

Science, Service, Stewardship



2023 5-Year Review:

Summary &
Evaluation of

Central California Coast Coho Salmon

National Marine Fisheries Service
West Coast Region



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5-Year Review: Central California Coast Coho Salmon

Species Reviewed	Distinct Population Segment
coho salmon (<i>Oncorhynchus kisutch</i>)	Central California Coast (CCC) coho salmon

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Acronyms

AIS	Aquatic Invasive Species
CDFW	California Department of Fish and Wildlife
CCC	Central California Coast
CMP	Coastal Management Plan
CVFF	Coyote Valley Fish Facility
DCFH	Don Clausen Fish Hatchery
DPS	Distinct Population Segments
EEZ	Exclusive Economic Zone
ESA	Endangered Species Act
ESU	Evolutionarily Significant Units
FMEP	Fisheries Management and Evaluation Plan
FMPs	Fishery Management Plans
GSA	Groundwater Sustainability Agencies
GSP	Groundwater Sustainability Plan
FIPs	Functionally Independent Populations
HGMP	Hatchery Genetic Management Plan
LCM	Life-Cycle Monitoring

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
NPDES	National Pollution Discharge Elimination System
OSP	Optimum Sustainable Population
PCBs	Polychlorinated Biphenyls
PFMC	Pacific Fishery Management Council
PIPs	Potentially Independent Populations
RCP	Representative Concentration Pathway
RSI	Remote Site Incubators
SGMA	Sustainable Groundwater Management Act
SIS	Species in the Spotlight
SWFSC	Southwest Fisheries Science Center
TMDL	Total Maximum Daily Loads
TRT	Technical Recovery Teams
TDC	Thiamine Deficiency Complex
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

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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. This document describes the results of the 2021 review of ESA-listed Central California Coast coho (CCC coho) salmon.

A 5-year review is:

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

A 5-year review is not:

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

1.1.1 Background on salmonid listing determinations

The ESA defines species to include subspecies and distinct population segments (DPS) of vertebrate species. A species may be listed as threatened or endangered. To identify taxonomically recognized species of salmon NMFS utilizes the Policy on Applying the Definition of Species under the ESA to Pacific Salmon (56 FR 58612). Under this policy, NMFS identifies population groups that are evolutionarily significant units (ESUs) within taxonomically recognized species. NMFS considers 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. NMFS considers an ESU as constituting a DPS and, therefore, a species under the ESA (56 FR 58612).

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 (U.S. District Court 2001). On June 28, 2005, we announced a final policy addressing the role of artificially propagated Pacific salmon and steelhead in listing determinations under the ESA (70 FR 37204) (Hatchery Listing Policy¹). 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 concerning the harvest of some Pacific salmon and steelhead populations, consistent with the conservation and recovery of listed salmon ESUs and steelhead DPSs.

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

Because the new Hatchery Listing Policy changed the way we considered hatchery fish in ESA listing determinations, we completed new status reviews and ESA listing determinations for West Coast salmon ESUs on June 28, 2005 (70 FR 37159), and for steelhead DPSs on January 5, 2006 (71 FR 834). On August 15, 2011, we announced the availability of the 5-year reviews and listing recommendations for 11 ESUs of Pacific salmon and 6 DPSs of steelhead (76 FR 50448). On May 26, 2016, we published our 5-year reviews and listing determinations for 17 ESUs of

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

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 that the public submit new information on these species that has become available since our 2015-2016 5-year reviews. In response to our request, we received information from federal and state agencies, Native American Tribes, conservation groups, fishing groups, and individuals. We considered this information, as well as information routinely collected by our agency, during the 5-year review process.

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. The scientists used the Viable Salmonid Population (VSP) concept developed by McElhany et al. (2000) to evaluate species viability. 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 delineation. At the end of this process, the science teams prepared reports detailing the results of their analyses (SWFSC 2022).

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

This report reflects the best available scientific information, including: the work of the Southwest Fisheries Science Center (SWFSC) (SWFSC 2022); reporting by the regional biologists regarding hatchery programs; findings in the CCC Coho recovery plan (NMFS 2012a) and technical reports prepared in support of the 2012 CCC coho recovery plan; the listing record (including designation of critical habitat and adoption of protective regulations); recent biological opinions issued for the CCC coho salmon; information submitted by the public and other government agencies; and the information and views provided by the geographically based management teams. The 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

The CCC coho salmon ESU was originally listed as threatened in 1996 (61 FR 56138). In 2005, following a reassessment of its status and after applying NMFS' Hatchery Listing Policy, we reclassified the ESU as endangered and listed several conservation hatchery programs associated with the ESU (70 FR 37159) (Table 1).

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

Salmonid Species	ESU/DPS Name	Original Listing	Revised Listing(s)
coho salmon (<i>O. kisutch</i>)	Central California Coast coho salmon	FR Notice: 61 FR 56138 Date: 10/31/1996 Classification: Threatened	FR Notice: 70 FR 37159 Date: 6/28/2005 Re-classification: Endangered including hatchery stocks

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 CCC 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 2002, NMFS promulgated 4(d) protective regulations for CCC coho salmon (67 FR 1116). In 2005, the CCC coho salmon ESU was reclassified as endangered, which superseded the 4(d) rule established in 2002 (70 FR 37159).

Table 2: Summary of rulemaking for 4(d) protective regulations and critical habitat for the CCC coho salmon ESU.

Salmonid Species	ESU/DPS Name	4(d) Protective Regulations	Critical Habitat Designation
coho salmon (<i>O. kisutch</i>)	Central California Coast coho salmon	ESA section 9 applies; FR notice: 67 FR 1116 Date: 1/9/2002; Revised: Removed with re- classification as endangered 6/28/2005 (70 FR 37159)	FR notice: 64 FR 24049 Date: 5/5/1999

1.3.4 Review History

Table 3 lists the numerous scientific assessments of the status of the CCC coho salmon ESU. These assessments include reviews conducted by our Northwest and Southwest Fisheries Science centers and technical reports prepared to support recovery planning for this ESU.

Table 3: Summary of previous scientific assessments for CCC coho salmon.

Salmonid Species	ESU/DPS Name	Document Citation
coho salmon (<i>O. kisutch</i>)	Central California Coast coho salmon	Weitkamp <i>et al.</i> 1995 NMFS 2001 Good <i>et al.</i> 2005 Bjorkstedt <i>et al.</i> 2005 Spence <i>et al.</i> 2008 Williams <i>et al.</i> 2011 Spence 2016, in Williams <i>et al.</i> 2016 SWFSC 2022

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. Under these guidelines, we assign each species a recovery priority number ranging from 1 (high) to 11 (low). This priority number reflects the species' demographic risk (based on the listing status and species' condition in terms of its abundance, productivity, spatial distribution, diversity), and recovery potential (major threats understood, management actions that exist under United States (U.S.) authority or influence to abate major threats, and certainty that actions will be effective). Additionally, if the listed species is in conflict with construction or other development projects or other forms of economic activity, then they are assigned a 'C' and are given a higher priority over those species that are not in conflict. Table 4 lists the recovery

priority number for the subject species that was in effect when this 5-year review began (NMFS 2019). In January 2022, NMFS issued a new report with updated recovery priority numbers. The number for the CCC coho salmon ESU remained unchanged (NMFS 2022).

1.3.6 Recovery Plan

Table 4: Recovery Priority Number (NMFS 2019) and Endangered Species Act Recovery Plan for the CCC coho salmon ESU.

Salmonid Species	ESU/DPS Name	Recovery Priority Number	Recovery Plan
coho salmon (<i>O. kisutch</i>)	Central California Coast coho salmon	1C	Title: Recovery Plan for the Evolutionarily Significant Unit of the Central California Coast coho salmon Available at: https://www.fisheries.noaa.gov/resource/document/recovery-plan-evolutionarily-significant-unit-central-california-coast-coho Date: 2012 Type: Final FR Notice: 77 FR 54565

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2. Review Analysis

This section reviews new information to determine whether the CCC coho salmon ESU delineation remains appropriate.

2.1 Delineation of Species under the Endangered Species Act

Is the species under review a vertebrate?

ESU/DPS Name	YES	NO
Central California Coast coho salmon	X	

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

ESU/DPS Name	YES	NO
Central California Coast coho salmon	X	

Was the ESU/DPS listed prior to 1996?

ESU/DPS Name	YES	NO	Date Listed if Prior to 1996
Central California Coast coho salmon		X	n/a

Prior to this 5-year review, was the ESU/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 CCC Coho Salmon ESU

ESU Delineation

This section summarizes information presented in SWFSC 2022: Viability Assessment for

Pacific Salmon and Steelhead Listed Under the Endangered Species Act: Southwest.

We found no new information that would justify a change in the delineation of the CCC coho salmon ESU (SWFSC 2022).

Membership of Hatchery Programs

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

In preparing this report, our hatchery management biologists reviewed the best available information regarding the hatchery membership of this ESU. 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 any errors and omissions in the existing descriptions of hatchery program membership. NMFS intends to address any needed changes and corrections via separate rulemaking subsequent to the completion of the 5-year review process and prior to any official change in hatchery membership.

In the 2016 5-year review, we defined the CCC coho salmon ESU as including naturally spawned coho salmon originating from rivers south of Punta Gorda, California, to and including Aptos Creek, as well as such coho salmon originating from tributaries to San Francisco Bay. In accordance with NMFS' 2005 Hatchery Listing Policy, we also included coho salmon from the three following artificial propagation programs: The Don Clausen Fish Hatchery (DCFH) Captive Broodstock Program, the Scott Creek/Kingfisher Flat Conservation Program, and the Scott Creek Captive Broodstock Program (70 FR 37159; 77 FR 19552; 85 FR 81822). These artificial propagation programs had been included in the listed ESU when it was reclassified as endangered in 2005 (70 FR 37159).

As part of this 5-year review, we re-evaluated the status of these hatchery stocks and programs to determine whether they are still operational and, if so, whether they have been substantially modified. Based on a review of the available information, these hatchery programs continue to be operational and propagate stocks that are part of this ESU.

