2024 5-Year Review: Summary & Evaluation of **Southern Oregon / Northern California Coast Coho Salmon**

National Marine Fisheries Service
West Coast Region

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5-Year Review: Southern Oregon / Northern California Coast Coho Salmon

Species Reviewed	Distinct Population Segment
Coho Salmon (*Oncorhynchus kisutch*)	**Southern Oregon / Northern California Coast (SONCC) coho salmon**

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Acronyms

AWQMP	Agricultural Water Quality Management Plan
Caltrout	California Trout
CEFF	California Environmental Flows Framework
CDFW	California Department of Fish and Wildlife
CDWR	California Department of Water Resources
SONCC	Southern Oregon/Northern California Coast
CMP	Coastal Management Plan
CWA	Clean Water Act
DPS	Distinct Population Segment
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FMEP	Fishery Management and Evaluation Plan
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
HCP	Habitat Conservation Plan
HCR	Harvest Control Rule
HGMP	Hatchery Genetic Management Plan
HVT	Hoopa Valley Tribe
KRRC	Klamath River Renewal Corporation
MAUCRSA	Medicinal and Adult-Use Cannabis Regulation and Safety Act
MMPA	Marine Mammal Protection Act
NFIP	National Flood Insurance Program
NMFS	National Marine Fisheries Service
NOAA	National Oceanographic and Atmospheric Administration
NOS	NOAA's National Ocean Service
NPDES	National Pollution Discharge Elimination System
NWPR	Navigable Waters Protection Rule
ODA	Oregon Department of Agriculture
ODEQ	Oregon Department of Environmental Quality
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyl
PG&E	Pacific Gas & Electric
PFMC	Pacific Fishery Management Council
RCP	Representative Concentration Pathway
RPA	Reasonable and Prudent Alternative
SGMA	Sustainable Groundwater Management Act
SIA	Strategic Implementation Area
SWFSC	Southwest Fisheries Science Center
TNC	The Nature Conservancy
TMDL	Total Maximum Daily Load
TRT	Technical Recovery Team

TRMP	Tribal Resource Management Plan
TU	Trout Unlimited
U.S.	United States of America
USACE	United States Army Corps of Engineers
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
VSP	Viable Salmonid Population
WOTUS	Waters of the United States
YT	Yurok Tribe

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1 General Information

1.1 Introduction

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

The ESA, under section 4(c)(2), directs the Secretary of Commerce to review the listing classification of threatened and endangered species at least once every 5 years. A 5-year review is a periodic analysis of a species' status conducted to ensure that the listing classification of a species as threatened or endangered on the List of Endangered and Threatened Wildlife and Plants (List) (50 CFR 17.11 – 17.12; 50 CFR 223.102, 224.101) is accurate (USFWS and NMFS 2006, NMFS 2020). After completing this review, the Secretary must determine if any species should be: (1) removed from the list; (2) have its status changed from endangered to threatened; or (3) have its status changed from threatened to endangered. If, in the 5-year review, a change in classification is recommended, the recommended change will be further considered in a separate rule-making process. The most recent 5-year review analysis for West Coast salmon and steelhead occurred in 2016 (NMFS 2016a). This document describes the results of the 2024 5-year review of the ESA-listed Southern Oregon/Northern California Coast (SONCC) Coho Salmon Evolutionarily Significant Unit (ESU).

A 5-year review is:

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

A 5-year review is not:

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

1.1.1 Background on salmonid listing determinations

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

Artificial propagation programs (hatcheries) are common throughout the range of ESA-listed West Coast salmon and steelhead. Prior to 2005, our policy was to include in the listed ESU or DPS only those hatchery fish deemed essential for conservation of a species. We revised that approach in response to a court decision and on June 28, 2005, announced a final policy addressing the role of artificially propagated Pacific salmon and steelhead in listing determinations under the ESA (70 FR 37204) (Hatchery Listing Policy). This policy establishes criteria for including hatchery stocks in ESUs and DPSs. In addition, it (1) provides direction for considering hatchery fish in extinction risk assessments of ESUs and DPSs; (2) requires that hatchery fish determined to be part of an ESU or DPS be included in any listing of the ESU or DPS; (3) affirms our commitment to conserving natural salmon and steelhead populations and the ecosystems upon which they depend; and (4) affirms our commitment to fulfilling trust and treaty obligations with regard to the harvest of some Pacific salmon and steelhead populations, consistent with the conservation and recovery of listed salmon ESUs and steelhead DPSs.
To determine whether a hatchery program is part of an ESU or DPS, we consider the origins of the hatchery stock, where the hatchery fish are released, and the extent to which the hatchery stock has diverged genetically from the donor stock. We include within the ESU or DPS (and therefore within the listing) hatchery fish that are derived from the population in the area where they are released, and that are no more than moderately diverged from the local population.

Because the new Hatchery Listing Policy changed the way we considered hatchery fish in ESA listing determinations, we completed new 5-year reviews and ESA listing determinations for West Coast salmon ESUs on June 28, 2005 (70 FR 37160), and for steelhead DPSs on January 5, 2006 (71 FR 834). On May 26, 2016, we published our most recent 5-year reviews and listing determinations for 17 ESUs of Pacific salmon, 10 DPSs of steelhead, and the southern DPS of eulachon (*Thaleichthys pacificus)* (81 FR 33468).

1.2 Methodology Used to Complete the Review

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

To complete the reviews, we first asked scientists from our Northwest and Southwest Fisheries Science centers to collect and analyze new information about ESU and DPS viability. To evaluate viability, our scientists used the Viable Salmonid Population (VSP) concept developed by McElhany et al. (2000). The VSP concept evaluates four criteria – abundance, productivity, spatial structure, and diversity – to assess species viability. Through the application of this concept, the science centers considered new information for a given ESU or DPS relative to the four salmon and steelhead population viability criteria. They also considered new information on ESU and DPS composition. At the end of this process, the science teams prepared reports detailing the results of their analyses. SONCC coho salmon were assessed in the Southwest Fisheries Science Center's (SWFSC) viability assessment (SWFSC 2022).

We also asked our salmon management biologists from the West Coast Region familiar with hatchery programs to consider new information available since the previous listing determinations. Among other things, they considered hatchery programs that have ended, new hatchery programs that have started, changes in the operation of existing programs, and scientific data relevant to the degree of divergence of hatchery fish from naturally spawning fish in the same area. Finally, we consulted salmon management biologists from our West Coast Region familiar with habitat conditions, hydropower operations, and harvest management. In a series of structured meetings by geographic area, these biologists identified relevant information and provided their insights on the degree to which circumstances have changed for each listed entity since the 2016 5-year review.

In preparing this report, we considered all relevant information, including the work of the SWFSC (SWFSC 2022), reporting by the regional biologists regarding hatchery programs, the SONCC coho salmon recovery plan (NMFS 2014), the listing record (including designation of critical habitat and adoption of protective regulations), recent biological opinions issued for SONCC coho salmon, information submitted by the public and other government agencies, and the information provided by the geographically based salmon recovery partners. The present report describes the agency's findings based on all of the information considered.

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

1.3.1 Federal Register Notice announcing initiation of this review

84 FR 53117; October 4, 2019

1.3.2 Listing history

In 1997, NMFS listed SONCC coho salmon under the ESA and classified it as a threatened species in 1997 (Table 1).

Table 1. Summary of the listing history under the Endangered Species Act for the SONCC Coho Salmon ESU.

Salmonid Species	ESU/DPS Name	Original Listing	Revised Listing
coho salmon *(O. kisutch)*	Southern Oregon / Northern California Coast coho salmon	FR Notice: 62 FR 24588 Date: 5/06/1997 Classification: Threatened	FR Notice: 70 FR 37160 Date: 6/28/2005 Re-classification: Threatened

1.3.3 Associated rulemakings

The ESA requires NMFS to designate critical habitat, to the maximum extent prudent and determinable, for species it lists under the ESA. Critical habitat is defined as: (1) specific areas within the geographical area occupied by the species at the time it is listed, on which are found those physical or biological features essential to the conservation of the species, and which may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by the species at the time it is listed, upon a determination by the Secretary that such areas are essential for the conservation of the species. We designated critical habitat for SONCC coho salmon in 1999 (Table 2) (64 FR 24049).

Section 9 of the ESA prohibits the take of species listed as endangered. The ESA defines take to mean harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct. For threatened species, the ESA does not automatically prohibit take. Instead, it authorizes the agency to adopt regulations it deems necessary and advisable for species conservation and to apply the take prohibitions of section 9(a)(1) through ESA section 4(d). In 2000, NMFS adopted 4(d) regulations for threatened salmonids that prohibit take except in specific circumstances. In 2005, we revised our 4(d) regulations for consistency between ESUs and DPSs, and to take our Hatchery Listing Policy into account.

Table 2. Summary of rulemaking for 4(d) protective regulations and critical habitat for the SONCC Coho Salmon ESU.

Salmonid Species	ESU Name	4(d) Protective Regulations	Critical Habitat Designation
coho salmon (*O. kisutch*)	Southern Oregon / Northern California Coast coho salmon	FR notice: 65 FR 42422 Date: 7/10/2000 Revised: 6/28/2005 (70 FR 37160)	FR notice: 64 FR 24049 Date: 5/5/1999

1.3.4 Review history

Table 3 lists the previous scientific assessments of the status of the SONCC Coho Salmon ESU.

These assessments include 5-year reviews conducted by our Southwest Fisheries Science Center and technical reports prepared in support of recovery planning for this ESU.

Table 3. Summary of previous scientific assessments of the SONCC Coho Salmon ESU.

Salmonid Species	ESU/DPS Name	Document Citation
coho salmon **(*O. kisutch*)**	**Southern Oregon / Northern California Coast** **coho salmon**	**SWFSC 2022** **NMFS 2016a** **Williams et al. 2016** **NMFS 2011** **Williams et al. 2008** **Williams et al. 2006** **Good et al. 2005** **NMFS 2001** **Weitkamp et al. 1995**

1.3.5 Species' Recovery Priority Number at start of 5-year review process

On April 30, 2019, NMFS issued new guidelines (84 FR 18243) for assigning listing and recovery priorities. For determining a recovery priority for recovery plan development and implementation, we assess demographic risk (based on the listing status and species' condition in terms of its productivity, spatial distribution, diversity, abundance, and trends) and recovery potential (major threats understood, management actions exist under United States (U.S.) authority or influence to abate major threats, and certainty that actions will be effective) to assign a Recovery Priority number from 1 (high) to 11 (low). Additionally, if the listed species is in conflict with construction or other development projects or other forms of economic activity, then they are assigned a 'C' and are given a higher priority over those species that are not in conflict. Table 4 lists the current recovery priority number for the SONCC Coho Salmon ESU as 3C, as reported in NMFS (2019). In December 2023, NMFS issued the 2021-2022 Recovering Threatened and Endangered Species Report to Congress with updated recovery priority numbers. The recovery priority number for the SONCC Coho Salmon ESU remained unchanged (NMFS 2023).

1.3.6 Recovery plan

The final SONCC coho salmon recovery plan was released on 9/30/2014 (Table 4).

Table 4. Recovery priority number and Endangered Species Act Recovery Plan for the SONCC Coho Salmon ESU.

Salmonid Species	ESU Name	Recovery Priority Number	Recovery Plan
coho salmon (*O. kisutch*)	**Southern Oregon / Northern California Coast coho salmon**	**3C**	**Title: Southern Oregon Northern California Coast Coho Salmon Recovery Plan Available at: https://www.fisheries.noaa.gov/resource/document/final-recovery-plan-southern-oregon-northern-california-coast-evolutionarily Date: 9/30/2014 Type: Final FR Notice: 79 FR 58750**

2 Review Analysis

This section reviews new information to determine whether the SONCC Coho Salmon ESU delineation remains appropriate.

2.1 Delineation of species under the Endangered Species Act

Is the species under review a vertebrate?

ESU Name	YES	NO
Southern Oregon / Northern California Coast coho salmon	X	

Is the species under review listed as a DPS?

ESU Name	YES	NO
Southern Oregon / Northern California Coast coho salmon	X	

Was the DPS listed prior to 1996?

ESU Name	YES	NO	Date Listed if Prior to 1996
Southern Oregon / Northern California Coast coho salmon		X	n/a

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

In 1991, NMFS issued a policy explaining how the agency would delineate DPSs of Pacific salmon for listing consideration under the ESA (56 FR 58612). Under this policy, a group of Pacific salmon populations is considered an ESU if it is substantially reproductively isolated from other con-specific populations, and it represents an important component in the evolutionary legacy of the biological species. The 1996 joint NMFS-U.S. Fish and Wildlife Service (USFWS) DPS policy (61 FR 4722) affirmed that a stock (or stocks) of Pacific salmon is considered a DPS if it represents an ESU of a biological species.

2.1.1 Summary of relevant new information regarding delineation of the SONCC Coho Salmon ESU

2.1.1.1 ESU Delineation

This section summarizes information presented in Williams (2022): Viability assessment for Pacific salmon and steelhead listed under the Endangered Species Act: Southwest (Southern

Oregon/Northern California Coast Recovery Domain).

We found no new information that would justify a change in the delineation of the SONCC Coho Salmon ESU (Williams 2022).

2.1.1.2 Membership of Hatchery Programs

For West Coast salmon and steelhead, many ESU and DPS descriptions include fish originating from specific artificial propagation programs (i.e., hatcheries) that, along with their naturally produced counterparts, are included as part of the listed species. NMFS' Policy on the Consideration of Hatchery-Origin Fish in Endangered Species Act Listing Determinations for Pacific Salmon and Steelhead (Hatchery Listing Policy) (70 FR 37204, June 28, 2005) guides our analysis of whether individual hatchery programs should be included as part of the listed species. The Hatchery Listing Policy states that hatchery programs will be considered part of an ESU/DPS if they exhibit a level of genetic divergence relative to the local natural population(s) that is not more than what occurs within the ESU/DPS.

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

In the 2016 5-year review, the SONCC Coho Salmon ESU was defined as including naturally spawned coho salmon originating from coastal streams and rivers between Cape Blanco, Oregon, and Punta Gorda, California, and coho salmon from the following artificial propagation programs: The Cole Rivers Hatchery Program (ODFW Stock #52); Trinity River Hatchery Program; and the Iron Gate Hatchery Program (70 FR 37160, June 28, 2005). In 2020, we removed the ODFW stock number from the name of the Cole Rivers Hatchery Program to standardize conventions for naming hatchery programs (85 FR 81822, December 17, 2020). No further changes have been made to the hatchery programs included in this ESU.

On February 1, 2023, the California Department of Fish and Wildlife (CDFW) submitted a final Fall Creek Hatchery (FCH) coho salmon program Hatchery Genetic Management Plan (HGMP) (CDFW 2023a) to NMFS as an attachment to an application for an ESA section 10(a)(1)(A) permit for scientific research and enhancement activities associated with implementation of the FCH coho salmon program HGMP. The FCH coho salmon program HGMP is an update to the 2014 HGMP developed for the coho salmon program at Iron Gate Hatchery (IGH). CDFW and PacifiCorp anticipated that the 2014 HGMP would cover hatchery operations until the mainstem Klamath River dams of the Klamath Hydroelectric Project were removed. NMFS completed a biological opinion on the effects to ESA-listed species of the dam removal project, including the construction of FCH, and changes to the non-ESA-listed Chinook salmon program at FCH. To ensure that hatchery operations continue without interruption during dam removal in 2023 and 2024, the FCH became operational and fish were transferred from IGH to FCH in December

2023. The 2023 HGMP covers activities related to the artificial production of coho salmon at FCH during the program's transition from IGH, and for 8 years after dam removal. Because the FCH coho salmon program is a continuation of the IGH coho salmon program, FCH-origin coho salmon will also be a component of the SONCC Coho Salmon ESU, and the ESU membership of hatchery programs remains unchanged.

2.2 Recovery Criteria

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

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

For Pacific salmon, Technical Recovery Teams (TRTs) appointed by NMFS define criteria to assess biological viability for each listed species. NMFS develops criteria to assess progress toward alleviating the relevant threats (listing factor [threats] criteria). NMFS adopts the TRT's viability criteria as the biological criteria for a recovery plan, based on best available scientific information and other considerations as appropriate. For the SONCC coho salmon recovery plan (NMFS 2014), NMFS adopted the viability criteria metrics defined by the SONCC Technical Recovery Team (Williams et al. 2008) as the biological recovery criteria for the threatened SONCC Coho Salmon ESU.

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

2.2.1 A final, approved recovery plan containing objective, measurable criteria

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

ESU Name	YES	NO
Southern Oregon / Northern California Coast coho salmon	X	

2.2.2 Adequacy of recovery criteria

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

ESU Name	YES	NO
Southern Oregon / Northern California Coast coho salmon	X	

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

ESU Name	YES	NO
Southern Oregon / Northern California Coast coho salmon	X	

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

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

The SONCC Coho Salmon ESU includes all naturally spawned coho salmon originating from coastal streams and rivers between Cape Blanco, Oregon, and Punta Gorda, California. The ESU also includes coho salmon from the following artificial propagation programs: the Cole Rivers Hatchery Program, Trinity River Hatchery Program, and the IGH Program (85 FR 81822, December 17, 2020).

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

For recovery planning and development of recovery criteria, the SONCC Technical Recovery Team (TRT) identified independent and dependent populations within the SONCC Coho Salmon ESU and grouped these populations into diversity strata. Diversity strata are groups of populations that together span the diversity and distribution that currently exists or historically existed within the ESU: "diversity" refers to the diversity of (potential) selective environments, diversity of phenotypes, including life history types, and diversity of genetic variation (Williams et al. 2006). The TRT grouped the populations that make up the ESU into seven diversity strata: Northern Coastal Basins, Interior Rogue River, Central Coastal Basins, Interior Klamath River, Interior Trinity River, Southern Coastal Basins, and Interior Eel River (Figure 1). Biological recovery criteria and associated strategies outlined in the 2014 SONCC coho salmon recovery plan are targeted to achieve, at a minimum, the TRT (Williams et al. 2008) biological viability criteria for each of the diversity strata in the ESU.

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

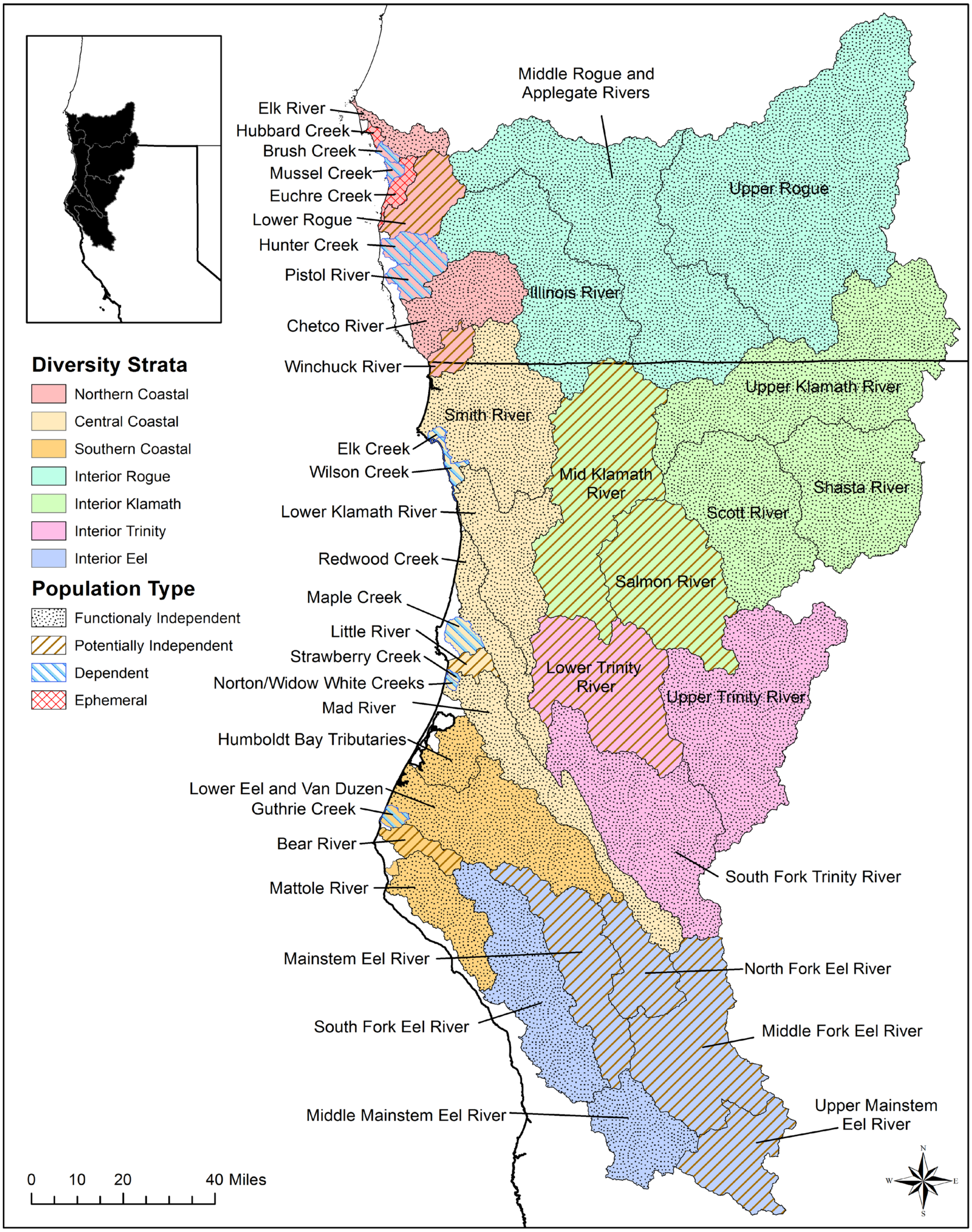

Figure 1. Historical population structure of the SONCC Coho Salmon ESU, including populations and diversity strata, as described by Williams et al. (2006). Source: NMFS (2014).

The VSP concept identifies the attributes, provides guidance for determining the conservation status of populations and larger-scale groupings of Pacific salmonids, and describes a general framework for how many and which populations within an ESU/DPS should be at a particular status for the ESU/DPS to have an acceptably low risk of extinction. The recovery plan (NMFS 2014) and the TRT (Williams et al. 2008) describe specific biological viability criteria based on the VSP concept (McElhany et al. 2000) at the population, diversity stratum, and DPS levels. At the population level, the TRT identified criteria for two of the components of VSP – abundance and productivity (Williams et al. 2008). The recovery plan (NMFS 2014) adopted these criteria and presented criteria for the remaining two viability components of VSP – spatial structure and diversity.

To achieve viability, the ESU must have sufficient representation, redundancy, connectivity, occupancy, and resiliency (Williams et al. 2008), which is accomplished when the populations within each diversity stratum meet their respective, population-specific biological recovery criteria, as articulated in the recovery plan (NMFS 2014). These biological recovery criteria address the VSP parameters of abundance, productivity, spatial structure, and diversity. The biological recovery criteria for each population, taken together, reflect a continuous set of functional populations across the ESU that together form the basis for a viable ESU (Williams et al. 2008).

The recovery plan describes the combination of population statuses most likely to achieve viability for each diversity stratum and thus the ESU. The biological recovery criteria are as follows (NMFS 2014): For the ESU to be viable, all seven diversity strata must be viable. Within a diversity stratum, at least two (or 50 percent) of the independent populations must achieve a low risk of extinction; these populations are designated ‘Core’ in NMFS (2014). The remaining independent populations (designated ‘Non-Core 1’) must achieve at least a moderate risk of extinction, and all the dependent populations must demonstrate juvenile occupancy during years following high ocean survival. Population growth rates should be neutral or positive for all Core and Non-Core 1 populations. Populations should be widely distributed, and there should be sufficient inter- and intra-stratum connectivity. Hatchery impacts on natural-origin fish should be low or moderate, and life history diversity should be restored and maintained. The abundance criteria are summarized below by diversity stratum.

2.2.3.1 Northern Coastal Basins

To ultimately delist the SONCC Coho Salmon ESU, the Elk River and Chetco River populations (Core) must reach a low risk of extinction. The Lower Rogue River and Winchuck River populations (Non-Core 1) must reach a low or moderate risk of extinction. The Brush Creek, Mussel Creek, Hunter Creek, and Pistol River populations (Dependent) should support juvenile occupancy following years of high ocean survival.

2.2.3.2 Interior Rogue River

To ultimately delist the SONCC Coho Salmon ESU, the Illinois River and Upper Rogue River populations (Core) must reach a low risk of extinction. The Middle Rogue and Applegate River population (Non-Core 1) must reach a low or moderate risk of extinction.

