summary of status; Coho salmon, Southern Oregon/Northern California ESU

Criteria	**Description**
Abundance / productivity trends	Data on population abundance and trends are limited for this ESU. Trend data are variable throughout the ESU.

Listing status	Threatened
Attainment of recovery goals	Criteria not yet met
Condition of PBFs	Spawning PBFs are degraded by logging; Rearing and migration PBFs degraded by loss of riparian vegetation and loss of floodplain habitat; Elevated temperatures and environmental mixtures anticipated in freshwater habitats

8.17 Sockeye salmon, Ozette Lake ESU

Table 56. Sockeye salmon, Ozette Lake ESU; overview table

Species	Common Name	ESU	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus nerka	Sockeye salmon	Ozette Lake	Threatened	2016	70 FR 37160	2009	70 FR 52630

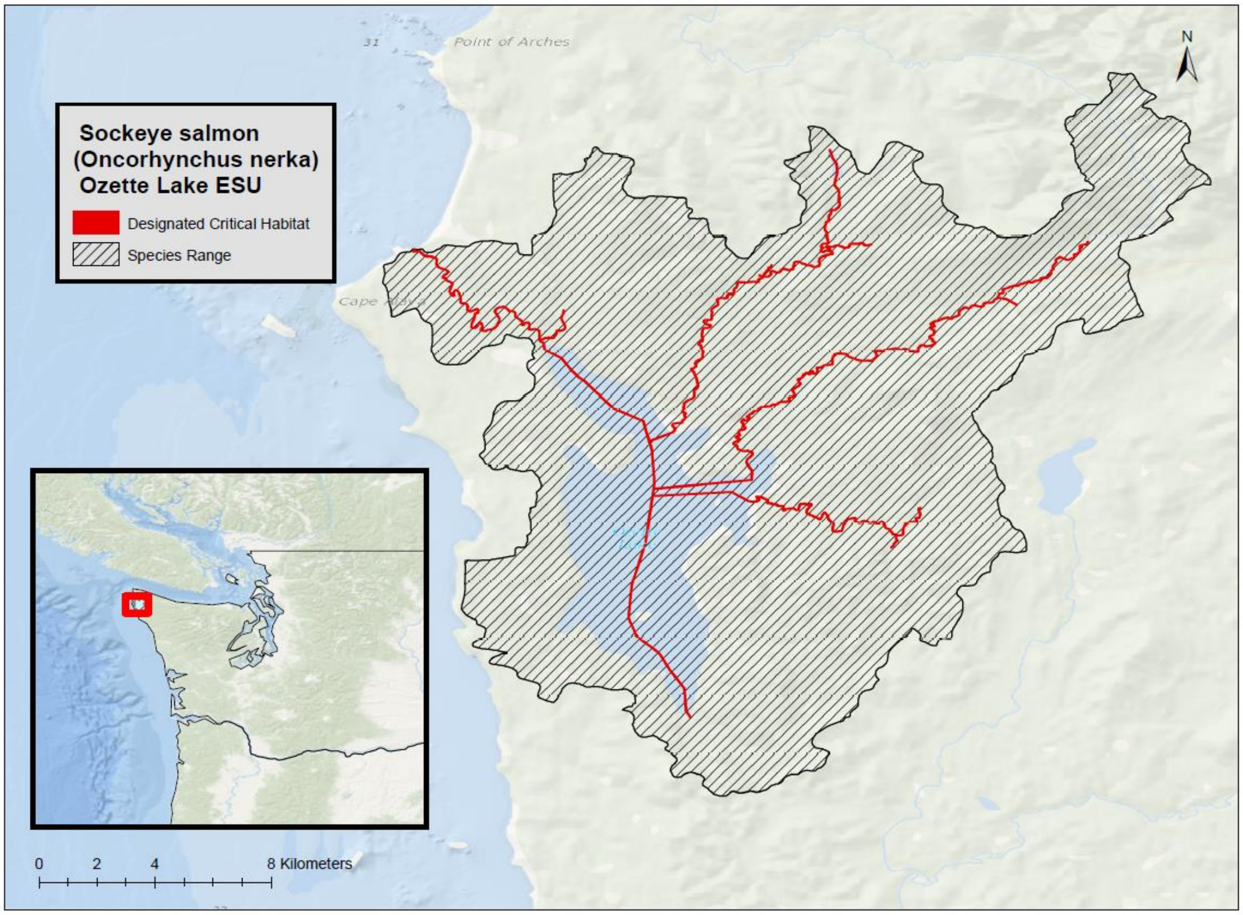

Figure 18. Sockeye salmon, Ozette Lake ESU range and designated critical habitat

Species Description The sockeye salmon is an anadromous species (i.e., adults migrate from marine to freshwater streams and rivers to spawn), although some sockeye spend their entire lives (about five years) in freshwater. Adult sockeye salmon are about three feet long and eight pounds. Sockeyes are bluish black with silver sides when they are in the ocean, and they turn bright red with a green head when they are spawning. On March 25, 1999, NMFS listed the Ozette Lake sockeye salmon ESU as threatened (64 FR 14528) and reaffirmed the ESU's status as threatened on June 28, 2005 (70 FR 37160). This 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.

Status NMFS listed the Ozette Lake sockeye salmon ESU because of habitat loss and degradation from the combined effects of logging, road building, predation, invasive plant species, and overharvest. Ozette Lake sockeye salmon have not been commercially harvested since 1982 and only minimally harvested by the Makah Tribe since 1982 (0 to 84 fish per year); there is no known marine fishing of this ESU. Overall abundance is substantially below historical levels, and whether the decrease in abundance is a result of fewer spawning aggregations, lower abundances in each aggregation, or a combination of both factors is unknown. Regardless, this ESU's viability has not improved, and the ESU would likely have a low resilience to additional perturbations. However, recovery potential for the Ozette Lake sockeye salmon ESU is good, particularly because of protections afforded it based on the lake's location within a national park (NMFS 2009d).

Life history Most sockeye salmon exhibit a lake-type life history (i.e., they spawn and rear in or near lakes), though some exhibit a river-type life history. Spawning generally occurs in late summer and fall, but timing can vary greatly among populations. In lakes, sockeye salmon commonly spawn along "beaches" where underground seepage provides fresh oxygenated water. Females spawn in three to five redds (nests) over a couple of days. Incubation period is a function of water temperature and generally lasts 100-200 days (Burgner 1991). Sockeye salmon spawn once, generally in late summer and fall, and then die (semelparity).

Sockeye salmon fry primarily rear in lakes; river-emerged and stream-emerged fry migrate into lakes to rear. In the early fry stage from spring to early summer, juveniles forage exclusively in the warmer littoral (i.e., shoreline) zone where they depend mostly on fly larvae and pupae, copepods, and water fleas. Sub-yearling sockeye salmon move from the littoral habitat to a pelagic (i.e., open water) existence where they feed on larger zooplankton; however, flies may still make up a substantial portion of their diet. From one to three years after emergence, juvenile sockeye salmon generally rear in lakes, though some river-spawned sockeye may migrate to sea in their first year. Juvenile sockeye salmon feeding behaviors change as they transition through life stages after emergence to the time of smoltification. Distribution in lakes and prey preference is a dynamic process that changes daily and yearly depending on many factors including water temperature, prey abundance, presence of predators and competitors, and size of the juvenile. Peak emigration to the ocean occurs in mid-April to early May in southern sockeye populations (lower than 52ºN latitude) and as late as early July in northern populations (62ºN latitude) (Burgner 1991). Adult sockeye salmon return to their natal lakes to spawn after spending one to four years at sea. The diet of adult salmon consists of amphipods, copepods, squid and other fish.

Table 57. Temporal distribution of Sockeye salmon, Ozette Lake ESU

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td>Present</td><td></td><td></td><td colspan="9">Present</td></tr>
<tr><td>Spawning</td><td>Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="4">Present</td></tr>
<tr><td>Incubation (eggs)</td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td></td><td></td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Population Dynamics

Abundance. The historical abundance of Ozette Lake sockeye salmon is poorly documented, but may have been as high as 50,000 individuals (Blum 1988). Kemmerich (Kemmerich 1945), reported a decline in the run size since the 1920s weir counts and Makah Fisheries Management (Makah Fisheries Management 2000) concluded a substantial decline in the Tribal catch of Ozette Lake sockeye salmon occurred at the beginning of the 1950s. Whether decrease in abundance compared to historic estimates is a result of fewer spawning aggregations, lower abundances at each aggregation, or both, is unknown (Good et al. 2005b).

The most recent (1996-2006) escapement estimates (run size minus broodstock take) range from a low of 1,404 in 1997 to a high of 6,461 in 2004, with a median of approximately 3,800 sockeye per year (geometric mean: 3,353) (Rawson et al. 2009). No statistical estimation of trends is reported. However, comparing four year averages (to include four brood years in the average since the species primarily spawn as four-year olds) shows an increase during the period 2000 to 2006: For return years 1996 to 1999 the run size averaged 2,460 sockeye salmon, for the years 2000 to 2003 the run size averaged just over 4,420 fish, and for the years 2004 to 2006, the three-year average abundance estimate was 4,167 sockeye (Data from appendix A in (Rawson et al. 2009)). It is estimated that between 35,500 and 121,000 spawners could be normally carried after full recovery (Hard et al. 1992).

Productivity / Population Growth Rate. The Ozette Lake sockeye salmon ESU is composed of one historical population (Currens et al. 2009) with multiple spawning aggregations and two populations from the Umbrella Creek and Big River sockeye hatchery programs. Historically, at least four lake beaches were used for spawning; today only two beach spawning locations, Allen’s and Olsen’s Beaches, are used. Additionally, spawning occurs in the two tributaries of the hatchery programs (NWFSC 2015b). The historical abundance of Ozette Lake sockeye salmon is poorly documented, but it may have been as high as 50,000 individuals (Blum 1988). Declines began to be reported in the 1920s. For the period from 1977 to 2011 the estimated annual number of natural spawners ranged from 699 to 5,313, well below the 31,250 – 121,000 viable population range proposed in the Lake Ozette sockeye recovery plan (Haggerty et al. 2009). The limited available data indicate that abundance of Lake Ozette sockeye did not change substantially from the 2011 status review (Ford 2011b) to the 2015 review (NWFSC 2015b). Productivity has fluctuated up and down over the last few decades, but overall appears to have remained stable (NWFSC 2015b). The proportion of beach spawners originating from the hatchery is unknown, but straying is likely low.

Genetic Diversity. For the Ozette Lake sockeye salmon ESU, the proportion of beach spawners is likely low; therefore, hatchery-originated fish are not likely to affect greatly the genetics of the naturally-spawned population. However, Ozette Lake sockeye have a relatively low genetic diversity compared to other sockeye salmon populations examined in Washington State (Crewson et al. 2001). Genetic differences do occur among age cohorts. However, because different age groups do not reproduce together, the population may be more vulnerable to significant reductions in population structure due to catastrophic events or unfavorable conditions affecting a single year class. Finally, actions identified in the Ozette Lake Sockeye Salmon Hatchery and Genetics Management Plan are being implemented, but the tributary hatchery reintroduction program will not reduce genetic diversity in the natural beach spawning aggregation because there is very little straying of hatchery-origin fish to beach spawning areas (NOAA 2016a).

Distribution. The Ozette Lake sockeye salmon ESU includes all naturally spawned aggregations of sockeye salmon in Lake Ozette and streams and tributaries flowing into Lake Ozette, Washington. The ESU also includes fish originating from two artificial propagation programs: the Umbrella Creek and Big River sockeye hatchery programs.

Designated Critical Habitat. NMFS designated critical habitat for Ozette Lake sockeye salmon on September 2, 2005 (70 FR 52630). It encompasses areas within the Hoh/Quillayute subbasin, Ozette Lake, and the Ozette Lake watershed. PBFs considered essential for the conservation of Sockeye salmon, Ozette Lake ESU are shown in Table 6.

Spawning habitat has been affected by loss of tributary spawning areas and exposure of much of the available beach spawning habitat due to low water levels in summer. Further, native and non-native vegetation as well as sediment have reduced the quantity and suitability of beaches for spawning. The rearing PBF is degraded by excessive predation and competition with introduced non-native species, and by loss of tributary rearing habitat. Migration habitat may be adversely affected by high water temperatures and low water flows in summer which causes a thermal block to migration (La Riviere 1991).

Recovery Goals Recovery goals, objectives and criteria for Ozette Lake sockeye salmon are fully outlined in the 2009 recovery plan (NMFS 2009c).

Table 58. Summary of proposed Lake Ozette sockeye viability criteria for naturally self-sustaining adults. Taken from (NMFS 2009c)

VSP Parameter	Proposed Criteria
Abundance Planning Range	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

Table 59. Summary of status; Sockeye salmon, Ozette Lake ESU

Criteria	Description
Abundance / productivity trends	Stable productivity rates, but abundance only 1 percent of historical levels. Low genetic diversity and low resilliance to future perturbations.
Listing status	threatened
Attainment of recovery goals	criteria not yet met
Condition of PBFs	Rearing PBFs are degraded by excessive predation, invasive species, and loss of habitat; Spawning and migration PBFs are degraded by low water levels, loss of suitable spawning habitat, and low summer water flows; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; The entire watershed is of high conservation value

8.18 Sockeye salmon, Snake River ESU

Table 60. Sockeye salmon, Snake River ESU; overview table

Species	Common Name	ESU	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus nerka	Sockeye salmon	Snake River	Endangered	2016	70 FR 37160	2015	58 FR 68543

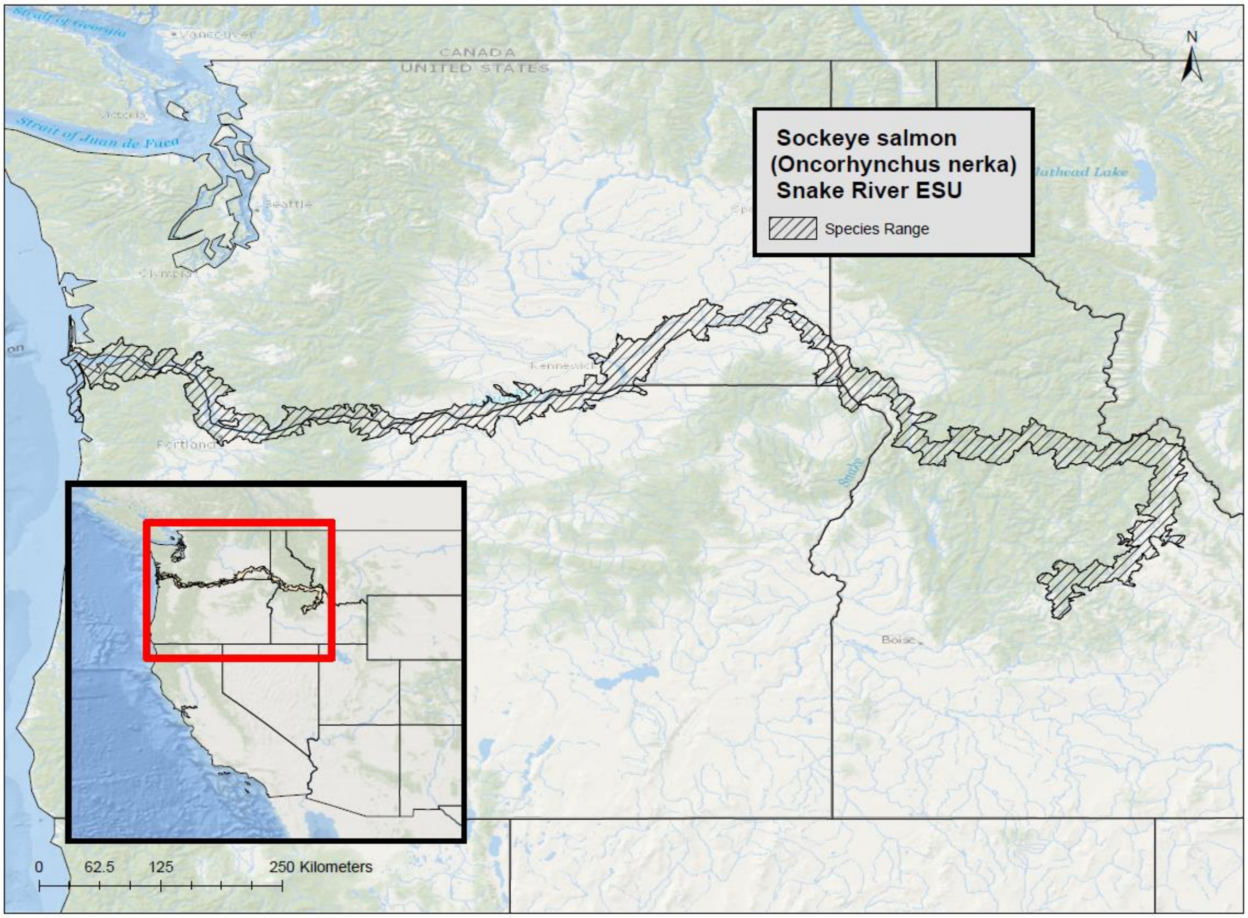

Figure 19. Sockeye salmon, Snake River ESU range and designated critical habitat

Species Description The sockeye salmon is an anadromous species (i.e., adults migrate from marine to freshwater streams and rivers to spawn), although some sockeye spend their entire lives (about five years) in freshwater. Adult sockeye salmon are about three feet long and eight pounds. Sockeyes are bluish black with silver sides when they are in the ocean, and they turn bright red with a green head when they are spawning. On November 20, 1991 NMFS listed the Ozette Lake sockeye salmon ESU as endangered (70 FR 37160) and reaffirmed the ESU's status as endangered on June 28, 2005 (70 FR 37160). This ESU includes naturally spawned anadromous and residual sockeye salmon originating from the Snake River basin, and also sockeye salmon from one artificial propagation program: Redfish Lake Captive Broodstock Program.