Since the 2016 5-year review, we have combined two programs – the Scott Creek/King Fisher Flats Conservation Program, administered by the Monterey Salmon and Trout Project and the Scott Creek Captive Broodstock Program, administered by NOAA's Southwest Fisheries Science Center (70 FR 37159) – into one program called the Southern Coho Salmon Captive

Broodstock Program. Initially, the conservation program consisted of two separate, but jointly-related efforts; however, because the goals of these two efforts were aligned and interrelated regarding the conservation and recovery of extant and functionally extirpated populations throughout the Santa Cruz Mountains Diversity Stratum, the two separate efforts have been consolidated. In addition, since the future site may not be located on Scott Creek, we did not include the name of the creek in the program's name.

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 necessary to recover the species, and time and cost estimates for implementing the recovery plan.

Evaluating a species for potential changes in ESA listing requires an explicit analysis of population or demographic parameters (the biological 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 the best available scientific information and other considerations as appropriate. For the CCC Coho Recovery Plan (NMFS 2012a), NMFS adopted the viability criteria metrics defined by the North Central California Coast Domain TRT as the biological recovery criteria for the endangered CCC coho salmon ESU.

Biological reviews of the species continue as the recovery plan is implemented and additional information becomes available. The reviews consider new scientific analyses that can increase certainty about whether the threats have been abated, whether improvements in population biological viability have occurred for CCC coho salmon, and whether linkages between threats and changes in salmon biological viability are understood. NMFS assesses the biological recovery criteria and the delisting criteria through the adaptive management program for the recovery 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/DPS Name	YES	NO
Central 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/DPS Name	YES	NO
Central California Coast coho salmon	X	

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

ESU/DPS Name	YES	NO
Central 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 (McElhany et al. 2000; Schtickzelle and Quinn 2007). 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.

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

are the units that are combined to form alternative recovery scenarios for multiple similar population groupings and ESU viability. Independent populations are a core group of extinction-resistant and highly resilient populations. Dependent populations provide connectivity among independent populations, as well as temporary source populations and genetic refugia in the event of catastrophic loss of neighboring independent populations. The recovery scenario includes both independent and dependent populations.

The VSP concept (McElhany et al. 2000) is based on the biological parameters of abundance, productivity, spatial structure, and diversity for an independent salmonid population to have a negligible risk of extinction over a 100-year time frame. The VSP concept identifies the attributes, provides guidance for determining the conservation status of populations and larger-scale groupings of Pacific salmonids, and describes a general framework for how many and which populations within an ESU/DPS should be at a particular status for the ESU/DPS to have an acceptably low risk of extinction.

The NMFS-appointed North Central California Coast Domain TRT developed viability criteria metrics based on the McElhany et al. 2000 VSP concepts (Agrawal et al. 2005; Bjorkstedt 2005; Spence et al. 2008). The 2012 CCC Coho Recovery Plan (NMFS 2012a) adopted the North Central California Coast Domain TRT viability criteria as the biological recovery criteria for the endangered CCC Coho Salmon ESU. These criteria metrics describe population extinction risk in 100 years (Figure 1). NMFS color-coded the risk assessment to help readers distinguish the various risk categories.

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

Figure 1: VSP Criteria Metrics.

For recovery planning and development of recovery criteria, the North Central California Coast Domain TRT identified functional independent, potentially independent, and dependent

populations within the CCC coho salmon ESU and grouped them into regions of environmental (and presumably genetic) similarity termed Diversity Strata (Bjorkstedt et al. 2005 with modifications described in Spence et al. 2008). The ESU is composed of five diversity strata: Lost Coast-Navarro Point, Navarro Point-Gualala Point, Coastal, San Francisco Bay, and Santa Cruz Mountains (Figure 1). However, the San Francisco Bay Diversity Stratum was determined to be functionally extirpated based on findings by Bjorkstedt et al. (2005) that the stratum supported only small and/or ephemeral populations, particularly in the drier and warmer interior watersheds, and no independent populations historically existed. Therefore, the San Francisco Bay diversity stratum will not be discussed further in this 5-Year Review.

The CCC coho salmon ESU includes all naturally spawned coho salmon originating from rivers south of Punta Gorda, California to and including Aptos Creek, as well as such coho salmon originating from tributaries to San Francisco Bay. Also, coho salmon from three artificial propagation programs: the DCFH Captive Broodstock Program; the Scott Creek/Kingfisher Flats Conservation Program; and the Scott Creek Captive Broodstock Program (70 FR 37159, June 28, 2005; 77 FR 19552, April 12, 2012; 85 FR 81822, December 17, 2020).

Recovery strategies outlined in the 2012 Final CCC Coho Salmon Recovery Plan aim to achieve, at a minimum, the biological viability criteria for each major diversity stratum in the ESU in order to have all four diversity strata at viable (low risk) status with representation of all the major life history strategies present historically, and with the abundance, productivity, spatial structure, and diversity attributes required for long-term persistence. The plan recognizes that, at the diversity stratum level, there may be several specific combinations of populations that could satisfy the recovery criteria. It identifies particular combinations of various populations that are the most likely to achieve diversity strata viability, and hence ESU viability.

The TRT recovery criteria are hierarchical in nature, with ESU-level criteria being based on the status of natural-origin salmon assessed at the population level. A detailed description of the TRT viability criteria and their derivation (Spence et al. 2008) can be found in Volume III of the 2012 CCC Coho Recovery Plan (NMFS 2012a).

The four ESU viability criteria are:

(1) Representation Criteria;

1.a. All identified diversity strata that include historical Functionally Independent Populations (FIPs) or Potentially Independent Populations (PIPs) within an ESU should be represented by viable populations for the ESU to be considered viable.

AND

1.b. Within each diversity stratum, all extant phenotypic diversity (*i.e.*, major life-history types) should be represented by viable populations.

(2) Redundancy and Connectivity;

2.a. At least 50 percent of historically independent populations (FIPs or PIPs) in each diversity stratum must be demonstrated to be at low risk of extinction according to population viability criteria. For strata with three or fewer independent populations, at least two populations must be viable.

AND

2.b. Within each diversity stratum, the total aggregate abundance of independent populations selected to satisfy this criterion must meet or exceed 50 percent of the aggregate viable population abundance (*i.e.*, meeting density-based criteria for low risk) for all FIPs and PIPs.

(3) Remaining populations, including historically dependent populations or any historical FIPs or PIPs not expected to attain a viable status, must exhibit occupancy patterns consistent with those expected under sufficient immigration subsidy arising from the ‘focus’ Independent populations selected to satisfy the preceding criterion.

(4) The distribution of extant populations, regardless of historical status, must maintain connectivity within the diversity stratum, as well as connectivity to neighboring diversity strata.

The 2012 recovery plan identifies a set of most likely scenarios to meet the TRT recommendations for low risk populations at the diversity stratum level. The following describes the combination of population status most likely to achieve viability for each of the diversity stratum (NMFS 2012a).

Lost Coast - Navarro Point Diversity Stratum

1. The Ten Mile River, Noyo River, Big River, and Albion River populations must reach at least *Viable* (low risk) status; and
2. Supporting dependent populations in Usal Creek, Cottaneva Creek, Wages Creek, Pudding Creek, Caspar Creek, and Big Salmon Creek must reach the established redundancy and occupancy criteria.

Navarro Point - Gualala Point Diversity Stratum

1. The Navarro River, Garcia River, and Gualala River populations must reach at least *Viable* (low risk) status.

Coastal Diversity Stratum

1. The Russian River, Walker Creek, Lagunitas Creek populations must reach at least *Viable* (low risk) status; and

2. Supporting dependent populations in Salmon Creek, Pine Gulch, and Redwood Creek must reach the established redundancy and occupancy criteria.

Santa Cruz Mountains Diversity Stratum

1. The Pescadero Creek and San Lorenzo River populations must reach at least *Viable* (low risk) status; and
2. Supporting dependent populations in San Gregorio Creek, Waddell Creek, Scott Creek, San Vincente Creek, Soquel Creek, Gazos Creek, and Aptos Creek must reach the established redundancy and occupancy criteria.

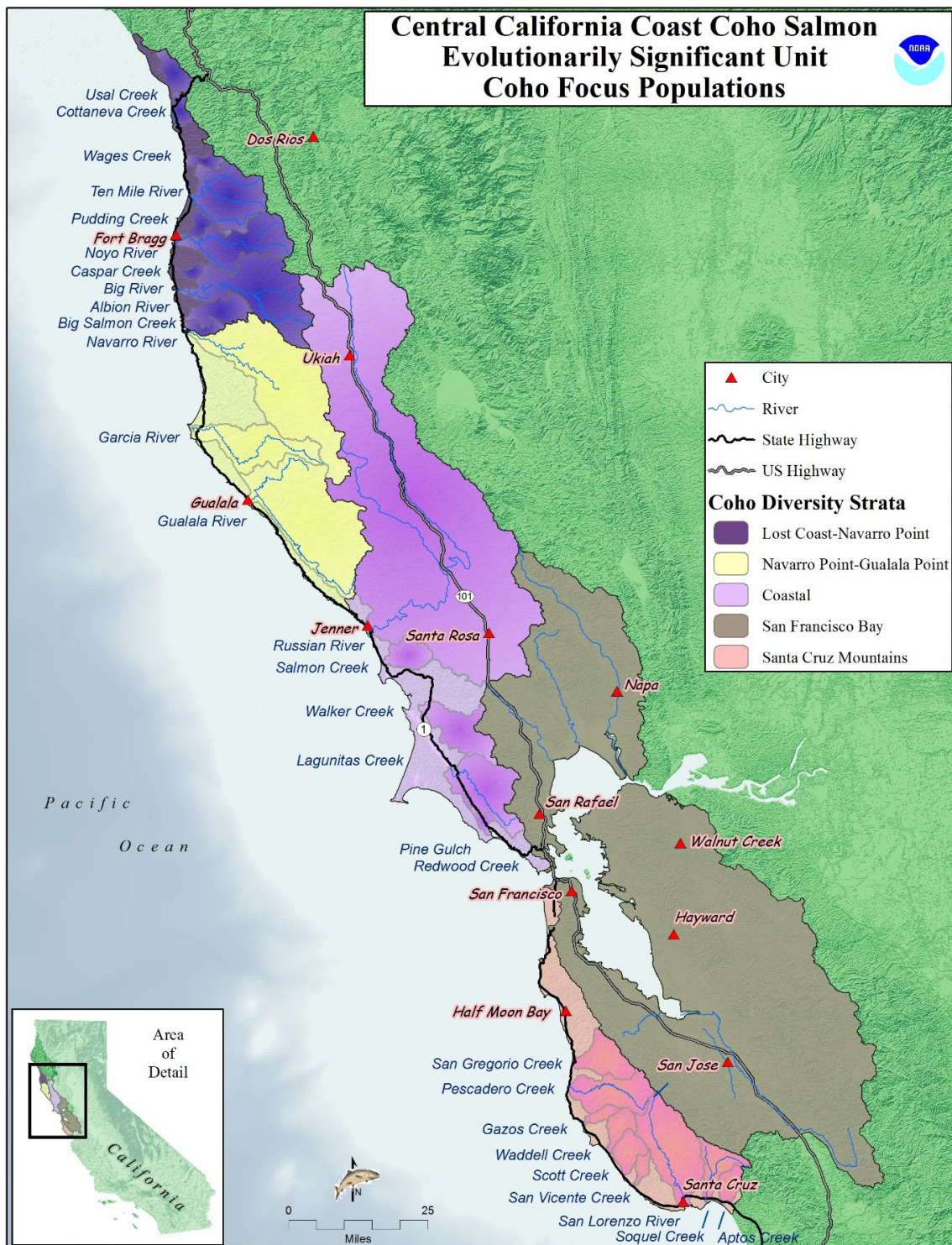


Figure 2: CCC Coho Salmon ESU and Diversity Strata.