2.2.3.3 Central Coastal Basins

To ultimately delist the SONCC Coho Salmon ESU, the Smith River, Lower Klamath River, and Redwood Creek populations (Core) must reach a low risk of extinction. The Mad River and Little River populations (Non-Core-1) must reach a low or moderate risk of extinction. The Elk Creek, Wilson Creek, Maple Creek/Big Lagoon, Strawberry Creek, and Norton/Widow White Creek populations (Dependent) must support juvenile occupancy following years of high ocean survival.

2.2.3.4 Interior Klamath River

To ultimately delist the SONCC Coho Salmon ESU, the Upper Klamath River, Scott River, and Shasta River populations (Core) must reach a low risk of extinction. The Middle Klamath River and Salmon River populations (Non-Core-1) must reach a low or moderate risk of extinction.

2.2.3.5 Interior Trinity River

To ultimately delist the SONCC Coho Salmon ESU, the Lower Trinity River and Upper Trinity River populations (Core) must reach a low risk of extinction. The South Fork Trinity River population (Non-Core-1) must reach a low or moderate risk of extinction.

2.2.3.6 Southern Coastal Basins

To ultimately delist the SONCC Coho Salmon ESU, the Humboldt Bay Tributaries and Lower Eel/Van Duzen River populations (Core) must reach a low risk of extinction. The Mattole River population (Non-Core 1) must reach a low or moderate risk of extinction. The Bear River (Non-Core 2) and Guthrie Creek (Dependent) populations must support juvenile occupancy following years of high ocean survival.

2.2.3.7 Interior Eel River

To ultimately delist the SONCC Coho Salmon ESU, the South Fork Eel River, Mainstem Eel River, and Middle Mainstem Eel River populations (Core) must reach a low risk of extinction. The Middle Fork Eel River, North Fork Eel River, and Upper Mainstem Eel River (Non-Core 2) must support juvenile occupancy following years of high ocean survival.

2.3 Updated Information and Current Species' Status

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

Information provided in this section is summarized from SWFSC (2022).

2.3.1.1 Updated Biological Risk Summary

The available data for populations within the SONCC Coho Salmon ESU indicate that all independent populations remain below recovery targets. Of the few populations with sufficient monitoring data to calculate the number of adults, two of these populations are at high risk of extinction (Shasta River and Mattole River). Of the seven times series available for this assessment, positive abundance trends were observed in only the Elk and Scott Rivers. Only the

Elk River abundance trend was significantly different from zero (positive); the remaining five populations had negative abundance trends, although only the Shasta River population trend was significantly different from zero. All independent populations that are included in this assessment and were included in the previous assessment had a smaller average annual abundance estimates in this most recent assessment, including the Scott River. The addition of Elk River abundance time series provides information for the Northern Coastal Basins diversity stratum and is the only significantly positive abundance trend in the ESU at the population-unit scale, although the annual average abundance (166) and most recent 12 years average abundance (296) are well below the population recovery target of 2,400.

The two composite estimates (includes multiple independent populations) for the Rogue River and the Trinity River provide information at a larger spatial scale and include longer time series of abundance estimates. Neither includes the entire habitat of the diversity stratum, but both include large portions of the diversity stratum. The Rogue Basin short-term abundance trend is positive and the long-term abundance trend is negative, but neither trend is significant; although the average abundance is lower in the most recent 12 years compared to the full 23-year time series. The Trinity River short-term abundance trend and the long-term abundance trend are both negative, with the most recent 12-year time series having a significant negative trend. These composite abundance estimates do not represent a stratum-level abundance estimate, but provide some relative information on the number of fish in these strata. The 12-year average abundance estimate from the Trinity River basin estimate is 1,116, or 12 percent of the recovery target for the stratum of 9,700 fish. The negative trends, including a significant decline over the past 12 years of natural-origin adult coho salmon returning to natural areas from Willow Creek weir upstream to the Trinity River Hatchery, is a concern.

As with the previous viability assessment, the low number of adults counted entering the Shasta River continues to be a concern. The significant negative trend of the 18-year time series and low numbers of fish observed in 10 of 12 most recent years is very concerning. The 12-year trend in the Scott River is not significant, but positive and has averaged 670 adult coho salmon. The positive trends in the Elk River and the non-statistically significant 12-year positive trend in the composite Rogue Basin time series are promising. The lack of increasing abundance trends across the ESU for most populations with adequate data remains of concern.

In summary, while data availability for this ESU remains generally poor, the new information available since Williams et al. (2016) does not suggest a change in demographic risk at this time, and the ESU is considered not viable and at moderate demographic risk.

2.3.2 Analysis of ESA Listing Factors

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

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

Significant habitat restoration and protection actions at the federal, state, tribal, and local levels have been implemented to improve degraded habitat conditions and restore fish passage. While these efforts have been substantial and are expected to benefit the survival and productivity of the targeted populations, we do not yet have evidence demonstrating that improvements in habitat conditions have led to improvements in population viability. The effectiveness of habitat restoration actions and progress toward meeting the viability criteria continues to be monitored and evaluated with the aid of newly implemented monitoring and evaluation programs. Generally, it takes one to five decades to demonstrate increases in viability.

Current Status and Trends in Habitat

Below, we summarize information on the current status and trends in habitat conditions by diversity stratum since our last 5-year review (NMFS 2016a). We specifically address: (1) the key emergent or ongoing habitat concerns (threats or limiting factors) focusing on the top concerns that potentially have the biggest impact on independent population viability; (2) the population-specific geographic areas (e.g., independent population major/minor spawning areas) where key emergent or ongoing concerns about this habitat condition remain; (3) population-specific key protective measures and major restoration actions taken since the 2016 5-year review toward achieving the ESU viability criteria established by the SONCC TRT (Williams et al. 2008) and adopted by NMFS in the final recovery plan for the Southern Oregon/Northern California Coast Evolutionarily Significant Unit of coho salmon (NMFS 2014) as efforts that substantially address a key concern noted in above #1 and # 2, or that represent a noteworthy conservation strategy; (4) key regulatory measures that are either adequate or inadequate and contributing substantially to the key concerns summarized above; and (5) recommended future recovery actions over the next 5 years toward achieving population viability, including: key near-term restoration actions that would address the key concerns summarized above, projects to address monitoring and research gaps, fixes or initiatives to address inadequate regulatory mechanisms, and addressing priority habitat areas when sequencing priority habitat restoration actions.

Northern Coastal Basins Diversity Stratum

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

- In 2019, the John D. Dingell Jr. Conservation, Management, and Recreation Act (Public Law 116-9; 133 Stat. 580) added approximately 46 miles of the Elk River to the National Wild and Scenic Rivers system (https://www.rivers.gov/rivers/elk.php) to the previously designated 28 miles. The national system was created in 1968 (Public Law 90-542) to preserve regionally and nationally significant rivers with outstanding values in a free-flowing condition, and protections include boundaries of approximately 0.25 miles on either side of the river. These extended protections will assist with retaining and enhancing important habitat features for coho salmon, including riparian areas, water quality, and off-channel habitat for approximately 74 river miles (Elk River population).

- The Elk River Coho Partnership developed a strategic action plan for coho salmon recovery to accelerate the strategic protection and restoration of critical coho habitats in the Elk River (Elk River Coho Partnership 2018). Restoration funds from the National Oceanographic and Atmospheric Administration (NOAA) Restoration Center, Wild Salmon Center, and Oregon Watershed Enhancement Board (OWEB) are now contributing to the implementation of this strategic action plan. For example, a recent project focused on enhancing summer and winter rearing habitat in Cedar Creek and Kermit Creek by planting riparian vegetation, placing wood in-stream, and creating wetlands (Elk River population).
- In 2019, nineteen miles of the Chetco River were permanently protected from mining activities, including mineral and geothermal extraction, under the John D. Dingell Jr. Conservation, Management, and Recreation Act (Public Law 116-9; 133 Stat. 580) (Chetco River population).

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

For the five independent SONCC coho salmon populations (Chetco River, Elk River, Lower Rogue River, Winchuck River, and Pistol River) in the Northern Coastal Basins diversity stratum, the primary habitat concerns since the 2016 5-year review continue to be:

- Elevated water temperatures (ODEQ 2020) (Winchuck River population).
- Lack of juvenile winter rearing habitat because of channelization and diking, loss of connectivity to off-channel habitat, and loss of in-stream channel complexity (all populations).
- Loss and filling of wetlands, water diversion, riparian alteration, polluted stormwater runoff, and blocked access to formerly productive tributaries because of agricultural practices. Although other land uses are also of concern, agricultural practices are a top threat for coho salmon because their impacts are concentrated in the lower basins throughout the stratum, where the highest intrinsic potential habitat exists and where all fish from the upper basin must pass. (See also Elk River Coho Partnership 2018) (All populations).
- A major emergent habitat concern since the 2016 5-year review is the increased frequency and severity of large wildfires, such as the Chetco Bar fire that burned approximately 191,197 acres from July 12 through containment on November 2, 2017. The Chetco, Winchuck, and Pistol Rivers were within the fire perimeter. With 41 percent of the area burned at high or moderate severity, the United States Forest Service (USFS 2017) described post-fire runoff, debris flows, ash, and sediment delivery as threats to the SONCC coho salmon populations.
- Sudden oak death (SOD) infections continue to be detected and the current quarantine

area is approximately 515 square miles in Oregon. Dispersal of SOD is influenced by climate, topography, spore abundance, and host vegetation susceptibility (Vaclavik 2010). Since 2001, the quarantine area has been expanded seven times with the most recent expansion in 2015 (ODF 2021). Although originally concentrated in the North Fork Chetco River watershed, infected trees have been recently detected farther north up the coast past the Lower Rogue River, as far as Port Orford, Oregon (California Oak Mortality Task Force 2021, KPIC 2021). The newest detection was approximately 21 miles north of the quarantine area (KPIC 2021). Resources are focused on treatments in areas of the quarantine area to minimize future expansion of the quarantine (Highland Economics and Mason Bruce & Girard, Inc. 2019). SOD infections, and the control efforts to limit outbreaks (i.e., cutting and burning all infected and nearby host plants) in Oregon (Oregon Department of Forestry 2023, Hansen et al. 2019), affect riparian function as they involve removing trees and/or canopy, especially tanoaks, from riparian and upland areas. Where large outbreaks or eradication efforts occur, riparian functions could be negatively affected. There is also a concern that standing dead vegetation from SOD can contribute to elevated wildfire risk, behavior, or severity because forests with SOD have more standing dead trees or dead and downed woody fuels compared to disease-free forests (Metz et al. 2017).

- Research since 2016 has shown that the severity of the threat posed by stormwater runoff from roadways and streets is greater than originally understood because it contains 6PPD, a degradation product of tires that has recently been shown to cause salmon mortality at concentrations of less than one part per billion (Peter et al. 2018, Tian et al. 2021). Multiple tire manufacturers use this contaminant in their tires. The dust and shreds from these tires have been widely found where both rural and urban roadways drain into waterways (Feist et al. 2017, Sutton et al. 2019). ***See Listing Factor D for a more thorough discussion.***

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

- Estuarine areas, Jack Creek, North Fork Chetco River, and Emily Creek (Chetco River population).
- Lower river and estuarine areas (including all tributaries of the alluvial coastal plain downstream of Rock Creek), Panther Creek, and Sunshine Creek (Elk River Coho Partnership 2018) (Elk River population).
- Lower river and estuarine areas, Lobster Creek (including both South Fork and North Fork), Indian Creek, and Saunders Creek (Lower Rogue River population).
- Lower mainstem, estuarine areas, and the South Fork Winchuck River (Winchuck River population).

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

The SONCC coho salmon recovery plan (NMFS 2014) and the previous 5-year review identified specific inadequate regulatory mechanisms, some of which affect SONCC populations in the

Northern Coastal Basins diversity stratum. Various federal, state, and county regulatory mechanisms are in place to minimize or avoid habitat degradation caused by human use and development. Many of these mechanisms have been improved and updated in the past 5 years. However, the implementation and effectiveness of regulatory mechanisms have not been adequately documented. ***See Listing Factor D: Inadequacy of Existing Regulatory Mechanisms in this document for details.***

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

The greatest opportunities to advance recovery of SONCC coho salmon in the Northern Coastal Basins Diversity Stratum are the following:

A1: Establish streamside buffers and plant native vegetation adjacent to streams to re-establish mature streamside forests and address concerns with elevated water temperatures (all populations).

A2: Increase the amount and quality of winter rearing habitat by improving stream and estuarine habitat complexity by increasing in-stream large wood and pool habitat, improving/increasing riparian vegetation along streams, and connecting side channels, wetlands, and other off-channel areas for all land uses including agricultural areas in the geographic locations mentioned above (all populations).

A3: Create incentives for key agricultural land owners and water users to conserve land and water and restore riparian areas and functions. Explore possibilities for utilizing funds from the Bipartisan Infrastructure Law, the Inflation Reduction Act, and other sources (all populations).

A4: Monitor the implementation of riparian buffer reforms on private forestlands (under the 2017 Oregon Forest Practices Act rules) and their success in meeting the Oregon Environmental Quality Commission's Protecting Cold Water criteria, to address concerns with elevated water temperatures (all populations).

A5: Develop a Habitat Conservation Plan (HCP) for private timber lands within this stratum and include protective buffers for large wood recruitment, shade to prevent increases in water temperature, and properly functioning and resilient areas riparian (all populations).

A6: Develop and implement beaver conservation plans that encourage beaver activity to create new and complex in-stream habitat and increase rearing habitat for salmonids. The plans should include education and outreach, technical assistance for landowners, and methods for reintroduction and/or relocation of beaver as a last resort (all populations).

A7: Implement habitat restoration projects identified in the Elk River Strategic Action Plan for Coho Salmon Recovery (Elk River Coho Partnership 2018) (Elk River population).

Central Coastal Basins Diversity Stratum

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

For the five independent SONCC coho salmon populations (Redwood Creek, Smith River, Lower Klamath River, Mad River, and Little River) in the Central Coastal Basins diversity stratum, the primary habitat concerns since the 2016 5-year review are:

- Lack of instream summer and winter rearing habitat, especially in tributaries, due to a lack of instream structure; insufficient access to floodplain habitat and to existing off-channel ponds, wetlands, and side channels; and degraded riparian forest conditions (NMFS 2014) (all populations).
- Levied estuaries and blocked sloughs. Much of the historical estuary in the Smith River Plain[1], Little River, and Redwood Creek has been lost through levies and tributary/slough blockages, which creates critical bottlenecks in juvenile survival and adult fish passage. The Smith River estuary is levied, and Tillis and Islis sloughs are blocked to create impoundments for agriculture (NCRWQCB 2018) (Smith River population). Redwood Creek is levied along the entire estuary, which affects the tidal prism and coho salmon smolt access to non-natal rearing and other estuarine functions that support coho salmon survival.
- Insufficient large wood and high sediment loads due to past logging practices and historic floods, respectively (NMFS 2014) (Redwood Creek population).
- Little River has lost much of its off-channel estuary habitat due to reclamation activities for agriculture and impingement from roads (e.g., Highway 101) (PWA 2019) (Little River population).
- Tributaries, including Waukell Creek, Blue Creek, McGarvey Creek, Panther Creek, and Salt Creek, provide important natal and non-natal rearing habitat for coho salmon; tributary stream habitat improvement projects should continue (Lower Klamath River population).
- Increased frequency of drought (Diffenbaugh et al. 2015), which began again in 2015, has impacted SONCC coho salmon by (1) reducing the quantity and quality of rearing habitat, (2) increasing stress and disease due to exposure to chronic high water temperatures; increasing the chances of redd scour due to low flow spawning followed by a storm event, or conversely leaving redds dry when flows recede; and (4) interfering with smolt outmigration because of disconnected flow, temperature barriers, or both (all populations). ***See Listing Factor E: Other natural or manmade factors affecting its***

[1] The Smith River Plain is a geologic term referring to "…a broad, subrectangular emerged marine terrace of low relief at the base of a range of rugged mountains…The area is drained principally by porous, 1,900 acre alluvial plain created by the Smith River and its tributaries…Lakes Earl and Talawa, shallow brackish-water lakes in the west-central part of the plain, form a collection basin for runoff from several minor streams (Back 1957)."

continued existence in this document for additional details on climate and drought.

- High water temperature and low flows caused by drought and diversions from the Upper Klamath River and the Trinity River (Bureau of Reclamation 2000; Som et al. 2019) create stress which immunosuppresses individuals and makes them more susceptible to disease and parasites (Lower Klamath River population).
- Rowdy Creek's altered hydrology and lack of channel structure (NMFS 2014) (Smith River population).
- Water quality concerns in the Smith River Plain arising from dairy (nutrients) and lily bulb production (pesticides and nutrients) (NCRWQCB 2018, NMFS and CDFW 2018) (Smith River population).
- Water quantity concerns in Smith River Plain tributaries, including Rowdy Creek, Dominie Creek, and others from agricultural and domestic diversions (Smith River population).
- Water diversions for cannabis cultivation affect Redwood Creek and Mad River populations.
- Continued water quality concerns (high temperature) in the Lower Klamath River due to low flows caused by drought, and diversions from the Upper Klamath River and Trinity River (Som et al. 2019, US Department of Interior 2000) (Lower Klamath River population).
- Lack of habitat complexity and impaired floodplain access in the lower river and estuary (NMFS 2014) (Mad River population).
- Inadequate large wood in streams continues to limit the formation and persistence of instream and off-channel coho salmon habitat (all populations).
- Climate change resulting in reduced snowpack, changes in precipitation patterns, reduced water quantity, and increased water temperatures (all populations).
- Research since 2016 has shown that the severity of the threat posed by stormwater runoff from roadways and streets is greater than originally understood because it contains 6PPD, a degradation product of tires that has recently been shown to cause salmon mortality at concentrations of less than one part per billion (Peter et al. 2018, Tian et al. 2021). Multiple tire manufacturers use this contaminant in their tires. The dust and shreds from these tires have been widely found where both rural and urban roadways drain into waterways (Feist et al. 2017, Sutton et al. 2019). ***See Listing Factor D for a more thorough discussion.***

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

- Estuaries and tidal sloughs (Smith River, Little River, and Redwood Creek populations).
- Smith River Plain tributaries, including Rowdy Creek (Smith River population).
- Lower Redwood Creek and estuary (Redwood Creek population).

- Lower Mad River and estuary (Mad River population).
- Lower Klamath River tributaries, including Waukell Creek, Blue Creek, McGarvey Creek, Panther Creek, and Salt Creek (Lower Klamath River population).

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

- The largest dam removal project in U.S. history is underway on the Klamath River. The removal of four mainstem dams will improve hydrologic function, water quality, and disease conditions in the Lower Klamath River and estuary. Copco No. 2 Dam was removed in December 2023. Complete removal of the three remaining mainstem dams is expected by September 2024 – J.C. Boyle, Copco No. 1, and Iron Gate. Sediment that has accumulated behind these dams has been released and the river has carried it downstream.
- Redwood National and State Park Prairie and Mill Creeks Ecosystem Restoration Programs, including forest thinning to enhance late seral characteristics, road removal, and additions of large wood to Prairie and Mill creeks and their tributaries (GPCER 2019) (Redwood Creek and Smith River populations).
- Fish barrier removals through culvert upgrades and bridge installations have been completed throughout the Central Coastal Stratum (e.g., Stotenburg Creek) (all populations).
- The Yurok Tribe continues to implement restoration in the Lower Klamath River, including the Blue Creek Stage Zero Project, McGarvey Creek beaver dam analog project, and the addition of large wood to Terwer Creek (Faulkner et al. 2019) (Lower Klamath River population).
- Transfer of riparian and upland habitat in the Blue Creek watershed from private timber land to tribal ownership. The Yurok Tribe intends to manage the land to support native wildlife, including a 15,000-acre Salmon Sanctuary along Blue Creek, a major tributary to the Lower Klamath River[2] (Lower Klamath River population).

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

The SONCC coho salmon recovery plan (NMFS 2014) and the previous 5-year review identified specific inadequate regulatory mechanisms, some of which affect populations in the Central Coastal Basins diversity stratum. Various federal, state, and county regulatory mechanisms are in place to minimize or avoid habitat degradation caused by human use and development. Many of these mechanisms have been improved and updated in the past 5 years. However, the implementation and effectiveness of regulatory mechanisms has not been adequately documented. ***See Listing Factor D: Inadequacy of Existing Regulatory Mechanisms in this document for details.***

[2] Contact the Yurok Tribe Fisheries Department for more information: https://www.yuroktribe.org/fisheries

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

The greatest opportunities to advance recovery of SONCC coho salmon in the Central Coastal Basins Diversity Stratum are the following:

A8: Add large wood pieces to streams and rivers (all populations).

A9: CDFW regulate the removal of large wood from streams and rivers (all populations).

A10: North Coast Regional Water Quality Control Board enforce existing regulations to protect and restore water quantity and quality in agricultural operations (e.g., dairy and lily bulb production) (Smith River population).

A11: Restore and enhance estuarine function (all populations).

A12: Implement actions in the Smith River Plain Restoration Strategy (Parish Hanson 2018) (Smith River population).

A13: Implement actions in the Greater Prairie Creek Ecosystem Restoration Strategy (Redwoods Rising 2019) (Redwood Creek population).

A14: Implement the Lower Prairie Creek Channel Restoration Project[3] (Redwood Creek population).

Southern Coastal Basins Diversity Stratum

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

For the three core, independent SONCC coho salmon populations (Humboldt Bay Tributaries, Lower Eel/Van Duzen Rivers, and Mattole River) in the Southern Coastal Basins diversity stratum, the primary habitat concerns since the 2016 5-year review are:

- Insufficient tidal prism continues to limit sediment movement, reduces available habitat and connectivity between tidal, brackish and freshwater habitats, and disrupts the formation, function, and persistence of salmon habitat. In addition, there is potential for increased bank armoring and raising of levees in these areas to protect existing infrastructure from sea level rise, which would be counter to recovery actions that seek to increase the tidal prism, such as levee and dike removal, set back, or reconfiguration (Humboldt Bay Tributaries and Lower Eel/Van Duzen Rivers populations).
- Eelgrass wasting disease has caused the distribution and abundance of this critically important aquatic plant to contract. First discovered in 2013 (Merkel & Associates, Inc. 2017), observations from 2009 to 2023 indicate significant contraction in multiple areas,

[3] https://scc.ca.gov/2019/12/19/ceqa-notice-of-intent-to-adopt-a-mitigated-negative-declaration-for-save-the-redwoods-leagues-redwood-national-and-state-park-visitor-center-and-restoration-project/

with losses of eelgrass up to 60 percent in the Eel River estuary (Merkel & Associates, Inc. 2023). The reduction in spatial coverage of eelgrass and a corresponding decrease in eelgrass biomass disrupts ecosystem processes and the overall resilience of Humboldt Bay and the Eel River estuary to the effects of climate change, including ocean acidification and sea level rise. Eelgrass provides prey resources and cover, both as living plants and as dead floating eelgrass wrack, which are essential features that are important for the outmigration of smolt life stages (Pinnix et al. 2013). Reductions in eelgrass biomass have and will continue to reduce the quality and quantity of estuarine and migratory habitat elements (Humboldt Bay Tributaries population, Lower Eel/Van Duzen River population).