Status The Snake River sockeye salmon ESU includes only one population comprised of all anadromous and residual sockeye salmon from the Snake River Basin, Idaho, as well as artificially propagated sockeye salmon from the Redfish Lake captive propagation program. Historical evidence indicates that the Snake River sockeye once had a range of life history patterns, with spawning populations present in several of the small lakes in the Sawtooth Basin (NMFS 2011). NMFS listed the Snake River sockeye salmon ESU because of habitat loss and degradation from the combined effects of damming and hydropower development, overexploitation, fisheries management practices, and poor ocean conditions. Recent effects of climate change, such as reduced stream flows and increased water temperatures, are limiting Snake River ESU productivity (NMFS 2016j). Adults produced through the captive propagation program currently support the entire ESU. This ESU is still at extremely high risk across all four basic risk measures (abundance, productivity, spatial structure, and diversity) and would likely have a very low resilience to additional perturbations. Habitat improvement projects have slightly decreased the risk to the species, but habitat concerns and water temperature issues remain. Overall, although the status of the Snake River sockeye salmon ESU appears to be improving, there is no indication that the biological risk category has changed (NWFSC 2015b).

Life history Most sockeye salmon exhibit a lake-type life history (i.e., they spawn and rear in or near lakes), though some exhibit a river-type life history. Spawning generally occurs in late summer and fall, but timing can vary greatly among populations. In lakes, sockeye salmon commonly spawn along “beaches” where underground seepage provides fresh oxygenated water. Females spawn in three to five redds (nests) over a couple of days. Incubation period is a function of water temperature and generally lasts 100-200 days (Burgner 1991). Sockeye salmon spawn once, generally in late summer and fall, and then die (semelparity).

Sockeye salmon fry primarily rear in lakes; river-emerged and stream-emerged fry migrate into lakes to rear. In the early fry stage from spring to early summer, juveniles forage exclusively in the warmer littoral (i.e., shoreline) zone where they depend mostly on fly larvae and pupae, copepods, and water fleas. Sub-yearling sockeye salmon move from the littoral habitat to a pelagic (i.e., open water) existence where they feed on larger zooplankton; however, flies may still make up a substantial portion of their diet. From one to three years after emergence, juvenile sockeye salmon generally rear in lakes, though some river-spawned sockeye may migrate to sea in their first year. Juvenile sockeye salmon feeding behaviors change as they transition through life stages after emergence to the time of smoltification. Distribution in lakes and prey preference is a dynamic process that changes daily and yearly depending on many factors including water temperature, prey abundance, presence of predators and competitors, and size of the juvenile. Peak emigration to the ocean occurs in mid-April to early May in southern sockeye populations (lower than 52ºN latitude) and as late as early July in northern populations (62ºN latitude)

(Burgner 1991). Adult sockeye salmon return to their natal lakes to spawn after spending one to four years at sea. The diet of adult salmon consists of amphipods, copepods, squid and other fish.

Table 61. Temporal distribution of Sockeye salmon, Snake River ESU

Life History phase	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Entering Fresh Water (adults/jacks)	Present											
Spawning									Present			
Incubation (eggs)	Present								Present			
Emergence (alevin to fry phases	Present											Present
Rearing and migration (juveniles)	Present											

Population Dynamics

Abundance / Productivity. For the Snake River ESU, the only extant population at the time of listing occurred in Redfish Lake. Adult returns to Redfish Lake during the period 1954 through 1966 ranged from 11 to 4,361 fish (Bjornn et al. 1968). In 1985, 1986, and 1987, 11, 29, and 16 sockeye, respectively, were counted at the Redfish Lake weir. Since 1987, only 18 natural-origin sockeye salmon have returned to the Stanley Basin. The first adult returns from the captive brood stock program returned to the Stanley Basin in 1999. From 1999 through 2005, 345 captive brood adults that had migrated to the ocean returned to the Stanley Basin, and returns increased to over 600 in 2008 and more than 700 returning adults in 2009. Annual adult releases during 2011-2014 averaged over 1,200; almost double the average for the prior five-year period (NWFSC 2015b). The large increases in returning adults in recent years reflect improved downstream and ocean survival as well as increases in juvenile production since the early 1990s. The captive brood program has been successful in providing substantial numbers of hatchery-produced sockeye for use in supplementation efforts. While increased abundance of hatchery-reared Snake River sockeye salmon has reduced the risk of loss, levels of naturally-produced sockeye salmon returns have remained extremely low (Ford 2011b; NWFSC 2015b). Substantial increases in survival rates across life history stages must occur to re-establish sustainable natural production (Hebdon et al. 2004; Keefer et al. 2008).

Genetic Diversity. For the Snake River ESU, the Sawtooth Hatchery is focusing on genetic conservation (NMFS 2016b). An overrepresentation of genes from the anadromous population in Redfish Lake exists, but inbreeding is low, which is a sign of a successful captive broodstock program (Kalinowski et al. 2012).

Distribution. The Snake River sockeye salmon ESU includes only one population comprised of all anadromous and residual sockeye salmon from the Snake River Basin, Idaho, as well as artificially propagated sockeye salmon from the Redfish Lake captive propagation program.

Designated Critical Habitat. NMFS designated critical habitat for Snake River sockeye salmon on December 28, 1993 (58 FR 68543). The critical habitat encompasses the waters, waterway bottoms, and adjacent riparian zones of specified lakes and river reaches in the Columbia River that are or were accessible to salmon of this ESU (except reaches above impassable natural falls, and Dworshak and Hells Canyon Dams). Specific PBFs are shown in Table 31.

Recovery Goals. See the 2015 recovery plan for the Snake River sockeye salmon ESU for complete down-listing/delisting criteria for recovery goals for the species (NMFS 2011c). Broadly, recovery plan goals emphasize restoring historical lake populations and improving water quality and quantity in lakes and migration corridors.

Table 62. Summary of status; Sockeye salmon, Snake River ESU

Criteria	**Description**
Abundance / productivity trends	Only one population remaining in Redfish Lake and it is supported by hatchery propagation. Increasing abundance, but well below those needed for sustainable natural production. Low resilience to future perturbations.
Listing status	Endangered
Attainment of recovery goals	Criteria not yet met
Condition of PBFs	Rearing and migration PBFs are degraded by impaired water quality from adjacent land uses; Migration PBFs are degraded by multiple dams; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; All occupied and used areas of the watershed are of high conservation value

8.19 Steelhead, California Central Valley DPS

Table 63. Steelhead, California Central Valley DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus mykiss	**Steelhead Trout**	**California Central Valley**	**Threatened**	2016	71 FR 834	2014	70 FR 52488

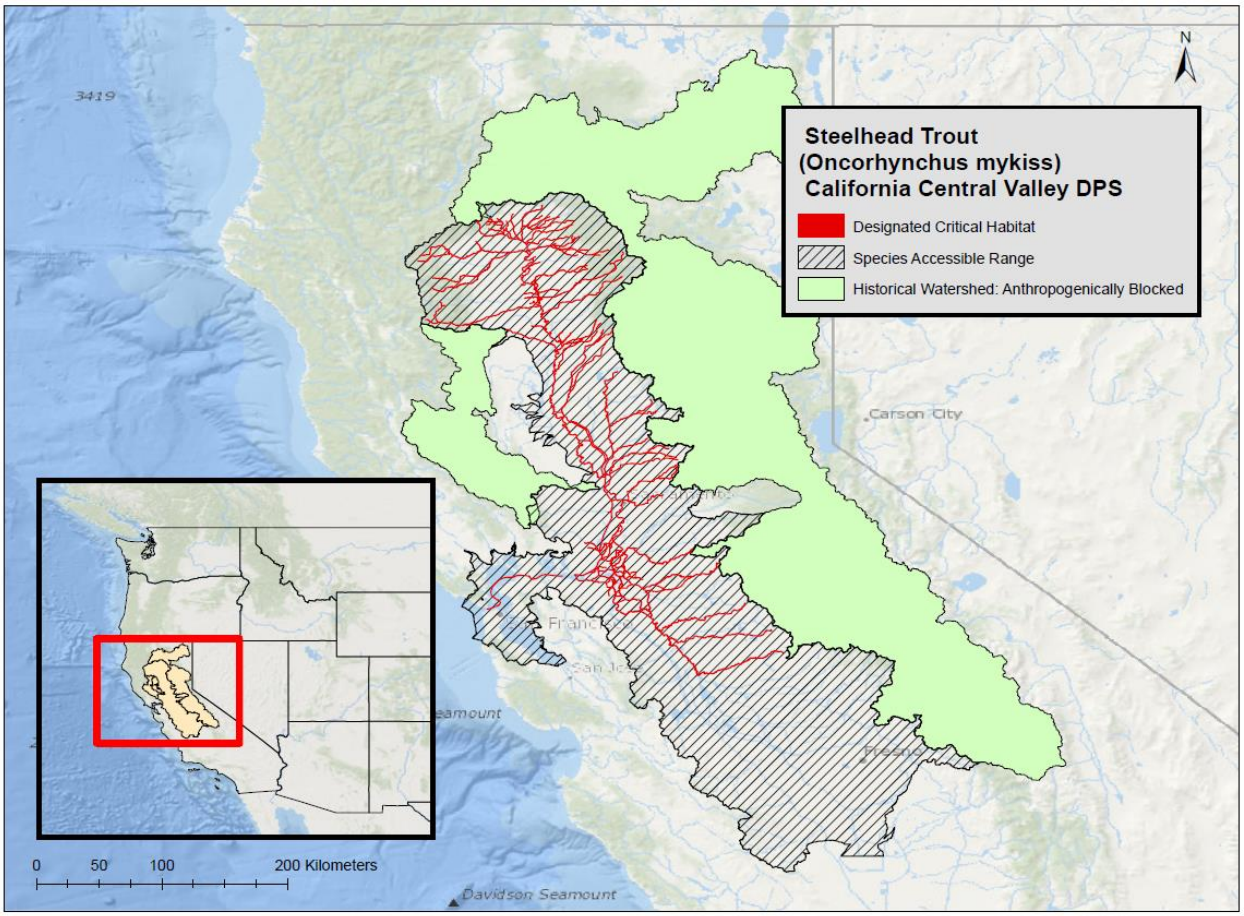

Figure 20. Steelhead, California Central Valley DPS range and designated critical habitat

Species Description. Steelhead are dark-olive in color, shading to silvery-white on the underside with a speckled body and a pink-red stripe along their sides. Those migrating to the ocean develop a slimmer profile, becoming silvery in color, and typically growing larger than rainbow trout that remain in fresh water. Steelhead trout grow to 55 pounds (25 kg) in weight and 45 inches (120 cm) in length, though average size is much smaller. On March 19, 1998 NMFS listed the California Central Valley (CCV) DPS of steelhead as threatened (63 FR 13347) and reaffirmed the DPS's status as threatened on January 5, 2006 (71 FR 834). This DPS includes naturally spawned anadromous O. mykiss (steelhead) originating below natural and manmade impassable barriers from the Sacramento and San Joaquin Rivers and their tributaries; excludes such fish originating from San Francisco and San Pablo Bays and their tributaries. This DPS includes steelhead from two artificial propagation programs.

Status. Many watersheds in the Central Valley are experiencing decreased abundance of CCV steelhead. Dam removal and habitat restoration efforts in Clear Creek appear to be benefiting CCV steelhead as recent increases in non-clipped (wild) abundance have been observed. Despite the positive trend in Clear Creek, all other concerns raised in the previous status review remain, including low adult abundances, loss and degradation of a large percentage of the historic spawning and rearing habitat, and domination of smolt production by hatchery fish. Many other planned restoration and reintroduction efforts have yet to be implemented or completed, or are focused on Chinook salmon, and have yet to yield demonstrable improvements in habitat, let alone documented increases in naturally produced steelhead. There are indications that natural production of steelhead continues to decline and is now at a very low levels. Their continued low numbers in most hatcheries, domination by hatchery fish, and relatively sparse monitoring makes the continued existence of naturally reproduced steelhead a concern. CCV steelhead is likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

Life history. Central Valley steelhead spawn downstream of dams on every major tributary within the Sacramento and San Joaquin River systems. The female steelhead selects a site with good intergravel flow, digs a redd with her tail, usually in the coarse gravel of the tail of a pool or in a riffle, and deposits eggs while an attendant male fertilizes them. The preferred water temperature range for steelhead spawning is reported to be 30°F to 52°F (Gallagher 2000). Following deposition of fertilized eggs in the redd, they are covered with loose gravel. The eggs hatch in three to four weeks at 50°F to 59°F, and fry emerge from the gravel four to six weeks later (Shapovalov and Taft 1954). Regardless of life history strategy, for the first year or two of life steelhead are found in cool, clear, fastflowing permanent streams and rivers where riffles predominate over pools, there is ample cover from riparian vegetation or undercut banks, and invertebrate life is diverse and abundant (Moyle 2002b). The smallest fish are most often found in riffles, intermediate size fish in runs, and larger fish in pools.

Steelhead typically migrate to marine waters after spending two years in fresh water. They reside in marine waters for typically two or three years prior to returning to their natal stream to spawn as four- or five-yearolds. Unlike Pacific salmon, steelhead are capable of spawning more than once before they die. However, it is rare for steelhead to spawn more than twice before dying, and most that do so are females (Moyle 2002b). Currently, Central Valley steelhead are considered "ocean-maturing" (also known as winter) steelhead, although summer steelhead may have been present prior to construction of large dams. Ocean maturing steelhead enter fresh water with well-developed gonads and spawn shortly after river entry. Central Valley steelhead enter fresh water from August through April. They hold until flows are high enough in tributaries to enter for spawning (Moyle 2002b). Steelhead adults typically spawn from December through April, with peaks from January through March in small streams and tributaries where cool, well oxygenated water is available year-round (Hallock et al. 1961b; McEwan 2001).

Table 64. Temporal distribution of Steelhead, California Central Valley DPS

Life History phase	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Entering Fresh Water (adults/jacks)	Present						Present					
Spawning	Present											Present
Incubation (eggs)	Present											Present
Emergence (alevin to fry phases)	Present											
Rearing and migration (juveniles)	Present											

Population Dynamics

Abundance. Historic CCV steelhead run size may have approached one to two million adults annually (McEwan 2001). By the early 1960s, the steelhead run size had declined to about 40,000 adults (McEwan 2001). Over the past 30 years, the naturally spawned steelhead populations in the upper Sacramento River have declined substantially. Hallock *et al.* (1961a) estimated an average of 20,540 adult steelhead in the Sacramento River, upstream of the Feather River, through the 1960s. Steelhead were counted at the Red Bluff Diversion Dam (RBDD) up until 1993. Counts at the dam declined from an average of 11,187 for the period of 1967 to 1977, to an average of approximately 2,000 through the early 1990s. An estimated total annual run size for the entire Sacramento-San Joaquin system was no more than 10,000 adults during the early 1990s (McEwan and Jackson 1996; McEwan 2001). Based on catch ratios at Chipps Island in the Delta and using some generous assumptions regarding survival, the average number of CCV steelhead females spawning naturally in the entire Central Valley during the years 1980 to 2000 **was estimated at about 3,600 (Good et al. 2005b)**

Productivity / Population Growth Rate. CCV steelhead lack annual monitoring data for calculating trends and lambda. However, the RBDD counts and redd counts up to 1993 and later sporadic data show that the DPS has had a significant long-term downward trend in abundance (NMFS 2009a).