2.3 Updated Information and Current Species Status

This section summarizes findings from the SWFSC 2022 – Viability assessment for Pacific salmon and steelhead listed under the Endangered Species Act: Southwest (Subsection 2.3.1) and our current ESA listing factor analysis (Subsection 2.3.2).

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 – Viability assessment for Pacific salmon and steelhead listed under the Endangered Species Act: Southwest. Please see SWFSC 2022 for a more detailed discussion of each species' VSP status.

Updated Biological Risk Summary

The available data for populations within the CCC coho salmon ESU indicate that all independent and dependent populations remain far below recovery targets for abundance and, in some cases, are below high-risk thresholds established by the TRTs. The current viability of the populations is progressively worse moving north to south in the ESU. Recent data from the Lost-Coast-Navarro Point and Navarro Point-Gualala Point diversity strata suggest a slight improvement in the viability of independent populations since the last status review (Spence 2016), with most populations having rebounded somewhat since low levels reached during California's multi-year drought between 2012 and 2015. However, for dependent populations in these strata, while the abundance of some populations has improved slightly since the previous status review, long-term trends have generally continued downward and remain a concern. The slight improvement in abundance of some populations is encouraging considering both the extended drought and the unprecedented warm ocean temperatures and associated marine ecosystem impacts that began in 2014 and have persisted most years since (SWFSC 2022). Smolt-to-adult survival estimates from four Life-Cycle Monitoring (LCM) stations on the Mendocino Coast indicate that marine survival of coho salmon was extremely low from brood years 2004 to 2008 (i.e., smolt outmigration years 2005–2009), but rates have since risen to levels more typically seen, even in years corresponding to the marine heat wave. Thus, it appears that near-coast conditions along the northern California coast during the springs of 2014 to 2016 may have been more favorable than occurred more generally in the northeast Pacific Ocean. For dependent populations in these strata, while the mean abundance of some populations has increased slightly since the previous viability assessment, long-term trends have generally continued downward and remain a concern.

Assessment of independent populations in the Coastal and Santa Cruz Mountain diversity strata remains difficult due to the scarcity of reliable data, though the establishment of a rigorous monitoring program in the Russian River basin is a positive development. While coho salmon numbers remain low in the Russian River population, fish are reproducing naturally in several watersheds that have received outplants of fish from the ongoing captive rearing program at the

DCFH. The extremely low numbers of coho salmon in the Santa Cruz Mountain Diversity Stratum, the high dependence of population persistence on the ongoing captive rearing program, and loss of genetic diversity in the hatchery broodstock (which has necessitated infusion of out-of-stratum broodstock from DCFH into the program) remain major concerns. Overall, the available new information since the 2016 viability assessment indicates the extinction risk has not changed appreciably. It shows slight improvements in the two northern-most diversity strata, but little change in the Coastal Diversity Stratum and perhaps worsening conditions in the Santa Cruz Mountain Stratum. The extinction risk for CCC coho salmon as a whole thus remains high.

2.3.2 Analysis of ESA Listing Factors

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

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

Significant habitat restoration and protection actions at the federal, state, and local levels have been implemented to improve 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 new reporting techniques. Generally, it takes one to five decades to demonstrate such increases in viability.

Current Status and Trends in Habitat

Below, we summarize information on the current status and trends in habitat conditions by diversity stratum since our last 2016 5-year review. We specifically address: (1) the key emergent or ongoing habitat concerns (threats or limiting factors) focusing on the top concerns that potentially have the biggest impact on independent population viability; (2) the population-specific geographic areas (e.g., independent population major/minor spawning areas) where key emergent or ongoing habitat concerns remain; (3) population-specific key protective measures and major restoration actions taken since the 2016 5-year review that move a population toward achieving the recovery plan viability criteria adopted by NMFS in the 2012 CCC Coho Salmon

ESU Recovery Plan (NMFS 2012a) 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.

Lost Coast-Navarro Point Diversity Stratum

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

For the four independent CCC coho populations (Ten Mile River, Noyo River, Big River, and Albion River) comprising the Lost Coast-Navarro Point Diversity Stratum, the primary habitat concerns, as reported in the 2016 5-year review (NMFS 2016), continue to be:

- Lack of instream habitat complexity (e.g., large woody canopy cover, riffle/run/pool diversity, and access to the floodplain) due largely from impacts associated with legacy timber operations and ranching grazing practices in all populations in this diversity stratum.
- Lack of high flow refuge habitat (e.g., off-channel, backwater channel, and floodplain areas), especially with increasing winter storm severity (See Listing Factor E for greater detail).
- Lack of estuarine complexity due to urbanization, recreation, California State Highway 1, and timber operations in the Noyo River, Big River, Albion River, Usal Creek, and Wages Creek. The lack of estuarine complexity leads to an increase in predation opportunity and reduced opportunity for full life history expression.
- Stream embeddedness related to mass wasting and fine sediment delivery from industrial forest road systems impacts spawning and egg survival in all the populations within the diversity stratum.
- Inadequate protection of the riparian zones in the warmer interior areas of the Albion River has led to an increase in summer and fall water temperatures.

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

There are no additional population-specific geographic areas of concern beyond the Ten Mile River, Noyo River, Big River, and Albion River concerns specifically identified above.

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

The key protective measures and major restoration actions addressing population-specific habitat concerns in the Lost Coast-Navarro Point Diversity Stratum implemented since the previous

2016 5-year review are:

- The NOAA Restoration Center, together with partners, funded the following large wood restoration projects (Figure 3).
 - Big River: 444 large wood pieces, 198 structures over 7.5 miles;
 - Noyo River: 1,485 large wood pieces, 596 structures over 14.5 miles;
 - Ten Mile River: 552 large wood pieces, 308 structures over 9.8 miles;
 - Albion River: 168 large wood pieces, 49 structures over 2.7 miles.
- The Nature Conservancy implemented phase 1 of a restoration action highlighted in NOAA's Species in the Spotlight Initiative. The first phase restored habitat at five sites in the lower South Fork Ten Mile River, including multiple engineered log jams and a sizeable wetland pond to provide refuge and rearing habitat for coho salmon.
- In Big River, the James Creek Fish Passage Project was implemented in 2018. The passage projects opened up seven miles of quality habitat, and coho salmon were documented upstream of the barriers the first winter after removal. Both projects were identified as a top priority in the recovery plan.

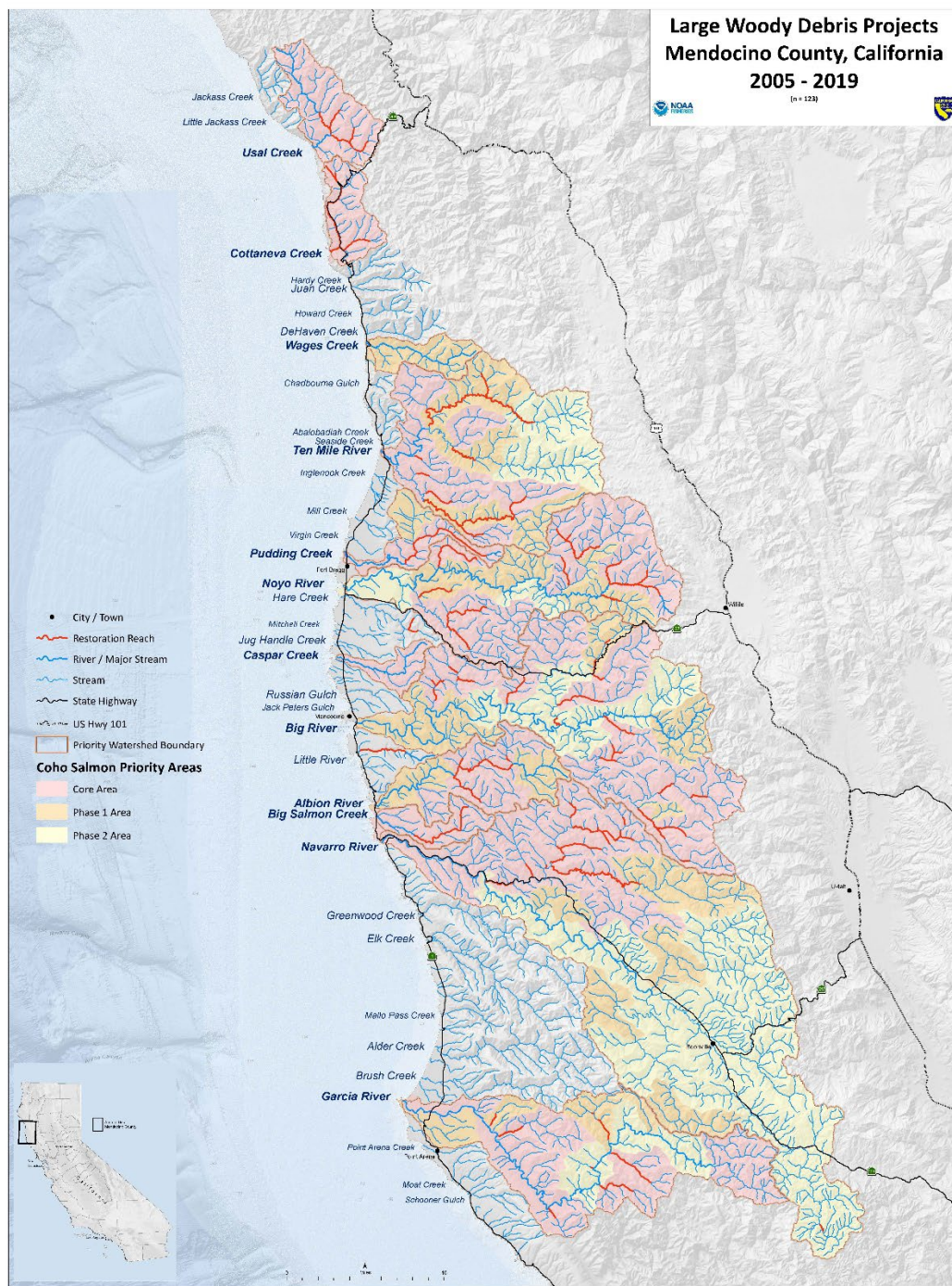


Figure 3: Map of large woody debris projects in Mendocino County, California from 2005-2019. Credit: NOAA Restoration Center.