- Removal of water from streams prior to the onset of fall rains remains a major habitat concern. When water is taken from springs or the streams they feed (through diversions) or from the ground before it reaches the river (through pumping from wells), water temperature increases, threatening the survival of juvenile coho salmon living there. Where this water removal causes dry and intermittent stream reaches throughout the stratum, these juveniles become stranded in disconnected pools and die as the pools dry up (Humboldt Bay Tributaries, Lower Eel/Van Duzen Rivers, and Mattole River populations).
- Groundwater use has significantly increased in all populations as water users rely more on groundwater pumping now that new state regulations further limit diversions directly from streams. In the Franciscan geology underlying the Eel River, groundwater is not only connected to surface water flowing in streams but is thought to be the mechanism that provides for all summer flow (Hahm et al. 2019) (all populations).
- Increased frequency of drought began again in 2015, resulting in (1) reduced amount and quality of rearing habitat; (2) increased stress and disease due to chronic high temperatures; (3) reduced reproductive success due to increased redd scour when spawning occurs in vulnerable areas due to low flows followed by a storm event, or redd drying when flows recede; and (4) disruption of smolt outmigration because of disconnected flow, temperature barriers, or both (all populations). ***See Listing Factor E: Other natural or manmade factors affecting its continued existence in this document for additional details on climate and drought.***
- Pacific Gas and Electric (PG&E)'s Potter Valley Project affects the timing and volume of flows in the Eel River. The resulting impaired hydrograph disrupts the function of the Lower Eel River (Lower Eel/Van Duzen Rivers population).
- Research since 2016 has shown that the severity of the threat posed by stormwater runoff from roadways and streets is greater than originally understood because it contains 6PPD, a degradation product of tires that has recently been shown to cause salmon mortality at concentrations of less than one part per billion (Peter et al. 2018, Tian et al. 2021). Multiple tire manufacturers use this contaminant in their tires. The dust and shreds from these tires have been widely found where both rural and urban roadways drain into

waterways (Feist et al. 2017, Sutton et al. 2019). ***See Listing Factor D for a more thorough discussion.***

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

- Humboldt Bay and tidal portions of its tributaries (Humboldt Bay Tributaries population).
- The Eel River estuary and mainstem (Lower Eel River population).
- Tributaries in headwaters of the Mattole River, which support the only rearing habitat occupied by coho salmon in the watershed (Mattole River population).

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

- The multi-agency Humboldt Bay Eelgrass Comprehensive Management Plan was completed in 2017 (Merkel & Associates, Inc. 2017). This ecosystem-based management plan describes consistent goals and strategies for the restoration and conservation of eelgrass habitat; improves the efficiency of the regulatory process for projects in Humboldt Bay; and establishes a long-term conservation strategy that allows for sea level rise adaptation, dredging, and economic development in Humboldt Bay. Eelgrass is an important aspect of the health of Humboldt Bay, a critical area for juveniles born in its freshwater tributaries (Humboldt Bay Tributaries population).
- The Mattole Salmon Group (MSG), the Mattole Restoration Council (MRC), the Bureau of Land Management (BLM), and state and federal partners have continued large-scale habitat restoration in the Mattole River by placing large wood in the estuary and freshwater areas of the lower river and restoring tidal sloughs and connections between freshwater and brackish habitats. (MRC 2020). In addition, MSG and MRC have reduced the risk of high-intensity fire in the watershed through the removal of trees from high-density stands and use of these trees for instream habitat restoration projects in mid-River tributaries (MRC 2020) (Mattole River population).
- An important area of the headwaters of the Mattole River is now permanently protected from development and slated for groundwater recharge efforts (MRC 2020). In 2019, Sanctuary Forest purchased 300 acres in the headwaters of McKee Creek and secured a working forest conservation easement on the entire Van Arken Creek watershed. Van Arken Creek has some of the highest potential in the Mattole watershed to support coho salmon, due to the lack of diversions and presence of clean, cold water (Mattole River population).
- The Salt River Ecosystem Restoration Project,[4] carried out by the Humboldt County Resource Conservation District, landowners, and other partners, has increased tidal prism and restored access to and improved instream and intertidal habitat. Multiple phases of the project have been implemented during the past 5 years (Lower Eel/Van Duzen Rivers population).

[4] https://humboldtrcd.org/projects/salt-river-ecosystem-restoration/

- Restoration planning in several key areas of the Lower Eel River has progressed. These efforts aim to increase tidal prism, restore estuarine processes, and improve the amount and condition of habitat for the rearing and migrating life stages of coho salmon and other salmonids.
- The construction phase of the Ocean Ranch Restoration Project was completed in 2022. This project restored and enhanced 571 acres of tidal marsh habitat on property owned by CDFW by removing water control structures, lowering and breaching levees, excavating tidal channels, creating habitat heterogeneity, and controlling invasive dense-flowered cordgrass (CDFW 2022). Coho salmon are already utilizing the habitat for overwintering and outmigrant rearing; monthly fish monitoring in 2023 documented 30 juvenile coho salmon in the project area from February through June, and one in December (Marisa McGrew, Wiyot Tribe, personal communication, December 20, 2023). In addition, whole large spruce trees were placed in the Ocean Ranch Unit via helicopter in December 2023 to enhance marsh habitat and observe how large wood functions in this estuarine environment (Marisa McGrew, Wiyot Tribe, personal communication, December 20, 2023).
- In 2019, CDFW awarded California Trout (Caltrout) a grant to conduct the baseline data collection, hydraulic modeling analysis, engineering design, and environmental compliance phases of restoration planning for 950 acres of the Eel River estuary surrounding Cannibal Island, adjacent to the mouth of the Eel River. The project area includes the 650-acre Cannibal Island Unit owned by CDFW, as well as 300 privately owned acres. Caltrout has completed the tasks from the 2019 CDFW grant, and Caltrout and CDFW are seeking funding for final restoration designs and the implementation of these designs (Darren Mierau, Caltrout, personal communication, December 18, 2023 and James Ray, CDFW, personal communication, January 16, 2024).
- Approximately seven acres of riparian and tidal wetland habitats were restored in Humboldt Bay's Martin Slough, providing improved overwintering and rearing habitat (Llanos and Love 2019) (Humboldt Bay Tributaries population).

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

The SONCC coho salmon recovery plan (NMFS 2014) and the previous 5-year review identified specific inadequate regulatory mechanisms, some of which affect populations in the Southern Coastal Basins diversity stratum. Various federal, state, and county regulatory mechanisms are in place to minimize or avoid habitat degradation caused by human use and development. Many of these mechanisms have been improved and updated in the past 5 years. However, the implementation and effectiveness of regulatory mechanisms has not been adequately documented. ***See Listing Factor D: Inadequacy of Existing Regulatory Mechanisms in this document for details.***

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

The greatest opportunities to advance recovery of SONCC coho salmon in the Southern Coastal

Basins Diversity Stratum are the following:

A15: Increase tidal prism through (1) restoration of estuarine habitat connectivity and function; and (2) support of land use planning and regulation that minimizes additional bank armoring and raising of levees to protect existing infrastructure, in favor of developmental retreat from areas impacted by sea level rise (Lower Eel/Van Duzen Rivers, Humboldt Bay Tributaries, and Mattole River populations).

A16: Collaborate with federal and state resource agencies, tribes, restoration practitioners, and landowners in the Lower Eel River and mainstem South Fork Eel River to identify priority habitat restoration projects through the Lower Eel River Salmon Habitat Restoration Planning (SHaRP) process[5] that would address the major limiting factors for SONCC coho salmon (Lower Eel/Van Duzen Rivers population).

A17: Rehabilitate aquatic habitat in a key tributary by implementing actions in the Elk River Stewardship Recovery Plan (California Trout et al. 2022) (Humboldt Bay Tributaries population).

A18: Evaluate the significant retreat of eelgrass and address any stressors identified in causing the severe eelgrass wasting disease and eelgrass loss observed in multiple locations throughout the Eel River estuary and Humboldt Bay (Lower Eel/Van Duzen Rivers and Humboldt Bay Tributaries populations).

A19: Increase water forbearance, streamflow enhancement, water conservation, and groundwater sustainability projects (Lower Eel/Van Duzen Rivers and Mattole River populations).

A20: Address the shallow and simplified holding and staging habitat in the Lower Eel River through a combination of actions to improve complexity and promote pool scour and address the lack of tidal prism and geomorphic dysfunction in the lower river, which will improve sediment routing and increase depths and complexity (Lower Eel/Van Duzen Rivers population).

A21: Continue to advance the decommissioning of PG&E’s Potter Valley Project to achieve the removal of Scott Dam and Cape Horn Dam, which would improve flows in the Eel River to more closely mimic a natural unimpaired hydrograph, improving the function of the Lower Eel River (Lower Eel/Van Duzen Rivers population).

Interior Rogue River Diversity Stratum

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

For the three independent SONCC coho salmon populations (Illinois River, Middle Rogue/Applegate rivers, and Upper Rogue River) in the Interior Rogue diversity stratum, the primary habitat concerns since the 2016 5-year review are:

[5] https://www.fisheries.noaa.gov/west-coast/habitat-conservation/collaborating-identify-salmon-habitat-restoration-priorities

- Lack of juvenile winter rearing habitat because of deficient floodplain and channel structure and degraded riparian forests (all populations).
- Altered hydrologic function from water withdrawals that results in low (or no) flow and associated impaired water quality in tributaries and limits summer rearing habitat (all populations).
- Increased drought conditions which (1) reduced the amount and quality of rearing habitat; (2) increased stress and disease due to chronic high temperatures; (3) reduced reproductive success due to increased red scour when spawning occurs in vulnerable areas due to low flows followed by a storm event, or red drying when flows recede; and (4) disrupted smolt outmigration because of disconnected flow, temperature barriers, or both (all populations). See Listing Factor E: Other natural or manmade factors affecting its continued existence in this document for additional details on climate and drought.
- Commercial production of cannabis became legal in Oregon in 2016, and since then, the number of cannabis operations in the Interior Rogue stratum has substantially increased. Approximately 50 percent of all state-registered hemp growers are located in southwest Oregon and hemp production there is centered in Josephine and Jackson Counties (OWRD 2021). Excessive water withdrawals and impacts on water quality parameters, including temperature, sediment, nutrients, dissolved oxygen, have been identified as areas of potential concern [Oregon Department of Agriculture (ODA) 2022]. In 2020, the Oregon Water Resources Department conducted a statewide audit and found that approximately a third of the 187 visited sites were found to have some form of violation (OWRD 2021).
- Research since 2016 has shown that the severity of the threat posed by stormwater runoff from roadways and streets is greater than originally understood because it contains 6PPD, a degradation product of tires that has recently been shown to cause salmon mortality at concentrations of less than one part per billion (Peter et al. 2018, Tian et al. 2021). Multiple tire manufacturers use this contaminant in their tires. The dust and shreds from these tires have been widely found where both rural and urban roadways drain into waterways (Feist et al. 2017, Sutton et al. 2019). ***See Listing Factor D for a more thorough discussion.***

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

- West Fork Illinois River, East Fork Illinois River, Althouse Creek, Sucker Creek, and Deer Creek (Illinois River population).
- Middle Rogue River tributaries Galice Creek, Grave Creek, Limpy Creek, Jumpoff Joe Creek, Quartz Creek, Pickett Creek, and Taylor Creek; mainstem Applegate River and its major tributaries (Middle Rogue/Applegate Rivers population).
- Evans, Trail, Elk, Big Butte, and Little Butte Creeks, which are all headwaters tributaries; cold water tributaries to Bear Creek (Upper Rogue River population).

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

- NOAA's Restoration Center, the Wild Salmon Center, and a diverse team of local partners have completed a multi-year planning process to develop a strategic action plan that prioritizes habitat protection and restoration to recover the Upper Rogue River population of coho salmon. Now in development, the draft plan focuses on protecting and restoring areas of cold-water refugia through instream and riparian enhancements. In addition, the plan establishes long-term temperature targets in the lower reaches of high-priority tributaries and prioritizes locations to enhance riparian function and augment flows to meet them.
- In 2019, the John D. Dingell Jr. Conservation, Management, and Recreation Act (Public Law No. 116-9; 133 Stat. 580) added approximately 119 miles of the Rogue River (and tributaries) to the National Wild and Scenic Rivers system, including rivers miles that are part of the Applegate/Middle Rogue River population (https://www.rivers.gov/rivers/rogue.php). Previously, approximately 175 miles were designated in both this population and the Illinois River population, as well as the Lower Rogue River population in the Northern Coastal Stratum. The national system was created in 1968 (Public Law 90-542) to preserve regionally and nationally significant rivers with outstanding values in a free-flowing condition, and protections include boundaries approximately 0.25 mile on either side of the river. These extended protections will assist with retaining and enhancing important habitat features for coho salmon, including riparian areas, water quality, and off-channel habitat for approximately 294 river miles, or approximately 78 percent of the Rogue River basin (Middle Rogue/Applegate population).
- In 2019, the Elk Creek Project (i.e., a U.S. Army Corps of Engineers water supply and flood control dam) was deauthorized (Public Law No. 116-9; 133 Stat. 580). While the dam was never completed and was partially demolished in 2008, the deauthorization ensures that this tributary to the Upper Rogue River will remain without a dam. The same law also transferred 7.3 miles of Elk Creek to the Department of Interior for administration as a Scenic River in the Upper Rogue River population. This is in addition to the 119 miles mentioned under Key Protective Measures (Upper Rogue River population).
- Multiple dams impeding passage to cold-water refugia in the upper tributaries have been removed: Smith-Meyer-Roper Diversion Dam in 2020 (Ashland Creek), Beeson-Robison Diversion Dam in 2017 (Wagner Creek), and two seasonal push-up dams on Salt Creek (Little Butte Creek) in 2018 at River Mile 0.5 and River Mile 2.3 (Upper Rogue River population).
- Technical teams led by the Rogue Basin Partnership’s Fish Passage Working Group continue to make progress on the development and design of multiple fish passage improvement projects that will benefit all the populations in this stratum: specifically,

Murphy Dam, McKee Diversion Dam, Harboldt Diversion Dam, White-Brown push-up dam, and the C-2#3 and C-2 #4 Salt Creek push-up dams) (all populations).

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

The SONCC coho salmon recovery plan (NMFS 2014) and the previous 5-year review identified specific inadequate regulatory mechanisms, some of which affect populations in the Interior Rogue River diversity stratum. Various federal, state, and county regulatory mechanisms are in place to minimize or avoid habitat degradation caused by human use and development. Many of these mechanisms have been improved and updated in the past 5 years. However, the implementation and effectiveness of regulatory mechanisms have not been adequately documented. ***See Listing Factor D: Inadequacy of Existing Regulatory Mechanisms in this document for details.***

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

The greatest opportunities to advance recovery of SONCC coho salmon in the Interior Rogue River Diversity Stratum are the following:

A22: Restore flows, increase in-stream habitat complexity, restore off-channel rearing areas, and re-connect channels to existing off-channel ponds, wetlands, and side channels (all populations).

A23: Assess instream flows and develop and implement a strategic instream flow restoration plan (all populations).

A24: Develop alternatives for irrigation diversions to improve summer rearing habitat and survival by reducing water withdrawals (all populations).

A25: Assess water withdrawals to ensure the amount withdrawn does not exceed that described in the water right (all populations).

A26: Implement improved irrigation equipment and practices to reduce the volume of water withdrawn (all populations).

A27: Maintain stream shade and improve water temperatures in this interior stratum to address recurring drought conditions (all populations).

A28: Develop and implement beaver conservation plans that encourage beaver activity to create new and complex in-stream habitat and increase rearing habitat for salmonids. The plans should include education and outreach, technical assistance for landowners, and methods for reintroduction and/or relocation of beaver as a last resort (all populations).

Interior Klamath River Diversity Stratum

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

For the five independent SONCC coho salmon populations (Upper Klamath River, Scott River, Shasta River, Middle Klamath River, and Salmon River) in the Interior Klamath River diversity stratum, the primary habitat concerns since the 2016 5-year review are:

- Low flows and warm water temperatures because of surface and groundwater diversions in key areas, including the Scott River and the Shasta River (McBain and Trush 2013, Scott River Watershed Council 2018) result in diminished cold-water refugia, a lack of juvenile rearing habitat during summer and winter, increased potential for disease impacts (USFWS 2016) and impaired adult migration (all populations).
- Lack of instream summer and winter rearing habitat resulting from inadequate instream structure, especially insufficient large wood pieces; insufficient access to floodplain habitat, off-channel ponds, wetlands, and side channels; and degraded riparian forest conditions. The Scott River previously exhibited a strong cohort in the 2007, 2010, and 2013 adult return data. However, Knechtle and Giudice (2019) report a reduction in the 2016 adult coho salmon return data such that the strong cohort is no longer evident. Reduced summer base flow volume and increased flow variability are persistent issues in this subbasin and are exacerbated by increased groundwater extraction within the interconnected zone. Depletion of the groundwater in this region contributes to delayed hydration at the surface and contributes to disconnection in the mainstem through the fall (all populations).
- Rapid decreases in summer base flow volume and increased flow variability due to surface water diversions to support agriculture have impacted coho salmon in the Shasta River, which persists at very low numbers: At most, 62 adult fish have been observed each year since the last 5-year review (CDFW, unpublished data) (Shasta River population).
- Research since 2016 has shown that the severity of the threat posed by stormwater runoff from roadways and streets is greater than originally understood because it contains 6PPD, a degradation product of tires that has recently been shown to cause salmon mortality at concentrations of less than one part per billion (Peter et al. 2018, Tian et al. 2021). Multiple tire manufacturers use this contaminant in their tires. The dust and shreds from these tires have been widely found where both rural and urban roadways drain into waterways (Feist et al. 2017, Sutton et al. 2019). ***See Listing Factor D for a more thorough discussion***.
- The removal of four dams on the mainstem Klamath River will allow SONCC coho salmon unimpeded access to the mainstem Klamath River and its tributaries upstream of and including Spencer Creek, placing ESA-threatened salmonids where they have not occurred for over 100 years. In this newly available habitat, they will experience degraded water quality resulting from land management practices, including agricultural water use (Upper Klamath River population).

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

The mainstem Klamath River, the migratory pathway for all populations of SONCC coho salmon in the Interior Klamath River diversity stratum, continues to exhibit harmful water quality conditions (high parasitic spore concentrations, high levels of toxic algae, altered thermal regime, low dissolved oxygen), and altered hydrologic function related to upstream barriers and Klamath Project diversions (NMFS 2019b).

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

- The largest dam removal project in U.S. history is underway on the Klamath River. The removal of four mainstem dams will improve hydrologic function, water quality, and disease conditions in the Lower Klamath River and estuary. These areas are used by juvenile coho salmon from all the populations in the Interior Klamath River diversity stratum. In addition, adult coho salmon returning to the Klamath River this fall (2024) will have access to over 31 miles of habitat in the upper basin for the first time in over 100 years. Copco No. 2 Dam was removed in December 2023. Complete removal of the three remaining mainstem dams is expected by September 2024 – J.C. Boyle, Copco No. 1, and Iron Gate. Sediment that has accumulated behind these dams has been released and the river has carried it downstream.
- Since 2016, summer and winter rearing habitat for juveniles has improved through numerous habitat restoration projects in key tributaries of this stratum, including the Scott, Shasta, and Salmon River basins, Seiad Creek, Horse Creek, Beaver Creek, and Fort Goff Creek. Restoration projects included installation of beaver dam analogs, cobble and gravel bar reshaping, step pools installation, road crossing culvert removal and passage modification, installation of complex instream structures composed of large wood pieces, off-channel habitat development, riparian planting and fencing, and instream flow leasing (all populations).
- To help prioritize actions and streamline funding for restoration projects in the Klamath Basin, the Integrated Fisheries Restoration and Monitoring Plan (IFRMP) process, funded by USFWS, resulted in a final plan (ESSA and Klamath Basin Working Groups 2023) and a completed Synthesis Report (ESSA 2017) that will help inform the ongoing IFRMP process by distilling relevant past and current information about stressors on focal fish populations. IFRMP participants have recently used this information to begin prioritizing restoration actions for implementation (all populations).
- PacifiCorp's Interim Operation Habitat Conservation Plan for Coho Salmon (HCP) (PacifiCorp 2012) stipulated various actions intended to mitigate for project effects and benefit coho salmon leading up to the removal of four mainstem Klamath dams. As part of the HCP, PacifiCorp funds the Coho Enhancement Fund to support restoration projects in this stratum, such as channel restoration, off-channel ponds, fish screen installation, passage barrier removal, habitat enhancement, riparian fencing, and water leasing (PacifiCorp 2012). The most recent information available indicates that, as of December 31, 2020, the PacifiCorp Coho Enhancement Fund has awarded approximately $5.7 million to 57 projects (PacifiCorp 2021). PacifiCorp selects projects to fund with the

assistance of a technical advisory team comprised of staff from NMFS and CDFW (all populations).

- Completion of fire and land management projects by the Joint Chief's Landscape Restoration Partnership and the Western Klamath Restoration Partnership to decrease sedimentation events on the mainstem Klamath River and Salmon River (Charnley et al. 2020, USDA 2018) (Middle and Upper Klamath River populations and Salmon River population).
- Safe Harbor Agreements (SHA) seek to address flow and habitat concerns on non-Federal properties and to provide a net conservation benefit to coho salmon. The Hart Ranch on the Little Shasta River entered into a SHA in 2018. Fourteen properties on the upper Shasta River and tributaries, including Parks Creek and Big Springs Creek, entered into a SHA in 2020 (Shasta River population).
- NMFS and USFWS completed a biological opinion on the Bureau of Reclamation's Klamath Project Operations in 2019 (NMFS 2019b). Following legal challenges, an agreement and interim plan were finalized in 2020 to improve flow-related habitat conditions for juvenile coho salmon (all populations).

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

The SONCC coho salmon recovery plan (NMFS 2014) and the previous 5-year review identified specific inadequate regulatory mechanisms, some of which affect populations in the Interior Klamath River diversity stratum. Various federal, state, and county regulatory mechanisms are in place to minimize or avoid habitat degradation caused by human use and development. Many of these mechanisms have been improved and updated in the past 5 years. However, the implementation and effectiveness of regulatory mechanisms has not been adequately documented. ***See Listing Factor D: Inadequacy of Existing Regulatory Mechanisms in this document for details.***

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

The greatest opportunities to advance recovery of SONCC coho salmon in the Interior Klamath River Diversity Stratum are the following:

A29: Work with agencies and landowners to address summer base flow concerns, restore habitat, and conserve water by upgrading diversion and fish screen infrastructure (Scott River and Shasta River populations).

A30: Provide adequate flushing flows via the Bureau of Reclamation's Klamath Project to address juvenile and adult coho salmon disease concerns in the mainstem Klamath River (Middle Klamath River and Upper Klamath River populations).

A31: Implement the prioritized recovery actions described in the Integrated Fisheries Restoration and Monitoring Plan for the Klamath Basin (ESSA and Klamath Basin Working Groups 2023) (all populations).

A32: Implement stage-0 restoration (i.e., Cluer and Thorne 2013) and other stream process-based restoration projects to reconnect floodplain habitat and provide off-channel habitat in the Scott and Shasta River watersheds as well as the following upper Klamath tributaries: Horse Creek, Seiad Creek, Humbug Creek, and Beaver Creek (Scott River, Shasta River, and Upper Klamath River populations).

A33: Increase flows and cold-water refugia areas (Scott River and Shasta River populations).

A34: Improve upland forest conditions via fire and forest management to improve hydrologic function and minimize negative sedimentation events (all populations).

Interior Trinity River Diversity Stratum

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

For the three independent SONCC coho salmon populations (Lower Trinity River, Upper Trinity River, and South Fork Trinity River) in the Interior Trinity River diversity stratum, the primary habitat concerns since the 2016 5-year review are:

- Trinity River flows that are currently based on meeting defined flow targets on specific dates as opposed to matching flows to a natural hydrograph (including ascending and descending limbs of storms) and the needs of salmonids, including the creation and maintenance of habitat (Bureau of Reclamation [BOR] 2000) (all populations).
- Increasing frequency of drought (Diffenbaugh et al. 2015) resulting in (1) reduced quality and quantity of rearing habitat; (2) chronic high temperatures resulting in increased stress and disease; (3) low flows resulting in increased chances of redd scour or complete redd desiccation when flows recede; and (4) increased disconnected flows and/or temperature barriers that interfere with smolt outmigration (all populations).
- Lack of instream structure; insufficient access to floodplain habitat and existing off-channel ponds, wetlands, and side channels; and degraded riparian forest conditions resulting in a lack of instream summer and winter rearing habitat (all populations).
- Degraded water quality and quantity caused by illegal cannabis cultivation (Trinity County 2020, NMFS 2014) (South Fork Trinity River population).
- Inadequate large wood in streams resulting in limited formation and persistence of instream and off-channel coho salmon habitat (all populations).
- Research since 2016 has shown that the severity of the threat posed by stormwater runoff from roadways and streets is greater than originally understood because it contains 6PPD, a degradation product of tires that has recently been shown to cause salmon mortality at concentrations of less than one part per billion (Peter et al. 2018, Tian et al. 2021). Multiple tire manufacturers use this contaminant in their tires. The dust and shreds from these tires have been widely found where both rural and urban roadways drain into

waterways (Feist et al. 2017, Sutton et al. 2019). ***See Listing Factor D for a more thorough discussion.***

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

- South Fork Trinity River and its tributaries (South Fork Trinity River population).
- Tributaries located on land of the Hoopa Valley Tribe (Lower Trinity River population).
- Upper Trinity River tributaries, especially Weaver, Reading, and Indian Creeks (Upper Trinity River population).
- Mainstem Trinity River because of the hydrologic impacts that may be caused by increased diversions to the Sacramento River for the Sites Reservoir Project (Upper Trinity River and Lower Trinity River populations).