Genetic Diversity / Distribution. The CCV steelhead distribution ranged over a wide variety of environmental conditions and likely contained biologically significant amounts of spatially structured genetic diversity (Lindley et al. 2006). Thus, the loss of populations and reduction in abundances have reduced the large diversity that existed within the DPS. The genetic diversity of the majority of CCV steelhead spawning runs is also compromised by hatchery-origin fish.

Designated Critical Habitat. NMFS designated critical habitat for CCV steelhead on September 2, 2005 (70 FR 52488). PBFs considered essential for the conservation of Steelhead, California Central Valley DPS are shown in Table 6.

Recovery Goals See the 2014 recovery plan for the California Central Valley steelhead DPS for complete down-listing/delisting criteria for recovery goals for the species. The delisting criteria for this DPS are:

- One population in the Northwestern California Diversity Group at low risk of extinction
- Two populations in the Basalt and Porous Lava Flow Diversity Group at low risk of extinction
- Four populations in the Northern Sierra Diversity Group at low risk of extinction
- Two populations in the Southern Sierra Diversity Group at low risk of extinction
- Maintain multiple populations at moderate risk of extinction

The current condition of CCV steelhead critical habitat is degraded, and does not provide the conservation value necessary for species recovery. In addition, the Sacramento-San Joaquin River Delta, as part of CCV steelhead designated critical habitat, provides very little function necessary for juvenile CCV steelhead rearing and physiological transition to salt water.

The spawning PBF is subject to variations in flows and temperatures, particularly over the summer months. Some complex, productive habitats with floodplains remain in the system and flood bypasses (*i.e.*, Yolo and Sutter bypasses). However, the rearing PBF is degraded by the channelized, leveed, and riprapped river reaches and sloughs that are common in the Sacramento-San Joaquin system and which typically have low habitat complexity, low abundance of food organisms, and offer little protection from either fish or avian predators. Stream channels commonly have elevated temperatures.

The current conditions of migration corridors are substantially degraded. Both migration and rearing PBFs are affected by dense urbanization and agriculture along the mainstems and in the Delta which contribute to reduced water quality by introducing several contaminants. In the Sacramento River, the migration corridor for both juveniles and adults is obstructed by the RBDD gates which are down from May 15 through September 15. The migration PBF is also obstructed by complex channel configuration making it more difficult for CCV steelhead to migrate successfully to the western Delta and the ocean. In addition, the state and federal government pumps and associated fish facilities change flows in the Delta which impede and obstruct for a functioning migration corridor that enhance migration. The estuarine PBF, which is present in the Delta, is affected by contaminants from agricultural and urban runoff and release of wastewater treatment plants effluent.

Table 65. Summary of status; Steelhead, California Central Valley DPS

Criteria	**Description**
Abundance / productivity trends	Long-term trend of declining abundances and reduced genetic diversity. Populations supplemented by hatchery propagation.
Listing status	Threatened

Attainment of recovery goals	Criteria not yet met
Condition of PBFs	Spawning PBFs are degraded by altered water flows and temperature; Rearing and migration PBFs are degraded by altered riverine habitat, dense urbanization and agriculture, poor water quality, and water diversions; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; Of 67 occupied watersheds, 37 are of high and 18 are of medium conservation value

8.20 Steelhead, Central California Coast DPS

Table 66. Steelhead, Central California Coast DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus mykiss	Steelhead Trout	Central California Coast	Threatened	2011	71 FR 834	2016	70 FR 52488

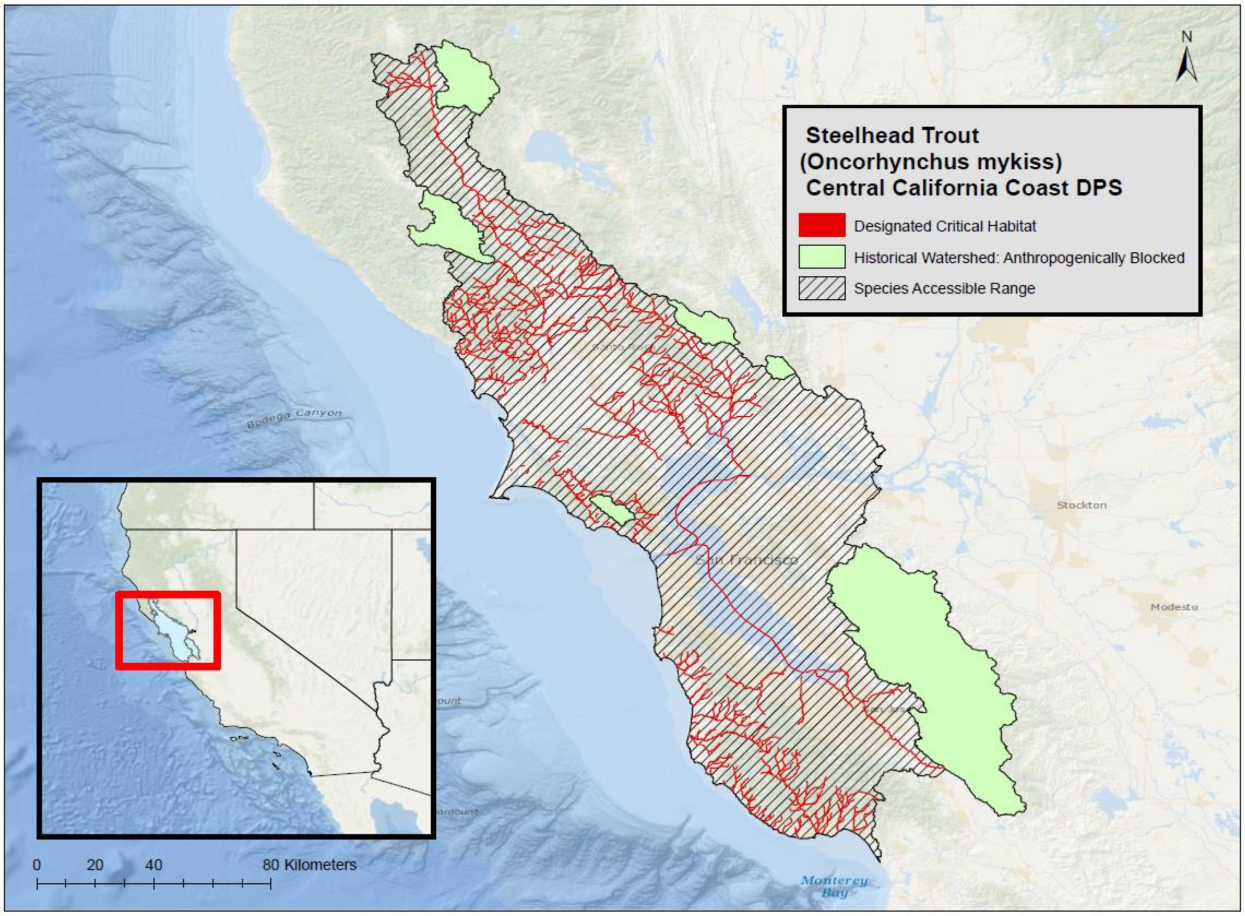

Figure 21. Steelhead, Central California Coast DPS range and designated critical habitat

Species Description Steelhead are dark-olive in color, shading to silvery-white on the underside with a speckled body and a pink-red stripe along their sides . Those migrating to the ocean develop a slimmer profile, becoming silvery in color, and typically growing larger than rainbow trout that remain in fresh water. Steelhead trout grow to 55 pounds (25 kg) in weight and 45 inches (120 cm) in length, though average size is much smaller. On August 18, 1997 NMFS listed the Central California Coast (CCC) DPS of steelhead as threatened (62 FR 43937) and reaffirmed the DPS's status as threatened on January 5, 2006 (71 FR 834). This DPS includes all naturally spawned populations of steelhead (and their progeny) in streams from the Russian

River to Aptos Creek, Santa Cruz County, California (inclusive). It also includes the drainages of San Francisco and San Pablo Bays.

Status The CCC steelhead consisted of nine historic functionally independent populations and 23 potentially independent populations (Bjorkstedt et al. 2005). Of the historic functionally independent populations, at least two are extirpated while most of the remaining are nearly extirpated. Current runs in the basins that originally contained the two largest steelhead populations for CCC steelhead, the San Lorenzo and the Russian Rivers, both have been estimated at less than 15 percent of their abundances just 30 years earlier (Good et al. 2005b). The Russian River is of particular importance for preventing the extinction and contributing to the recovery of CCC steelhead (NOAA 2013). Steelhead access to significant portions of the upper Russian River has also been blocked (Busby et al. 1996; NMFS 2008).

Life history The DPS is entirely composed of winter-run fish, as are those DPSs to the south. Adults return to the Russian River and migrate upstream from December – April, and smolts emigrate between March – May) (Hayes et al. 2004; Shapovalov and Taft 1954a). Most spawning takes place from January through April. While age at smoltification typically ranges for one to four years, recent studies indicate that growth rates in Soquel Creek likely prevent juveniles from undergoing smoltification until age two (Sogard et al. 2009). Survival in fresh water reaches tends to be higher in summer and lower from winter through spring for year classes 0 and 1 (Sogard et al. 2009). Larger individuals also survive more readily than do smaller fish within year classes (Sogard et al. 2009). Greater movement of juveniles in fresh water has been observed in winter and spring versus summer and fall time periods. Smaller individuals are more likely to be observed to exceed 0.3 mm per day, and are highest in winter through spring, potentially due to higher water flow rates and greater food availability (Boughton et al. 2007; Sogard et al. 2009).

Table 67. Temporal distribution of Steelhead, Central California Coast DPS

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Present</td></tr>
<tr><td>Spawning</td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Incubation (eggs)</td><td colspan="5">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td></td><td></td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Population Dynamics

Abundance. Historically, the entire CCC steelhead DPS may have consisted of an average runs size of 94,000 adults in the early 1960s (Good et al. 2005b). Information on current CCC steelhead populations consists of anecdotal, sporadic surveys that are limited to only smaller portions of watersheds. Presence-absence data indicated that most (82 percent) sampled streams (a subset of all historical steelhead streams) had extant populations of juvenile *O. mykiss* (Adams 2000; Good et al. 2005b).

Productivity / Population Growth Rate. Though the information for individual populations is limited, available information strongly suggests that no population is viable. Long-term population sustainability is extremely low for the southern populations in the Santa Cruz mountains and in the San Francisco Bay (NMFS 2008). Declines in juvenile southern populations are consistent with the more general estimates of declining abundance in the region (Good et al. 2005b). The interior Russian River winter-run steelhead has the largest runs with an estimate of an average of over 1,000 spawners; it may be able to be sustained over the long-term but hatchery management has eroded the population's genetic diversity (Bjorkstedt et al. 2005; NMFS 2008). Data on abundance trends do not exist for the DPS as a whole or for individual watersheds. Thus, it is not possible to calculate long-term trends or lambda.

Genetic Diversity / Distribution. This DPS includes all naturally spawned populations of steelhead (and their progeny) in streams from the Russian River to Aptos Creek, Santa Cruz County, California (inclusive). It also includes the drainages of San Francisco and San Pablo Bays.

Designated Critical Habitat. Critical habitat was designated for this species on September 2, 2005 (70 FR 52630). It includes the Russian River watershed, coastal watersheds in Marin County, streams within the San Francisco Bay, and coastal watersheds in the Santa Cruz Mountains down to Apos Creek. PBFs considered essential for the conservation of Steelhead, Central California Coast DPS are shown in Table 6.

Streams throughout the critical habitat have reduced quality of spawning PBFs; sediment fines in spawning gravel have reduced the ability of the substrate attribute to provide well oxygenated and clean water to eggs and alevins. High proportions of fines in bottom substrate also reduce forage by limiting the production of aquatic stream insects adapted to running water. Elevated water temperatures and impaired water quality have further reduced the quality, quantity and function of the rearing PBF within most streams. These impacts have diminished the ability of designated critical habitat to conserve the CCC steelhead.

Recovery Goals See the 2016 recovery plan for the Central California Coast steelhead DPS for complete down-listing/delisting criteria for recovery goals for the species. Recovery plan objectives are to:

- Reduce the present or threatened destruction, modification, or curtailment of habitat or range;
- Ameliorate utilization for commercial, recreational, scientific, or educational purposes;
- Abate disease and predation;

- Establish the adequacy of existing regulatory mechanisms for protecting CCC steelhead now and into the future (i.e., post-delisting);
- Address other natural or manmade factors affecting the continued existence of CCC steelhead;
- Ensure CCC steelhead status is at a low risk of extinction based on abundance, growth rate, spatial structure and diversity.

Table 68. Summary of status; Steelhead, Central California Coast DPS

Criteria	**Description**
Abundance / productivity trends	5-year population trend uncertain. Population abundance supplemented by hatchery propagation. Populations are likely not viable, and have lost spatial structure.
Listing status	threatened
Attainment of recovery goals	criteria not yet met
Condition of PBFs	Spawning and rearing PBFs are degraded by sedimentation and elevated temperature; All PBFs are degraded by loss of habitat, low summer flows, erosion, and contaminants; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; Of 47 occupied watersheds, 19 are of high and 15 are of medium conservation value

8.21 Steelhead, Lower Columbia River DPS

Table 69. Steelhead, Lower Columbia River DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus mykiss	Steelhead Trout	Lower Columbia River	Threatened	2016	71 FR 834	2013	70 FR 52630

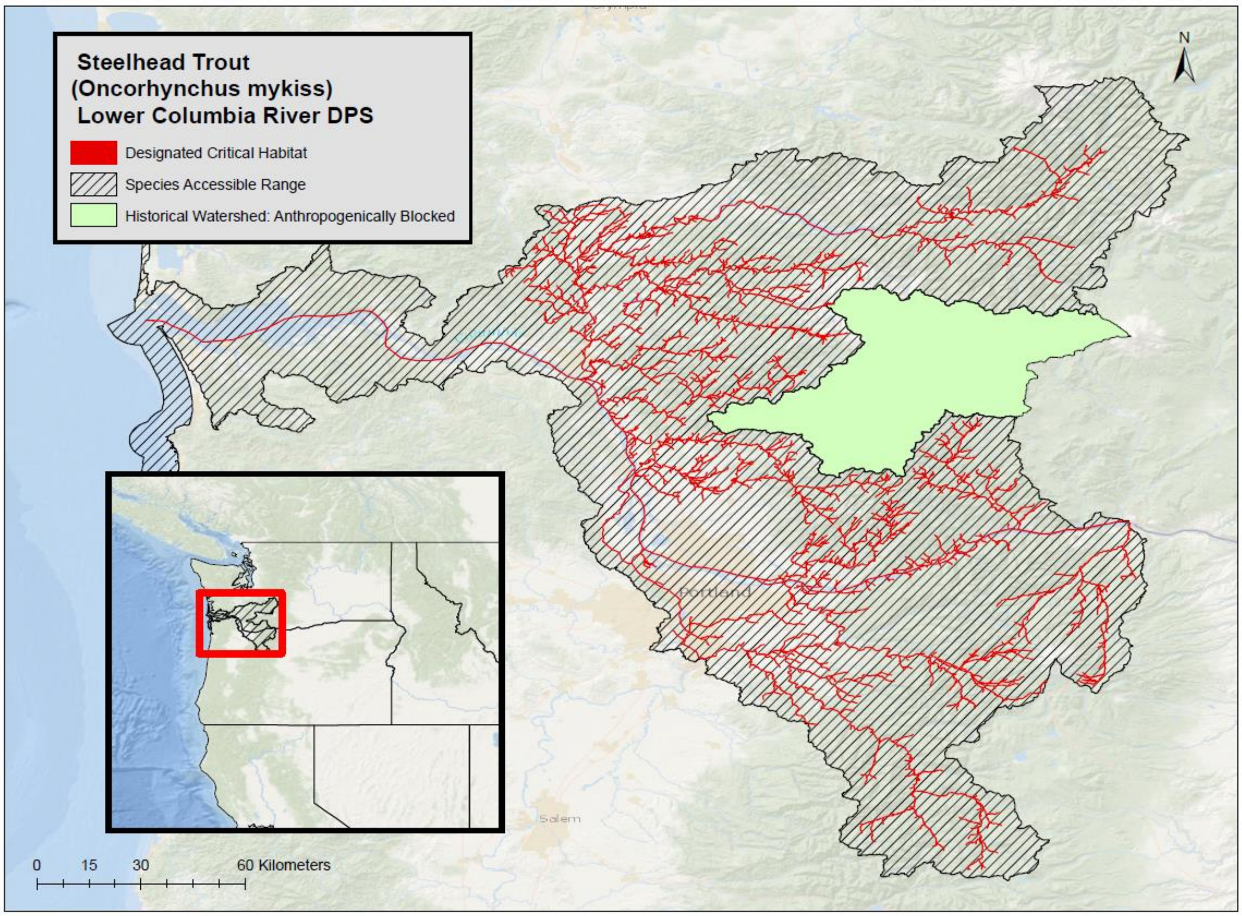

Figure 22. Steelhead, Lower Columbia River DPS range and designated critical habitat

Species Description Steelhead are dark-olive in color, shading to silvery-white on the underside with a speckled body and a pink-red stripe along their sides . Those migrating to the ocean develop a slimmer profile, becoming silvery in color, and typically growing larger than rainbow trout that remain in fresh water. Steelhead trout grow to 55 pounds (25 kg) in weight and 45 inches (120 cm) in length, though average size is much smaller. On March 19, 1998 NMFS listed the Lower Columbia River (LCR) DPS of steelhead as threatened (63 FR 13347) and reaffirmed the DPS's status as threatened on January 5, 2006 (71 FR 834). This DPS includes naturally spawned anadromous O. mykiss (steelhead) originating below natural and manmade impassable barriers from rivers between the Cowlitz and Wind Rivers (inclusive) and the Willamette and Hood Rivers (inclusive); excludes such fish originating from the upper Willamette River basin above Willamette Falls. This DPS includes steelhead from seven artificial propagation programs.