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

The NMFS 2012 CCC Coho Salmon ESU Recovery Plan (NMFS 2012a) and the previous 5-year review identified inadequate regulatory mechanisms as contributing substantially to the decline

of the CCC coho salmon ESU. Although many regulatory mechanisms and conservation efforts were in place when this ESU was listed, NMFS concluded that they were insufficient to provide for the attainment of properly functioning habitat conditions that would protect and conserve the species. Specifically, for the Lost Coast-Navarro Point Diversity Stratum various federal, state, county, and tribal regulatory mechanisms are in place to minimize or avoid habitat degradation caused by human use and development. Some of these mechanisms have been improved and updated in the past 5 years, such as California State Sustainable Groundwater Management Act Regulations. However, the implementation and effectiveness of regulatory mechanisms have not been adequately documented. *See Listing Factor D: Inadequacy of Regulatory Mechanisms in this document for details.*

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

The greatest opportunity to advance recovery of CCC coho salmon in the Lost Coast-Navarro Point Diversity Stratum is to:

- Retain, recruit and actively input large wood into the stream to increase shelter value, pool volume, and floodplain connectivity.
- Design and implement restoration projects to create or restore alcove, floodplain, off-channel, backwater channel, ephemeral tributary or seasonal habitats.
- Minimize new road construction within floodplains and riparian areas or upon unstable soils or other sensitive areas. Design new roads that are hydrologically disconnected from the stream network.
- Promote the re-vegetation of the native riparian plant community within inset floodplains and riparian corridors.
- Eliminate depletion of summer flows (in Albion and Big rivers) and promote passive diversion devices designed to allow diversions of water only when minimum streamflow is met (in Noyo River).
- Remove hard structures (i.e., riprap) from estuaries and replace with a bioengineered solution.
- Acquire conservation easements from industrial timber companies to protect riparian areas, improve riparian shade, and promote wood delivery to stream channels.

Navarro Point-Gualala Point Diversity Stratum

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

For the three independent CCC coho populations (Navarro River, Garcia River, and Gualala River) comprising the Navarro Point-Gualala Point Diversity Stratum, the primary habitat concerns, as reported in the 2016 5-year review (NMFS 2016), continue to be:

- High water temperatures and low water flows due to a lack of riparian vegetation and

rural residential and agricultural water withdrawals in the Gualala and Navarro rivers.

- Lack of instream habitat complexity (e.g., large woody canopy cover, riffle/run/pool diversity, and access to the floodplain or off-channel habitat) due largely from impacts associated with legacy timber operations and ranching grazing practices in all populations in this diversity stratum.
- Lack of high flow refuge habitat (e.g., off-channel, backwater channel, and floodplain areas), especially with increasing winter storm severity (See Listing Factor E for greater detail).
- Lack of estuarine habitat complexity (including floodplain and off-channel habitat) due to grazing practices, California State Highway 1, and timber operations throughout the diversity stratum, leading to an increased risk of predation, reduced stream carrying capacity, and reduced opportunity for full life history expression.

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

There are no additional population-specific geographic areas of concern beyond the Navarro River, Garcia River, and Gualala River concerns specifically identified above.

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

The key protective measures and major restoration actions addressing population-specific habitat concerns in the Navarro Point-Gualala Point Diversity Stratum implemented since the previous 2016 5-year review are:

- The NOAA Restoration Center and partners funded large wood restoration projects (Figure 3) in the:
 - Navarro River (primarily on the North Fork): 505 large wood pieces, 198 structures over 7.8 miles;
 - Garcia River: 250 large wood pieces, 103 structures over 3.4 miles.
- The Garcia River Estuary Enhancement Plan which was completed in late 2022. This high-priority recovery action is restoring estuarine and floodplain habitats, influencing the survival and fitness of salmon at population-level scales.

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

The NMFS 2012 CCC Coho Salmon ESU Recovery Plan (NMFS 2012a) and the previous 5-year review identified inadequate regulatory mechanisms as contributing substantially to the decline of the CCC coho salmon ESU. Although many regulatory mechanisms and conservation efforts were in place when this ESU was listed, NMFS concluded that they were insufficient to provide for the attainment of properly functioning habitat conditions that would protect and conserve the species. Specifically, for the Navarro Point-Gualala Point Diversity Stratum, various federal, state, county, and tribal regulatory mechanisms are in place to minimize or avoid habitat

degradation caused by human use and development. Some of these mechanisms have been improved and updated in the past 5 years, such as California State Cannabis Regulation and California State Sustainable Groundwater Management Act Regulations. However, the implementation and effectiveness of regulatory mechanisms have not been adequately documented. *See Listing Factor D: Inadequacy of Regulatory Mechanisms in this document for details.*

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

The greatest opportunity to advance the recovery of CCC coho salmon in the Navarro Point-Gualala Point Diversity Stratum is to:

- Retain, recruit, and actively input large wood into the stream to increase shelter value, pool volume, and floodplain connectivity. Implement restoration projects that create or restore off-channel, estuarine, and floodplain habitat.
- Design and implement restoration projects to create or restore alcove, floodplain, backwater channel, ephemeral tributary, or seasonal habitats for high-flow refuge.
- Minimize new road construction within floodplains and riparian areas and upon unstable soils or other sensitive areas. Design new roads that are hydrologically disconnected from the stream network.
- Promote the re-vegetation of the native riparian plant community within inset floodplains and riparian corridors.
- Eliminate depletion of summer flows and promote off-stream storage and passive diversion devices designed to allow diversions of water only when minimum streamflow is met.

Coastal Diversity Stratum

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

For the three independent CCC coho populations (Russian River, Walker Creek, and Lagunitas Creek) comprising the Coastal Diversity Stratum, the primary habitat concerns, as reported in 2016 5-year review (NMFS 2016), continue to be:

- Lack of instream habitat complexity (e.g., large woody canopy cover, riffle/run/pool diversity off-channel habitat, and access to the floodplain) due largely to urbanization, agriculture, mining, and ranching grazing practices in all populations in this diversity stratum.
- Lack of high flow refuge habitat (e.g., off-channel, backwater channel, and floodplain areas), especially with increasing winter storm severity (See Listing Factor E for greater detail).
- Diversity stratum-wide lack of instream water flow leading to diminished water quality

and dewatered reaches because of surface and groundwater diversions primarily for residential and agriculture use.

- Diversity stratum-wide impairment of estuarine water quality.

A major emergent habitat concern since the 2016 5-year review is the increased frequency and severity of large, unprecedented wildfires throughout the diversity stratum. The Russian River watershed was severely impacted by the 2017 Pocket, Tubbs, and Nuns Fires, the 2019 Kincade Fire, and the 2020 Walbridge and Glass Fires (Figure 4).² The Austin Creek, Mill Creek, Maacama Creek, and Mark West Creek watersheds experienced significant damage from these wildfires. Fires of this magnitude cause substantial damage to riparian habitat and instream wood shelter, and contribute to increased landslides and sediment input to streams. Roads and fire breaks cut by bulldozers to provide access and stop the fire's movement, respectively, can also cause unintentional impacts via vegetation removal and increasing sources of fine sediment input into streams.

Another emerging threat is from contaminated stormwater runoff from roadways and streets, especially when containing a degradation product of tires (6PPD) known to cause salmon mortality at concentrations of less than a 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 The 2020 Glass Fire occurred in the Russian River headwaters but is outside the CCC coho salmon recovery footprint.