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

- The largest dam removal project in U.S. history is underway on the Klamath River. The removal of four mainstem dams will improve hydrologic function, water quality, and disease conditions in the Lower Klamath River and estuary. These areas are used by juvenile and adult coho salmon from all Trinity River populations. Copco No. 2 Dam was removed in December 2023. Complete removal of the three remaining mainstem dams is expected by September 2024 – J.C. Boyle, Copco No. 1, and Iron Gate. Sediment that has accumulated behind these dams has been released and the river has carried it downstream.
- Since 2016, numerous habitat restoration projects have been completed in key tributaries of this stratum, including Mill Creek, Supply Creek, Sharber Creek and Peckham Creek, Bucktail Channel, Sheridan Creek, Deep Gulch, Browns Creek, East Weaver Creek, and Sidney Gulch. Actions included installation of beaver dam analogs, construction of key habitat features, increased water flow, addition of coarse substrate, culvert removal and passage improvements, riparian improvements, and road improvements (TRRP 2022) (all populations).
- The 2016-2020 implementation of flow releases from the Trinity River Project dams, including diurnal flow fluctuations to better mimic a natural hydrograph (TRRP 2022) (Upper and Lower Trinity River populations).

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

The SONCC coho salmon recovery plan (NMFS 2014) and the previous 5-year review identified specific inadequate regulatory mechanisms, some of which affect populations in the Interior Trinity River diversity stratum. Various federal, state, and county regulatory mechanisms are in place to minimize or avoid habitat degradation caused by human use and development. Many of these mechanisms have been improved and updated in the past 5 years. However, the implementation and effectiveness of regulatory mechanisms has not been adequately documented. ***See Listing Factor D: Inadequacy of Existing Regulatory Mechanisms in this document for details.***

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

The greatest opportunities to advance recovery of SONCC coho salmon in the Interior Trinity River Diversity Stratum are the following:

A35: Add large wood pieces to streams and rivers (all populations).

A36: CDFW regulate the removal of large wood from streams and rivers (all populations).

A37: Improve BOR's reservoir operations to maintain sufficient minimum Trinity Reservoir water levels that ensure adequate water temperature control in the mainstem Trinity River (Upper Trinity River and Lower Trinity River populations).

A38: Shift current flow releases from BOR's Lewiston Dam to a flow schedule synchronized with natural hydrology, allowing for releases in the winter months (Upper Trinity River population)

A39: Restore habitat in the tributaries and mainstem to support coho salmon juvenile production (all populations).

Interior Eel River Diversity Stratum

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

For the three independent populations (South Fork Eel River, Mainstem Eel River, and Middle Mainstem Eel River) in the Interior Eel River diversity stratum, the primary habitat concerns since the 2016 5-year review are:

- Increased groundwater use and removal of water from streams through diversions before the onset of fall rains resulted in increased water temperatures and dry and intermittent stream reaches that strand juveniles in disconnected pools. In the Franciscan geology underlying the Eel River, groundwater is not only connected to surface water flowing in streams but is thought to be the mechanism that provides for all summer flow (Hahm et al. 2019) (all populations).
- Increased frequency of drought, which has persisted since 2012 (Diffenbaugh et al. 2015), resulting in (1) reduced amount and quality of rearing habitat; (2) increased stress and disease by exposing fish to chronic high temperatures; (3) increased redd scour because of low flow spawning followed by a storm event, or dry redds upon receding flows; and (4) disruption of smolt outmigration because of disconnected flow and/or temperature barriers (all populations). See Listing Factor E: Other natural or manmade factors affecting its continued existence in this document for additional details on climate and drought.
- A severe deficiency of large wood pieces impairs the formation and persistence of habitat for rearing juveniles and holding migratory adults, and the recovery of spawning habitat

impacted by fine sediment deposition (all populations).Research since 2016 has shown that the severity of the threat posed by stormwater runoff from roadways and streets is greater than originally understood because it contains 6PPD, a degradation product of tires that has recently been shown to cause salmon mortality at concentrations of less than one part per billion (Peter et al. 2018, Tian et al. 2021). Multiple tire manufacturers use this contaminant in their tires. The dust and shreds from these tires have been widely found where both rural and urban roadways drain into waterways (Feist et al. 2017, Sutton et al. 2019). *See Listing Factor D for a more thorough discussion.*

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

- Groundwater use has been significantly increasing throughout the diversity stratum as cannabis growers discontinue unpermitted summer water diversions in favor of groundwater wells. In the Franciscan geology underlying most of the diversity stratum, groundwater is not only connected to surface water flowing in streams but is thought to be the mechanism that provides for all summer flow (Hahm et al. 2019). Legal groundwater pumping and diversion of surface flow continue to cause dry and intermittent stream reaches, particularly in these areas:
  - Redwood, Salmon, Ten Mile, Sproul, and Cahto Creeks (South Fork Eel River population);
  - Tomki Creek, Ryan Creek, and Outlet Creek (Middle Mainstem Eel River population);
  - Woodman Creek (Mainstem Eel River population).
- Degraded riparian habitat and summer water quality (temperature) and quantity (insufficient flow) in mainstem Eel River during dry summer months, limiting juvenile rearing and outmigration (all populations).
- Rearing habitat in Outlet Creek and Long Valley Creek (Middle Mainstem Eel River population).
- Estuarine habitat in the Lower Eel River (Lower Eel River population, Southern Coastal Stratum).

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

- Long-term protection of coho salmon overwintering habitat in Little Lake Valley, a portion of Outlet Creek near Willits, through the 2015 Caltrans' purchase of 2,087 acres of wet meadow, stream corridor, and oak woodland habitat found there (Caltrans 2012) (Middle Mainstem Eel River population).
- Completion of two fish passage projects on tributaries to Outlet Creek, a tributary of the Middle Mainstem Eel River, restoring access to approximately 5 miles of salmonid habitat (Caltrans 2020) (Middle Mainstem Eel River population).

- Restoration of fish passage at the mouth of Woodman Creek, opening 14 miles of coho salmon spawning and rearing habitat (Mainstem Eel River population).

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

The SONCC coho salmon recovery plan (NMFS 2014) and the previous 5-year review identified specific inadequate regulatory mechanisms, some of which affect populations in the Interior Eel River diversity stratum. Various federal, state, and county regulatory mechanisms are in place to minimize or avoid habitat degradation caused by human use and development. Many of these mechanisms have been improved and updated in the past 5 years. However, the implementation and effectiveness of regulatory mechanisms have not been adequately documented. ***See Listing Factor D: Inadequacy of Existing Regulatory Mechanisms in this document for details.***

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

The greatest opportunities to advance recovery of SONCC coho salmon in the Interior Eel River Diversity Stratum are the following:

A40: Implement habitat restoration projects identified in the South Fork Eel River (SFER) Salmon Habitat Restoration Priorities (SHaRP) plan (SFER SHaRP Collaborative 2021) (South Fork Eel River population).

A41: Implement water forbearance, streamflow enhancement, water conservation, and groundwater sustainability projects (all populations).

A42: Improve shallow and simplified holding and staging habitat in the Lower Eel River by improving complexity, promoting pool scour, increasing tidal prism, and improving sediment routing (Lower Eel/Van Duzen Rivers population in Southern Coastal Diversity Stratum).

A43: Fully implement NMFS' interim protective measures for PG&E's Potter Valley Project, including water temperature management and re-operation of water release strategy associated with Lake Pillsbury (all populations).

A44: Continue to advance the decommissioning of PG&E's Potter Valley Project to achieve the removal of Scott Dam and Cape Horn Dam to restore access to hundreds of miles of habitat upstream (all populations).

A45: Increase production of coho salmon in Outlet Creek by developing habitat restoration projects that reconnect floodplain and off-channel habitats, increase summer flow by facilitating storage of water diverted during high winter flows in storage tanks and off-channel ponds for human use during summer months, and add large wood pieces to improve summer and winter rearing habitat (Middle Mainstem Eel River population).

Listing Factor A: Conclusion

Destruction, modification, and curtailment of habitat remain the primary factor limiting recovery of SONCC coho salmon. The habitat issues that have most impaired the species since 2016 include:

- Removal of surface water and groundwater during months when there is no rainfall to recharge the system.
- Increased frequency of drought, which has exacerbated the impacts of most existing threats (e.g., diversions).
- Curtailment of the extent of habitat available to the species in estuaries, and insufficient tidal prism.
- Simplified physical habitat in channels and disconnection of channels from floodplains.

Water diversions from streams and rivers, and groundwater pumping that removes water that would otherwise recharge these systems during the summer months when there is no rainfall, have likely continued at unsustainable levels since 2016. Sufficient, cool flow is paramount to coho salmon survival and productivity. By reducing the amount of flow, diversions and groundwater pumping cause the water to warm up faster, contributing to temperature impairment. While recent regulatory changes in California may reduce the extent of and impacts from such water removal, it remains to be seen whether in-stream conditions will change in adequate magnitude and timeliness to offset the concurrent effects of drought and prevent the condition of the ESU from worsening.

Structural habitat concerns persist in each of the seven diversity strata in this ESU. There have been substantial investments in freshwater and estuarine habitat restoration projects since the last 5-year review, which have improved habitat conditions. The most comprehensive advancement in habitat restoration has been the removal of four PacifiCorp dams on the Klamath River in 2023 and 2024, and the benefits of these dam removals will be felt in the coming years. Still, to recover SONCC coho salmon, the scope and scale of habitat restoration actions yet to be completed across the ESU are likely an order of magnitude greater than those accomplished to date. In addition, continued water use, high summer water temperatures, and low flow conditions exacerbated by drought and climate change have reduced the efficacy of these restoration actions. In particular, low flow conditions throughout the SONCC Coho Salmon ESU have limited the productivity of the habitat and reduced the potential for the habitat to support the conditions that juvenile coho salmon need to survive and grow prior to their migration to the ocean.

We conclude that the risk to the species' persistence resulting from habitat destruction and modification has not improved since 2016.

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

Harvest

Adult SONCC coho salmon are captured and handled in marine, estuarine, and freshwater fisheries. Marine and estuarine fisheries that target coho salmon generally only allow the retention of hatchery-origin coho salmon, but may allow retention of all coho salmon (i.e., in certain Oregon fisheries). Fisheries that target other species may encounter coho salmon. The capture and handling of ESA-listed, natural-origin coho salmon in any fishery are forms of take. Although capture and handling may not immediately kill a salmon, it causes stress to the animal that can affect its survival and ability to successfully reproduce. Adult coho salmon returning to spawn are already under great stress, and successful reproduction by these fish is critical to the survival and recovery of the entire ESU. If take is too high, the likelihood of survival and recovery of the SONCC Coho Salmon ESU may be reduced.

ESA section 7 consultation on fisheries managed by the Pacific Fishery Management Council (PFMC) (NMFS 1999) limited the overall impacts of fisheries encountering SONCC coho salmon to no more than a 13 percent exploitation rate annually, but accounted only for ocean fisheries.

PFMC recently adopted a new fishery Harvest Control Rule (HCR) for SONCC coho salmon under Amendment 23 to the Pacific Coast Salmon Fishery Management Plan (PFMC 2022), which NMFS evaluated under ESA section 7 (NMFS 2022a). This new HCR accounts for impacts of all tribal and non-tribal fisheries in ocean, tidal, and freshwater areas where SONCC coho salmon occur. The HCR manages for a lower overall exploitation rate compared to what was previously in place, particularly for Klamath River basin coho salmon populations. Through this HCR, ocean salmon fisheries are constrained to total exploitation rates of (1) 16 percent for the Trinity population unit (Upper Trinity River, Lower Trinity River, and South Fork Trinity River; and (2) 15 percent for each of the remaining individual populations within the SONCC Coho Salmon ESU. Adherence to these limits relies on accounting for impacts from all fisheries that may encounter SONCC coho salmon, including those fisheries managed by states and tribes in tidal and freshwater areas.

To be in compliance with the 4(d) regulations, fisheries carried out by states and tribal entities must be managed under a NMFS-approved Fishery Management and Evaluation Plan (FMEP) or a NMFS-approved Tribal Resource Management Plan (TRMP), respectively. The primary goal of an FMEP or TRMP is to implement biologically based fishery management strategies that will not appreciably reduce the survival and recovery of listed ESUs, such as SONCC coho salmon. Take prohibitions do not apply to fisheries managed in accordance with a NMFS-approved FMEP or TRMP. The state of Oregon’s FMEP provides take coverage for some of their fisheries, while TRMPs provide take coverage for tribal fisheries in California.

Federal-Managed Fisheries

In the ocean, SONCC coho salmon primarily occur off the coast of California and southern Oregon. Coho salmon-directed ocean fisheries, and retention of coho salmon incidentally captured in other fisheries, have been prohibited off the coast of California since 1996. Ocean fishing mortality of SONCC coho salmon results from non-retention impacts in California and Oregon in fisheries targeting Chinook salmon, impacts in Oregon’s hatchery-selective coho salmon fisheries, and impacts in Oregon’s coho salmon fisheries. Rogue/Klamath coho salmon ocean exploitation rates have been estimated for years 1986-2019 using postseason runs of the Fishery Regulation Assessment Model (FRAM). Exploitation rates have been low and relatively stable since the early 1990s (average of 5.4 percent for years 1994-2019), which contrasts sharply with the much higher rates estimated for the 1980s and early 1990s. In 2022, the PFMC began implementing the new HCR described above for all fisheries occurring in federal waters.

Tribal-Managed Fisheries

The Hoopa Valley Tribe (HVT) and the Yurok Tribe (YT) manage their own fisheries in California. There are no tribal fisheries within the SONCC coho salmon range in Oregon. The 10-year (2010-2019) average exploitation rates for the fisheries of the HVT and YT were 3.4 percent and 6.4 percent, respectively (NMFS 2022b). Since the 2016 5-year review (NMFS 2016a), the HVT began operation of a weir to selectively harvest salmon in the Trinity River (NMFS 2022b). HVT fisheries, including the selective harvest weir, were included in a TRMP submitted to NMFS for evaluation under the ESA Tribal 4(d) Rule (NMFS 2022b). On August 4, 2022, NMFS issued a final determination on the HVT TRMP (87 FR 47724). The approved TRMP provides a framework through which tribal salmon fisheries can be implemented consistent with the ESA Tribal 4(d) Rule (NMFS 2022b). In 2023, the YT submitted a TRMP for their Klamath River salmonid fisheries, which is under NMFS review. Additionally, the impacts of the fisheries of the HVT and YT are accounted for within the overall exploitation rates identified in the 2022 HCR described above.

State-Managed Fisheries

California's freshwater sport fishing regulations (CDFW 2023b) prohibit retention of coho salmon. However, as described above, the capture and release of coho salmon results in take. The California Fish and Game Commission has established partial protection measures to provide fishing opportunities while reducing threats to federally listed salmonids. Recreational angling is popular across all ESUs and DPSs, yet its impact on ESA-listed species in California remains uncertain, despite the partial protection measures, because the state of California has not developed FMEPs for the fisheries they manage. FMEPs should be developed for all fisheries managed by the state of California in tidal and freshwater areas that may affect SONCC coho salmon.

Oregon's freshwater sport fishing regulations allow a recreational fishery for hatchery-origin coho salmon in the Rogue River, where a hatchery for SONCC coho salmon is in operation. In other Oregon rivers within the range of the SONCC Coho Salmon ESU, incidental catch of natural-origin SONCC coho salmon occurs in recreational fisheries that target fall Chinook salmon and winter steelhead; these coho salmon must be released, but experience take as described above. FMEPs should be developed for fisheries targeting natural-origin SONCC coho salmon in Oregon waters.

Scientific Research and Monitoring

SONCC coho salmon take under ESA sections 10(a)(1)(A) and 4(d) for scientific research and monitoring remains low, and much of the work being conducted is done for the purpose of fulfilling state and Federal agency obligations under the ESA to ascertain the species' status. Authorized mortality rates (i.e., lethal take allowed under the permits NMFS issues) associated with scientific research and monitoring are generally capped at 0.5 percent of the total estimated abundance for an ESU. As a result, the mortality levels that research causes are very low. In addition, the effects research has on SONCC coho salmon are spread out over various reaches, tributaries, and areas across the range of this ESU; thus no area or population is likely to experience a disproportionate amount of loss. Therefore, the research program, has only a very small impact on overall population abundance, a similarly small impact on productivity, and no measurable effect on spatial structure or diversity.

Based on years of data, the majority of the research take for SONCC coho salmon juveniles is expected to occur through capture via screw traps, electrofishing units, beach seines, fyke nets, and minnow traps, with smaller numbers being captured via hand or dip nets, hoop nets, incline plane traps, hook and line angling, other seines, trawls, and weirs. Similarly, adult SONCC coho salmon take is expected to occur through capture via weirs, with smaller numbers that may be captured by hook and line angling, trawls, and unintentionally captured in seines or screw traps targeting juveniles. Database records (NMFS APPS database; https://apps.nmfs.noaa.gov/) show that mortality rates for screw traps are typically less than one percent and backpack electrofishing are typically less than three percent. Unintentional mortality rates from seining, hand or hoop netting, fyke nets, minnow or incline plane traps, weirs, and hook and line methods are also limited to no more than three percent. Also, interactions with trawl sampling equipment may result in a small number of adult fish dying as an unintended result.

Non-lethal take of SONCC coho salmon from 2015 through 2019 increased by 8 percent compared to the total take from 2010 through 2014, while lethal take reported from 2015 through 2019 decreased by almost 59 percent.

Overall, research impacts on SONCC coho salmon remain minimal and geographically well-distributed throughout the species' range. Because the amount of take has only increased slightly and the number of mortalities have decreased, the overall effect of research on listed populations is actually less than it was at the time of the last 5-year review (NMFS 2016a). Therefore, the risk to the species' persistence because of utilization related to scientific studies remains low.

Listing Factor B: Conclusion

Since 2016, the impacts of federally managed fisheries decreased slightly, and the impacts of fisheries managed by the state of Oregon on SONCC coho salmon have not changed appreciably. The extent to which California-managed fisheries in tidal and freshwater areas impact SONCC coho salmon remains unknown, as California has not developed the FMEPs for these fisheries. Similarly, the impact of fisheries targeting natural-original SONCC coho salmon in Oregon waters is unknown due to the lack of an FMEP addressing these fisheries. The impacts of scientific research have decreased slightly (non-lethal impacts slightly increased while lethal impacts substantially decreased) compared to the last 5-year review period. We conclude that the risk to the species' persistence because of overutilization has not changed since the 2016 5-year review.

Recommended future actions for the next 5 years

B1: PFMC ensure that incidental take of SONCC coho salmon associated with all Federal fisheries for salmon species is consistent with the 2022 Fishery (HCR) for SONCC coho salmon.

B2: Develop FMEPs for all state-managed fisheries in freshwater areas within California that may affect SONCC coho salmon and submit the FMEPs to NMFS.

B3: Develop FMEPs for all state-managed fisheries targeting natural-origin coho salmon in Oregon waters and submit the FMEPs to NMFS.

2.3.2.3 Listing Factor C: Disease and predation

Disease

Disease impacts continue to be a concern for coho salmon in the Interior Klamath diversity stratum and have been the focus of substantial research since 2016. The largest disease impact has been the effect of the *Ceratonova shasta* parasite on rearing and outmigrating juvenile coho salmon. The annual prevalence of this parasite has been documented in emigrating juvenile salmon populations during spring and early summer in the Klamath River (True et al. 2016a; True et al. 2016b, 2017; Voss et al. 2018; Som et al. 2019; Voss et al. 2019; Robinson et al. 2020; Voss et al. 2020), and the processes that influence its impacts on Klamath River salmon are increasingly well-understood (Robinson et al. 2020). Robinson et al. (2020) results suggest that the release of hatchery-origin smolts may exacerbate the impacts of the disease, as evidenced by an associative relationship between the prevalence of infection in outmigrating hatchery fish with the densities of water-borne *C. shasta* spores in subsequent seasons. Som et al. (2019) estimated mortality due to *C. shasta* for coho salmon entering the mainstem Klamath from the Shasta River and Scott River populations to be as high as 68 percent annually. The Upper Klamath River population is also impacted by *C. shasta* because individuals from that population migrate through the infectious zone in the mainstem Klamath River. The *C. shasta* life cycle requires both a worm host and a salmonid host. Disrupting the life cycle of the *C. shasta* parasite through management actions can reduce the incidence and severity of coho salmon infection (Bartholomew et al. 2022). We expect disease conditions to improve for salmonids in the Klamath Basin in the next 5 years due to changing aspects of flow, sediment, and water temperature resulting from the removal of four mainstem dams. With the removal of Iron Gate Dam, the flow compliance point for the Klamath Project will shift from Iron Gate Dam to Keno Dam, as discussed in the NMFS (2021) Biological Opinion on dam removal.

While they do not impact coho salmon directly, two plant diseases, sudden oak death (Section 2.3.2.1) and eelgrass wasting disease (2.3.2.1), have significant negative impacts on riverine and estuarine SONCC coho salmon habitat.

Predation and Competition from Sacramento pikeminnow

The non-native Sacramento pikeminnow (*Ptychocheilus grandis*) is a large piscivorous fish that was introduced into Lake Pillsbury (upper mainstem Eel River) around 1979 and has since expanded its distribution throughout most of the Eel River basin (SEC 1998, Brown 1990, Brown and Moyle 1997, Harvey et al. 2002, Kinziger et al. 2014). High pikeminnow abundance has been documented in different parts of the watershed (White and Harvey 2001, Higgins 2020, PG&E 2020) and the species has the potential to fundamentally alter the aquatic ecosystem and negatively impact many native species (Stillwater and Wiyot 2020). Many studies indicate that pikeminnow compete with, prey on, or alter the behavior of juvenile salmonids in the Eel River basin (Brown and Moyle 1997, White and Harvey 2001, Reese and Harvey 2002, Nakamoto and Harvey 2003, Stillwater and Wiyot 2020).

A natural barrier called Split Rock on the North Fork Eel River was once thought to limit upstream distribution of pikeminnow in that basin. The first known record of Sacramento pikeminnow above Split Rock comes from the Cal Poly Humboldt fish collection, which contains juvenile pikeminnow collected at Mina Bridge (two miles above Split Rock) in 2011. The presence of juveniles indicates spawning has occurred above Split Rock since at least 2010. An adult pikeminnow was first sighted above Split Rock by Patrick Higgins of the Eel River Recovery Project in 2016, prompting subsequent monitoring and suppression efforts by the BLM and CDFW (Ruddy 2022). Beginning in 2019 through 2022, the Wiyot Tribe partnered with Stillwater Sciences to investigate population monitoring and suppression techniques in the South Fork Eel River, where boat-based electrofishing methods prevailed as the most effective method tested thus far (Stillwater and Wiyot 2020). In 2023, the Wiyot Tribe, Stillwater Sciences, U.C. Berkeley, and Caltrout expanded Sacramento pikeminnow suppression efforts by installing a temporary weir in the South Fork Eel River to intercept and segregate adult pikeminnow from prime coho salmon rearing habitat in the upper mainstem the South Fork Eel River. Recent findings of an acoustic telemetry study of juvenile coho salmon carried out by UC Berkeley, CDFW, and Caltrout (Rossi et al. 2024) suggest that many juvenile coho salmon leaving tributaries of the South Fork Eel River perish in the mainstem South Fork Eel River. Average survival of tagged coho salmon in the mainstem South Fork Eel River was 20% during the study, with 0% survival of tagged juveniles originating from the upper South Fork – a key coho salmon spawning area (Rossi et al. 2024). Pikeminnow predation may be a contributing factor in this mortality.

PG&E is required by NMFS’ 2002 Potter Valley Project Biological Opinion (NMFS 2002) to implement a Sacramento pikeminnow suppression program targeting the project’s infrastructure. Since 2017, PG&E has worked closely with NMFS to develop and implement new suppression techniques and monitoring protocols. The expanded efforts into Lake Pillsbury now include the use of boat electrofishing and mark-recapture techniques. These efforts have been significantly more effective than past efforts but remain in the early stages of development. Various species of bass have been observed by PG&E in recent years, occupying areas near the Cape Horn Dam fish ladder entrance.