Status The LCR steelhead had 17 historically independent winter steelhead populations and 6 independent summer steelhead populations (McElhany et al. 2003; Myers et al. 2006). All historic LCR steelhead populations are considered extant. However, spatial structure within the historically independent populations, especially on the Washington side, has been substantially reduced by the loss of access to the upper portions of some basins due to tributary hydropower development. The majority of winter-run steelhead populations in this DPS continue to persist at low abundances (NWFSC 2015b). Hatchery interactions remain a concern in select basins, but the overall situation is somewhat improved compared to prior reviews. Summer-run steelhead DIPs were similarly stable, but at low abundance levels. Habitat degradation continues to be a concern for most populations. Even with modest improvements in the status of several winter-run populations, none of the populations appear to be at fully viable status, and similarly none of the MPGs meet the criteria for viability. The DPS therefore continues to be at moderate risk (NWFSC 2015b).

Life history The LCR steelhead DPS includes both summer- and winter-run stocks. Summer-run steelhead return sexually immature to the Columbia River from May to November, and spend several months in fresh water prior to spawning. Winter-run steelhead enter fresh water from November to April, are close to sexual maturation during freshwater entry, and spawn shortly after arrival in their natal streams. Where both races spawn in the same stream, summer-run steelhead tend to spawn at higher elevations than the winter-run. The majority of juvenile LCR steelhead remain for two years in freshwater environments before ocean entry in spring. Both winter- and summer-run adults normally return after two years in the marine environment.

Table 70. Temporal distribution of Steelhead, Lower Columbia River DPS

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td colspan="12">Present</td></tr>
<tr><td>Spawning</td><td></td><td></td><td colspan="4">Present</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Incubation (eggs)</td><td></td><td></td><td colspan="5">Present</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Emergence (alevin to fry phases</td><td></td><td></td><td></td><td></td><td colspan="4">Present</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Population Dynamics

Abundance. All LCR steelhead populations declined from 1980 to 2000, with sharp declines beginning in 1995. Historical counts in some of the larger tributaries (Cowlitz, Kalama, and Sandy Rivers) suggest the population probably exceeded 20,000 fish. During the 1990s, fish abundance dropped to 1,000 to 2,000 fish. Recent abundance estimates of natural-origin spawners range from completely extirpated for some populations above impassable barriers to over 700 fishes for the Kalama and Sandy winter-run populations. A number of the populations have a substantial fraction of hatchery-origin spawners in spawning areas. Many of the long-and short-term trends in abundance of individual populations are negative.

Productivity / Population Growth Rate. There is a difference in population stability between winter- and summer-run LCR steelhead. The winter-run steelhead in the Cascade region has the highest likelihood of being sustained as it includes a few populations with moderate abundance and positive short-term population growth rates (Good et al. 2005b; McElhany et al. 2007a). The Gorge summer-run steelhead is at the highest risk over the long-term as the Hood River population is at high risk of being lost (McElhany et al. 2007a)

Genetic Diversity / Distribution. This DPS includes naturally spawned anadromous O. mykiss (steelhead) originating below natural and manmade impassable barriers from rivers between the Cowlitz and Wind Rivers (inclusive) and the Willamette and Hood Rivers (inclusive); excludes such fish originating from the upper Willamette River basin above Willamette Falls. This DPS includes steelhead from seven artificial propagation programs. The WLC TRT identified 23 historical independent populations of Lower Columbia River steelhead: 17 winter-run populations and six summer-run populations, within the Cascade and Gorge ecozones.

Designated Critical Habitat. Critical habitat was designated for the LCR steelhead on September 2, 2005 (70 FR 52488). PBFs considered essential for the conservation of Steelhead, Lower Columbia River DPS are shown in Table 6.

Critical habitat is affected by reduced quality of rearing and juvenile migration PBFs within the lower portion and alluvial valleys of many watersheds; contaminants from agriculture affect both water quality and food production in these reaches of tributaries and in the mainstem Columbia River. Several dams affect adult migration PBF by obstructing the migration corridor. Watersheds which consist of a large proportion of federal lands such as is the case with the Sandy River watershed, have relatively healthy riparian corridors that support attributes of the rearing PBF such as cover, forage, and suitable water quality.

Recovery Goals NMFS therefore has developed the following delisting criteria for the Lower Columbia River steelhead DPS. (NMFS has amended the WLC TRT's criteria to incorporate the concept that each stratum should have a probability of persistence consistent with its historical condition, thus allowing for resolution of questions regarding the Gorge strata):

1. All strata that historically existed have a high probability of persistence or have a probability of persistence consistent with their historical condition. High probability of stratum persistence is defined as:

a. At least two populations in the stratum have at least a 95 percent probability of persistence over a 100-year time frame (i.e., two populations with a score of 3.0 or higher based on the TRT's scoring system).
b. Other populations in the stratum have persistence probabilities consistent with a high probability of stratum persistence (i.e., the average of all stratum population scores is 2.25 or higher, based on the TRT's scoring system). (See Section 2.6 for a brief discussion of the TRT's scoring system.)
c. Populations targeted for a high probability of persistence are distributed in a way that minimizes risk from catastrophic events, maintains migratory connections among populations, and protects within-stratum diversity.
d. A probability of persistence consistent with historical condition refers to the concept that strata that historically were small or had complex population structures may not have met Criteria A through C, above, but could still be considered sufficiently viable if they provide a contribution to overall ESU viability similar to their historical contribution.

2. The threats criteria described in Section 3.2.2 of the recovery plan have been met.

Table 71. Summary of status; Steelhead, Lower Columbia River DPS

Criteria	**Description**
Abundance / productivity trends	5-year population trend stable. Populations have low genetic diversity and impacted by a loss of available habitat.
Listing status	threatened
Attainment of recovery goals	criteria not yet met
Condition of PBFs	Rearing PBFs are degraded by agricultural runoff and lack of available prey; Spawning, rearing and migration PBFs are degraded by timber harvests, dams, and loss of floodplain habitat; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; Of 41 occupied watersheds, 28 are of high and 11 are of medium conservation value

8.22 Steelhead, Middle Columbia River DPS

Table 72. Steelhead, Middle Columbia River DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus mykiss	Steelhead Trout	Middle Columbia River	Threatened	2016	71 FR 834	2009	70 FR 52630

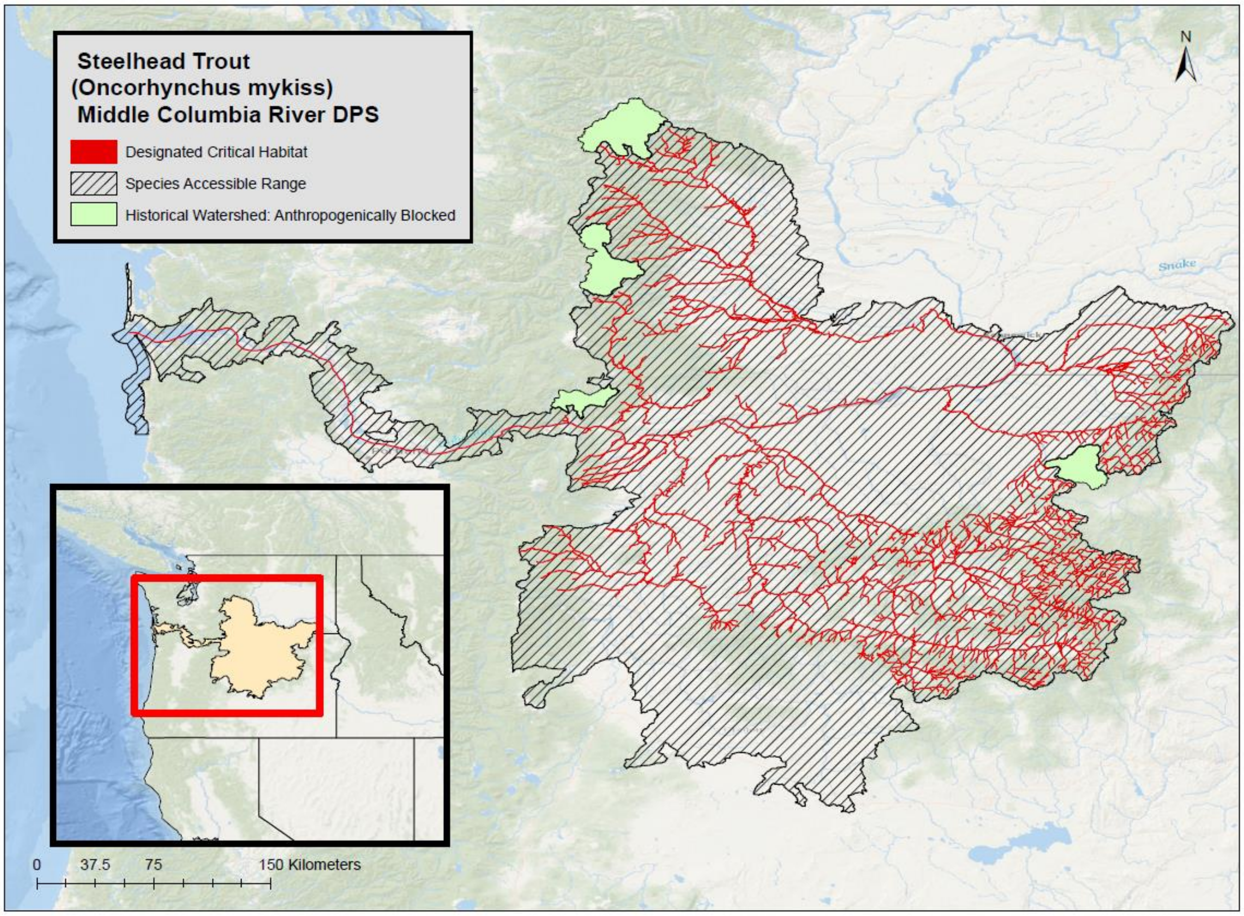

Figure 23. Steelhead, Middle Columbia River DPS range and designated critical habitat

Species Description Steelhead are dark-olive in color, shading to silvery-white on the underside with a speckled body and a pink-red stripe along their sides . Those migrating to the ocean develop a slimmer profile, becoming silvery in color, and typically growing larger than rainbow trout that remain in fresh water. Steelhead trout grow to 55 pounds (25 kg) in weight and 45 inches (120 cm) in length, though average size is much smaller. On March 25, 1999 NMFS listed the Middle Columbia River (MCR) DPS of steelhead as threatened (64 FR 14517) and reaffirmed the DPS's status as threatened on January 5, 2006 (71 FR 834). This DPS includes naturally spawned anadromous O. mykiss (steelhead) originating below natural and manmade impassable barriers from the Columbia River and its tributaries upstream of the Wind and Hood Rivers (exclusive) to and including the Yakima River; excludes such fish originating from the Snake River basin. This DPS includes steelhead from seven artificial propagation programs.

Status The ICTRT identified 16 extant populations in four major population groups (Cascades Eastern Slopes Tributaries, John Day River, Walla Walla and Umatilla Rivers, and Yakima River) and one unaffiliated independent population (Rock Creek) (ICTRT 2003). There are two extinct populations in the Cascades Eastern Slope major population group: the White Salmon River and the Deschutes Crooked River above the Pelton/Round Butte Dam complex. Present population structure is delineated largely on geographical proximity, topography, distance, ecological similarities or differences. Using criteria for abundance and productivity, the ICTRT modeled a gaps analysis for each of the four MPGs in this DPS under three different ocean conditions and a base hydro condition (most recent 20-year survival rate). The results showed that none of the MPGs would be able to achieve a five percent or less risk of extinction over 100 years without recovery actions. It is important to consider that significant gaps in factors affecting spatial structure and diversity also contribute to the risk of extinction for these fish.

Life history MCR steelhead populations are mostly of the summer-run type. Adult steelhead enter fresh water from June through August. The only exceptions are populations of inland winter-run steelhead which occur in the Klickitat River and Fifteenmile Creek (Busby et al. 1996). The majority of juveniles smolt and outmigrate as two-year olds. Most of the rivers in this region produce about equal or higher numbers of adults having spent one year in the ocean as adults having spent two years. However, summer-run steelhead in Klickitat River have a life cycle more like LCR steelhead whereby the majority of returning adults have spent two years in the ocean (Busby et al. 1996). Adults may hold in the river up to a year before spawning.

Table 73. Temporal distribution of Steelhead, Middle Columbia River DPS

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td colspan="12">Present</td></tr>
<tr><td>Spawning</td><td colspan="7">Present</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Incubation (eggs)</td><td colspan="7">Present</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td></td><td></td><td></td><td colspan="5">Present</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Population Dynamics

Abundance. Historic run estimates for the Yakima River imply that annual species abundance may have exceeded 300,000 returning adults (Busby et al. 1996). The five-year average (geometric mean) return of natural MCR steelhead for 1997 to 2001 was up from previous years' basin estimates. Returns to the Yakima River, the Deschutes River, and sections of the John Day River system were substantially higher compared to 1992 to 1997 (Good et al. 2005b). The five-year average for these basins is 298 and 1,492 fish, respectively (Good et al. 2005b).

Productivity / Population Growth Rate. Good *et al.* (2005b) calculated that the median estimate of long-term trend over 12 indicator data sets was –2.1 percent per year (–6.9 to 2.9), with 11 of the 12 being negative. Long-term annual population growth rates (λ) were also negative (Good et al. 2005b). The median long-term λ was 0.98, assuming that hatchery spawners do not contribute to production, and 0.97 assuming that both hatchery- and natural-origin spawners contribute equally.

Distribution. The MCR steelhead DPS includes all naturally spawned steelhead populations below natural and manmade impassable barriers in streams from above the Wind River, Washington, and the Hood River, Oregon (exclusive), upstream to, and including, the Yakima River, Washington, excluding *O. mykiss* from the Snake River Basin. Steelhead from the Snake River basin (described later in this section) are excluded from this DPS. Seven artificial propagation programs are part of this DPS. They include: the Touchet River Endemic, Yakima River Kelt Reconditioning Program (in Satus Creek, Toppenish Creek, Naches River, and Upper Yakima River), Umatilla River, and the Deschutes River steelhead hatchery programs. These artificially propagated populations are considered no more divergent relative to the local natural populations than would be expected between closely related natural populations within the DPS. According to the ICBTRT (ICTRT 2003), this DPS is composed of 16 populations in four major population groups (Cascade Eastern Slopes Tributaries, John Day River, Walla Walla and Umatilla Rivers, and Yakima River), and one unaffiliated population (Rock Creek).

Designated Critical Habitat. Critical habitat was designated for this species on September 2, 2005 (70 FR 52630). PBFs considered essential for the conservation of Steelhead, Middle Columbia River DPS are shown in Table 6.