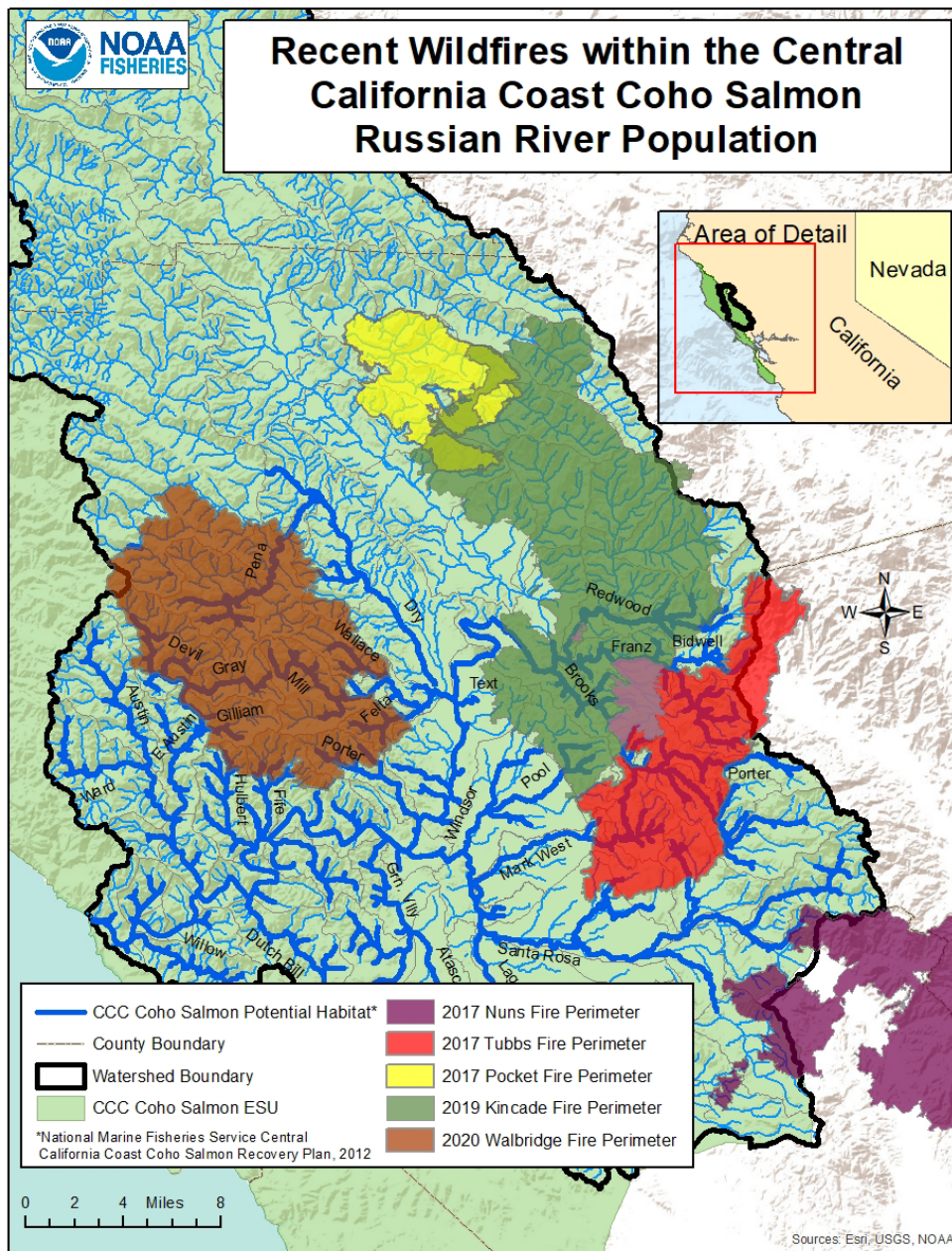


Figure 4: Recent Wildfires within the Central California Coast Coho Salmon Russian River Population

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

As noted above, the following specific geographic areas are affected by ongoing or emergent habitat impacts.

- Destruction of the riparian corridor, bank destabilization and contribution of fine sediments to the creek due to grazing practices in Walker Creek.
- Contaminated stormwater runoff from roadways and streets is a problem on the Russian

River mainstem and major tributaries downstream of Healdsburg, Windsor, and Santa Rosa and on Lagunitas Creek/San Geronimo Creek tributary, especially where the creek runs adjacent to Sir Francis Drake Boulevard.

- Lack of water is especially a problem in the Russian River and Walker and Lagunitas creeks and tributaries where the juvenile coho are rearing during the summer and fall.
- Lack of estuarine habitat complexity (e.g., wetlands, and large wood) in Russian River and Walker Creek.

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

The key protective measures and major restoration actions addressing population-specific habitat concerns in the Coastal Diversity Stratum implemented since the previous 2016 5-year review include:

- In 2016, NMFS completion of the first Safe Harbor Agreement in the country, in the Dry Creek watershed of the Russian River (81 FR 34378). Safe Harbor Agreements provide assurances landowners will not face new restrictions on their land because of their good stewardship practices. The Dry Creek agreement creates an environment for collaborative conservation, building on local knowledge and innovation to inspire on-the-ground action. The partnership among NMFS, the United States Army Corps of Engineers (USACE), Sonoma Water, California Department of Fish and Wildlife (CDFW), and private landowners in the Dry Creek Valley has facilitated the construction of three miles of high-quality habitat in Dry Creek towards the requirement of a Biological Opinion for reservoir and water supply operations in the Russian River. An additional three miles of habitat remain to be constructed by 2025 under the 2008 Biological Opinion (NMFS 2008a).
- From 2015-2020, the Russian River Coho Water Resources Partnership³ implemented 27 streamflow enhancement projects in Russian River tributaries critical to CCC coho salmon. The Coho Partnership research has demonstrated that increasing stream connectivity increases the probability of juvenile salmon survival. Since it can take as little as 0.01 ft³/s to keep pools connected in these streams, these seemingly small flow improvements support greater coho salmon survival.
- From 2017-2019, the Salmon Protection and Watershed Network (SPAWN) enhanced a 1.0-mile of floodplain in Lagunitas Creek, Marin County. Over 10,000 cubic yards of fill and numerous abandoned and dilapidated buildings were removed from the floodplain, creating side channels with refuge habitat for steelhead and juvenile coho salmon.

³ The Russian River Coho Water Resources Partnership is comprised of California Sea Grant Gold Ridge Resource Conservation District, Occidental Arts and Ecology Center's WATER Institute, Sonoma Resource Conservation District, and Trout Unlimited and with major support from the National Fish and Wildlife Foundation, Sonoma Water, and many other partners.

SPAWN installed large woody debris, removed invasive plants, and reforested the riparian corridor with over 9,000 native plants.

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

The NMFS 2012 CCC Coho Salmon ESU Recovery Plan (NMFS 2012a) and the previous 5-year review identified inadequate regulatory mechanisms as contributing substantially to the decline of the CCC coho salmon ESU. Although many regulatory mechanisms and conservation efforts were in place when this ESU was listed, NMFS concluded that they were insufficient to provide for the attainment of properly functioning habitat conditions that would protect and conserve the species, especially for the Coastal Diversity Stratum. Various federal, state, county and tribal 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, such as California State Cannabis Regulation and California State Sustainable Groundwater Management Act Regulations. However, the implementation and effectiveness of regulatory mechanisms have not been adequately documented. ***See Listing Factor D: Inadequacy of Regulatory Mechanisms in this document for details.***

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

The greatest opportunity to advance recovery of CCC coho salmon in the Coastal Diversity Stratum is to:

- Exclude livestock from Walker Creek and replant streambanks and riparian areas. Remove invasive species from the riparian areas and replace with native vegetation.
- Use off-channel storage to reduce impacts of water diversions and implement water conservation strategies (e.g., drip irrigation) throughout the diversity stratum. Find opportunities to release water from irrigation ponds to augment flows during the dry season.
- Retain, recruit, and actively input large wood into the stream to increase shelter values and pool volume.
- Implement restoration projects that create or restore instream habitat complexity and off-channel, estuarine, and floodplain habitat.
- Design and implement restoration projects to create or restore alcove, floodplain, backwater channel, ephemeral tributary, or seasonal habitats for high-flow refuge.
- Implement an improved flow regime for Dry Creek within the Russian River as required in the 2008 Biological Opinion (NMFS 2008a) through interagency consultation with USACE and Sonoma Water.

Santa Cruz Mountains Diversity Stratum

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

Two historically independent CCC coho populations (Pescadero Creek and San Lorenzo River) comprise the Santa Cruz Mountains Diversity Stratum, though both are currently extirpated or nearly so. In this diversity stratum, the largest extant populations are dependent populations located in Scott Creek, Waddell Creek, and San Vicente Creek. This is largely attributed to the ongoing conservation hatchery broodstock program and because these dependent populations have some of the best remaining coho salmon habitat within the stratum. Because of that, we will consider dependent populations from this diversity stratum in this 5-year review. The primary habitat concerns, as reported in the 2016 5-year review (NMFS 2016), continue to be:

- Lack of instream habitat complexity, access to the floodplain, and stream simplification (e.g., large woody debris, canopy cover, and riffle/run/pool diversity) throughout this diversity stratum primarily from urbanization, legacy forest practices, and agriculture (all populations).
- Lack of high flow refuge habitat (e.g., off-channel, backwater channel, and floodplain areas), especially with increasing winter storm severity (See Listing Factor E for greater detail).
- Diversity stratum-wide lack of instream water flow leading to diminished water quality and dewatered reaches because of surface and groundwater diversions primarily for residential and agriculture use.
- Diversity stratum-wide impairment of estuarine water quality (i.e., temperature, dissolved oxygen) because of lack of streamflow.
- Impaired or loss of seasonal estuarine rearing habitat due to urbanization, sandbar breaching, and reduced freshwater inflow.

A major emergent habitat concern since the 2016 5-year review is the increased frequency and severity of intense, large unprecedented wildfires throughout the diversity stratum. In 2020, the CZU Fire Complex⁴ burned a significant portion of the best remaining habitat for CCC coho salmon in the Santa Cruz Diversity Stratum (Figure 5). Fires of this magnitude cause substantial damage to riparian habitat and instream wood shelter, as well as contribute to increased landslides and sediment input to streams. Roads and fire breaks cut by bulldozers to provide access and stop the fire's movement, respectively, can also cause unintentional impacts from vegetation removal and increase fine sediment input into streams.

Another emerging threat is contaminated stormwater runoff from roadways and streets, especially when containing a degradation product of tires (6PPD) known to cause salmon

⁴ CZU refers to the Cal Fire designation for its San Mateo–Santa Cruz Unit, the administrative division for San Mateo, Santa Cruz, and San Francisco counties.

mortality at concentrations of less than a 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 in streams 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.***