Predation from Seals and Sea Lions

Recent research suggests that predation pressure on ESA-listed salmon and steelhead from seals and sea lions has increased in the northeastern Pacific over the past several decades (Chasco et al. 2017). With the passing of the Marine Mammal Protection Act (MMPA) in 1972, seal and sea lion stocks along the West Coast of the United States have steadily increased in abundance (Carretta et al. 2019).

With their increasing numbers and expanded geographic range, seals and sea lions are consuming more Pacific salmon and steelhead and may be adversely impacting certain ESA-listed species in some areas (Chasco et al. 2017, Thomas et al. 2016; Marshall et al. 2016). Whether seal and sea lion populations in Oregon and California are associated with a significant level of decreased survival of SONCC coho salmon adults or migrating smolts moving through estuarine and freshwater migration corridors is currently unknown, as there have not been survival assessments of populations in coastal estuaries/rivers in these states.

Listing Factor C: Conclusion

The impacts of *C. shasta* infection have increased since 2016 in the Klamath River due to the effects of drought on water temperature and fish distribution. Sudden oak death and eelgrass wasting disease continue to detrimentally affect coho salmon habitat. The threat of pikeminnow predation is significant and has not improved since 2016. The severity of the threat of seal and sea lion predation on SONCC coho salmon is unknown.

Recommended future actions for the next 5 years

C1: Continue to disrupt the life cycle of the *C. shasta* parasite in the Klamath River basin by increasing the amount and variability of flows from BOR's Klamath Project flow compliance point at Keno Dam. Specifically, implement sediment flushing and/or geomorphic flows to control infected host worm populations, spore dilution, and disruption flows during juvenile salmonid outmigration in the spring, and pulse flows in the late fall to redistribute and dry out spores.

C2: Continue the study of Sacramento pikeminnow in the South Fork Eel River and implementation of pikeminnow suppression methods.

C3: Continue to study the survival of juvenile coho salmon in the mainstem South Fork Eel River and the sources of mortality in this area.

C4: Continue to refine PG&E's Sacramento Pikeminnow monitoring and suppression program in Lake Pillsbury and between Scott Dam and Cape Horn Dam.

C5: Develop and implement monitoring to detect and document seal and sea lion predation on Pacific salmon, including SONCC coho salmon, in key areas (e.g., river mouths and migratory pinch points).

2.3.2.4 Listing Factor D: Inadequacy of Existing Regulatory Mechanisms

Various federal, state, county, and tribal regulatory mechanisms are in place to reduce habitat loss and degradation caused by human use and development and harvest impacts. For this 5-year review, we focus our analysis on regulatory mechanisms that have either improved for SONCC coho salmon or are causing the most concern in terms of providing adequate protection for SONCC coho salmon.

Regulation of Activities that Affect Habitat

Habitat concerns are described throughout Listing Factor A as having either a system-wide influence, or more localized influence, on the populations and diversity strata that comprise the species. Recovery of SONCC coho salmon will not be achieved without sufficient improvement in habitat conditions in tributaries, mainstems, estuaries, and the ocean. These habitat conditions are influenced by a wide array of federal, state, and local regulatory mechanisms. The influence of regulatory mechanisms on listed salmonids and their habitat resources largely reflects the underlying ownership of the land and water resources. Federal, state, and local governments own the majority of lands in the SONCC Coho Salmon ESU, with the balance in private ownership.

Four primary federal agencies are responsible for land and water management in the watersheds where SONCC coho salmon occur: the USFS and the BLM, which together own and manage millions of acres of the ESU, the Bureau of Reclamation, which oversees the operation of major hydropower dams, and the U.S. Army Corps of Engineers (USACE) given their significant role in flood protection. Regulation of land and water use by the states of California and Oregon under the relevant state regulations plays a critical role in addressing factors that limit recovery of SONCC coho salmon.

One factor affecting habitat conditions across all land or water ownerships is climate change, which is discussed under Section 2.3.2.5 (Listing Factor E: Other natural or manmade factors affecting its continued existence). We reviewed summaries of national and international regulations and agreements governing greenhouse gas emissions. These summaries indicate that while the number and efficacy of such mechanisms have increased in recent years, there has not yet been a substantial deviation in global emissions from the past trend, and that it would be prudent to upscale and accelerate far-reaching, multilevel, and cross-sectoral climate mitigation to reduce future climate-related risks (IPCC 2014, IPCC 2018). These findings suggest that current regulatory mechanisms, both in the U.S. and internationally, are not currently adequate to address the rate at which climate change is negatively impacting habitat conditions for many ESA-listed salmon and steelhead.

Regulatory Mechanisms Resulting in Adequate or Improved Protection

New information available since the last 5-year review indicates that the adequacy of certain regional regulatory mechanisms has increased, resulting in improved protection of SONCC coho salmon and their habitat.

ESA-Driven Management of Eel River Water through the Potter Valley Hydroelectric Project

In 2002, NMFS issued a jeopardy biological opinion on PG&E's Potter Valley Project, which included a suite of reasonable and prudent alternatives (RPAs) to avoid the likelihood of jeopardizing the continued existence of California Coastal (CC) Chinook salmon, SONCC coho salmon, and Northern California (NC) steelhead due to project operations and exclusion of high value habitat (NMFS 2002). These RPAs include an annual 2,500 acre-feet of water (blockwater) that is reserved for release from Scott Dam to enhance flow conditions, and the release of warm water from the spillway of Scott Dam in the late winter/early spring period to promote the timely downstream migration of juvenile salmonids between Scott and Cape Horn dams.

Blockwater (RPA D.1) and/or warm water releases (RPA B.3) have been implemented every year since 2012. Although at the discretion of the resource agencies, each blockwater and/or warmer water release requires a formal request to the project proponent (PG&E) and is often scrutinized by various parties, especially as extreme drought conditions occur at a higher frequency. Each blockwater and/or warm water release request is fully vetted and is jointly issued by NMFS, CDFW, and Round Valley Indian Tribes.

Between 2016 and 2020, blockwater releases have also been used in various ways to augment low fall flows for adult CC Chinook salmon and aid summer rearing conditions for NC steelhead and SONCC coho salmon. However, NMFS believes the most effective use of blockwater releases is to augment the spring recession, while mimicking natural environmental cues for emigration (flow and temperature). The releases improve flow conditions for migration (upstream and downstream), increase foraging opportunities, and may assist juvenile salmonids in avoiding predators as they emigrate. Based on preliminary data from ongoing monitoring at the time of this 5-year review, these releases appear to have been successful in meeting their intended objective.

The Potter Valley Drought Working Group, comprised of resource agencies, tribes, municipalities, and agricultural interests, was established in 2014 and continues to work collaboratively as drought conditions persist. In response to a higher frequency in extreme drought conditions, the Working Group has successfully worked together on several occasions to make formal variance requests to FERC to achieve beneficial changes to existing project operations due to limited water availability. Without these collaborative variance requests and FERC approvals, Lake Pillsbury storage conditions would have reached inoperable conditions (dead-pool) several times, resulting in the inability to release water for environmental purposes, particularly for CC Chinook salmon, NC steelhead, and SONCC coho salmon, as well as for other water interests.

California's Instream Flow Management

The California Water Action Plan, issued by Governor Brown in January 2014, sets forth ten priority actions that guide the state's effort to create more resilient, reliable water systems and to restore critical ecosystems. Action 4 addresses the instream flow needs of imperiled salmonids, stating: "the State Water Resources Control Board and the Department of Fish and Wildlife will implement a suite of individual and coordinated administrative efforts to enhance flows statewide in at least five stream systems that support critical habitat for anadromous fish." As part of implementing Action 4, CDFW's Instream Flow Program has supported flow enhancement activities and is developing flow criteria in five priority streams throughout the state that support critical habitat for threatened and endangered anadromous salmonids, including two in the range of SONCC coho salmon: The South Fork Eel River in Humboldt and Mendocino counties, and the Shasta River in Siskiyou County.

To set instream flow prescriptions, CDFW uses the California Environmental Flows Framework (CEFF), a consistent and defensible approach to identifying ecological flow needs for rivers and streams in California. The CEFF utilizes historical flow records and site-specific instream habitat analysis to quantify ecologically relevant flow characteristics (flow magnitude, frequency, duration, timing, and rate of change) at the individual stream reach. The identified flow characteristics then inform flow patterns supportive of five identified "functional flow components" (fall pulse flow, wet-season baseflow, wet-season peak flow, spring recession flows, and dry-season baseflow) that inform habitat suitability for various life stages of anadromous salmonids. The resulting ecological flow recommendations will be used in water management, planning, and decision-making processes, which may include submission to the State Water Resources Control Board (SWRCB) pursuant to Public Resources Code §10000-10005. The state of California is currently developing instream flow recommendations for the South Fork Eel River and the Shasta River.

California's Medicinal and Adult-Use Cannabis Regulation and Safety Act

In 2015, the California legislature established the first state-wide regulatory systems for medical cannabis via the Medical Marijuana Regulation and Safety Act. After Proposition 64 passed in 2016, allowing recreational cannabis use for adults (the Adult Use Marijuana Act), the legislature consolidated the provisions of both acts into the Medicinal and Adult-Use Cannabis Regulation and Safety Act (MAUCRSA) in 2017. The MAUCRSA established several state-wide permitting programs for the cannabis industry, three of which pertain specifically to minimizing environmental impacts arising from outdoor cannabis cultivation. These programs, discussed further below, are implemented by the CDFW, State Water Resources Control Board, and the Regional Water Quality Control Boards.

CDFW is responsible for ensuring cannabis cultivation does not adversely impact fish and wildlife resources and accomplishes this task through Lake and Streambed Alteration Agreement permitting as well as enforcing applicable Fish and Game Code and California Penal Code violations. The California State Water Resources Control Board (State Board) and Regional Water Quality Control Boards (Regional Boards) also regulate and permit various aspects of the cultivation operation, namely those related to water diversion and pollutant discharge. The State Board's Cannabis Cultivation Policy (State of California State Water Resource Control Board 2019) addresses water quality impacts through various regulations carried out by the Regional Boards, including those setting riparian setback and slope limitations, road development and stream crossing requirements, and fertilizer and pesticide application and management protocols. The State Board addresses impacts to surface water quantity through both numeric and narrative instream flow requirements, the most pertinent being restrictions on the surface flow diversion season (no diversions between April 1 and October 31), and mandatory bypass flow requirements at each diversion point.

The regulatory and permitting program outlines a comprehensive approach to minimize cannabis cultivation impacts on surface water quality and quantity, including those affecting salmon and steelhead. However, most cannabis cultivators seeking permitting from CDFW and the State Board propose using groundwater pumping as their water source, thus avoiding the season and bypass flow requirements stipulated for surface water diversions. An unknown, but likely large number of these wells are located near streams and rivers since shallow groundwater depths decrease well drilling costs, and groundwater depths typically increase proportionally with distance from a stream. These wells may be depleting hydraulically connected streamflow and significantly impairing salmon and steelhead instream habitat, especially during summer months when flows are lowest and irrigation demand highest. This groundwater-surface water relationship largely goes unrecognized and unanalyzed during local and state permitting processes. Another factor that limits the State's environmental protection efforts is the number of illegal/unregulated cultivation operations that remain on the landscape. Many growers object to the cost associated with permitting a "legal" grow operation, which may incentivize growers to avoid state regulation. Appreciable improvements in instream habitat quality for salmon, steelhead, and other native aquatic resources may not be realized unless industry oversight is improved and expanded.

Regulatory Mechanisms Resulting in Inadequate or Decreased Protection

We are concerned about the adequacy of the existing federal and state regulatory mechanisms designed to reduce high water temperatures, excess sediments, and toxicity in waterways, address loss of habitat resulting from habitat conversions and disconnection of streams and rivers from their floodplains, and reduce the detrimental impacts of altered floodplain connectivity, and hydrology. The following regulatory mechanisms are highlighted because they provide inadequate protection.

National Flood Insurance Program

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

Nearly all West Coast salmon species, including 27 of the 28 species listed under the ESA, are negatively affected by an overall loss of floodplain habitat connectivity and complex channel habitat. The reduction and degradation of habitat has progressed over decades as flood control and wetland filling occurred to support agriculture, forest management, or conversion of natural floodplains to urbanizing uses (e.g., residential and commercial development). Loss of habitat through conversion was identified among the factors for decline for most ESA-listed salmonids. "NMFS believes altering and hardening stream banks, removing riparian vegetation, constricting channels and floodplains, and regulating flows are primary causes of anadromous fish declines" (65 FR 42450 July 10, 2000); "Activities affecting this habitat include…wetland and floodplain alteration" (64 FR 50414, September 16, 1999).

Development proceeding in compliance with NFIP minimum standards ultimately results in impacts to floodplain connectivity, hydrology, habitat-forming processes, and inundation through flood storage. Development consequences of levees, stream bank armoring, stream channel alteration projects, and floodplain fill, combine to prevent streams from functioning properly and result in degraded habitat. The full expression of the life history of SONCC coho salmon is dependent on a functional floodplain, and the NFIP systemically allows a pattern of adverse effects that incrementally and permanently diminish floodplain habitat values of connectivity, complexity, hyporheic connection and streamflow recharge, refugia, and prey base.

Most communities (counties, towns, cities) in Oregon and California are NFIP participating communities, applying the NFIP minimum criteria. For this reason, it is important to note that, where it has been analyzed for effects on salmonids, floodplain development that occurs consistent with the NFIP's minimum standards has been found to jeopardize the continued existence of 18 ESA-listed species of salmon and steelhead (including Chinook salmon, steelhead, chum salmon, coho salmon, sockeye salmon) (NMFS 2008b, 2016a). The Reasonable and Prudent Alternative (RPA) provided in NMFS' 2016 biological opinion (NMFS 2016b) (Columbia Basin species, Oregon Coast coho salmon, SONCC coho salmon) has not yet been implemented

The 2016 biological opinion (NMFS 2016b) called for FEMA to (1) monitor the direct, indirect, and cumulative impacts of the activities implemented under the NFIP in Oregon, (2) effectively determine program compliance, (3) take timely and effective corrective actions when the consequences of NFIP activities exceed measurable standards and criteria, and (4) structure the program in a manner that allows assurances that floodplain activities will not jeopardize ESA-listed species or their designated critical habitat. These measures (i.e., the NFIP Implementation Plan) are intended to prevent further loss of floodplain function once affected communities begin applying those development standards, so there will be an inherent lag-time between when the Implementation Plan is final and when loss of floodplain function will slow down.

It has been 8 years since the issuance of the 2016 biological opinion, and the risk that NFIP poses to the survival and recovery of SONCC coho salmon has not been alleviated. NMFS is very concerned that FEMA has not implemented substantive changes to the NFIP to avoid jeopardy of SONCC coho salmon (as well as other species).

As of August 2024, NMFS is in the formal consultation phase of the ESA section 7 process with FEMA regarding NFIP implementation in California, and is evaluating the program's effects on SONCC coho salmon and its designated critical habitat in California. However, life history patterns and associated habitat requirements among ESA-listed salmonids in Oregon and California are fairly consistent, suggesting that NFIP implementation in California is likely to incrementally and permanently diminish floodplain habitat form and function to the detriment of SONCC coho salmon similar to what has been seen in Oregon.

Clean Water Act (CWA) Administration

The Federal Clean Water Act addresses the development and implementation of water quality standards, the development of Total Maximum Daily Loads (TMDLs), point source permitting, the regulation of stormwater, and other provisions related to the protection of U.S. waters. The states of California and Oregon administer the Clean Water Act, with oversight by the U. S. Environmental Protection Agency (EPA). State water quality standards are set to protect beneficial uses, which include several categories of salmonid use. Together the State and Federal Clean Water Acts regulate the level of pollution within streams and rivers in California and Oregon.

Each state has a water quality section 401 certification program that reviews projects expected to discharge into waters of the U.S., and issues certifications that the proposed action meets State water quality standards and other aquatic protection regulations, if appropriate. Each state also issues National Pollution Discharge Elimination System (NPDES) permits under section 402 for discharges from industrial point sources, waste-water treatment plants, construction sites, and municipal stormwater conveyances, with established parameters for the allowance of mixing zones if the discharged constituent does not meet existing water quality standards at the 'end of the pipe.'

State water quality standards are set in order to protect beneficial uses, which include several categories of salmonid use. TMDL standards are prepared to reduce concentrations of those specific contaminants, or improve those specific natural constituents, within a waterbody that fails to meet water quality standards in repeated testing.

Under section 303(d) of the Clean Water Act, states, territories and authorized tribes are required to submit lists of impaired waters that constitute the '303(d) list.' These waters are too polluted or otherwise degraded to meet water quality standards. The state water quality agencies and the EPA may only develop TMDLs for the water bodies on the 303(d) list, and are required to do so for all water bodies on the 303(d) list.

Natural constituents include physical characteristics of water, such as temperature and sediment load. Most TMDLs for water bodies within the range of SONCC coho salmon are for physical characteristics, e.g., the Upper Elk River Sediment TMDL (Humboldt Bay). High water temperature and turbidity are among those aspects of water quality that most impact SONCC coho salmon. The SONCC coho salmon recovery plan described "impaired water quality" (which includes temperature) and "altered sediment supply" as high or very high stresses for 64 percent and 79 percent of populations within the ESU, respectively (NMFS 2014).

Oregon's Rogue River Temperature TMDLs

In 2019, the Portland Division of the U.S. District Court of Oregon issued a final order and judgement in the case of Northwest Environmental Advocates (NEA) v. U.S. EPA et al. (NEA v. EPA et al. 2019). The court ruled that Oregon and EPA must replace 15 temperature TMDLs, including those for subbasins of the Rogue River. As described on the Oregon Department of Environmental Quality (ODEQ)'s Temperature TMDL Replacement Project web site,[6] "These TMDLs must be updated because they were based in part on the Natural Conditions Criterion, a section of the temperature standard that was subject to litigation and has since been disapproved by EPA." ODEQ's schedule lists April 17, 2026 for the replacement TMDLs for subbasins of the Rogue River. By this court-ordered date, ODEQ must prepare replacement TMDLs for subbasins of the Rogue River, and EPA must take action to approve or disapprove each of them (Michele Martin, ODEQ, personal communication, January 22, 2024).

CWA Section 404 Permit Exemptions for Agriculture, Forestry, and Transportation

The USACE regulates the discharged of dredged and fill material into "waters of the United States" (WOTUS), including wetlands, through permitting under the CWA section 404 Program. The CWA 404 standard is that permitted activities should not "cause or contribute to significant degradation of the WOTUS." Activities that are regulated under this program include fill for development, water resource projects (such as dams and levees), infrastructure development (such as highways and airports), and mining projects. Section 404 requires a permit before dredged or fill material may be discharged into WOTUS, unless the activity is exempt from section 404 regulation (e.g., certain farming and forestry activities). However, many agricultural, forestry, and transportation activities degrade water quality in areas critical to the survival of SONCC coho salmon. CWA 404 permit exemptions, particularly those affecting agricultural and transportation activities, therefore fail to prevent the degradation of tributary and mainstem habitat conditions resulting from these activities.

Regulatory Mechanisms Controlling Contaminants in Stormwater Runoff

Stormwater runoff is the primary route by which nonpoint source pollution is conveyed to waterways, where pollutants it carries can harm salmonids and their habitat. Pollutants in

[6] https://www.oregon.gov/deq/wq/tmdls/pages/tmdlreplacement.aspx

stormwater are reflective of their source areas and land use. For example, agricultural areas often contribute current and legacy agricultural use pesticides, herbicides, and fungicides, nutrients from crops and livestock, and elevated levels of suspended sediments and turbidity resulting from land management to water bodies. Urbanized areas contribute general-use pesticides sold in stores and legacy contaminants from current and former land uses such as dioxins and PCBs, nutrients from lawn and garden care, and elevated levels of suspended sediment and turbidity from land-disturbing activities.

Runoff from roadways contains a complex mixture of contaminants associated with automobiles and used in tire manufacturing [polycyclic aromatic hydrocarbons (PAHs), oils, grease, heavy metals (copper, zinc, cadmium, chromium, lead), and other toxic substances such as tire particles (6PPD-quinone)], and these contaminants are often found where rural and urban roadways drain into waterways. Some contaminants have been known and documented for many decades, such as heavy metals and various organic contaminants (e.g., Caltrans 2003, Feist et al. 2017, Peter et al. 2022). The tire particle-associated chemical, 6PPD-quinone, has only recently been identified, although it has been in use for many decades and the tire dust and shreds that are its source have been found to be ubiquitous where roadways drain into waterways (Sutton et al. 2019, Feist et al. 2017). These tire particles may be responsible for observations of toxicity whose cause was previously listed as unknown. Other tire-derived products used by agencies and municipalities, such as asphalt rubber paving, fill for overpass construction or surface area covers for porous walkways, and surfacing for paths and bike trails, may also contribute harmful chemicals to waterways (CA DTSC 2022). Potential impact levels in a waterbody are dependent on roadway use (traffic density and average speeds) and road density (Feist et al. 2017, Peter et al. 2022), as well as the specific drainage patterns from the roadways.

Published research has identified stormwater from highways, roadways, and streets as causing rapid mortality or rapidly noticeable symptoms of exposure to some salmonid species, including coho salmon (e.g., Scholz et al. 2011, McIntyre et al. 2018, Chow et al. 2019, French et al. 2022, Peter et al. 2018, Tian et al. 2021). Symptoms of morbidity to coho salmon were noticeable within minutes to hours, and the exposed fish did not recover when transferred to clean water (Chow et al. 2019, French et al. 2022). Mortality of 50 percent of the test subjects occurred at low levels (<1 part per billion (ug/L); Tian et al. 2022). These low levels are documented in the environment and realistic to expect coho salmon to encounter (Challis et al. 2022, Johannessen et al. 2022).

Fortunately, other recent literature has shown that mortality impacts from stormwater runoff can be prevented by filtering the road runoff through soil media containing organic matter, which results in the removal of this (and other) contaminant(s) (McIntyre et al. 2015, Spromberg et al. 2016). These types of green infrastructure or low-impact development practices are often included in new construction projects in some urban and urbanizing areas, but are often lacking in existing infrastructure. In addition, many redevelopment or routine maintenance projects in roadway or urban development settings do not require mitigation of this pollution source.

Heavy metals such as copper and zinc are also well documented contaminants in stormwater from roadways (CA DTSC 2021, Caltrans 2000, Caltrans 2003) and have been shown to detrimentally affect salmonids and their habitat at very low, environmentally realistic levels. These low levels are noted to impact the resistance of fishes to disease, cause hyperactivity, impair respiration, disrupt osmoregulation and calcium levels and/or impact olfactory performance, leading to disruption in critical fish behaviors at concentrations that are at, or just slightly above, ambient concentrations. A NOAA Technical Memorandum (Hecht et al. 2007) established a benchmark concentration of 2 ug/L dissolved copper above background levels. Above this concentration, predators are more successful in killing juvenile coho salmon because the copper suppresses their ability to smell and avoid the predators. This suppression occurs within a few minutes of copper exposure. If copper concentrations are high enough, they can kill the coho salmon sensory cells, and it may take weeks for these sensory cells to recover.

PAHs are present in roadway stormwater from sources including vehicle exhaust, fuel leaks and spills, oils and greases, roadway sealants, and rubber asphalt paving (McIntyre et al. 2015, CA DTSC 2022, Peter et al. 2022). Fish embryos and larvae exposed to PAHs have been documented to experience adverse changes in heart physiology and morphology, including pericardial and/or yolk sac edema leading to heart failure or impaired swimming performance, even with only temporary exposure to low concentrations (Hicken et al. 2011, Incardona et al. 2014, Brette et al. 2014, Incardona and Sholz 2017). Exposure of some PAHs to sunlight harms invertebrates (Pelletier et al. 1997, Swartz et al. 1997), with as little as 2 µg/L being toxic to calanoid copepods (Duesterloh et al. 2002). Impacts to phytoplankton and zooplankton communities have also been reported in the literature (Sibley et al. 2004, Bestari et al. 1998).

The highest concentrations of chemicals harmful to instream habitats are expected to be associated with the point of discharge during and shortly after rainfall, particularly “first-flush” rain events after long antecedent dry periods. However, when road densities are high enough, many contaminants exhibit transport-limited, rather than mass-limited, characteristics. This means the source of contaminants within the system is large enough that additional precipitation continues to mobilize the pollutants either by transporting that which was newly deposited on the roadway or that which was less mobile or more distant from the discharge point (Peter et al. 2022, 2020, Johannessen et al. 2022, Feist et al. 2017). In these cases, designated critical habitat has the potential to experience a temporary or permanent reduction in function and value.