The current condition of critical habitat designated for the MCR steelhead is moderately degraded. Critical habitat is affected by reduced quality of juvenile rearing and migration PBFs within many watersheds; contaminants from agriculture affect both water quality and food production in several watersheds and in the mainstem Columbia River. Loss of riparian vegetation to grazing has resulted in high water temperatures in the John Day basin. Reduced quality of the rearing PBFs has diminished its contribution to the conservation value necessary for the recovery of the species. Several dams affect adult migration PBF by obstructing the migration corridor.

Recovery Goals See the 2016 recovery plan for the Middle Columbia River steelhead DPS for complete down-listing/delisting criteria for recovery goals for the species (NMFS 2009b).

Table 74. Summary of status; Steelhead, Middle Columbia River DPS

Criteria	Description
Abundance / productivity trends	5-year population trend stable to improving, but abundances still low compared to historical numbers.

Listing status	threatened
Attainment of recovery goals	criteria not yet met
Condition of PBFs	Rearing PBFs are degraded by water quality, reduced invertebrate prey, and loss of riparian vegetation; Migration PBFs are degraded by several dams; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; Of 106 assessed watersheds, 73 are of high and 24 are of medium conservation value

8.23 Steelhead, Northern California DPS

Table 75. Steelhead, Northern California DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus mykiss	Steelhead Trout	Northern California	Threatened	2016	71 FR 834	2016	70 FR 52488

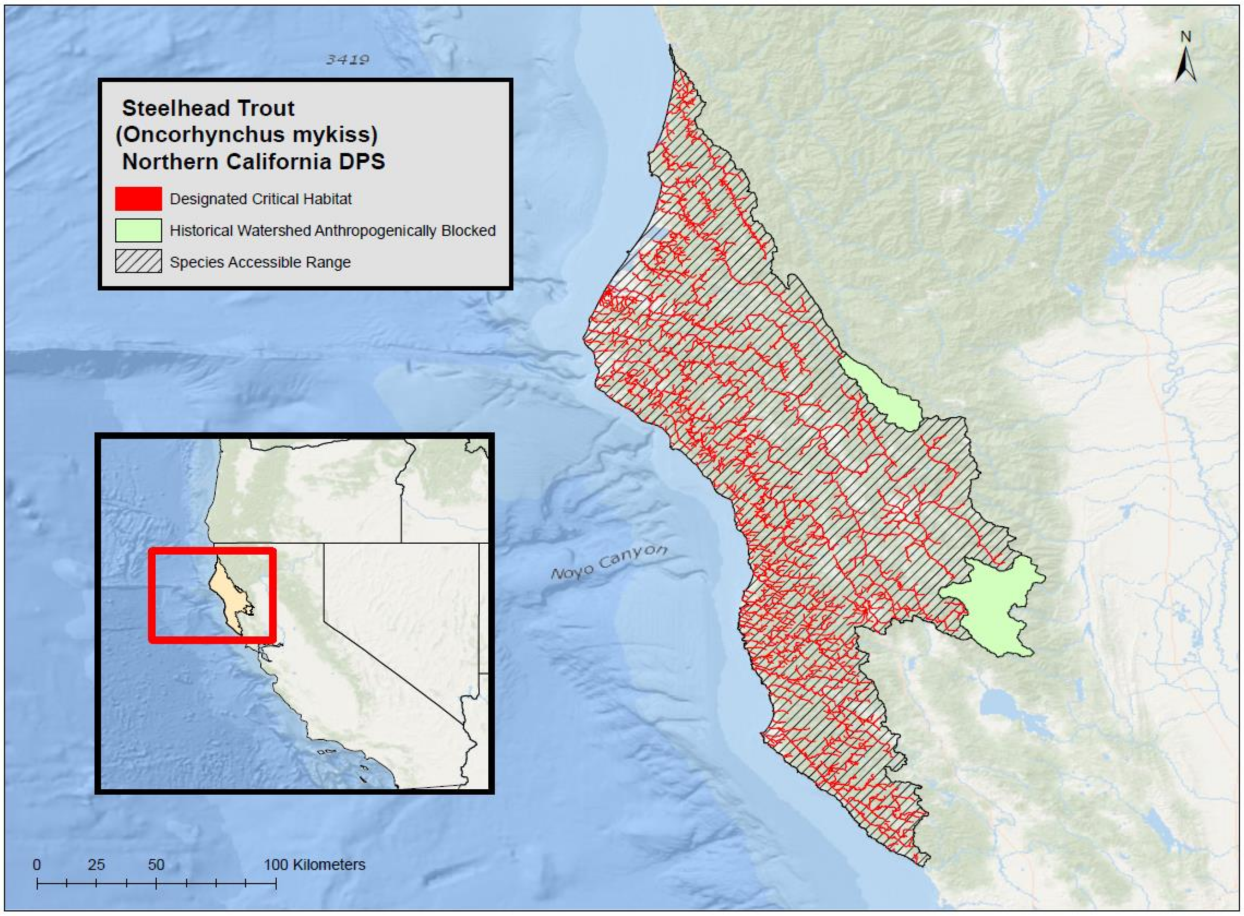

Figure 24. Steelhead, Northern California DPS range and designated critical habitat

Species Description Steelhead are dark-olive in color, shading to silvery-white on the underside with a speckled body and a pink-red stripe along their sides . Those migrating to the ocean develop a slimmer profile, becoming silvery in color, and typically growing larger than rainbow trout that remain in fresh water. Steelhead trout grow to 55 pounds (25 kg) in weight and 45 inches (120 cm) in length, though average size is much smaller. On June 7, 2000 NMFS listed the Northern California (NC) DPS of steelhead as threatened (65 FR 36074) and reaffirmed the DPS's status as threatened on January 5, 2006 (71 FR 834). This DPS includes naturally spawned anadromous O. mykiss (steelhead) originating below natural and manmade impassable barriers in California coastal river basins from Redwood Creek to and including the Gualala River.

Status The available data for winter-run populations— predominately in the North Coastal, North-Central Coastal, and Central Coastal strata— indicate that all populations are well below viability targets, most being between 5 percent and 13 percent of these goals. For the two Mendocino Coast populations with the longest time series, Pudding Creek and Noyo River, the 13-year trends have been negative and neutral, respectively (Williams et al. 2016). However, the short-term (6-year) trend has been generally positive for all independent populations in the North-Central Coastal and Central Coastal strata, including the Noyo River and Pudding Creek. Data from Van Arsdale Station likewise suggests that, although the long-term trend has been negative, run sizes of natural-origin steelhead have stabilized or are increasing. Thus, we have no strong evidence to indicate conditions for winter-run populations in the DPS have worsened appreciably since the last status review (Williams et al. 2016). Summer-run populations continue to be of significant concern because of how few populations currently exist. The Middle Fork Eel River population has remained remarkably stable for nearly five decades and is closer to its viability target than any other population in the DPS. Although the time series is short, the Van Duzen River appears to be supporting a population numbering in the low hundreds. However, the Redwood Creek and Mattole River populations appear small, and little is known about other populations including the Mad River and other tributaries of the Eel River (i.e., Larabee Creek, North Fork Eel, and South Fork Eel). Most populations for which there are population estimates available remain well below viability targets; however, the short-term increases observed for many populations, despite the occurrence of a prolonged drought in northern California, suggests this DPS is not at immediate risk of extinction.

Life history This DPS includes both winter- and summer –run steelhead. In the Mad and Eel Rivers, immature steelhead may return to fresh water as “half-pounders” after spending only two to four months in the ocean. Generally, a half-pounder will overwinter in fresh water and return to the ocean in the following spring.

Juvenile out-migration appears more closely associated with size than age but generally, throughout their range in California, juveniles spend two years in fresh water (Busby et al. 1996). Smolts range from 14-21 cm in length. Juvenile steelhead may migrate to rear in lagoons throughout the year with a peak in the late spring/early summer and in the late fall/early winter period (Shapovalov and Taft 1954a; Zedonis 1992).

Steelhead spend anywhere from one to five years in salt water, however, two to three years are most common (Busby et al. 1996). Ocean distribution is not well known but coded wire tag recoveries indicate that most NC steelhead migrate north and south along the continental shelf (Barnhart 1986).

Table 76. Temporal distribution of Steelhead, Northern California DPS

<table>
<tr><td>Life History phase</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Present</td></tr>
<tr><td>Spawning</td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Present</td></tr>
<tr><td>Incubation (eggs)</td><td></td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Emergence (alevin to fry phases</td><td></td><td></td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Population Dynamics

Abundance. Northern California steelhead historic functionally independent populations and their abundances and hatchery contributions are provided in Table 77.

Table 77. Northern California DPS steelhead historic and recent spawner abundance

Population	Historical Abundance	Recent Spawner Abundance	Hatchery Abundance Contributions
Mad River (S)	6,000	162-384	2%
MF Eel River (S)	Unknown	384-1,246	0%
NF Eel River (S)	Unknown	Extirpated	N/A
Mattole River (S)	Unknown	9-30*	Unknown
Redwood Creek (S)	Unknown	6*	Unknown
Van Duzen (W)	10,000	Unknown	Unknown
Mad River (W)	6,000	Unknown	Unknown
SF Eel River (W)	34,000	2743-20,657	Unknown
Mattole River (W)	12,000	Unknown	Unknown
Redwood Creek (W)	10,000	Unknown	Unknown
Humboldt Bay (W)	3,000	Unknown	Unknown
Freshwater Creek (W)		25-32	
Ten Mile River (W)	9,000	Unknown	Unknown
Noyo River (W)	8,000	186-364*	Unknown
Big River (W)	12,000	Unknown	Unknown
Navarro River (W)	16,000	Unknown	Unknown
Garcia River (W)	4,000	Unknown	Unknown
Gualala River (W)	16,000	Unknown	Unknown
Total	198,000	Unknown	

**From Spence et al. (2008). Redwood Creek abundance is mean count over four generations. Mattole River abundances from surveys conducted between 1996 and 2005. Noyo River abundances from surveys conducted since 2000.*

Population	Historical Abundance	Recent Spawner Abundance	Hatchery Abundance Contributions
Summer –run steelhead is noted with a (S) and winter-run steelhead with a (W)			

Productivity / Population Growth Rate Good *et al.* (2005b) estimated lambda at 0.98 with a 95% confidence interval of 0.93 and 1.04. The result is an overall downward trend in both the long- and short- term. Juvenile data were also recently examined. Both upward and downward trends were apparent (Good et al. 2005b).

Reduction of summer-run steelhead populations has significantly reduced current DPS diversity compared to historic conditions. Of the 10 summer-run steelhead populations, only four are extant. Of these, only the Middle Fork Eel River population is at moderate risk of extinction, the remaining three are at high risk (Spence et al. 2008a). Hatchery influence has likely been limited.

Genetic Diversity / Distribution: Artificial propagation was identified as negatively affecting wild stocks of salmonids through interactions with non-native fish, introductions of disease, genetic changes, competition for space and food resources, straying and mating with native populations, loss of local genetic adaptations, mortality associated with capture for broodstock and palliating the destruction of habitat and concealing problems facing wild stocks.

Designated Critical Habitat NMFS designated critical habitat for NC steelhead on September 2, 2005 (70 FR 52488). PBFs considered essential for the conservation of Steelhead, Northern California DPS are shown in Table 6.

The current condition of critical habitat designated for the NC steelhead is moderately degraded. Nevertheless, it does provide some conservation value necessary for species recovery. Within portions of its range, especially the interior Eel River, rearing PBF quality is affected by elevated temperatures by removal of riparian vegetation. Spawning PBF attributes such as the quality of substrate supporting spawning, incubation, and larval development have been generally degraded throughout designated critical habitat by silt and sediment fines in the spawning gravel. Bridges and culverts further restrict access to tributaries in many watersheds, especially in watersheds with forest road construction, thereby reducing the function of adult migration PBF.

Recovery Goals See the 2016 recovery plan for the Northern California steelhead DPS for complete down-listing/delisting criteria for recovery goals for the species (NMFS 2016b).

Table 78. Summary of status; Steelhead, Northern California DPS

Criteria	Description

Abundance / productivity trends	5-year population trend stable to improving, but abundances still low compared to historical numbers.
Listing status	threatened
Attainment of recovery goals	criteria not yet met
Condition of PBFs	Rearing PBFs are degraded by loss of riparian vegetation and elevated temperature; Spawning PBFs are degraded by lack of quality substrate and sedimentation; Migration PBFs are degraded by bridges, culverts, and forest road construction; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; Of 50 assessed watersheds, 27 are of high and 14 are of medium conservation value

8.24 Steelhead, Puget Sound DPS

Table 79. Steelhead, Puget Sound DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus mykiss	Steelhead Trout	Puget Sound	Threatened	2011	72 FR 26722	None	81 FR 9251

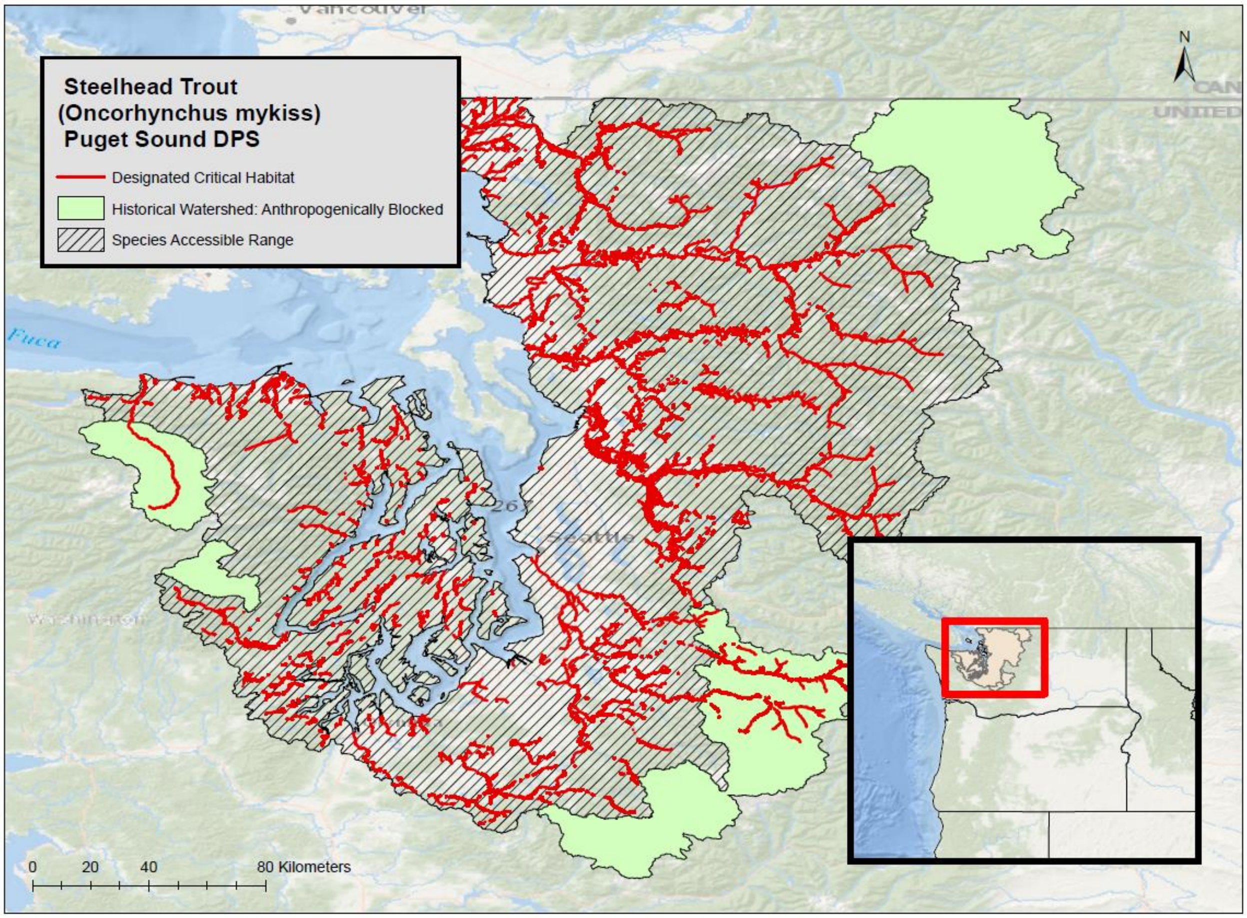

Figure 25. Steelhead, Puget Sound DPS range and designated critical habitat

Species Description Steelhead are dark-olive in color, shading to silvery-white on the underside with a speckled body and a pink-red stripe along their sides . Those migrating to the ocean develop a slimmer profile, becoming silvery in color, and typically growing larger than rainbow trout that remain in fresh water. Steelhead trout grow to 55 pounds (25 kg) in weight and 45 inches (120 cm) in length, though average size is much smaller. On May 11, 2007 NMFS listed the Puget Sound (PS) DPS of steelhead as threatened (72 FR 26722). This DPS includes naturally spawned anadromous O. mykiss (steelhead) originating below natural and manmade impassable barriers from rivers flowing into Puget Sound from the Elwha River (inclusive) eastward, including rivers in Hood Canal, South Sound, North Sound and the Strait of Georgia. Also, steelhead from six artificial propagation programs.