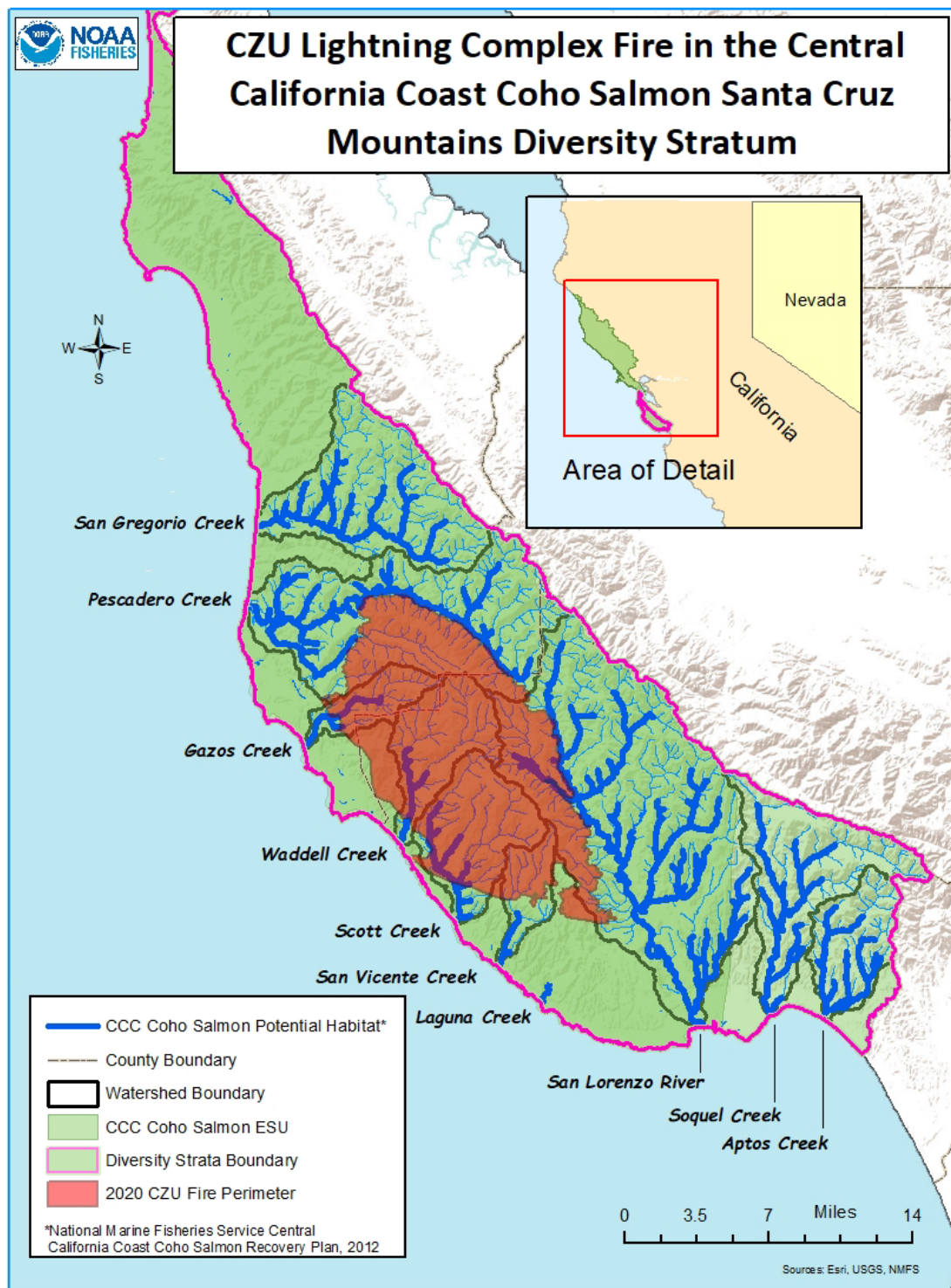


Figure 5: Map of CZU Lightning Complex Fire in the Central California Coast Coho Salmon Santa Cruz Mountains Diversity Stratum. The northern fire boundary is shown to be at Pescadero Creek but the fire mainly burned only to the ridgetop south of Pescadero Creek. The majority of the small tributaries that drain into Pescadero Creek from the south were outside of the fire boundary.

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

Specific geographic areas of concern include:

- Increased sedimentation in freshwater rearing habitats within Scott, Waddell, and Gazos creeks due to the CZU Lightning Complex Fire.

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

The key protective measures and major restoration actions addressing population-specific habitat concerns in the Santa Cruz Mountains Diversity Stratum implemented since the previous 2016 5-year review include:

- The 2019 completion of the Butano Creek Channel Hydrologic Reconnection Project located in the Pescadero Creek watershed. This project reconnected Butano Creek to the Pescadero Creek estuary by dredging approximately 1.5 miles of channel and providing fish access to over 10 miles of upstream spawning habitat that is currently impeded by sedimentation. This project also alleviates the regular steelhead fish kills caused by poor water quality.⁵
- The San Mateo Resource Conservation District Ponds for Farmers, Fish and People is ongoing construction, repair, and enhancement of farm ponds and other water retention features to conserve water. This project will result in more water being left in the stream for salmonids during the dry season. Off-stream water storage is essential in preparation for droughts and climate change.
- Completion of the Lower Scott Creek Floodplain and Habitat Enhancement Project Phases 1-3, 2014 and 2017. This project included the installation and enhancement of multiple instream wood complexes, reconnecting the stream channel with the adjacent floodplain. Overall, the project will increase habitat complexity and floodplain connectivity along 4,500 feet of the lower mainstem of Scott Creek, where the Scott Creek/King Fisher Flats Conservation Program/Scott Creek Captive Broodstock Program monitoring and outplanting sites are located.
- The 2017 implementation of the San Vicente Creek Large Wood Habitat Enhancement Project. This project included the felling of 48 standing redwood trees into San Vicente Creek to improve habitat complexity.
- The 2019 completion of the Upper Zayante Creek Stream Wood Enhancement Project. The project included installing 18 wood structures in over one mile of habitat in Upper Zayante Creek, a tributary to the San Lorenzo River, to retain sediment, develop riffles, create, pools, and provide cover habitat for CCC coho salmon and CCC steelhead.

⁵ <https://www.fisheries.noaa.gov/feature-story/butano-creek-restoration-reopens-habitat-salmon-california>

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

The NMFS 2012 CCC Coho Salmon ESU Recovery Plan (NMFS 2012a) and the previous 5-year review identified inadequate regulatory mechanisms as contributing substantially to the decline of the CCC coho salmon ESU. Although many regulatory mechanisms and conservation efforts were in place when this ESU was listed, NMFS concluded that they were insufficient to provide for the attainment of properly functioning habitat conditions that would protect and conserve the species. Specifically, for the Santa Cruz Mountains Diversity Stratum various federal, state, county, and tribal 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, such as California State Cannabis Regulation and California State Sustainable Groundwater Management Act Regulations. However, the implementation and effectiveness of regulatory mechanisms have not been adequately documented. *See Listing Factor D: Inadequacy of Regulatory Mechanisms in this document for details.*

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

The greatest opportunity to advance the recovery of CCC coho salmon in the Santa Cruz Mountains Diversity Stratum is to:

- Design and implement restoration projects to create or restore alcove, floodplain, backwater channel, ephemeral tributary, or seasonal habitats.
- Restore and protect dry season flows by encouraging water conservation and winter diversions (off-stream storage).
- Retain, recruit and actively input large wood into streams.
- Expand public outreach on the adverse impacts of recreational sandbar breaching with the goal of reducing or eliminating breaches caused by the public during the critical rearing periods.
- Encourage the completion of fish passage improvement in Branciforte Creek Flood Control Channel.

ESU Summary

The risk to the species' persistence because of habitat destruction or modification has not changed significantly since the last 5-year review. Major habitat concerns remain in this ESU, particularly with regard to: (1) water quantity and quality; (2) lack of instream habitat complexity and access to floodplains; (3) properly functioning estuaries; and (4) impacts from increased frequency and severity of wildfires.

Listing Factor A: Conclusion

New information available since the last 5-year review indicates there has not been a major improvement in freshwater and estuary habitat conditions because of restoration or habitat

protection. 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. While existing and new partnerships have leveraged numerous opportunities for habitat restoration and protection throughout the range of this ESU, additional habitat protection and restoration actions are needed to bring this ESU to viable status. Future 5-year assessments would benefit from a systematic review and quantitative analysis to estimate the amount of habitat improved and protected, relative to the targets for the same in priority watersheds in the 2012 Recovery Plan (NMFS 2012a) in order to track progress towards plan objectives. We conclude that the risk to the species' persistence because of habitat destruction or modification has not changed significantly since the last 5-year review in 2016.

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

Harvest

Overfishing as a threat to CCC coho salmon survival has likely remained a low threat, comparable to that described at the time of listing. Commercial and sport ocean harvest of coho salmon was banned along the entire California coast in 1996, yet a small proportion of coho salmon are incidentally captured and killed as bycatch in other fisheries (PFMC 2019). However, marine exploitation rates for California coho salmon have been below the allowed exploitation rate established by NMFS (1999). The most recent marine exploitation rate of Southern Oregon/Northern California Coast and CCC coho salmon combined during the 2019 season had a preliminarily postseason estimate of at 3.4 percent, which is well below the 13 percent maximum ESA consultation standard and Fisheries Management Plan conservation objective (PFMC 2019). Freshwater fishing for coho salmon has been illegal in California since 1996 (PFMC 2019). Recreational fishing is limited to catch and release of wild fish and retention of only hatchery produced fish such as steelhead.⁶ *See Listing Factor D for more information related to the low-flow fishing closure regulations.*

Scientific Research and Monitoring

The quantity of take authorized under ESA sections 10(a)(1)(A) and 4(d) for scientific research and monitoring for CCC coho salmon remains low in comparison to their abundance, 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 associated with scientific research and monitoring are generally capped at 0.5 percent across the West Coast Region for all listed salmonid ESUs and DPSs. As a result, the mortality levels that research causes are very low throughout the ESU. In addition, and as with all other listed salmonids, the effects that research has on CCC coho salmon are spread out over various reaches, tributaries, and rivers across CCC coho salmon's range, and thus no population or diversity stratum is likely

⁶ CDFW Fishing Regulations: <https://wildlife.ca.gov/Regulations>

to experience a disproportionate amount of loss. Therefore, the research program, as a whole, has only a very small impact on overall population abundance, a similarly small impact on productivity, and no measurable effect on spatial structure or diversity for CCC coho salmon.

Database records (NMFS APPS database; <https://apps.nmfs.noaa.gov/>) show that from 2015 through 2019 researchers were approved to take a yearly average of fewer than 3,200 adult (<49 lethally) and fewer than 185,000 juveniles (<3,700 lethally) of naturally produced CCC coho salmon per year. For the vast majority of scientific research actions, history has shown that researchers generally take far fewer salmonids than are authorized every year. Reporting from 2015 through 2019 indicates that over those 5 years, the average actual (reported) yearly total take for naturally produced juveniles was only 13 percent of the amount authorized, and over the same period, the average reported yearly total take for adults was five percent of the average amount authorized per year. The reported lethal take was even lower over the same 5-year period: average yearly lethal take of naturally produced adults and juveniles was only four percent of the average amount authorized per year.