Pollution from roads and streets is a concern for SONCC coho salmon survival and recovery. Although most of the watersheds that make up this ESU don’t include large urban centers, nearly all contain major highways that transport many vehicles through the watersheds, leading to potential exposure to contaminants from tire dust and shreds. Further, the lower portion of any watershed is likely to show higher contaminant levels in runoff than the upper portion because all the stormwater runoff from the upstream portion of the watershed travels downstream to the lower portion. The preferred rearing habitat for coho salmon is nearly always in this lower portion, where the wider, lower gradient habitat is found.

Lack of Methodology for Assessing Cumulative Impacts of Continued Development of Waterfront, Riverine, Coastal, and Wetland Properties

USACE guidelines do not specify a methodology for assessing the cumulative impacts of activities they permit in combination with those they do not (i.e., due to 404 permit exemptions), or how much weight to assign them in decision-making. Therefore, the USACE makes permitting decisions regarding the development of waterfront, riverine, coastal, and wetland properties without a complete consideration of their impact on the SONCC coho salmon.

2021 Modification of Nationwide Permits

The USACE authorizes certain floodplain fill and removal activities with Nationwide Permits (NWPs). In 2021, the USACE finalized the re-issuance of existing NWPs with modifications (86 FR 2744, January 13, 2021; 86 FR 73522, December 27, 2021). These modifications allow an increase in the amount of fill and destruction of habitat possible for nationwide permits that are frequently used throughout the range of SONCC coho salmon, which will likely lead to further disconnection of off-channel habitat from floodplain areas and simplification of stream habitats. Although regional conditions could be applied to particular nationwide permits to address some of these issues, there has been no indication that regional conditions will be developed to reduce impacts to listed species and their designated critical habitat.

Groundwater Management

California's Sustainable Groundwater Management Act (SGMA)

California's Sustainable Groundwater Management Act (SGMA) was signed into law in January 2015, during the height of an historic drought. SGMA required groundwater basins with currently unsustainable groundwater usage to form local Groundwater Sustainability Agencies (GSAs) by 2017. Three of these groundwater basins are within the range of SONCC coho salmon: Eel River Valley, Scott Valley, and Shasta Valley. The GSAs for these groundwater basins were required to develop Groundwater Sustainability Plans (GSPs) by 2022 that would achieve sustainable groundwater conditions no later than 2042. Sustainability under the act is defined as avoiding six "undesirable results" caused by unsustainable groundwater management, one of which is "significant and unreasonable impacts to beneficial uses of surface water." Since many waterways overlying SGMA basins contain federally designated critical habitat for ESA-listed salmonids, NMFS has actively participated as a stakeholder in many GSP development processes throughout the state, including those for the Eel River Valley, Scott Valley, and Shasta Valley Groundwater Basins, by advising GSAs to consider and avoid streamflow depletion impacts to salmon and steelhead habitat.

A provision in SGMA legislation allows each GSA to choose whether they wish to address any undesirable results occurring prior to January 1, 2015. To date, the vast majority of GSAs, as well as the California Department of Water Resources (CDWR), have interpreted that language as allowing streamflow depletion rates consistent with summer 2014 as an appropriate and legal management objective. This means that the threshold to take action on streamflow depletion only applies when streamflow depletion is ***worse*** than seen during California's historic drought. 2014 was the third year in the driest 4-year stretch in California's recorded history (Hanak et al. 2016), with many detrimental consequences for salmon and steelhead individuals and habitat. Therefore, NMFS has consistently commented within every basin during the past 5 years of GSP development that these proposed streamflow depletion thresholds are likely to degrade salmon/steelhead migration, spawning, and rearing habitat and harm ESA-listed species.

Given the lack of response by CDWR to any of NMFS' attempts to directly raise this issue to date, NMFS is not confident that any GSA will be required to amend their GSP to thresholds that do not use the 2014 drought conditions as an acceptable objective. Streamflow depletion is difficult to measure, and often requires a groundwater/surface water model for analysis, which the GSPs will develop within the first 5 years of plan implementation. One basin outside of the SONCC Coho Salmon ESU (Sonoma Creek) developed a "preliminary" model during GSP development that estimated groundwater pumping causes a streamflow depletion rate of 90 percent (as compared to a "no pumping" scenario) during summer/fall 2014, providing support for NMFS' concern about detrimental impacts to salmon and steelhead habitat.

NMFS has designated much of the area in the Eel River Valley, Scott Valley, and Shasta Valley Groundwater Basins as critical habitat under the ESA for three listed salmonids, including SONCC coho salmon. NMFS has also designated the Eel River as Essential Fish Habitat for Pacific Salmon Fisheries under the Magnuson-Stevens Fishery Conservation and Management Act. The SONCC coho salmon recovery plan describes areas of high intrinsic potential to support the species throughout all three groundwater basins (NMFS 2014).

In January 2021, the County of Humboldt's GSA submitted the final Eel River Valley Groundwater Basin GSP to CDWR. In April 2022, in a comment letter to CDWR, NMFS recommended denial of the GSP unless appropriate Sustainable Management Criteria with Minimum Thresholds and Measurable Objectives were developed for the critical summer and early fall low flow period (NMFS 2022c). In October 2022, Friends of the Eel River sued the County of Humboldt over their regulation of groundwater, citing a 2018 public trust doctrine legal decision as well as NMFS and CDFW's comments on the GSP.

In 2023, CDWR evaluated and approved the GSPs for the Eel River Valley, Scott Valley, and Shasta Valley Groundwater Basins (CDWR 2023a, 2023b, and 2023c, respectively). CDWR included the following recommended action in each groundwater basin's acceptance letter: that the GSA "Prioritize collaborating and coordinating with local, state, and federal regulatory agencies as well as interested parties to better understand the full suite of beneficial uses and users that may be impacted by pumping induced surface water depletion within the GSA's jurisdictional area." CDWR considers their recommended actions as corrective actions that "ensure the Plan's implementation continues to be consistent with SGMA and the Department is able to assess progress in achieving the sustainability goal within the basin."

County-Level Regulation of Well Drilling and Operation

Much of the critical habitat for SONCC coho salmon is impacted by insufficient flows in the summer months. Such low flows are exacerbated by drought, surface water withdrawals from streams, and groundwater pumping from wells (see Listing Factor A, Section 2.3.2.1). Insufficient water quantity is identified as a habitat concern for all seven diversity strata of SONCC coho salmon (Section 2.3.2.1). As described in Listing Factor A, surface water is connected to groundwater, and groundwater pumping can cause decreases in surface streamflows. Given that this is a widespread concern across the ESU, and few groundwater basins within the ESU are regulated under SGMA, in many cases, proposed and existing wells in the range of SONCC coho salmon have received little or no review for impacts to surface stream flows.

A 2018 court decision in California (Envtl. Law Found. v. State Water Res. Control Bd., 26

Cal.App.5th 844, 237 Cal. Rptr. 3d 393) established that counties have a duty to consider impacts to public trust uses of surface waters when issuing permits to drill new wells. In the spring of 2023, Sonoma County amended its well permitting ordinance to require a consideration of public trust impacts, using anadromous fish as a key indicator of affected resources. NMFS participated in the amendment of the Sonoma County well permitting ordinance. NMFS expects other counties in the range of SONCC coho salmon will develop similar amended ordinances, providing a regulatory mechanism to address streamflow depletion from groundwater pumping across broad swathes of high potential salmonid habitat as well as designated critical habitat for salmonids. In the next 5 years, development of these ordinances in each county throughout the range of SONCC coho salmon is critically important for the survival of this species.

Listing Factor D: Conclusion

Although many regulatory mechanisms and conservation efforts were in place when the SONCC coho salmon ESU was listed under the ESA in 1997, NMFS concluded in the listing determination at that time that these were insufficient to provide for the attainment of properly functioning habitat conditions and sustainable harvest conditions that would protect and conserve the species. More recently, the SONCC coho salmon recovery plan (NMFS 2014) and the previous 5-year review (NMFS 2016a) identified inadequate regulatory mechanisms as contributing substantially to the continued decline of the SONCC coho salmon. The primary regulatory mechanisms that protect SONCC coho salmon are not comprehensive and are vastly different across the landscape and various land uses (NMFS 2016a).

As described under Listing Factor B (Section 2.3.2.2), several harvest-related regulatory mechanisms have improved since the last 5-year review. Specifically, the PFMC developed a new HCR for SONCC coho salmon, and the Hoopa Valley Tribe now holds a final TRMP. In addition, as described under Listing Factor E (Section 2.3.2.5), there are now approved HGMPs for all hatcheries that produce coho salmon in SONCC coho salmon watersheds, and all hatcheries that produce other species that may affect SONCC coho salmon. Three additional changes in regulatory mechanisms resulting in improved protections are highlighted in Section 2.3.2.4: ESA-driven management of Eel River water through the Potter Valley Project, California's instream flow management, and California's Medicinal and Adult-Use Cannabis Regulation and Safety Act.

Still, NMFS continues to have concerns about the sufficiency of certain regulatory mechanisms intended to reduce the effects of human activities such that they do not cause extinction or prevent recovery of this ESU. Three regulatory mechanisms that currently provide inadequate or decreased protection are highlighted in Section 2.3.2.4: FEMA's National Flood Insurance Program, five components of administration of the Clean Water Act, and regulation of groundwater.

We conclude that the risk to the species' persistence from inadequate regulatory mechanisms has increased compared to the risk assessed in 2016 because the activities that are not adequately regulated continue to increase. While recently developed regulatory mechanisms/documents are expected to improve conditions for the species over time (e.g., cannabis regulations in California, new HCR, TRMPs, HGMPs), they have not yet resulted in much change to impacts experienced by SONCC coho salmon. At the same time, with the latest drought, groundwater pumping has likely increased since 2016, and NMFS has low confidence that the current application of SGMA will regulate this water use effectively. In addition, our longstanding concerns regarding Oregon's regulation of the coastal zone and water quality remain unaddressed, and it is unclear whether the state's SIA approach can bring about changes sufficient to ensure species recovery.

Recommended future actions for the next 5 years

The greatest opportunities to advance recovery of SONCC coho salmon are:

D1: Comply with the RPA from the 2016 NMFS biological opinion on the effects of FEMA's NFIP in Oregon.

D2: Revise FEMA's NFIP to minimize adverse effects to SONCC coho salmon and avoid jeopardizing their existence in California.

D3: ODEQ submits replacement TMDLs under the CWA for all subbasins of the Rogue River based on the remaining segments of the temperature criteria, in sufficient time for EPA to approve or disapprove them by the court-ordered date of April 17, 2026.

D4: Review and consider revising USACE's CWA 404 permit exemptions for those agricultural, forestry, and transportation activities that degrade habitat conditions in tributaries and mainstems.

D5: Develop a comprehensive and consistent process as part of the CWA 404 permitting to address the cumulative effects of the continued development of waterfront, riverine, coastal, and wetland properties on listed salmonids and their designated critical habitat.

D6: Apply regional conditions to those recently modified Nationwide Permits (NWPs) under the CWA that allow an increase in the possible amount of fill and destruction of habitat in the range of SONCC coho salmon in order to reduce further disconnection of off-channel habitat from floodplain areas, simplification of stream habitats, and resulting impacts to SONCC coho salmon, its designated critical habitat, and Essential Fish Habitat for Pacific Salmon Fisheries.

D7: Create incentives for key agricultural land owners and water users to conserve land and water and restore riparian areas and functions.

D8: States and counties develop regulations for development, redevelopment, and routine maintenance projects in roadway or urban development settings within the range of SONCC coho salmon to mitigate stormwater pollutants, including those derived from car tires, through methods such as filtering road runoff through soil media containing organic matter.

D9: Humboldt County amends the Eel River Valley Groundwater Sustainability Plan to include ecologically based Sustainable Management Criteria that avoid impacts to SONCC coho salmon, its designated critical habitat, and Essential Fish Habitat for Pacific Salmon Fisheries by protecting surface water beneficial uses.

D10: Siskiyou County amends the Scott Valley and Shasta Valley Groundwater Sustainability Plans to include ecologically based Sustainable Management Criteria that avoid impacts to

SONCC coho salmon and its designated critical habitat by protecting surface water beneficial uses.

D11: Humboldt County prioritizes collaborating and coordinating with local, state, and federal regulatory agencies and interested parties to gain a better understanding of the full suite of beneficial uses and users that may be impacted by pumping-induced surface water depletion within the Eel River Valley GSA's jurisdictional area.

D12: Siskiyou County prioritizes collaborating and coordinating with local, state, and federal regulatory agencies and interested parties to gain a better understanding of the full suite of beneficial uses and users that may be impacted by pumping-induced surface water depletion within the Scott Valley and Shasta Valley GSA jurisdictional areas.

D13: Modify the current sustainable management criteria in Humboldt and Siskiyou County's GSPs to ensure avoidance of undesirable results due to streamflow depletion under SGMA, particularly impacts to SONCC coho salmon, its designated critical habitat, and Essential Fish Habitat for Pacific Salmon Fisheries.

D14: NMFS continues engaging with CDWR, GSAs, local parties, and interested environmental organizations (e.g., Friends of the Eel River, The Nature Conservancy , Trout Unlimited, and Caltrout) to provide technical expertise on how streamflow depletion impacts ESA-listed salmonids, and how to effectively avoid those impacts.

D15: Develop or amend county ordinances to provide a discretionary well permitting process that adequately analyzes and minimizes streamflow depletion from groundwater pumping affecting SONCC coho salmon, its designated critical habitat, and Essential Fish Habitat for Pacific Salmon Fisheries.

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

Climate Change

Major ecological realignments are already occurring in response to climate change (IPCC 2022). Long-term trends in warming have continued at global, national, and regional scales. Global surface temperatures in the 2010s were estimated to be 1.09°C higher than the 1850-1900 baseline period, with larger increases over land ~1.6°C compared to oceans ~0.88°C (IPCC 2021). The vast majority of this warming has been attributed to anthropogenic releases of greenhouse gases (IPCC 2021). Globally, 2014-2018 were the five warmest years on record, both on land and in the ocean (2018 was the 4th warmest) (NOAA NCEI 2022). Events such as the 2013-2016 marine heatwave (Jacox et al. 2018) have been attributed directly to anthropogenic warming in the annual special issue of Bulletin of the American Meteorological Society on extreme events (Herring et al. 2018). Global warming and anthropogenic loss of biodiversity represent profound threats to ecosystem functionality (IPCC 2022). These two factors are often examined in isolation but likely have interacting effects on ecosystem function.

Updated projections of climate change are similar to or greater than previous projections (IPCC

2021). NMFS is increasingly confident in our projections of changes to freshwater and marine systems because every year brings stronger validation of previous predictions in both physical and biological realms. Retaining and restoring habitat complexity, access to climate refuges (flow and temperature), and improving growth opportunity in both freshwater and marine environments are strongly advocated in the recent literature (Siegel and Crozier 2020).

Climate change is systemic, influencing freshwater, estuarine, and marine conditions. Other systems are also being influenced by changing climatic conditions. Literature reviews on the impacts of climate change on Pacific salmon (Crozier 2015, 2016, 2017; Crozier and Siegel 2018; Siegel and Crozier 2019, 2020) have described hundreds of papers documenting the major themes relevant for salmonids. Below, we describe habitat changes that are relevant to Pacific salmon and steelhead.

Effects on Freshwater Habitat

Forests and Wildfires

Climate change will impact forests of the western U.S., which dominate the landscape of many watersheds in the region. Forests already show evidence of increased drought severity, forest fire, and insect outbreak (Halofsky et al. 2020). Additionally, climate change will affect tree reproduction, growth, and phenology, leading to spatial shifts in vegetation. Halofsky et al. (2018) projected that the largest changes will occur in low- and high-elevation forests, with expansion of low-elevation dry forests and diminishing of high-elevation cold forests and subalpine habitats.

A major emergent habitat concern since the 2016 5-year review is the increased frequency and severity of large (>20,000 acres), unprecedented wildfires throughout the SONCC Coho Salmon ESU. As described in BLM et al. (2018), intense fire can produce extensive areas of water-repellent soils, which combine with widespread vegetation loss to reduce water infiltration and create an elevated runoff response to precipitation events. This sudden increase in overland and instream flow renders channels vulnerable to fine sediment delivery through erosion and large hillslope failures. Existing culverts have been burned or, where they still exist, overwhelmed by debris jams with flow eventually eroding through the road prism. Further, freshly excavated roads, and fire breaks cut by bulldozers to access and stop a fire’s movement, remove vegetation and expose soil. If these excavations are not rehabilitated before the rainy season, they may confine runoff and promote rill erosion. Damage to riparian habitat significantly reduces stream shading, instream large wood, and long-term recruitment of large woody material input. It also decreases upslope filtering of mobilized sediments by organic material. Ultimately, water quality and fisheries habitat are degraded by accelerated surface runoff and erosional processes (surface erosion and increased landslide risk) that produce elevated nutrients, suspended sediment, turbidity, and accumulation of fines in pool habitat and spawning beds. High-intensity wildfire has the greatest potential to damage aquatic habitat through increased surface erosion and increased risk of landslides that deliver large quantities of sediment to streams.

Holden et al. (2018) examined environmental factors contributing to observed increases in the extent of forest fires throughout the western U.S. They found strong correlations between the number of dry-season rainy days and the annual extent of forest fires, as well as a significant decline in the number of dry-season rainy days over the study period (1984-2015). Consequently, predicted decreases in dry-season precipitation, combined with increases in air temperature, will likely contribute to the trend toward more extensive and severe forest fires and the continued expansion of fires into higher-elevation and wetter forests (Alizedeh et al. 2021).

Climate change may also increase insect outbreaks and other pathogens affecting coastal Douglas-fir forests in the Pacific Northwest. Research by Agne et al. (2018) suggests that Douglas-fir beetle and black stain root disease could become more prevalent with climate change, while other pathogens will be more affected by management practices. Agne et al. (2018) also suggested that climate impacts will differ by region and forest type due to complex interacting effects of disturbance and disease.

The following is excerpted from Siegel and Crozier (2019), who present a review of recent scientific literature evaluating the effects of climate change, describing the projected impacts of climate change on instream flows:

> Cooper et al. (2018) examined whether the magnitude of low river flows in the western U.S., which generally occur in September or October, are driven more by summer conditions or the prior winter's precipitation. They found that while low flows were more sensitive to summer evaporative demand than to winter precipitation, interannual variability in winter precipitation was greater. Sridhar et al. (2018) predicted that summer evapotranspiration is likely to increase in conjunction with declines in snowpack and increased variability in winter precipitation. Their results suggest that low summer flows are likely to become lower, more variable, and less predictable.
>
> The effect of climate change on groundwater availability is likely to be uneven. Sridhar et al. (2018) coupled a surface-flow model with a ground-flow model to improve predictions of surface water availability with climate change in the Snake River basin. Projections using representative concentration pathway (RCP) 4.5 and 8.5 emission scenarios suggested an increase in water table heights in downstream areas of the basin and a decrease in upstream areas.

As cited in Siegel and Crozier (2019), Isaak et al. (2018) examined recent trends in stream temperature across the western U.S. using a large regional dataset. Stream warming trends paralleled changes in air temperature and were pervasive during the low-water warm seasons of 1996-2015 (0.18-0.35°C/decade) and 1976-2015 (0.14-0.27°C/decade). Isaak et al. (2018) concluded that most stream habitats will likely remain suitable for salmonids in the near future, with some becoming too warm. However, in cases where dams and other barriers restrict habitat access, salmon and steelhead will be confined to downstream reaches that are typically most at risk of rising temperatures unless passage is restored (FitzGerald et al. 2021, Myers et al. 2018).

Streams with intact riparian corridors in mountainous terrain are likely to be more resilient to changes in air temperature. These areas may provide refuge from climate change for Pacific salmon and many other species. Krosby et al. (2018) identified potential stream refugia throughout the Pacific Northwest based on a suite of features thought to reflect the ability of streams to serve as such refuges: large temperature gradients, high canopy cover, large relative stream width, low exposure to solar radiation, and low levels of human modification. They created an index of refuge potential for all streams in the region, with mountain area streams scoring the highest. Nearly all habitat with high intrinsic potential to support rearing juvenile SONCC coho salmon is in low-gradient areas (Williams et al. 2006). Flat lowland areas, which also commonly contain migration corridors, generally scored lowest, and thus were prioritized for conservation and restoration. Forest fires can increase stream temperatures dramatically in short time-spans by removing riparian cover (Koontz et al. 2018), and streams that lose their snowpack with climate change may see the largest increases in stream temperature due to the removal of temperature buffering (Yan et al. 2021). These processes may threaten some habitats that are currently considered refugia, highlighting the value in identifying, restoring, and protecting locations of cold-water refugia within the range of SONCC coho salmon.

Drought

At the time of the 2016 5-year review, California had experienced well below average precipitation from 2012-2015 and record-high surface air temperatures during 2014 and 2015.

The drought has had lasting impacts past 2015. In water years 2017 and 2018, rainfall was plentiful and, while summer stream flows improved, they did not return to the levels recorded before the drought (Dolman et al. 2019). The decrease in streamflow shows that the drought had cumulative impacts on the alluvial aquifer and groundwater conditions (Dolman et al. 2019). As the quantity and severity of droughts continue, the cumulative impacts will become more limiting to the recovery of SONCC coho salmon.

Starting in 2020, historically severe drought conditions prevailed in much of the range of SONCC coho salmon, and these conditions continued through late 2022. Drought monitoring data for the southern and inland counties of the ESU (Mendocino, Trinity, Shasta, and Siskiyou counties in California, and Josephine and Jackson counties in Oregon), which we expect would be more impacted by drought than coastal areas, show most of the entire area of these counties was experiencing severe drought (orange), if not worse, from May 2020 through December 2022 (Figure 2). The darker the color, the more severe the drought conditions. Orange shows the proportion of the total area in severe drought. Red shows the proportion of the total area in an extreme drought. Brown shows the proportion of the total area in an exceptional drought.

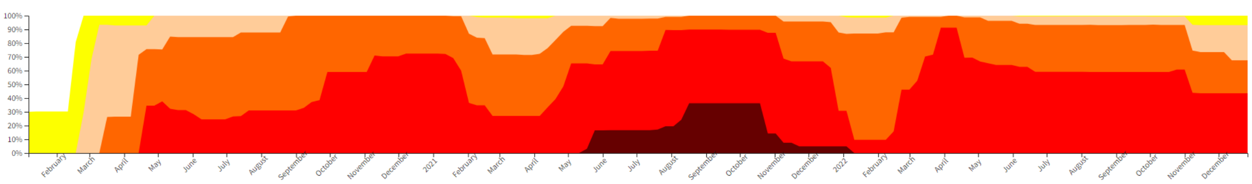

Figure 2. Drought conditions for the southern and inland counties of the SONCC Coho Salmon ESU, shown as a percentage of the total area (on the y axis) over time (on the x axis), beginning in January 2020 and ending in December 2022. Source: NOAA's National Integrated Drought Information System (https://cpo.noaa.gov/national-integrated-drought-information-system/).

As 2020 progressed, drought conditions worsened across these counties. A brief reprieve from January to April of 2021 resulted in some improvement of conditions due to winter rains (Figure

3), although even during the best conditions in mid-March 2021, about 72 percent of the area was in severe drought (orange) (Figure 3).

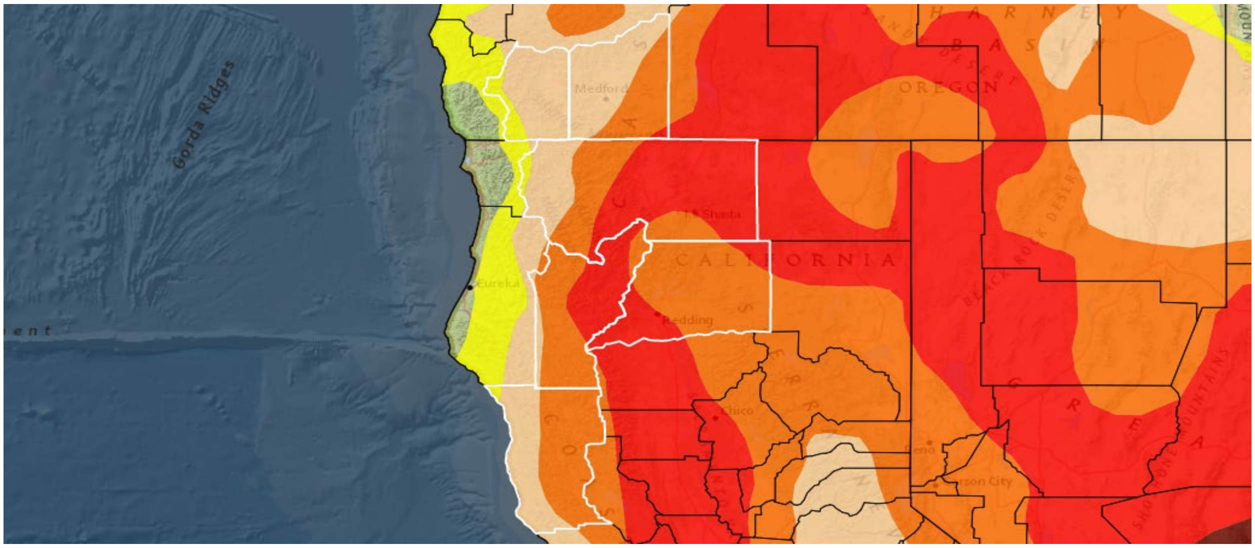

Figure 3. Drought severity during week of March 16, 2021, with the coastal and inland counties of the SONCC Coho Salmon ESU outlined in white. Source: NOAA's National Integrated Drought Information System (https://cpo.noaa.gov/national-integrated-drought-information-system/).