Status For all but a few putative demographically independent populations of steelhead in Puget Sound, estimates of mean population growth rates obtained from observed spawner or redd counts are declining—typically 3 to 10 percent annually. Extinction risk within 100 years for most populations in the DPS is estimated to be moderate to high, especially for draft populations in the putative South Sound and Olympic major population groups. Collectively, these analyses indicate that steelhead in the Puget Sound DPS remain at risk of extinction throughout all or a significant portion of their range in the foreseeable future, but are not currently in danger of imminent extinction. 5-Year Review: Puget Sound NOAA Fisheries 23 Our Biological Review Team identified degradation and fragmentation of freshwater habitat, with consequent effects on connectivity, as the primary limiting factors and threats facing the PS steelhead DPS. In the three years since listing, the status of threats has not changed appreciably. The status of the listed PS steelhead DPS has not changed substantially since the 2007 listing. Most populations within the DPS are showing continued downward trends in estimated abundance, a few sharply so. The limited available information indicates that this DPS remains at a moderate risk of extinction.

Life history The Puget Sound steelhead DPS contains both winter-run and summer-run steelhead. Adult winter-run steelhead generally return to Puget Sound tributaries from December to April (NMFS 2005b). Spawning occurs from January to mid-June, with peak spawning occurring from mid-April through May. Prior to spawning, maturing adults hold in pools or in side channels to avoid high winter flows. Less information exists for summer-run steelhead as their smaller run size and higher altitude headwater holding areas have not been conducive for monitoring. Based on information from four streams, adult run time occur from mid-April to October with a higher concentration from July through September (NMFS 2005b).

The majority of juveniles reside in the river system for two years with a minority migrating to the ocean as one or three-year olds. Smoltification and seaward migration occur from April to mid-May. The ocean growth period for Puget Sound steelhead ranges from one to three years in the ocean (Busby et al. 1996). Juveniles or adults may spend considerable time in the protected marine environment of the fjord-like Puget Sound during migration to the high seas.

Table 80. Temporal distribution of Steelhead, Puget Sound DPS

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td colspan="12">Present</td></tr>
<tr><td>Spawning</td><td></td><td colspan="6">Present</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Incubation (eggs)</td><td></td><td colspan="7">Present</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td></td><td></td><td></td><td colspan="6">Present</td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Population Dynamics

Abundance. In the 1996 and 2005 status reviews, the Skagit and Snohomish Rivers (North Puget Sound) winter-run steelhead were found to produce the largest escapements ((Busby et al. 1996), (NMFS 2005b)). The two rivers still produce the largest wild escapement with a recent (2005 to 2008) four-year geometric mean of 5,468 for the Skagit River and an average 2,944 steelhead in Snohomish River for the two years 2005 and 2006 (Washington Department of Fish and Wildlife (WDFW) 2009). Lake Washington has the lowest abundances of winter-run steelhead with an escapement of less than 50 fish in each year from 2000 through 2004 (Washington Department of Fish and Wildlife (WDFW) 2008). The stock is now virtually extirpated with only eight and four returning fish in 2007 and 2008, respectively (Washington Department of Fish and Wildlife (WDFW) 2009). No abundance estimates exist for most of the summer-run populations; all appear to be small, most averaging less than 200 spawners annually.

Productivity / Population Growth Rate. Long-term trends (1980 to 2004) for the Puget Sound steelhead natural escapement have declined significantly for most populations, especially in southern Puget Sound, and in some populations in northern Puget Sound (Stillaguamish winter-run), Canal (Skokomish winter-run), and along the Strait of Juan de Fuca (Dungeness winter-run) (NMFS 2005b). Positive trends were observed in the Samish winter-run (northern Puget Sound) and the Hamma Hamma winter-run (Hood Canal) populations. The increasing trend on the Hamma Hamma River may be due to a captive rearing program rather than to natural escapement (NMFS 2005b).

The negative trends in escapement of naturally produced fish resulted from peaks in natural escapement in the early 1980s. Still, the period 1995 through 2004 (short-term) showed strong negative trends for several populations. This is especially evident in southern Puget Sound (Green, Lake Washington, Nisqually, and Puyallup winter-run), Hood Canal (Skokomish winter-run), and the Strait of Juan de Fuca (Dungeness winter-run) (NMFS 2005b). As with the long-term trends, positive trends were evident in short-term natural escapement for the Samish and Hamma Hamma winter-run populations, and also in the Snohomish winter-run populations.

Median population growth rates (λ) using 4-year running sums is less than 1, indicating declining population growth, for nearly all populations in the DPS (NMFS 2005b). However, some of the populations with declining recent population growth show only slight declines, (*e.g.*, Samish and Skagit winter-run in northern Puget Sound, and Quilcene and Tahuya winter-run in Hood Canal).

Genetic Diversity. Only two hatchery stocks genetically represent native local populations (Hamma Hamma and Green River natural winter-run). The remaining programs, which account for the vast preponderance of production, are either out-of-DPS derived stocks or were within-DPS stocks that have diverged substantially from local populations. The WDFW estimated that 31 of the 53 stocks were of native origin and predominantly natural production (Washington Department of Fish and Wildlife (WDFW) 1993).

Distribution NMFS listed Puget Sound steelhead as threatened on May 11, 2007 (72 FR 26722). Fifty-three populations of steelhead have been identified in this DPS, of which 37 are winter-run. Summer-run populations are distributed throughout the DPS but are concentrated in northern Puget Sound and Hood Canal; only the Elwha River and Canyon Creek support summer-run steelhead in the rest of the DPS. The Elwha River run, however, is descended from introduced Skamania Hatchery summer-run steelhead. Historical summer-run steelhead in the Green River and Elwha River were likely extirpated in the early 1900s.

Designated Critical Habitat. NMFS designated critical habitat for Puget Sound steelhead on February 2, 2016 (81 FR 9251). PBFs considered essential for the conservation of Steelhead, Puget Sound DPS are shown in Table 6.

Recovery Goals A recovery plan has not yet been developed for the Puget Sound DPS of steelhead.

Table 81. Summary of status; Steelhead, Puget Sound DPS

Criteria	**Description**
Abundance / productivity trends	5-year population trend stable, but populations have reduced genetic diversity.
Listing status	Threatened
Attainment of recovery goals	Criteria not yet met
Condition of PBFs	Rearing, migration and spawning PBFs are degraded by forestry, agriculture, urbanization, loss of floodplain habitat, and poor water quality; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; Most watersheds are of high or medium conservation value

8.25 Steelhead, Snake River Basin

Table 82. Steelhead, Snake River Basin DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus mykiss	Steelhead Trout	Snake River Basin	Threatened	2016	71 FR 834	In Process	70 FR 52630

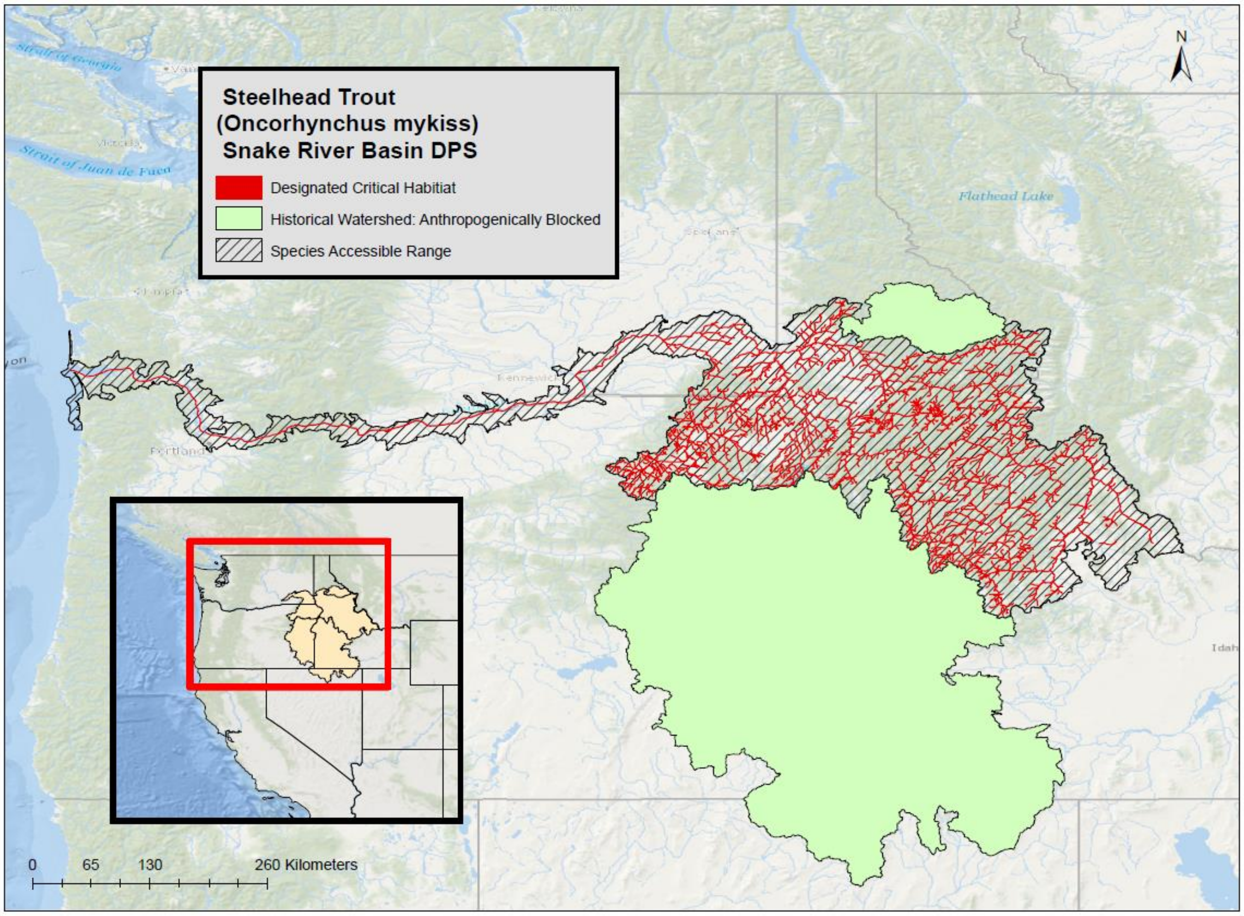

Figure 26. Steelhead, Snake River Basin DPS range and designated critical habitat

Species Description Steelhead are dark-olive in color, shading to silvery-white on the underside with a speckled body and a pink-red stripe along their sides . Those migrating to the ocean develop a slimmer profile, becoming silvery in color, and typically growing larger than rainbow trout that remain in fresh water. Steelhead trout grow to 55 pounds (25 kg) in weight and 45 inches (120 cm) in length, though average size is much smaller. On August 18, 1997 NMFS listed the Snake River Basin DPS of steelhead as threatened (62 FR 43937) and reaffirmed the DPS's status as threatened on January 5, 2006 (71 FR 834). This DPS includes naturally spawned anadromous O. mykiss (steelhead) originating below natural and manmade impassable barriers from the Snake River basin, and also steelhead from six artificial propagation programs.

Status Four out of the five MPGs are not meeting the specific objectives in the draft recovery plan being written by NMFS based on the updated status information available for this review, and the status of many individual populations remains uncertain (NWFSC 2015b). The Grande Ronde MPG is tentatively rated as viable; more specific data on spawning abundance and the relative contribution of hatchery spawners for the Lower Grande Ronde and Wallowa populations would improve future assessments. A great deal of uncertainty still remains regarding the relative proportion of hatchery fish in natural spawning areas near major hatchery release sites within individual populations.

Life history SR basin steelhead are generally classified as summer-run fish. They enter the Columbia River from late June to October. After remaining in the river through the winter, SR basin steelhead spawn the following spring (March to May). Managers recognize two life history patterns within this DPS primarily based on ocean age and adult size upon return: A-run or B-run. A-run steelhead are typically smaller, have a shorter freshwater and ocean residence (generally one year in the ocean), and begin their up-river migration earlier in the year. B-run steelhead are larger, spend more time in fresh water and the ocean (generally two years in ocean), and appear to start their upstream migration later in the year. SR basin steelhead usually smolt after two or three years.

Table 83. Temporal distribution of Steelhead, Snake River Basin DPS

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td></td><td></td><td></td><td></td><td colspan="6">Present</td><td></td><td></td></tr>
<tr><td>Spawning</td><td></td><td></td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Incubation (eggs)</td><td></td><td></td><td colspan="4">Present</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td></td><td></td><td></td><td colspan="4">Present</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Population Dynamics

Abundance / Productivity. There is uncertainty for wild populations given limited data for adult spawners in individual populations. Regarding population growth rate, there are mixed long- and short-term trends in abundance and productivity. Overall, the abundances remain well below interim recovery criteria.

Genetic Diversity. Genetic diversity is affected by the displacement of natural fish by hatchery fish (declining proportion of natural-origin spawners)

Distribution. The ICTRT (ICTRT 2003) identified 23 populations. SR basin steelhead remain spatially well distributed in each of the six major geographic areas in the Snake River basin (Good et al. 2005b). The SR basin steelhead B- run populations remain particularly depressed.

Designated Critical Habitat. Critical habitat was designated for this species on September 2, 2005 (70 FR 52630). PBFs considered essential for the conservation of Steelhead, Snake River Basin DPS are shown in Table 6.

The current condition of critical habitat designated for SR basin steelhead is moderately degraded. Critical habitat is affected by reduced quality of juvenile rearing and migration PBFs within many watersheds; contaminants from agriculture affect both water quality and food production in several watersheds and in the mainstem Columbia River. Loss of riparian vegetation to grazing has resulted in high water temperatures in the John Day basin. These factors have substantially reduced the rearing PBFs contribution to the conservation value necessary for species recovery. Several dams affect adult migration PBF by obstructing the migration corridor.

Recovery Goals The Snake River Basin steelhead recovery plan is currently in the process of being developed.