The majority of the requested methods of take for naturally produced juveniles have primarily been (and are expected to continue to be) capture via screw traps, electrofishing efforts, beach seines, fyke nets, minnow traps, and hand or dip netting, with smaller numbers collected as a result of other seine types, trawling, hook and line sampling, and those intentionally sacrificed. Adult methods of take requested have primarily been (and are expected to continue to be) capture via weirs or fish ladders, hook and line angling, with smaller numbers captured via trawls or hand or dip nets, and getting unintentionally captured by screw traps, seining, and other methods that target juveniles (NMFS APPS database; <https://apps.nmfs.noaa.gov/>). Our records indicate that mortality rates for screw traps are typically less than one percent and backpack electrofishing mortality is typically less than three percent. Unintentional mortality rates from seining, hand or hoop netting, fyke nets, minnow traps, weirs, and hook and line methods are also limited to no more than three percent. Finally, a small number of adult fish may die as an unintended result of research because of interactions with trawl sampling equipment.

The quantity of total take (juvenile and adult combined) authorized over the past 5 years has increased by 165 percent for CCC coho salmon (~938,000 total over the past 5 years versus ~354,000 total over 2010-2014), and concurrently the lethal take requested and authorized has also increased by 96 percent (~18,600 total over 2015-2019 versus ~9,459 over 2010-2014). Total reported take of CCC coho salmon from 2015 through 2019 tripled (~121,400 versus ~39,700 over 2010-2014), and was more than four times higher for lethal take than the total reported from 2010 through 2014 (801 individuals versus 184 over 2010-2014), the majority of which were juveniles (791 juvenile and ten mortalities from 2015-2019). Although the reported total and lethal take has increased over the past 5 years, the absolute numbers of individuals authorized and reported taken remain low relative to abundance (estimated at 0.1 percent of the abundance of naturally produced juveniles and adults per year). The increase in requested take is largely due to the increase in monitoring and research.

Overall, research impacts remain minimal due to the low mortality rates authorized under research permits and the fact that research is spread out geographically throughout the ESU. Therefore, the overall effect on listed populations has not changed substantially. We conclude that the risk to the species' persistence because of utilization related to scientific studies has changed little since the last 5-year review (NMFS 2016).

Listing Factor B: Conclusion

Information available since the last 5-year review indicates that the risk from harvest remains stable since the listing. Scientific research take authorized through the West Coast Region has increased for CCC coho salmon compared to the prior 5 years (NMFS APPS database; <https://apps.nmfs.noaa.gov/>). Due to the relatively small number of individuals taken compared to the species' abundance and the dispersed nature of research activities, the impact from this source of mortality is not considered to be a major limiting factor for this ESU. The risk to the species' persistence because of overutilization remains essentially unchanged since the 2016 5-year review, with harvest and research/monitoring as a source of mortality continuing to have little to no impact on the recovery of the CCC coho salmon ESU.

Listing Factor B: Recommendations

- Increase species identification signage in areas where steelhead fishing occurs to reduce any unintentional capture of coho salmon.

Listing Factor C: Disease and Predation

Disease

Disease was not considered a major factor causing the decline of CCC coho salmon in California at the time of listing. Many common coho salmon disease pathogens exist in wild populations, but increased individual resistance and natural ecological dynamics limit disease outbreaks and any resulting population-level impacts. Production-scale hatcheries (i.e., those producing fish intended for angling opportunities) likely have increased incidences of disease and related mortality as compared to natural populations, in part due to increased stress from overcrowding and sub-optimal habitat conditions that can lower the natural immunity of individual fish (USFWS 2015). Both northern and southern coho salmon conservation broodstock hatcheries have a draft or final HGMP in place that minimizes the risk of disease to the hatchery and wild fish (See Hatchery discussion in Listing Factor E for more information).

In the wild, disease incidence and severity are likely exacerbated by drought since low flows and high-water temperatures can facilitate the transmission of some pathogens within adult salmon populations (Belchik *et al.* 2004). No quantitative information has emerged since the last 5-year review that would suggest disease impacts have elevated in the time since, or that disease impacts are a more prominent factor in the present depressed state of the CCC coho salmon ESU.

Predation

Marine Mammals

Recent research over the past 5 years suggests that predation pressure on ESA-listed salmon and steelhead from seals, sea lions, and killer whales has been increasing in the northeastern Pacific Ocean over the past few decades (Chasco *et al.* 2017a; Chasco *et al.* 2017b). Killer whales are known to selectively prey on Chinook salmon, so they are not considered a major predator of coho salmon (Hanson *et al.* 2021). On a Pacific coast-wide scale, converting juvenile Chinook salmon into adult equivalents, Chasco *et al.* (2017a) estimated that by 2015, seals and sea lions (pinnipeds) consumed double the amount of Chinook salmon taken by Southern Resident killer whales and six times the combined commercial and recreational catches.

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

- California Sea Lion (United States Stock):

The current population size of California sea lions is 257,606 (Carretta 2019). The stock is estimated to be approximately 40 percent above its maximum net productivity level (183,481 animals), and it is considered within the range of its optimum sustainable population (OSP) size (Carretta 2019). There are no qualitative or quantitative estimates (number of seasonal animals) of California sea lions in California estuaries/rivers.

- Steller Sea Lion (Eastern United States Stock):

The current population size of Steller sea lions is 71,562 (52,139 non-pups and 19,423 pups) (Muto *et al.* 2019). Muto *et al.* (2017) conclude that the eastern stock of Steller sea lions is likely within its OSP range; however, NMFS has made no determination of its status relative to OSP. In California, the current population size of Steller sea lions (California rookery sites) is 3,120 non-pups, and 936 pups (Muto *et al.* 2019; Muto *et al.* 2020). There are no qualitative or quantitative estimates (number of seasonal animals) of Steller sea lions in California estuaries/rivers.

- Harbor Seals (California Stock):

The current population size of the California stock of mainland and offshore islands haul out sites is 30,968 (Carretta 2019), with a minimum population size estimated at 27,348 (Carretta 2019). This stock's status relative to OSP is unknown.

In California, pinnipeds occur seasonally in the American River and the Sacramento River; however, there are no qualitative or quantitative assessments of pinnipeds (i.e., number of seasonal animals) in these systems. In the Columbia Basin, recent research found that survival of adult spring-summer Chinook salmon through the estuary and lower Columbia River is negatively impacted by higher sea lion abundance for populations with run timing that overlaps with seasonal increases in Steller and California sea lions (Wargo Rub *et al.* 2019; Sorel *et al.* 2021). Whether increasing sea lion populations in California are associated with decreased survival of any ESA-listed salmonid ESU or DPS through estuarine and freshwater migration corridors in the state is currently unknown, as there have not been assessments of predation on Pacific salmon and steelhead populations in California estuaries/rivers to date.

Most authors have focused research on Chinook salmon because they have the highest energy value for predators (O'Neill *et al.* 2014). However, some study authors have found that pinnipeds like harbor seals can have a significant impact on other species of salmon (Thomas *et al.* 2017) and steelhead (Moore *et al.* 2021) through the consumption of outmigrating juveniles. Harbor seal predation data specific to California is not currently available, so whether predation of outmigrating juveniles is a threat to ESA-listed salmonids in California rivers and estuaries is currently unknown.

Avian, Fish, and Other Mammal Predation

The effect of avian predation on CCC coho salmon from birds (e.g., terns, cormorants, and gulls) is not well understood. Certain conditions may provide higher opportunity, such as in nearshore environments, where avian or even mammalian predation could have a substantial effect on outmigrating juveniles. An indirect effect of urbanization may be a resultant increase in opportunistic, generalist predators (e.g., western gulls or raccoons) that utilize anthropogenic resources (e.g., landfills, garbage) to increase their local carrying capacity. For example, Osterback *et al.* (2013) determined that juvenile salmonid mortality from western gull predation in Central California populations was greater than previously estimated. Non-native fish predation is likely a larger source of mortality, such as with striped bass, which regularly occur in San Francisco and Tomales Bays, occasionally occur in coastal lagoons, and are found year-round in the lower Russian River. While additional studies are needed to better understand predatory impacts in general, understanding predation mechanisms and rates from introduced species on coho populations throughout the ESU is a high priority. Overall, however, the predation threat to CCC coho salmon is thought to be unchanged since the last 5-year review in 2016 and is not considered a major factor limiting CCC coho salmon's recovery.

Hatchery Steelhead Predation

An emerging potential threat to CCC coho salmon is the predation by hatchery-produced steelhead in the Russian River. Adult CCC natural-origin and hatchery-origin steelhead are collected, and hatchery juveniles are produced from the DCFH and the Coyote Valley Fish Facility (CVFF) on the Russian River. The USACE and CDFW (2021) identified in the Hatchery

Genetic Management Plan (HGMP) for the Russian River steelhead programs that the release size and location of hatchery steelhead smolts has a high predation risk to CCC coho salmon in the Russian River. DCFH hatchery produced steelhead smolts are comparably larger than their hatchery coho fingerling counterparts which are also released to Dry Creek. Larger CVFF steelhead smolts are also found to residualize in the mainstem Russian River (USACE and CDFW 2021). However, since few CCC coho salmon are found in the upper Russian River basin (upstream of Dry Creek confluence), predation risk to coho salmon is not likely to occur until hatchery steelhead migrate to the lower Russian River. A high ecological risk exists because of the high hatchery steelhead to natural and conservation program coho salmon ratio in Dry Creek and the lower Russian River.

To address these concerns, the DCFH CCC steelhead HGMP implements several actions (i.e., reduced smolt size, modified release location, modified steelhead production targets) to lower the risk to CCC coho salmon (USACE and CDFW 2021).

Listing Factor C: Conclusion

Information available since the last 5-year review clearly indicates that predation by pinnipeds on Pacific salmon and steelhead continues to pose an adverse impact on the recovery of some ESA-listed salmon and steelhead. Pinniped populations on the West Coast have increased significantly since the MMPA was enacted in 1972, and recent modeling efforts indicate predation by pinniped species has been on the rise, particularly Chinook salmon, over the last few decades in Washington, Oregon, and California. Given the lack of information currently available in California, further study of pinniped predation interactions is warranted to determine whether these impacts are limiting the recovery of ESA-listed salmon and steelhead in the state. Actions to reduce potential predation risk to juvenile coho salmon from hatchery released steelhead are being addressed via the HGMP for the DCFH Russian River programs. There is no new information available since listing or the last 5-year review to indicate whether there is an increase in the threat of invasive species to CCC coho salmon, or that disease impacts are more than a minor factor in the present depressed state of the CCC coho salmon ESU.