Starting in May 2021, drought conditions worsened further (Figure 2). At its height in September of 2021, all of these counties were in at least severe drought conditions (orange), 90 percent were in extreme drought (red), and 36 percent experienced exceptional drought conditions (brown) (Figure 4). Winter rains in late 2021 did not improve conditions as much as they had in late 2020, and drought conditions similar to those seen 2020 persisted through 2022 (Figure 2).

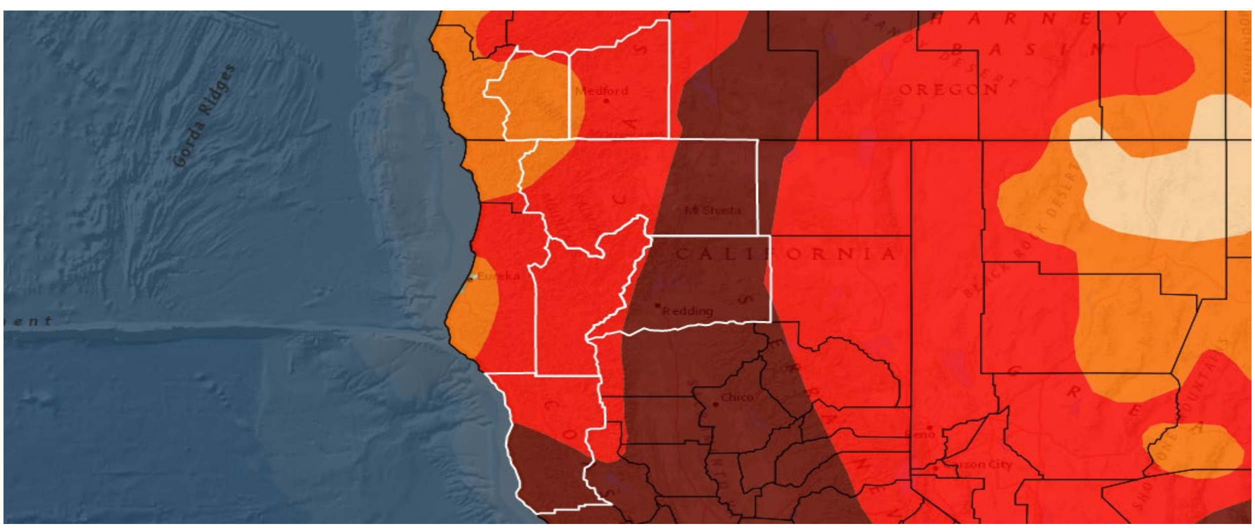

Figure 4. Drought severity during week of September 18, 2021, with the coastal and inland counties of the SONCC Coho Salmon ESU outlined in white. Source: NOAA's National Integrated Drought Information System (https://cpo.noaa.gov/national-integrated-drought-information-system/).

As shown in Figure 2, drought conditions depressed the growth and survival of three consecutive year classes of juvenile coho salmon in five of the seven diversity strata of this ESU. The extent of impacts on the affected coho salmon populations will not be fully apparent until monitoring occurs when they return as adults. In the future, juvenile monitoring would afford a more immediate assessment of the effects of drought.

Effects on Estuarine and Freshwater Wetland Habitat

Along with warming stream temperatures and concerns about sufficient groundwater to recharge streams, a 2018 study projects a nearly complete loss of existing tidal wetlands (estuarine habitat) along the U.S. West Coast due to sea-level rise (Thorne et al. 2018). Coastal development prevents inland migration of most wetlands, and this development and the steep topography also prevent lateral expansion of most wetlands, resulting in an overall reduction of the amount and distribution of the wetland habitat crucial for SONCC coho salmon. Increasing frequency and duration of harmful algal blooms may affect salmon directly, depending on the toxin, and are expected to result in indirect effects to salmon by affecting predatory seabirds and marine mammals.

Effects on Ocean Habitat

Rising ocean temperatures, stratification, ocean acidity, hypoxia, algal toxins, and other oceanographic processes will alter the composition and abundance of a vast array of oceanic species. Climate change is likely to reduce the availability of biologically essential omega-3 fatty acids produced by phytoplankton in marine ecosystems. Loss of these lipids may induce cascading trophic effects, with distinct impacts on different species depending on compensatory mechanisms (Gourtay et al. 2018). Perhaps the most dramatic change in physical ocean conditions will occur through ocean acidification and deoxygenation. It is unclear how sensitive salmon and steelhead might be to the direct effects of ocean acidification because of their tolerance to a wide pH range in freshwater (although see Ou et al. 2015 and Williams et al. 2019). However, the impacts of ocean acidification and hypoxia on sensitive species (e.g., plankton, crabs, rockfish, and groundfish) will likely affect salmon indirectly through their interactions as predators and as prey when small. The full effects of these ecosystem dynamics are not known but will be complex.

Substantial changes in both predators and prey of Pacific salmon are likely, affecting both salmonid life history traits and relative abundance. Siegel and Crozier (2019) observed that changes in marine temperature are likely to have a number of physiological consequences on fishes. For example, in a study of small planktivorous fish, Gliwicz et al. (2018) found that higher ambient temperatures increased the distance at which fish reacted to prey. Numerous fish species (including many tuna and sharks) demonstrate regional endothermy, which in many cases augments eyesight by warming the retinas. However, Gliwicz et al. (2018) suggest that ambient temperatures can similarly affect fish that do not demonstrate this trait. Reproduction rates of many marine fish species are also likely to be altered with temperature (Veilleux et al. 2018). The ecological consequences of these effects and their interactions add complexity to predictions of climate change impacts in marine ecosystems.

Effects of Climate Change on Salmon

Within the historical range of climate variability, less suitable conditions for salmonids (e.g., warmer temperatures, lower stream flows) have been associated with detectable declines in many of the ESA-listed Pacific salmon and steelhead species, highlighting how sensitive they are to climate drivers (Ford 2022, Lindley et al. 2009, Williams et al. 2016, Ward et al. 2015). In some cases, the combined and potentially additive effects of poorer climate conditions for fish and intense anthropogenic impacts caused the population declines that led to these population groups being listed under the ESA (Crozier et al. 2019).

In freshwater, year-round increases in stream temperature and changes in flow will affect physiological, behavioral, and demographic processes in salmon, and change the species with which they interact. For example, as stream temperatures increase, many native salmonids face increased competition with more warm-water tolerant invasive species. Changing freshwater temperatures are likely to affect egg incubation and emergence timing, as well as influence survival. Changes in temperature and flow regimes may alter the amount of habitat and food available for juvenile rearing. This, in turn, could restrict the distribution of juveniles, further decreasing productivity through density dependence. Rising river temperatures increase the energetic cost of migration and the risk of *en route* or pre-spawning mortality of adults with long freshwater migrations, although populations of some ESA-listed salmon and steelhead may be able to make use of cool-water refuges and run-timing plasticity to reduce thermal exposure (Keefer et al. 2018, Barnett et al. 2020).

Marine survival of salmonids is affected by a complex array of factors, including prey abundance, predator interactions, the physical condition of salmon within the marine environment, and carryover effects from the freshwater experience (Holsman et al. 2012, Burke et al. 2013). It is generally accepted that salmon marine survival is size-dependent, and thus larger and faster-growing fish are more likely to survive (Gosselin et al. 2021). Furthermore, early arrival timing in the marine environment is generally considered advantageous for populations migrating through the Columbia River. However, the optimal day of arrival varies across years, depending on the seasonal development of productivity in the California Current, which affects prey available to salmon and the risk of predation (Chasco et al. 2021). Siegel and Crozier (2019) point out the concern that for some salmon populations, climate change may drive mismatches between juvenile arrival timing and prey availability in the marine environment. However, diversity in arrival timing can contribute to metapopulation-level resilience by reducing the risk of a complete mismatch.

At the individual scale, climate impacts on salmon in one life stage generally affect body size or timing in the next life stage, and negative impacts can accumulate across multiple life stages (Healey 2011, Wainwright and Weitkamp 2013, Gosselin et al. 2021). Changes in winter precipitation will likely affect the incubation and/or rearing stages of most populations. Changes in the intensity of cool-season precipitation, snow accumulation, and runoff could influence migration cues for fall, winter and spring adult migrants, such as coho salmon and steelhead. Egg survival rates may suffer from more intense flooding that scours or buries redds. Changes in hydrological regime, such as a shift from mostly snow to more rain, could drive changes in life history, potentially threatening diversity within an ESU (Beechie et al. 2006). Changes in summer temperature and flow will affect both juvenile and adult stages in some populations, especially those with yearling life histories and summer migration patterns (Crozier and Zabel 2006, Crozier et al. 2010, Crozier et al. 2019).

At the population level, the ability of organisms to genetically adapt to climate change depends on how much genetic variation currently exists within salmon populations, as well as how selection on multiple traits interact, and whether those traits are linked genetically. While genetic diversity may help populations respond to climate change, the remaining genetic diversity of many populations may be reduced compared to historic levels. For example, Johnson et al. (2018) compared genetic variation in Chinook salmon from the Columbia River basin between contemporary and ancient samples. A total of 84 samples determined to be Chinook salmon were collected from vertebrae found in ancient middens and compared to 379 contemporary samples. Results suggest a decline in genetic diversity, as demonstrated by a loss of mitochondrial haplotypes as well as reductions in haplotype and nucleotide diversity. Genetic losses in this comparison appeared larger for Chinook salmon from the mid-Columbia than those from the Snake River basin. Such genetic impacts could also have occurred for SONCC coho salmon. In addition to other stressors, modified habitats and flow regimes may create unnatural selection pressures that reduce the diversity of functional behaviors (Sturrock et al. 2020). Managing to conserve and augment existing genetic diversity may be increasingly important with more extreme environmental change (Anderson et al. 2015), though the low levels of remaining diversity present challenges to this effort (Freshwater 2019). Salmon historically maintained relatively consistent returns across variation in annual weather through the portfolio effect (Schindler et al. 2015), in which different populations are sensitive to different climate drivers.

Climate vulnerability assessment

Crozier et al. (2019) describe the results of an expert ranking process that determined the vulnerability of each species of ESA-listed Pacific salmon and steelhead to the effects of climate change. The results for SONCC coho salmon are summarized in Figure 5 (taken from the S3 Appendix of Crozier et al. 2019) and discussed below.

	Southern Oregon/Northern California Coast Coho	Expert Scores	Data Quality	Expert Scores Plots (Portion by Category)
Sensitivity attributes	Early life history	2.5	1.8	
	Juvenile freshwater stage	3.7	2.8	
	Estuary stage	3.2	1.5	
	Marine stage	3.4	2.8	
	Adult freshwater stage	1.6	2.5	
	Cumulative life-cycle effects	3.3	1.5	
	Hatchery influence	2.2	2.8	
	Other stressors	3.6	2.3	
	Population viability	3.5	3	
	Ocean acidification sensitivity	1.8	1.8	
	Sensitivity Score	High		
Exposure variables	Stream temperature	3.7	2	
	Summer water deficit	2.7	1.8	
	Flooding	3.4	1.3	
	Hydrologic regime	1.4	2.3	
	Sea level rise	3.3	2	
	Sea surface temperature	3.3	2	
	Ocean acidification exposure	4	2.5	
	Upwelling	2.9	1	
	Ocean currents	1.9	1	
	Exposure Score	High		
Overall Vulnerability Rank		High		

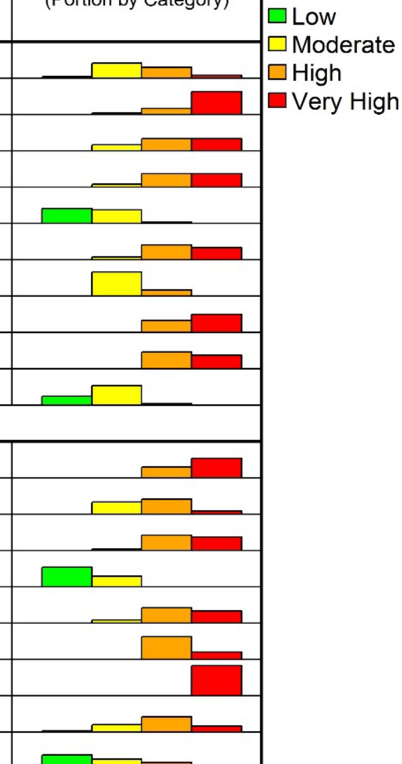

Figure 5. SONCC coho salmon climate effects, exposure, and vulnerability assessment. Source: Crozier et al. (2019).

Crozier et al. (2019) rated the juvenile freshwater, estuary, and marine life stages of SONCC coho salmon as highly vulnerable (Figure 5), meaning these life stages are both most sensitive to climate change and most exposed to changing environmental conditions. The estuary life stage is exposed to the effects of sea level rise. The juvenile freshwater life stage is also impacted by estuarine conditions, since some juveniles utilize estuaries as rearing habitat in addition to migratory habitat. The juvenile freshwater life stage and marine life stages are exposed to increasing stream temperature and sea surface temperature, respectively. Temperature and flow changes can reduce or block juvenile coho salmon access between freshwater and ocean habitats and create mismatches between migration timing and favorable conditions. This ESU ranks as highly sensitive to cumulative life cycle impacts caused by climate change.

In addition, this ESU's sensitivity to other stressors was ranked high. Stressors such as dams, water diversions, and erosion from damaging logging practices affect various populations within this ESU. Water diversions, in particular, have a major impact on the survival of the juvenile life stage in nearly all populations across the ESU when drought conditions prevail, as they have for much of the last 10 years. These stressors, in combination with current populations failing to meet viability criteria (i.e., high sensitivity to population viability) make the SONCC Coho Salmon ESU vulnerable to increased risk of extinction as the impacts of stressors are exacerbated by climate change.

Effects on Adaptive Capacity

Climate change affects the ESU's adaptive capacity. Because this ESU is near the southern limit of the range of coho salmon worldwide, it may be limited in its ability to further modify its life history or to tolerate higher temperatures. Crozier et al. (2019) consequently ranked the ESU as low for adaptive capacity and described its vulnerability to increased risk of extinction as existing stressors are exacerbated by climate change effects. Sustained efforts to improve habitat conditions so that spatial and temporal expressions of genetic and life history diversity are possible will aid resilience over time.

Habitat is particularly diverse within the range of SONCC coho salmon, and this diversity will likely cause greater differentiation in response to climate impacts and possibly a wider range of responses than would be possible with less diverse habitat characteristics. The three large basins that penetrate coastal mountain ranges include snowmelt-driven hydrographs, hot dry summers, and cold winters in their inland portions. In contrast, the lower portions of these basins, along with the entirety of the numerous moderately sized and small coastal basins inhabited by this ESU, typically experience relatively wet, cool, and temperate conditions. The contrast between coastal and interior sub-basins provides a range of environmental conditions that will most likely be impacted differently by climate-driven changes.

Climate Change Conclusion

SONCC coho salmon is at high risk of overall climate vulnerability based on its high risk for biological sensitivity, high risk for climate exposure, and low capacity to adapt (Crozier et al. 2019). Life-stage sensitivity attributes scored high for both juvenile and adult freshwater stages. The ESU is near the southern distributional limit of coho salmon and thus already faces numerous limiting factors stemming from climate effects (Crozier et al. 2019). Further, the adaptive capacity of this ESU was rated low due to its location on the southern edge of the species distribution near coho salmon's limit of temperature tolerance.

Small population size

If the number of adult coho salmon in a population is below that population's high-risk depensation threshold (as described in NMFS 2014), the population is at risk from natural stochastic processes, in addition to the threats described elsewhere in Section 2.3.2. As populations get smaller, stochastic processes can cause alterations in genetic characteristics, breeding structure, and population dynamics that undermine their ability to take advantage of improved habitat conditions and any reduction of stressors. Two examples of how small population size can limit productivity are when scarce spawners are unable to find mates and, therefore, suffer reduced probability of reproductive success, and when insufficient eggs are produced to saturate predator populations (Liermann and Hilborn 2001). These stochastic processes must be considered when evaluating how populations may respond to potential and/or implemented recovery actions.

Small population size, therefore, poses a threat to the persistence of individual populations of SONCC coho salmon and to the persistence of the ESU overall. Adult population monitoring conducted over the last 5 years provided demographic data for seven of the 26 independent populations, leaving NMFS with no insight into the population size and associated risk of extinction that the remaining 73 percent of these independent populations currently face. We recommend new monitoring approaches in the next 5 years to identify those populations already suffering the effects of small population size. Rapid summer juvenile surveys can be the most appropriate monitoring method to use when adults are scarce. Annually implementing such surveys in all independent populations where adult surveys do not occur would provide NMFS with insights into the threat of small population size faced by each population, and the true overall extinction risk of the ESU.

More discussion of this topic is included in Section 2.3.2.6 under Monitoring and Evaluation.

Hatchery Effects

The effects of hatchery fish on the status of an ESU or DPS depends upon which of the four key attributes – abundance, productivity, spatial structure, and diversity – are currently limiting the ESU/DPS, and how the hatchery fish within the ESU/DPS affect each of the attributes (70 FR 37204). Hatchery programs can provide short-term demographic benefits, such as increases in abundance during periods of low natural abundance. They also can help preserve genetic resources until limiting factors can be addressed. However, the long-term use of artificial propagation may pose risks to natural productivity and diversity. The magnitude and type of the risk depends on the status of affected populations and on specific practices in the hatchery program.

Hatchery managers have continued to implement and monitor changes in hatchery management since the last 5-year review for the hatchery programs within this ESU (shown in Table 1). The Hatchery Scientific Review Group recommends that the proportion of natural-origin broodstock (pNOB) be 20 percent at a minimum for broodstock used at hatcheries (CHSRG 2012). The HGMP for the IGH Program includes this target (CDFW and PacifiCorp 2014), the pNOB included in the Trinity River Hatchery HGMP is 100 percent (BOR and CDFW 2017), and the Cole River Hatchery protocol includes a target of 30 percent of natural-origin fish included in the annual broodstock (ODFW 2016a). These hatcheries have seen high levels of pNOB since the 2016 5-year review. In addition, the HGMPs include monitoring of the proportion of hatchery-origin fish on spawning grounds (pHOS), and include measures to mitigate any potential related impacts (e.g., weir operation at Bogus Creek).

When the Klamath dams are removed, IGH will lose its water supply. As a result, hatchery production will move to a revitalized facility at Fall Creek. CDFW and PacifiCorp anticipated that the 2014 Iron Gate HGMP would cover hatchery operations until the Klamath dams are removed. On February 1, 2023, CDFW submitted a final Fall Creek Hatchery (FCH) coho salmon program HGMP (CDFW 2023a) to NMFS as an attachment to an application for an ESA section 10(a)(1)(A) permit for scientific research and enhancement activities associated with implementation of the FCH coho salmon program HGMP. The FCH coho salmon program HGMP (CDFW 2023a) is an update to the 2014 Iron Gate Hatchery coho program HGMP (CDFW and PacifiCorp 2014).

Removal of Iron Gate Dam is scheduled for completion in September 2024. NMFS has completed a biological opinion on the effects to ESA-listed species of the dam removal project, including construction of FCH, and changes to the non-ESA-listed Chinook salmon program at FCH. To ensure that hatchery operations continue without interruption in the year of dam removal (2024), the FCH has been operational in the months prior to dam removal. The 2023 FCH HGMP covers activities related to the artificial production of coho salmon at FCH during the transition of the program from IGH, and for 8 years after dam removal.

Table 5. ESA status of hatchery programs producing coho salmon in watersheds of the SONCC Coho Salmon ESU. HGMP = Hatchery Genetic Management Plan; C = Review under the ESA is complete, (year) = year completed.

Program Stock Origin	Program	Population	Watershed Location of Release (State)	HGMP Status
Rogue River	Cole Rivers Hatchery	Interior Rogue River	Rogue River (OR)	C (ODFW 2016a)
Klamath River	Iron Gate Hatchery / Fall Creek Hatchery	Interior Klamath River	Klamath River (CA)	C (CDFW and PacifiCorp 2014, CDFW 2023a)
Trinity River	Trinity River Hatchery	Interior Trinity River	Trinity River (CA)	C (BOR and CDFW 2017)

In addition, four fish hatcheries in the range of SONCC coho salmon produce other hatchery-origin salmonid species that could impact SONCC coho salmon. All of these hatcheries are managed by HGMPs that monitor and incorporate measures to limit the impacts of their operations, including broodstock collection, on SONCC coho salmon. The name of each hatchery, the affected SONCC coho salmon population and diversity stratum, and the citation for its HGMP are as follows: Mad River Hatchery winter-run steelhead program (Mad River, Central Coastal Stratum) (CDFW 2016), the Rowdy Creek Fish Hatchery programs for fall Chinook salmon (Tolowa Dee-ni' Nation 2018a) and winter steelhead (Tolowa Dee-ni' Nation 2018b) (Smith River, Central Coastal Stratum), and the Elk River Fish Hatchery's Chetco River Fall Chinook Salmon Program (ODFW 2016b) and Chetco River Winter Steelhead Program (ODFW 2016c) (Chetco River, Northern Coastal Stratum).

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

All three hatcheries that produce SONCC coho salmon, and all four hatcheries in the range of SONCC coho salmon that produce other salmonid species that could impact SONCC coho salmon, are now managed under HGMPs that are designed to limit potential negative impacts of hatchery operations on the reproduction of SONCC coho salmon on spawning grounds. Improvements in hatchery management are designed to increase pNOB in the hatchery, limit pHOS at natural spawning grounds that could be impacted by hatchery returns, and improve fitness of hatchery-reared individuals. All hatcheries in the range of SONCC coho salmon with the potential to affect coho salmon are now managed based on approved final HGMPs that limit potential negative impacts of hatchery operations on wild production. As a result, the risk of detrimental hatchery impacts to this ESU is reduced.

Listing Factor E: Conclusion

The impacts of climate change on freshwater habitat have worsened since 2016 due to widespread wildfires and drought. The threat of small population size remains high. Negative impacts from hatcheries have been reduced since 2016 due to the completion of HGMPs for the Cole River Hatchery on the Rogue River and the Trinity River Hatchery.

Recommended future actions for the next 5 years

Increase resilience to climate change by prioritizing habitat restoration projects designed to maintain or re-establish access to a wide variety of physical and thermal conditions within a watershed. Specifically, in suitable locations throughout the range of SONCC coho salmon, prioritize the following actions:

E1: Reconnect habitats longitudinally and laterally (floodplains).

E2: Ameliorate temperature and flow restraints.

E3: Identify and improve access to food-rich environments.

E4: Identify, restore, and protect locations of cold-water refugia.

2.3.2.6 Other Recommendations

Research, Monitoring, and Evaluation

Status and trend monitoring

The viability assessment conducted by the SWFSC (SWFSC 2022), and particularly that section therein that assessed SONCC coho salmon specifically (Williams 2022), informs this 5-year review and assesses progress to meeting viability targets for SONCC coho salmon at the population-, diversity stratum-, and ESU-level. The SWFSC relies on data collected by the states of Oregon and California, tribes, and non-governmental organizations to complete the viability assessments for SONCC coho salmon.