Table 84. Summary of status; Steelhead, Snake River Basin DPS

Criteria	**Description**
Abundance / productivity trends	5-year population trend stable to improving, but still in moderate danger of extinction. Overall abundances are still below thresholds necessary for recovery.
Listing status	threatened
Attainment of recovery goals	criteria not yet met
Condition of PBFs	Rearing PBFs are degraded by agricultural runoff, reduced invertebrate prey, loss of riparian vegetation, and elevated temperature; Migration PBFs are degraded by several dams; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; Of assessed watersheds, 229 are of high and 41 are of medium conservation value

8.26 Steelhead, South-Central California Coast DPS

Table 85. Steelhead, South-Central California Coast DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus mykiss	Steelhead Trout	South-Central California Coast	Threatened	2016	71 FR 834	2013	70 FR 52488

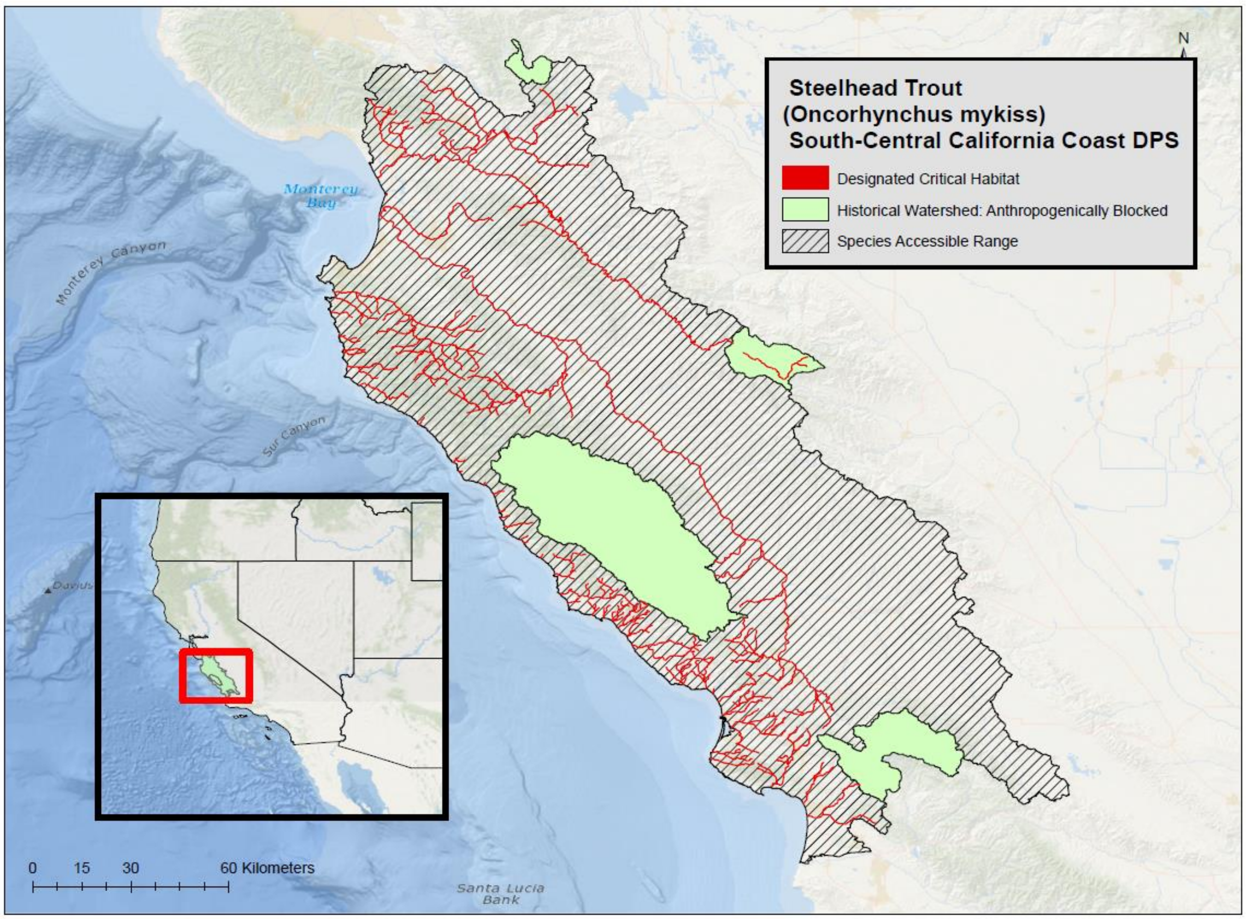

Figure 27. Steelhead, South-Central California Coast DPS range and designated critical habitat

Species Description Steelhead are dark-olive in color, shading to silvery-white on the underside with a speckled body and a pink-red stripe along their sides . Those migrating to the ocean develop a slimmer profile, becoming silvery in color, and typically growing larger than rainbow trout that remain in fresh water. Steelhead trout grow to 55 pounds (25 kg) in weight and 45 inches (120 cm) in length, though average size is much smaller. On August 18, 1997 NMFS listed the South-Central California Coast (SCCC) DPS of steelhead as threatened (62 FR 43937) and reaffirmed the DPS's status as threatened on January 5, 2006 (71 FR 5248). This DPS includes naturally spawned anadromous O. mykiss (steelhead) originating below natural and manmade impassable barriers from the Pajaro River to (but not including) the Santa Maria River.

Status Following the dramatic rise in South-Central California's human population after World War II and the associated land and water development within coastal drainages (particularly major dams and water diversions), steelhead abundance rapidly declined, leading to the extirpation of populations in many watersheds and leaving only sporadic and remnant populations in the remaining, more highly modified watersheds such as the Salinas River and Arroyo Grande Creek watersheds (Boughton et al. 2007; Good et al. 2005b). As conditions in South-Central California coastal rivers and stream continued to deteriorate, put-and-take trout stocking became more focused on suitable manmade reservoirs. Since the listing of the SCCC DPS as threatened in 1997, the California Department of Fish and Wildlife has ceased stocking hatchery reared fish in the anadromous waters of South-Central California (California Department of Fish and Wildlife and U.S. Fish and Wildlife Service 2010). A substantial portion of the upper watersheds, which contain the majority of historical spawning and rearing habitats for anadromous O. mykiss, remain intact (though inaccessible to anadromous fish) and protected from intensive development as a result of their inclusion in the Los Padres National Forest (Blakley and Barnette 1985).

Life history Only winter steelhead are found in this DPS. Migration and spawn timing are similar to adjacent steelhead populations. There is limited life history information for steelhead in this DPS.

Table 86. Temporal distribution of Steelhead, South-Central California Coast DPS

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Spawning</td><td></td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Incubation (eggs)</td><td></td><td colspan="4">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td></td><td></td><td></td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Population Dynamics

Abundance / Productivity. The data summarized in this status review indicate small (generally <10 fish) but surprisingly persistent annual runs of anadromous O. mykiss are currently being monitored across a limited but diverse set of basins within the range of this DPS, but interrupted in years when the mouth of the coastal estuaries fail to open to the ocean due to low flows (Williams et al. 2011; Williams et al. 2016).

Genetic Diversity / Distribution. South-Central California Coast (SCCC) steelhead include all naturally spawned steelhead populations below natural and manmade impassable barriers in streams from the Pajaro River (inclusive) to, but not including the Santa Maria River, California. No artificially propagated steelhead populations that reside within the historical geographic range of this DPS are included in this designation. The two largest basins overlapping within the range of this DPS include the inland basins of the Pajaro River and the Salinas River.

Designated Critical Habitat. Critical habitat was designated for this species on September 2, 2005 (70 FR 52488). PBFs considered essential for the conservation of Steelhead, South-Central California Coast DPS are shown in Table 6.

Migration and rearing PBFs are degraded throughout critical habitat by elevated stream temperatures and contaminants from urban and agricultural areas. Estuarine PBF is impacted by most estuaries being breached, removal of structures, and contaminants.

Recovery Goals. See the 2013 recovery plan for the South-Central California Coast steelhead DPS for complete down-listing/delisting criteria for recovery goals for the species.

Table 87. Summary of status; Steelhead, South-Central California Coast DPS

Criteria	Description
Abundance / productivity trends	5-year popluation trend declining, depressed abundances.
Listing status	threatened
Attainment of recovery goals	criteria not yet met
Condition of PBFs	Rearing and migration PBFs are degraded by elevated temperatures and contaminants from urban and agricultural runoff; Estuarine PBFs are degraded by altered habitat and contaminated runoff; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; Of 29 occupied watersheds, 12 are of high and 11 are of medium conservation value

8.27 Steelhead, Southern California DPS

Table 88. Steelhead, Southern California DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus mykiss	Steelhead Trout	Southern California Coast	Endangered	2016	71 FR 834	2012	70 FR 52488

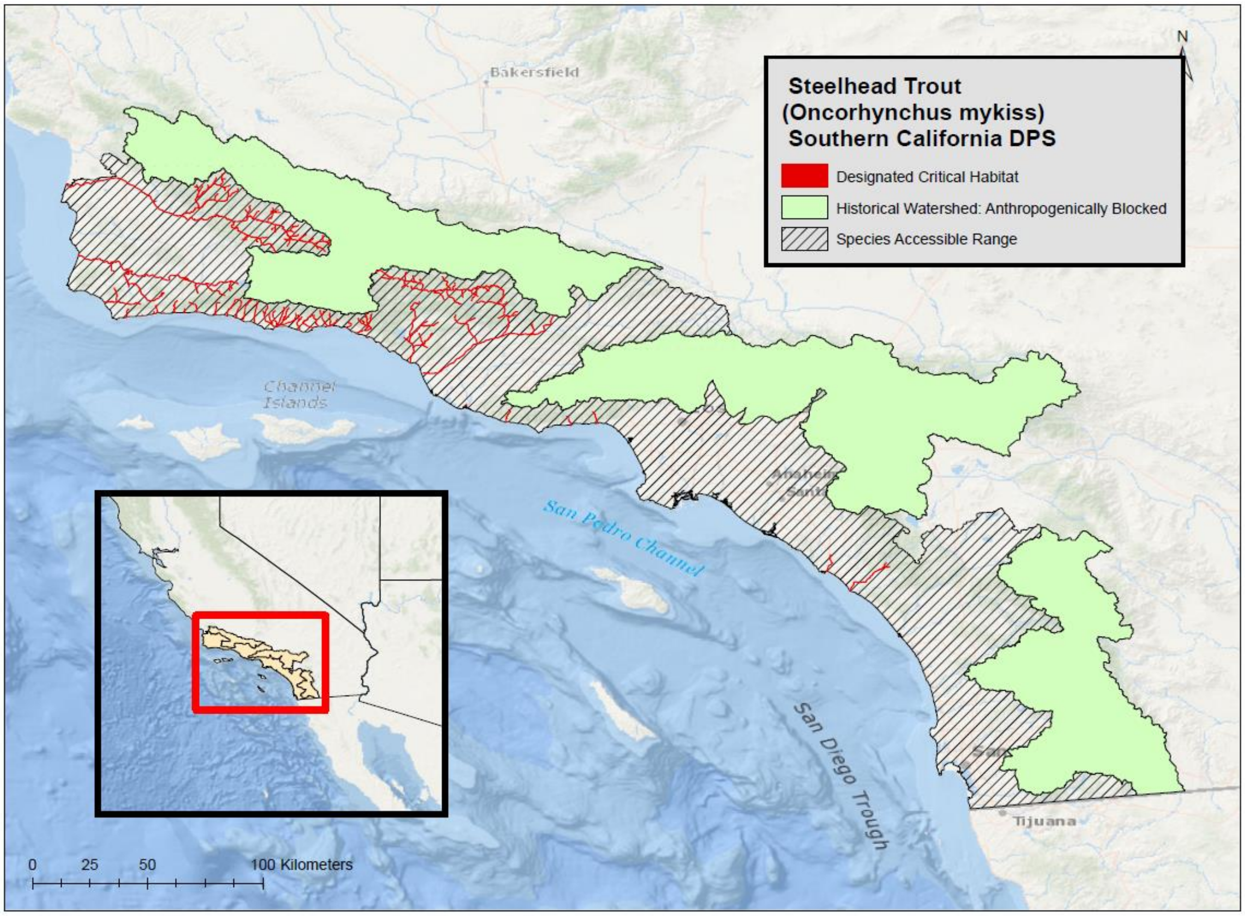

Figure 28. Steelhead, Southern California DPS range and designated critical habitat

Species Description. Steelhead are dark-olive in color, shading to silvery-white on the underside with a speckled body and a pink-red stripe along their sides . Those migrating to the ocean develop a slimmer profile, becoming silvery in color, and typically growing larger than rainbow trout that remain in fresh water. Steelhead trout grow to 55 pounds (25 kg) in weight and 45 inches (120 cm) in length, though average size is much smaller. On August 18, 1997 NMFS listed the Southern California (SC) DPS of steelhead as endangered (62 FR 43937) and reaffirmed the DPS's status as endangered on January 5, 2006 (71 FR 5248). This DPS includes naturally spawned anadromous O. mykiss (steelhead) originating below natural and manmade impassable barriers from the Santa Maria River to the U.S.-Mexico Border.

Status. There is little new evidence to indicate that the status of the Southern California Coast Steelhead DPS has changed appreciably in either direction since the last status review (Williams et al. 2011). The extended drought and the recent genetic data documenting the high level of introgression and extirpation of native O. mykiss stocks in the southern portion of the DPS has elevated the threats level to the already endangered populations; the drought, and the lack of 55 comprehensive monitoring, has also limited the ability to fully assess the status of individual populations and the DPS as whole. The systemic anthropogenic threats identified at the time of the initial listing have remained essentially unchanged over the past 5 years, though there has been significant progress in removing fish passage barriers in a number of the smaller and mid-sized watersheds. Threats to the Southern California Steelhead DPS posed by environmental variability resulting from projected climate change are likely to exacerbate the factors affecting the continued existence of the DPS.

Life history. There is limited life history information for SC steelhead. In general, migration and life history patterns of SC steelhead populations are dependent on rainfall and stream flow (Moore 1980). Steelhead within this DPS can withstand higher temperatures compared to populations to the north. The relatively warm and productive waters of the Ventura River have resulted in more rapid growth of juvenile steelhead compared to the more northerly populations (Moore 1980).

Table 89. Temporal distribution of Steelhead, Southern California DPS

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td></td><td colspan="4">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Spawning</td><td></td><td></td><td></td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Incubation (eggs)</td><td></td><td></td><td></td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Population Dynamics

Abundance / Productivity. Limited information exists on SC steelhead runs. Based on combined estimates for the Santa Ynez, Ventura, and Santa Clara rivers, and Malibu Creek, an estimated 32,000 to 46,000 adult steelhead occupied this DPS historically. In contrast, less than 500 adults are estimated to occupy the same four waterways presently. The last estimated run size for steelhead in the Ventura River, which has its headwaters in Los Padres National Forest, is 200 adults (Busby et al. 1996).

Genetic Diversity / Distribution. Limited information is available regarding the structural and genetic diversity of the Southern California steelhead.

Designated Critical Habitat. Critical habitat was designated for this species on September 2, 2005 (70 FR 52630). PBFs considered essential for the conservation of Steelhead, Southern California DPS are shown in Table 6.

All PBFs have been affected by degraded water quality by pollutants from densely populated areas and agriculture within the DPS. Elevated water temperatures impact rearing and juvenile migration PBFs in all river basins and estuaries. Rearing and spawning PBFs have also been affected throughout the DPS by management or reduction in water quantity. The spawning PBF has also been affected by the combination of erosive geology and land management activities that have resulted in an excessive amount of fines in the spawning gravel of most rivers.

Recovery Goals. See the 2012 recovery plan for the California Central Valley steelhead DPS for complete down-listing/delisting criteria for recovery goals for the species.

Table 90. Summary of status; Steelhead, Southern California DPS

Criteria	Description
Abundance / productivity trends	5-year population trend uncertain. Population abundance supplemented by hatchery propagation. Populations are at the extreme southern end of the species' range. Large annual variations in abundances, and fragmented distributions.
Listing status	endangered
Attainment of recovery goals	criteria not yet met
Condition of PBFs	All PBFs are degraded by pollutants in urban and agricultural runoff, elevated temperatures, erosion, and low water flows; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; Of 29 freshwater and estuarine watersheds, 21 are of high and 5 are of medium conservation value

8.28 Steelhead, Upper Columbia River DPS

Table 91. Steelhead, Upper Columbia River DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus mykiss	Steelhead Trout	Upper Columbia River	Endangered	2016	74 FR 42605	2007	70 FR 52630