<u>Oregon</u>

As noted in the last two SONCC coho salmon viability reports (Williams et al. 2016 and SWFSC

2022), the lack of population-unit spatial scale monitoring in Oregon is of great concern. As of 2021, the few estimates that were previously available at the population-unit spatial scale from the Oregon portion of the ESU were no longer collected. Fifty years of newly available data from the Elk River, a small coastal Oregon river, showed the only significantly positive trend in the ESU (Williams 2022). The only other estimate available to assess the viability of coho salmon in the Oregon portion of the SONCC Coho Salmon ESU is a composite time series from the Rogue Basin, which provides insight into the overall trend in the basin but cannot be resolved at the population scale (Williams 2022).

Table 20 in ODFW's Rogue-South Coast Multi-Species Conservation and Management Plan describes existing and planned monitoring for coho salmon and other salmonids (ODFW 2021). Action V.A.1 describes plans to continue fall spawning ground surveys of coho salmon abundance in the Elk River and other non-specified coastal basins. A new proposed action to conduct fall spawning ground surveys within the Rogue stratum (V.B.2) would target coho salmon in the Upper Rogue, and would continue surveys in the Lower Rogue River for coho salmon. Winter spawning ground surveys targeting steelhead are also planned in coastal streams (V.A.2). Action V.A.7 would continue summer snorkel surveys in the Coastal Stratum; however, it is unclear whether coho salmon are a target species. Action V.B.9 proposes to start summer snorkel surveys at index sites in core juvenile coho salmon rearing areas for the Illinois, Middle Rogue/Applegate, and Upper Rogue River populations. Two new proposed actions (V.A.4) would establish pilot DIDSON sonar counting stations in the Lower Chetco River and the Upper Rogue River (V.A.4 and V.B.5, respectively), but winter steelhead are the only species listed. A new proposed action to conduct annual winter snorkel surveys on the Chetco River (V.A.3) will target steelhead and does not list coho salmon.

NMFS is optimistic that ODFW's new and ongoing monitoring efforts will result in more demographic data for Oregon SONCC coho salmon populations. We recommend that ODFW record observations of coho salmon in all of the monitoring described above, including the DIDSON sonar counting stations and the winter steelhead snorkel surveys, even if is not possible to carry out the monitoring for the entire duration of the coho salmon spawning run. A partial picture of coho salmon abundance from these surveys would provide more information than we currently have for the Chetco River and the Upper Rogue River populations. We would welcome the opportunity to collaborate with ODFW in planning these adult and juvenile surveys, so that the methods used would produce data that NMFS' Science Center could utilize in future status reviews.

California

The CDFW/NMFS Coastal Monitoring Program (CMP), described in Adams et al. 2011 (i.e., CDFW Fish Bulletin 180), draws on the Viable Salmonid Population framework of McElhaney et al. (2000) to assess salmonid viability in terms of the four population metrics: abundance, productivity, spatial structure, and diversity. CMP divides the coastal zone of California into northern and southern areas based on differences in species composition, levels of abundance, distribution patterns, and habitat differences that require distinct monitoring approaches. CMP data includes adult estimates based on redd count surveys of stream reaches using a statistically valid sampling design expanded to adult estimates based on spawner-to-redd ratios, redd surveys, and estimates that are not expanded to adult estimates (e.g., no spawner-to-redd ratio estimates available), and weir counts (Shasta, Scott, and Trinity Rivers).

The longer time series available in the northern monitoring area since CMP has been implemented have improved our ability to assess status and trends for SONCC coho salmon populations. Some of these time series were approaching or exceeding the four generations essential to evaluate progress toward the delisting criteria described in the recovery plan (NMFS 2014). Information on several SONCC coho salmon populations (Redwood Creek, the Mad River, and multiple populations in the Eel River) has improved with the installation of sonar cameras.

Unfortunately, due to lapses in funding since the last 5-year review, some monitoring programs that assessed SONCC coho salmon have been interrupted or discontinued. For example, funds were insufficient to continue monitoring efforts in Redwood Creek and the Mad River into 2023, and there has been no monitoring at the population scale in the Smith River since 2015. Furthermore, spatial coverage has been lacking in many areas and remains highly patchy in others (e.g., the Interior Trinity River Stratum, the Central Coastal Stratum, and the Southern Coastal Stratum. Most core populations of SONCC coho salmon, which are expected to anchor recovery of this ESU, are not currently monitored.

Despite these challenges, CMP nonetheless provides a substantially better basis for informing NMFS' recovery and viability criteria compared with assessments prepared prior to CMP, and will increase greatly in value if these time series become longer. Where adult monitoring has been underway, this monitoring should continue to maintain these valuable ongoing data sets.

Our reliance on adult and redd counts alone impairs our ability to more accurately evaluate the ESU's extinction risk. This limitation will continue until additional monitoring data from more SONCC coho salmon populations exists. Considering that this ESU is likely decades away from recovering to the extent that it can be considered for delisting, state resource managers and partners should collect a complementary type of population information that would provide NMFS, state resource agencies, and other partners with more geographically complete and timely information across the breadth of the ESU, specifically by using rapid juvenile summer surveys.

The first 12 years of CMP implementation have focused on monitoring the numbers of returning adult coho salmon, partly because the biological recovery criteria for abundance (described in the guidance documents developed by the TRTs for all of California's listed salmonids) uses this metric. In 2021, NMFS and CDFW hosted a series of meetings about California's Coastal Monitoring Program, collectively known as the CMP Workshop. Agency staff and partners who carry out population monitoring participated. The goal of these meetings was to explore lessons learned from CMP implementation, review questions the monitoring program seeks to answer about viable salmonid population (VSP) parameters, and identify next steps and updates to methodologies to make the program more effective, efficient, flexible, and adaptive (CDFW and NOAA Fisheries 2021).

As described at the CMP Workshop, during the first 12 years of CMP implementation, managers learned that observing adult coho salmon (or observing redds and inferring the number of adults through redd surveys) can be time-intensive and logistically difficult or impossible in some locations. Adults begin to move upstream in response to the first significant rain events, so adult monitoring always occurs during the wet season when flows are high. Turbidity from higher flows can decrease the ability to see through water to detect redds. In larger systems, the volume of flow can endanger staff carrying out redd surveys. In addition, methods of detecting adults and redds are less effective when these adults are scarce compared to when they are more abundant (CDFW and NOAA Fisheries 2021). In contrast, monitoring juvenile coho salmon (the progeny of the adults that arrived the previous fall and winter) via methods such as rapid juvenile summer surveys during the summer months can be more effective at detecting the presence[7] and distribution of coho salmon in areas where they are scarce, and is likely feasible at more locations because it occurs when flows are low during the Mediterranean summer climate typical of this ESU. During these surveys, juveniles coho salmon are visually observed by snorkelers. The amount of time and effort involved in performing juvenile summer surveys is typically a fraction of that needed for adult monitoring. Adults are moving upstream and creating redds throughout the months-long spawning season, necessitating field observations throughout the season. Because juvenile monitoring occurs during a time of lower flows when fish are moving through the river much less, monitors can accurately assess juvenile abundance and distribution in a given habitat area by conducting a survey as little as once per summer. Another compelling benefit of juvenile monitoring is that it provides an immediate signal of the effects of drought on each year class. Rather than assessing the impacts of drought in a watershed on a particular year class by waiting for 2 years for the adults of that year class to return from the ocean (and needing to factor in the effects of ocean conditions on the strength of adult returns), monitors could conduct rapid juvenile surveys during the summer of the drought to assess the extent of juvenile distribution and infer impacts to the juvenile year class living in freshwater at that time.

As described in Williams (2022), available data since 2016 shows that six of the seven populations with available adult abundance estimates are at high risk of extinction because the number of adults is critically low, increasing the chance that these populations could be subject to the natural stochastic processes described above. The extent of the threat of small population size across the ESU is largely unknown, given that no demographic data are available for 12 of the 19 independent populations in the ESU. Further, we cannot assume that the trends in these unmonitored populations are the same as those in the monitored ones. Of the seven populations where adult monitoring occurred at the population scale since 2016, three are in relatively strong populations where enough adults are known to spawn that a redd survey has been feasible (Humboldt Bay Tributaries, Redwood Creek, and the South Fork Eel River). Adult monitoring in the Scott and Shasta Rivers is based on weirs with video recording, which allows for reliable detection of even very low numbers of adults. Only one of the locations where redd surveys are conducted is in a population that has historically been at very low abundance (the Mattole River). It is likely that many of the remaining 12 currently unmonitored populations are also subject to

[7] Observed presence of juveniles is proof of occupancy, but absence cannot be proven, although the probability of absence can be determined. The frequency of “false” abundances depends on the abundance and distribution of individuals, the sampling method and intensity, and the scale of sampling. This can be particularly problematic for species that are rare or patchily distributed, or as species and populations decline in abundance and distribution leading to errors in estimates that vary with habitat and environmental conditions and species abundance. Development of a juvenile spatial structure protocol that estimates detection probability is key to addressing this source of error.

the natural stochastic processes described above due to low population size, which can drive them to extinction even absent other threats.

Given the limitations of using redd surveys to assess abundance in populations where adults are scarce (CDFW and NOAA Fisheries 2021), rapid summer surveys for juvenile coho salmon should be carried out in these twelve currently unmonitored independent populations over the next 5 years. Rapid summer juvenile surveys should also occur in any of the seven independent populations where adult monitoring has occurred but is not planned in any given year (e.g., the Smith River). These rapid summer surveys will inform NMFS of the degree of successful spawning in a population area and the current geographic extent of juvenile rearing. This will inform the spatial structure viability criterion for this species as described in the recovery plan (NMFS 2014). Knowing that few or no juveniles have been observed in any given population may indicate the number of spawning adults is extremely low; this inference will be critical for NMFS to have a realistic picture of the state of recovery of that population, and the ESU overall.

In summary, resource agencies have no insight into the number and distribution of coho salmon in 73 percent of the independent populations of this ESU. To address this problem, implementation of monitoring actions will be critically important in the next 5 years. Specifically, in every independent population where adult monitoring is not planned in a given year, rapid juvenile surveys should be completed. A juvenile sampling protocol that accounts for detection probability should also be finalized. However, rapid juvenile surveys can begin before this protocol is finalized. As we learned in the first 12 years of CMP with adult monitoring, it can take time to successfully monitor a new life stage in any given river. It is critical to begin this process now, rather than wait until all aspects of the protocol are finalized.

Monitoring SONCC coho salmon in the Upper Klamath River after dam removal

Following the removal of four dams on the Klamath River by September 2024 (Iron Gate Dam, Copco 1 and 2 Dams, and J.C. Boyle Dam), numerous anadromous fish species will have access to the area upstream of the dams for the first time in over 100 years. The volitional repopulation, redistribution, reproduction, abundance, and life histories of SONCC coho salmon accessing this new habitat should be carefully monitored and evaluated. ODFW and The Klamath Tribes authored a 2021 plan titled "Reintroduction Implementation Plan of Anadromous Fishes into the Oregon portion of the Upper Klamath Basin" (ODFW and the Klamath Tribes 2021). This plan identifies the constraints to monitoring, the key questions monitoring should address, the monitoring facilities and activities to address these questions, and the recommended monitoring and evaluation parameters (and the tools to measure them) to determine if salmonid populations are becoming self-sustaining.

Recommended future monitoring actions in the next 5 years

Monitoring (M)1: Continue annual adult surveys in the South Fork Eel River, Lower Mainstem Eel River, Shasta River, Scott River, and Freshwater Creek-Humboldt Bay) population areas.

M2: Annually conduct spawning ground surveys for coho salmon in the Elk, Chetco, Winchuck, Lower Rogue, Upper Rogue, Middle Rogue/Applegate, and Illinois Rivers populations.

M3: Annually conduct rapid summer juvenile surveys in all independent populations of SONCC coho salmon in California where no adult monitoring is planned in any given year.

M4: Annually conduct summer snorkel surveys for coho salmon in the Elk, Chetco, Winchuck, Lower Rogue, Illinois, Middle Rogue/Applegate, and Upper Rogue River populations.

M5: Document coho salmon observed during spawner surveys and at DIDSON sonar counting stations targeting other salmonids in Oregon.

M6: Develop and finalize an adaptive monitoring strategy for California that balances spatial coverage with the VSP parameter monitored, allows for methodological flexibility, and describes the circumstances (based on occupancy patterns, abundance, etc.) when juvenile vs. adult monitoring methods may be most appropriate.

M7: Develop and finalize a juvenile spatial structure monitoring protocol for California that includes estimation of detection probability.

M8: Collaborate with NMFS on the design of ODFW monitoring projects that include observations of coho salmon in Oregon, to ensure data collected can be utilized in future SONCC coho salmon status reviews.

M9: Monitor the presence and abundance of SONCC coho salmon above Iron Gate Dam.

2.4 Synthesis

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

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

2.4.1 Updated Biological Risk Summary

The following excerpt from Williams (2022) summarizes the current risk of extinction of the SONCC Coho Salmon ESU:

Based on the available data, while the extinction risk category is still moderate, the recent extinction risk trend of the SONCC Coho Salmon ESU is declining (i.e., less viable) since the previous assessment. The ESU is considered not viable and at a moderate risk of extinction.

As described in the latest viability assessment (SWFSC 2022), there has been no improvement in the status of SONCC coho salmon since 2016, and the ESU remains at moderate risk of extinction.

2.4.2 ESA Listing Factor Analysis

Listing Factor A (habitat): We conclude that since the last 5-year review, the risk to SONCC coho salmon persistence because of habitat conditions has not improved. Habitat improvement remains a priority objective throughout this ESU, particularly with regard to habitat quality, streamflow, and water temperature in areas that exceed water quality standards due to anthropogenic causes.

Listing Factor B (overutilization): We conclude that since the last 5-year review, the risk to SONCC coho salmon persistence because of overutilization and scientific study remains low based on available data. However, the lack of any FMEPs for fisheries managed by the state of California means there is no assessment of the risks these fisheries pose to SONCC coho salmon.

Listing Factor C (disease and predation): We conclude that since the last 5-year review, the risk to SONCC coho salmon persistence because of disease or predation remains high, given the harm caused by *C. shasta*, which affects all coho salmon in the Klamath River basin, and by Sacramento pikeminnow which can access all salmonid habitat in the Eel River basin.

Listing Factor D (inadequacy of existing regulatory mechanisms): New information available since the last 5-year review indicates that the adequacy of several regulatory mechanisms has improved, but several major regulatory mechanisms continue to provide inadequate protection. Overall, the inadequacy of regulatory mechanisms has increased since 2016, primarily due to the rise of groundwater pumping and the inadequacy of regulatory mechanisms to regulate it.

Listing Factor E (other manmade or natural factors): We conclude that since the last 5-year review, the overall risk to SONCC coho salmon persistence because of other manmade and natural factors remains high and has worsened overall due to droughts and wildfires that have severely affected SONCC coho salmon and their habitats. This species is especially vulnerable to the impacts of changing climate due to their long freshwater residence time, relatively strict life-history patterns, and location toward the southernmost edge of the range of coho salmon overall. Hatchery effects are well-understood and minimized now that HGMPs have been finalized for all the hatcheries that affect coho salmon. The demographic effects of small population size continue to threaten the persistence of numerous populations.

2.4.3 Conclusion

Although conservation efforts for coho salmon have reduced the detrimental effects of some threats for this ESU, many threats described in Section 2.3.2 (five listing factors) have worsened since the 2016 5-year review. While historical threats such as timber harvest and commercial exploitation have lessened during the past few decades, other previously unidentified threats, often linked to climate change, have worsened and will likely worsen further in the coming decades. The risk and impact of wildfires on SONCC coho salmon's habitat have been widespread and will continue. Shifts in oceanographic dynamics, such as sea-surface temperatures, wind patterns, and coastal upwelling, can alter salmon migration patterns and decrease food availability. These alterations greatly impact SONCC coho salmon survival in the marine environment. Likewise, shifting temperature and precipitation patterns throughout the western U.S. are expected to significantly alter riverine hydrologic patterns, with warmer winter temperatures leading to less snowpack storage, more intense runoff events, and lower stream flows during dry periods. While local and state regulatory efforts have the potential to help mitigate the impact of climate change on streamflow, the extent of groundwater pumping has increased since the last 5-year review, and California's SGMA process is currently inadequate for regulating this activity. Overall, California has been a leader in addressing climate change through innovative technology and regulation, but international solutions will be key to reducing threats to SONCC coho salmon, given the global nature and extent of the issue.

Drought conditions have persisted since 2016 and are ongoing. These conditions are unprecedented in the time since SONCC coho salmon have been listed, and have likely resulted in reduced juvenile survival and stressful rearing conditions in nearly all parts of the ESU range. Those juveniles that survived the stressful freshwater conditions may have also faced poor ocean conditions, the results of which will only be apparent once these year classes return as adults. There have been no notable regulatory changes since 2016, which would significantly improve the outlook for this species. Numerous habitat restoration projects have been completed in many rivers and streams in the SONCC coho salmon range, but existing habitat conditions are inadequate to ensure species viability, and recovery will not be achieved without further habitat restoration.

After considering the biological viability of the SONCC Coho Salmon ESU and the status of its ESA section 4(a)(1) factors, we conclude that there has been no improvement in the status of the SONCC Coho Salmon ESU since it was last reviewed in 2016. The biological benefits of habitat restoration and protection efforts have yet to be fully expressed, and will likely take one to two decades to result in measurable improvements to population viability. Meanwhile, worsening drought and wildfire conditions are severely impacting individual SONCC coho salmon and their habitat. The species would be in a much worse state without the progress in regulatory mechanisms and habitat restoration that has occurred since 2016, which has enabled it to persist through the environmental and unprecedented human stressors experienced in the intervening years. Further improvements in regulatory mechanisms, and associated improvement in habitat conditions, over the next 5 years will be critical to enable this ESU to continue to persist through the environmental and human stressors that continue to inhibit its survival and recovery.

The SONCC Coho Salmon ESU remains likely to become endangered within the foreseeable future.

2.4.4 ESU Delineation and Hatchery Membership

The SWFSC's review (SWFSC 2022) found no new information that would justify a change in the delineation of the SONCC Coho Salmon ESU.

Our review of new information since the 2016 5-year review regarding the ESU membership status of various hatchery programs indicates no changes in the SONCC Coho Salmon ESU are warranted.

2.4.5 ESU Viability and Statutory Listing Factors

The SWFSC's review of updated information (SWFSC 2022) does not indicate a change in the biological risk category of SONCC coho salmon since the time of their last assessment (Williams et al. 2016).

Our analysis of ESA section 4(a)(1) factors indicates that the collective risk to the persistence of SONCC coho salmon has not changed significantly since our 2016 5-year review. However, the overall level of concern has increased based on likely effects from increased water withdrawal in many areas, drought conditions, and no apparent trend toward recovery since the 2005 listing.

3 Results

3.1 Classification

3.1.1 Listing Status

Based on the information provided above, we recommend that the SONCC Coho Salmon ESU remain classified as a threatened species.

3.1.2 ESU Delineation

Based on the information provided above, we recommend no changes to the delineation of the SONCC Coho Salmon ESU.

3.1.3 Hatchery Membership

Based on the information provided above, we recommend no changes to the hatchery membership of the SONCC Coho Salmon ESU.

3.2 New Recovery Priority Number

Since the 2016 5-year review, NMFS revised the recovery priority number guidelines in 2019 and reevaluated the numbers most recently in the 2021-2022 Recovering Threatened and Endangered Species Report to Congress (NMFS 2019c, NMFS 2023). Table 4 indicates the number in place for the SONCC coho salmon ESU at the beginning of the current review (3C).

As part of this 5-year review, we reevaluated the number based on the best available information, including the new viability assessment (SWFSC 2022), and concluded that the current recovery priority number remains 3C.

4 Recommendations for Future Actions

4.1 Overarching recommendations

Recommended actions to pursue over the next 5 years are described in Section 2.3.2.1 (Listing Factor A: Habitat); Section 2.3.2.2 (Listing Factor B: Overutilization); Section 2.3.2.3 (Listing Factor C: Disease and Predation); Section 2.3.2.4 (Listing Factor D: Inadequacy of Existing Regulatory Mechanisms); Section 2.3.2.5 (Listing Factor E: Other Factors); and Section 2.3.2.6 (Monitoring). This section describes additional overarching actions to carry out across the ESU in the next 5 years in order to address key habitat concerns.

4.1.1 Habitat

As described in Listing Factor A (Section 2.3.2.1), the habitat issues that have most impaired the species since 2016 include:

- Removal of surface water and groundwater during months when there is no rainfall to recharge the system.
- Increased frequency of drought, which has exacerbated impacts of most existing threats (e.g., diversions).
- Curtailment of the extent of habitat available to the species in estuaries, and insufficient tidal prism.
- Simplified physical habitat in channels and disconnection of channels from floodplains.

4.1.1.1 Flow

Over the next 5 years, the most important action to safeguard SONCC coho salmon against extinction is to ensure sufficient instream flows, including by implementing the three flow-related recommended actions below. The most important areas to carry out these actions are those where hydrologic conditions of the landscape, as well as the underlying geomorphic characteristics and processes, exhibit habitat characteristics suitable for rearing coho salmon. These are generally areas of sufficient rainfall, low gradient, and unconfined floodplains (Agrawal et al. 2005, Burnett et al. 2003) and are reflected in the Intrinsic Potential maps in the recovery plan (NMFS 2014).

Flow (F)1: Conduct studies to determine minimum instream flows for recovery of independent populations of coho salmon.

F2: Use existing authorities held by the states of California and Oregon to ensure sufficient flows remain in the rivers by regulating, monitoring, and enforcing water rights, water diversions, and groundwater extractions.

F3: Increase voluntary water conservation measures and incentives (e.g., storage, forbearance).

4.1.1.2 Habitat Complexity

The following actions should be prioritized over the next 5 years in areas of high intrinsic potential to support rearing coho salmon (as identified in NMFS et al. 2014) in all independent populations of this ESU to address simplified physical habitat.

Habitat Complexity (HC)1: (Re-)establish off-channel winter rearing habitat.

HC2: Increase the amount of stream-estuary ecotone habitat available to coho salmon.

HC3: Add structure to channels to form pools, increase complexity, and sort sediment.

HC4: Revise state regulations to make them more protective of beavers.

4.1.1.3 Habitat Connectivity

Dams in two major basins of this ESU cause harmful environmental conditions and preclude the recovery of at least two diversity strata of the ESU. In the next 5 years, continuing to advance the decommissioning of PG&E's Potter Valley Project to achieve the removal of Scott Dam and Cape Horn Dam will be of utmost importance. In addition, removal of four dams on the Klamath River will restore access to over 31 miles of habitat in the Upper Klamath River starting in late 2024. In the next 5 years, monitoring of the presence and abundance of SONCC coho salmon above Iron Gate Dam will be important to assess to what degree habitat connectivity has been restored.

The actions described in Section 2.3.2.5 (Listing Factor E) should be implemented to address the effects of climate change by maintaining or re-establishing access to suitable physical and thermal habitat conditions across the range of SONCC coho salmon.

4.1.2 Monitoring

Agencies have insufficient demographic information on SONCC coho salmon populations and so have no insight into the number and distribution of coho salmon in 73 percent of the independent populations of this ESU. Without this information, we cannot know the true extinction risk faced by this ESU, and could be managing as though it is in much better condition than it is. To address this problem, implementation of monitoring actions will be critically important in the next 5 years. Specifically, in every independent population where adult monitoring is not planned in a given year, rapid juvenile surveys should be completed, and a juvenile sampling protocol that accounts for detection probability should be finalized. However, rapid juvenile surveys can begin before this protocol is finalized. As with adult monitoring, it can take time to successfully monitor a new life stage in any given river. It is critical to begin this process, rather than wait until all aspects of the protocol are finalized.

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NATIONAL MARINE FISHERIES SERVICE
5-YEAR REVIEW

Southern Oregon / Northern California Coast Coho Salmon ESU

Current Classification: Threatened

Recommendation resulting from the 5-Year Review

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

Review Conducted By (Name and Office):

West Coast Region Southern Oregon / Northern California Coast
Coho Salmon ESU Evaluation Team

REGIONAL OFFICE APPROVAL:

Lead Regional Administrator, NOAA Fisheries

Approve RUVELAS.PENNY.1365830491 Digitally signed by RUVELAS.PENNY.1365830491 Date: 2024.11.25 14:10:12 -08'00' Date: ________

Cooperating Regional Administrator, NOAA Fisheries

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

Signature____ Date: _______

HEADQUARTERS APPROVAL:

Assistant Administrator, NOAA Fisheries

[x] Concur [ ] Do Not Concur

Signature RAUCH.SAMUEL.DEAN.1365850948 Digitally signed by RAUCH.SAMUEL.DEAN.1365850948 Date: 2024.12.03 12:40:42 -05'00' Date: _______