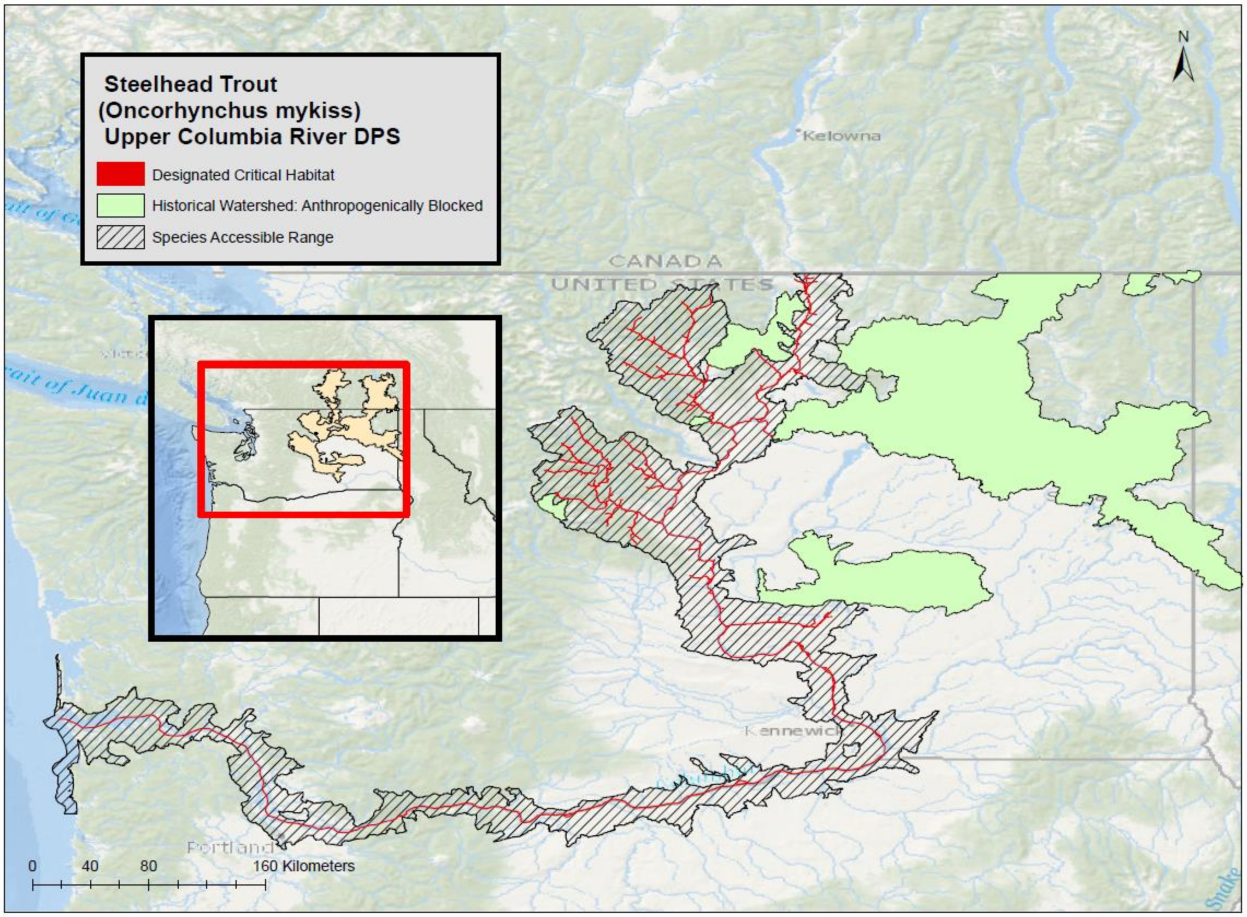

Figure 29. Steelhead, Upper Columbia River DPS range and designated critical habitat

Species Description. Steelhead are dark-olive in color, shading to silvery-white on the underside with a speckled body and a pink-red stripe along their sides . Those migrating to the ocean develop a slimmer profile, becoming silvery in color, and typically growing larger than rainbow trout that remain in fresh water. Steelhead trout grow to 55 pounds (25 kg) in weight and 45 inches (120 cm) in length, though average size is much smaller. On August 18, 1997 NMFS listed the Upper Columbia River (UCR) DPS of steelhead as endangered (62 FR 43937) and reaffirmed the DPS's status as endangered on January 5, 2006 (71 FR 834). This DPS includes naturally spawned anadromous O. mykiss (steelhead) originating below natural and manmade impassable barriers from the Columbia River and its tributaries upstream of the Yakima River to the U.S.-Canada border. Also, steelhead from six artificial propagation programs.

Status. Current estimates of natural origin spawner abundance increased relative to the levels observed in the prior review for all three extant populations, and productivities were higher for the Wenatchee and Entiat and unchanged for the Methow (NWFSC 2015b). However abundance and productivity remained well below the viable thresholds called for in the Upper Columbia Recovery Plan for all three populations. Short-term patterns in those indicators appear to be largely driven by year-to year fluctuations in survival rates in areas outside of these watersheds. All three populations continued to be rated at low risk for spatial structure but at high risk for diversity criteria. Although the status of the ESU is improved relative to measures available at the time of listing, all three populations remain at high risk (NWFSC 2015b).

Life history. All UCR steelhead are summer-run steelhead. Adults return in the late summer and early fall, with most migrating relatively quickly to their natal tributaries. A portion of the returning adult steelhead overwinters in mainstem reservoirs, passing over upper-mid-Columbia dams in April and May of the following year. Spawning occurs in the late spring of the year following river entry. Juvenile steelhead spend one to seven years rearing in fresh water before migrating to sea. Smolt outmigrations are predominantly year class two and three (juveniles), although some of the oldest smolts are reported from this DPS at seven years. Most adult steelhead return to fresh water after one or two years at sea.

Table 92. Temporal distribution of Steelhead, Upper Columbia River DPS

Life History phase	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Entering Fresh Water (adults/jacks)	Present											
Spawning			Present									
Incubation (eggs)			Present									
Emergence (alevin to fry phases					Present							
Rearing and migration (juveniles)	Present											

Population Dynamics

Abundance. Returns of both hatchery and naturally produced steelhead to the upper Columbia River have increased in recent years. The average 1997 to 2001 return counted through the Priest Rapids fish ladder was approximately 12,900 fish. The average for the previous five years (1992 to 1996) was 7,800 fish. Abundance estimates of returning naturally produced UCR steelhead were based on extrapolations from mainstem dam counts and associated sampling information (Good et al. 2005b). The natural component of the annual steelhead run over Priest Rapids Dam increased from an average of 1,040 (1992-1996), representing about 10 percent of the total adult count, to 2,200 (1997-2001), representing about 17 percent of the adult count during this period of time (ICTRT 2003).

Recent population abundances for the Wenatchee and Entiat aggregate population and the Methow population remain well below the minimum abundance thresholds developed for these populations (ICTRT 2003). A five-year geometric mean (1997 to 2001) of approximately 900 naturally produced steelhead returned to the Wenatchee and Entiat rivers (combined). The abundance is well below the minimum abundance thresholds but it represents an improvement over the past (an increasing trend of 3.4 percent per year).

Productivity / Population Growth Rate. Regarding the population growth rate of natural production, on average, over the last 20 full brood year returns (1980/81 through 1999/2000 brood years), including adult returns through 2004-2005, UCR steelhead populations have not replaced themselves. Overall adult returns are dominated by hatchery fish, and detailed information is lacking on the productivity of the natural population.

Genetic Diversity. All UCR steelhead populations have reduced genetic diversity from homogenization of populations that occurred during the Grand Coulee Fish Maintenance project from 1939-1943, from 1960, and 1981 (Chapman et al. 1994).

Distribution. The UCR steelhead consisted of four historical independent populations: the Wenatchee, Entiat, Methow, and Okanogan. All populations are extant. The UCR steelhead must navigate over several dams to access spawning areas. The construction of Grand Coulee Dam in 1939 blocked access to over 50 percent of the river miles formerly available to UCR steelhead (ICTRT 2003).

Designated Critical Habitat. Critical habitat was designated for this species on September 2, 2005 (70 FR 52630). PBFs considered essential for the conservation of Steelhead, Upper Columbia River DPS are shown in Table 6.

The current condition of critical habitat designated for the UCR steelhead is moderately degraded. Habitat quality in tributary streams varies from excellent in wilderness and roadless areas to poor in areas subject to heavy agricultural and urban development. Critical habitat is affected by reduced quality of juvenile rearing and migration PBFs within many watersheds; contaminants from agriculture affect both water quality and food production in several watersheds and in the mainstem Columbia River. Several dams affect adult migration PBF by obstructing the migration corridor.

Recovery Goals. See the 2007 recovery plan for the Upper Columbia River steelhead DPS for complete down-listing/delisting criteria for recovery goals for the species.

Table 93. Summary of status; Steelhead, Upper Columbia River DPS

Criteria	Description

Abundance / productivity trends	5-year population trend improving, but low genetic diversity. Abundances still below those necessary for recovery.
Listing status	threatened
Attainment of recovery goals	criteria not yet met
Condition of PBFs	Rearing PBFs are degraded by agricultural runoff and lack of available prey; Migration PBFs are degraded by several dams; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; Of 41 occupied watersheds, 31 are of high and 7 are of medium conservation value

8.29 Steelhead, Upper Willamette River DPS

Table 94. Steelhead, Upper Willamette River DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus mykiss	Steelhead Trout	California Central Valley	Threatened	2016	71 FR 834	2011	70 FR 52630

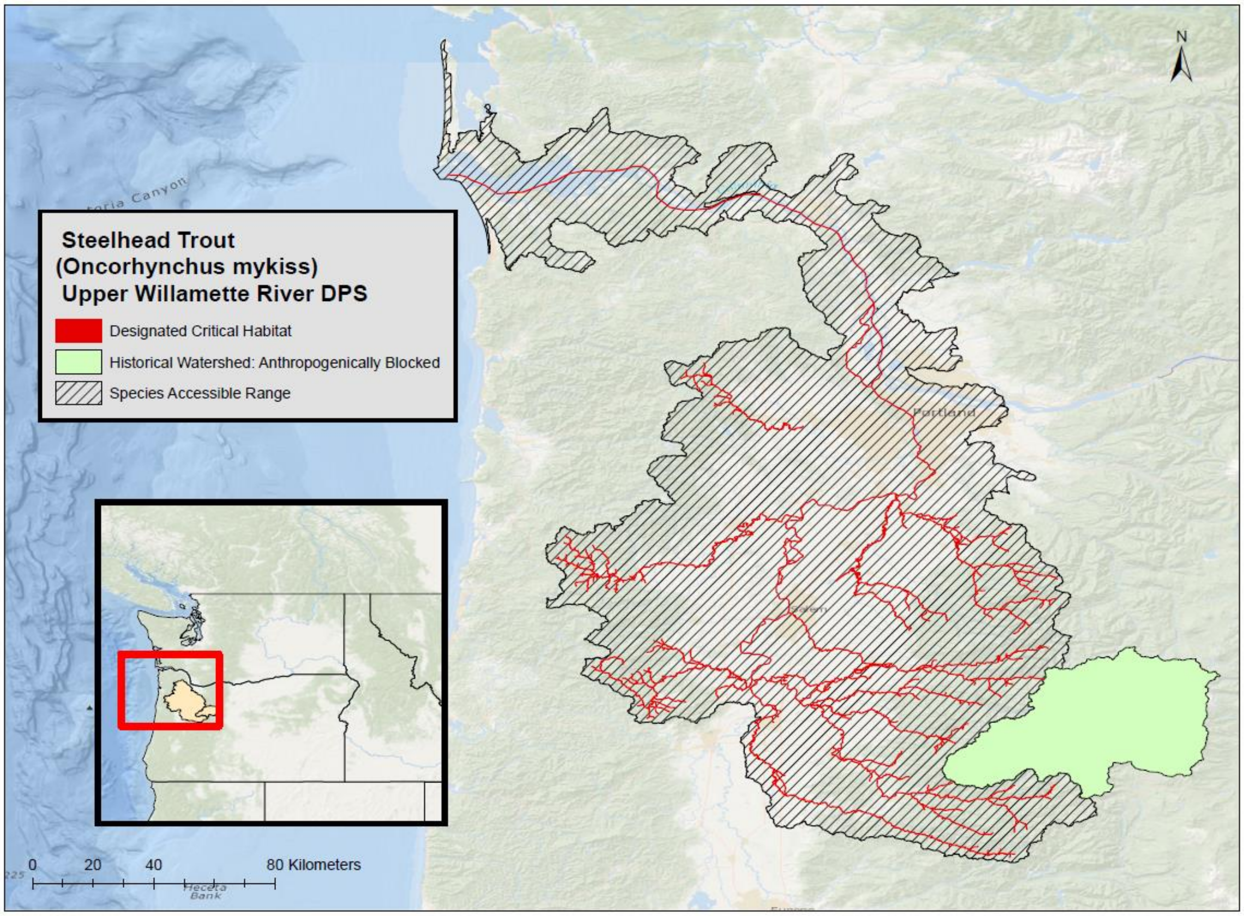

Figure 30. Steelhead, Upper Willamette River DPS range and designated critical habitat

Species Description. Steelhead are dark-olive in color, shading to silvery-white on the underside with a speckled body and a pink-red stripe along their sides . Those migrating to the ocean develop a slimmer profile, becoming silvery in color, and typically growing larger than rainbow trout that remain in fresh water. Steelhead trout grow to 55 pounds (25 kg) in weight and 45 inches (120 cm) in length, though average size is much smaller. On March 25, 1999 NMFS listed the Upper Willamette River (UWR) DPS of steelhead as threatened (64 FR 14517) and reaffirmed the DPS's status as threatened on January 5, 2006 (71 FR 834). This DPS includes 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.

Status. Four basins on the east side of the Willamette River historically supported independent populations for the UWR steelhead, all of which remain extant. Data reported in McElhaney et al. (2007) indicate that currently the two largest populations within the DPS are the Santiam River populations. Mean spawner abundance in both the North and South Santiam River is about 2,100 native winter-run steelhead. However, about 30 percent of all habitat has been lost due to human activities (McElhany et al. 2007a). The North Santiam population has been substantially affected by the loss of access to the upper North Santiam basin. The South Santiam subbasin has lost habitat behind non-passable dams in the Quartzville Creek watershed. Notwithstanding the lost spawning habitat, the DPS continues to be spatially well distributed, occupying each of the four major subbasins.

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 nonnative 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.

Life history. Native steelhead in the Upper Willamette are a late-migrating winter group that enters fresh water in January and February (Howell et al. 1985). UWR steelhead do not ascend to their spawning areas until late March or April, which is late compared to other West Coast winter steelhead. Spawning occurs from April to June 1. The unusual run timing may be an adaptation for ascending the Willamette Falls, which may have facilitated reproductive isolation of the stock. The smolt migration past Willamette Falls also begins in early April and proceeds into early June, peaking in early- to mid-May (Howell et al. 1985). Smolts generally migrate through the Columbia via Multnomah Channel rather than the mouth of the Willamette River. As with other coastal steelhead, the majority of juveniles smolt and outmigrate after two years; adults return to their natal rivers to spawn after spending two years in the ocean. Repeat spawners are predominantly female and generally account for less than 10 percent of the total run size (Busby et al. 1996).

Table 95. Temporal distribution of Steelhead, Upper Willamette River DPS

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td colspan="6">Present</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Spawning</td><td></td><td></td><td></td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Incubation (eggs)</td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Population Dynamics

Abundance. UWR steelhead are moderately depressed from historical levels (McElhany et al. 2007a). Average number of late-fall steelhead passing Willamette Falls decreased during the 1990s to less than 5,000 fish. The number again increased to over 10,000 fish in 2001 and 2002. The geometric and arithmetic mean number of late-run steelhead passing Willamette Falls for the period 1998 to 2001 were 5,819 and 6,795, respectively.

Productivity / Population Growth Rate. Population information for individual basins exist as redds per (river) mile. These redd counts show a declining long-term trend for all populations (Good et al. 2005b). One population, the Calapooia, had a positive short-term trend during the years from 1990 to 2001. McElhany *et al.* (2007a) however, found that the populations had a low risk of extinction. Two of the populations were considered at moderate risk from failed abundances and recruitment levels and two (North and South Santiam Rivers) were considered at low risk given current abundances and recruitment (McElhany et al. 2007a).

Genetic Diversity. 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).

Distribution. The UWR steelhead DPS includes all naturally spawned winter-run steelhead populations in the Willamette River and its tributaries upstream from Willamette Falls to the Calapooia River (inclusive). The North Santiam and South Santiam rivers are thought to have been major production areas (McElhany et al. 2003) and these populations were designated as “core” and “genetic legacy”. The four “east-side” subbasin populations are part of one stratum, the Cascade Tributaries Stratum, for UWR winter steelhead. There are no hatchery programs supporting this DPS (Myers et al. 2006). The hatchery summer-run steelhead that are produced and released in the subbasins are from an out-of-basin stock and not considered part of the DPS. 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 2015b).

Designated Critical Habitat. NMFS designated critical habitat for this species on September 2, 2005 (70 FR 52488). PBFs considered essential for the conservation of Steelhead, Upper Willamette River DPS are shown in Table 6.

The current condition of critical habitat designated for the UWR steelhead is degraded, and provides a reduced the conservation value necessary for species recovery. Critical habitat is affected by reduced quality of juvenile rearing and migration PBFs within many watersheds; contaminants from agriculture affect both water quality and food production in several watersheds and in the mainstem Columbia River. Several dams affect adult migration PBF by obstructing the migration corridor.

Recovery Goals See the 2011 recovery plan for the Upper Willamette River steelhead DPS for complete down-listing/delisting criteria for recovery goals for the species.

Table 96. Summary of status; Steelhead, Upper Willamette River DPS

Criteria	**Description**
Abundance / productivity trends	5-year population trend declining, large fluctuations in abundances.
Listing status	threatened
Attainment of recovery goals	criteria not yet met
Condition of PBFs	Rearing PBFs are degraded by agricultural runoff and lack of available prey; Migration PBFs are degraded by dams and elevated temperatures; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; Of assessed watersheds, 14 are of high and 6 are of medium conservation value