Recommended Future Actions

- Expand, develop, and implement monitoring efforts in California to identify pinniped predation interactions in select areas (e.g., river mouths, migratory pinch points) and quantitatively assess predation impacts by pinnipeds on Pacific salmon and steelhead stocks.
- Develop and evaluate a long-term management strategy to reduce pinniped predation on ESA-listed species in select areas (e.g., river mouths/migratory pinch points).
- Implement the DCFH Russian River steelhead HGMP to reduce threats to Russian River CCC coho salmon (CDFW and USACE 2021).

- Implement studies to better understand the risk of avian and fish predation on CCC coho salmon.

Listing Factor D: Inadequacy of 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, such as hydrosystem, as well as harvest. For this 5-year review, we focus our analysis on regulatory mechanisms that have either improved for CCC coho, or are still causing the most concern in terms of providing adequate protection for CCC coho.

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. The habitat conditions across all habitat components (tributaries, mainstems, estuary, and marine) necessary to recover the listed CCC coho 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 as federal, state, or private holdings.

One factor affecting habitat conditions across all land or water ownerships is climate change, the effects of which are discussed under 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 documents indicate that, while the number and efficacy of such mechanisms have increased in recent years, there has not yet been a substantial deviation in global emissions from the past trend, and upscaling and acceleration of far-reaching, multilevel, and cross-sectoral climate mitigation will be needed to reduce future climate-related risks (IPCC 2014; IPCC 2018). These findings suggest that current regulatory mechanisms, both in U.S. and internationally, are not adequate to address the rate at which climate change is negatively impacting habitat conditions for many ESA-listed salmon and steelhead.

A majority of the CCC coho salmon ESU is in private ownership (85 percent), with the remaining area under Federal (5 percent), tribal and state (10 percent) ownership (NMFS 2012a). Most of the federal landscape consist of forestland and open space.

There are three primary Federal agencies responsible for land and water management in the CCC coho salmon ESU: the Bureau of Land Management, the National Park Service, and the USACE, with a significant role in flood protection. Since Federal lands make up such a small percentage (5 percent) of the CCC coho salmon ESU, their impact on recovery is relatively minor.

Regulatory Mechanisms Resulting in Adequate or Improved Protection

New information available since the last 5-year review indicates that the adequacy of some regulatory mechanisms has improved and has increased the protection of CCC coho salmon. These include state regulatory mechanisms.

1. 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 California 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 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. It accomplishes this task through Lake and Streambed Alteration Agreement permitting and 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 related to water diversion and pollutant discharge. The State Board's Cannabis Cultivation Policy (State of California State Water Resource Control 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. Eradicating unregulated cannabis operations and increasing overall industry oversight through MAUCRSA will be required to realize appreciable improvements in instream habitat quality for salmon and steelhead and other native aquatic resources.

2. Frost Protection Regulations

Water extractions from streams or hydraulically connected groundwater, specifically those aimed at protecting grapevines from frost damage, can strand newly emerged coho salmon fry during the spring period. On September 20, 2011, the State Water Resources Control Board adopted Frost Protection Regulations for the Russian River Watershed. The regulation seeks to minimize harmful stream stage changes by controlling and coordinating "frost protection" diversions. The use of water for frost protection is widespread in the basin, particularly in spring seasons with many frost events. Regulation is likely to improve fry survival in tributaries and portions of the mainstem where coho salmon spawn and rear. The regulations went into effect starting with the 2015 frost protection season (March 15 through May 15) and anyone diverting water for frost protection must participate in a Water Demand Management Program. Generally, coho salmon populations are absent in the upper Russian River area of Mendocino County, but frost protection actions in Sonoma County are more important for the protection of coho salmon. Agricultural producers in the Sonoma County portion of the Russian River watershed that participate in the frost protection program are registered with the North Coast Water Coalition. This program utilizes stream gauges to monitor changes in stream stage elevation from water diversions that may strand juvenile salmonids. Since 2015, risk assessment results have been reported for various focus areas where approximately 30 stream gauges monitor frost water diversions in the Russian River watershed. Risk assessment reporting since 2015 indicates that there are a relatively low number of stage elevation reductions that would have the potential to strand salmonid juveniles or fry. The number and amount of direct diversions for frost protection activities largely depends on water year type, with drought years or dry spring years having more potential for diversions that may result in strandings.

Frost assessment reports for the Sonoma County North Coast Water Coalition suggest that grape growers who are not in the program can pose an additional risk because it is difficult to identify these diverters and remediate their diversion activities. Also, recharge for pond-refilling can sometimes be difficult to assess and needs to be further evaluated to understand how ponds are managed for frost (O'Conner Environmental Inc. 2020). Many agricultural producers are now using wind as a means to reduce frost damage along with improved weather forecasting to reduce the time frost protection is used (C. Munselle, personal communication 2021). Future efforts to reduce diversions for frost protection should focus on increased use of wind and improvements in pond-refilling management.

3. CA Forest Practices/CA Anadromous Salmon Protection

At the time of salmon and steelhead listings, the State Forest Practice Rules were found to inadequately protect salmonids. Many of the identified inadequacies have been ameliorated through regulation changes by the State Board of Forestry. The most notable rule changes with input from NMFS, CDFW, and other State agencies are the 2010 Anadromous Salmonid Protection Rules and the 2012 Road Rules. These rules expanded stream-buffer widths, reduced the use of damaging road and harvest techniques, and limited riparian harvesting to collectively improve instream and riparian habitat and function over the long-term. Additionally, some private timber companies are actively restoring damaged aquatic and upslope habitat by increasing instream large wood volume or abating upslope erosion sources. The State Forest Practice Rules have also made additional changes to the cumulative watershed effects analysis of proposed timber harvest practices. These Board of Forestry rules (which apply to the northern/central portion of the ESU) provide additional no-cut buffer protections to certain Class II-Standard watercourses. The rules do not apply to the southern portion of the CCC coho salmon ESU (i.e., the area encompassing Santa Cruz and San Mateo counties). However, Santa Cruz County has its own specifications for timber management that provide additional protections for salmonids.

Since the 2017 wildfires throughout the ESU, salvage logging of burned trees has substantially increased, posing a threat to coho salmon spawning and rearing habitats. While salvage logging is considered a ministerial action not requiring review or allowing modification to timber operations, the harvest of burned but otherwise healthy trees has increased substantially in Sonoma Mendocino, and Santa Cruz counties, impacting numerous populations in several diversity strata. Revision of the rules to modify these actions to protect coho salmon is necessary given the increased level of wildfires recently.

Regulatory Mechanisms Resulting in Inadequate or Decreased Protection

We remain concerned about the adequacy of existing habitat regulatory mechanisms regarding water quality from excess sediment and toxicity, loss of habitat due to habitat conversions and access to floodplains, and the impacts of floodplain connectivity, flood storage/inundation, and hydrology. These include Federal and State regulatory mechanisms.

1. Clean Water Act

The Federal Clean Water Act addresses the development and implementation of water quality standards, the development of Total Maximum Daily Loads (TMDLs)⁷, filling of wetlands, point source permitting, the regulation of stormwater, and other provisions related to the protection of

⁷ A TMDL is a pollution budget and includes a calculation of the maximum amount of a pollutant that can occur in a waterbody and allocates the necessary reductions to one or more pollutant sources. A TMDL serves as a planning tool and potential starting point for restoration or protection activities with the ultimate goal of attaining or maintaining water quality standards.

U.S. waters. The State of California administers the Clean Water Act with oversight by the U.S. Environmental Protection Agency. 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.

Each state has a water quality section 401 certification program that reviews projects that will discharge dredged or fill materials into waters of the U.S., and issues certifications that the proposed action meets State water quality standards and other aquatic protection regulations, if appropriate. Each state also issues National Pollution Discharge Elimination System (NPDES) permits 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(s) do(es) not meet existing water quality standards at the ‘end of the pipe.’ TMDLs are prepared to develop actions to reduce concentrations of specific contaminants or natural constituents recognized within a waterbody that fail to meet water quality standards in repeated testing.⁸ These constituents may be pesticides, such as dieldrin which is regulated under the Federal Insecticide, Fungicide and Rodenticide Act; industrial chemicals, such as polychlorinated biphenyls (PCBs) regulated under the Toxic Substances Control Act;⁹ or physical measures of water such as temperature for which numeric water quality standards have been developed. Numerous toxicants have yet to be addressed in a TMDL.

The USACE regulates dredging and filling in the waters of the United States through the Federal Clean Water Act Section 404 Program. The USACE program is implemented through the issuance of a variety of individual, nationwide, and emergency permits. Permitted activities should not “cause or contribute to significant degradation of the waters of the United States.” A variety of factors, including inadequate staffing, training, and in some cases regulatory limitations on land uses (e.g., agricultural activities) and policy direction, resulted in ineffective protection of aquatic habitats important to migrating, spawning, or rearing coho salmon. The deficiencies of the current program are particularly acute during large-scale flooding events, such as those associated with El Niño conditions, which can put additional strain on the administration of the Clean Water Act Section 404 and 401 programs. The Clean Water Act is not effectively protecting fishery resources, particularly regarding non-point sources of pollution. USACE guidelines do not specify a methodology for assessing cumulative impacts or how much weight to assign them in decision-making. USACE continues to lack a comprehensive and consistent

⁸ Under section 303(d) of the Clean Water Act, states, territories and authorized tribes (included in the term State here) are required to submit lists of impaired waters. These are waters that are too polluted or otherwise degraded to meet water quality standards. A TMDL is only issued if a contaminant is on the 303(d) list for the specific water body.

⁹ The Toxic Substances Control Act (TSCA) of 1976 provides the U.S. Environmental Protection Agency with authority to require reporting, record-keeping and testing requirements, and restrictions relating to chemical substances and/or mixtures. Certain substances are generally excluded from TSCA, including, among others, food, drugs, cosmetics, and pesticides.

process to address the cumulative effects of the continued development of waterfront, riverine, coastal, and wetland properties.

The Federal government has a “no net wetland loss” policy under the Clean Water Act; however, in California, the land use regulation of coastal wetlands has been most directly administered under the State of California’s Federally certified Coastal Zone Management Program. However, the Federal government’s “no net wetland loss” regulations have been largely ineffective at preserving the amount and, more importantly, the ecological functions of wetland habitat in the U.S. (Dahl and Stedman 2013).

2. Federal Insecticide, Fungicide, and Rodenticide Act and Toxics

NMFS has performed a series of consultations on the effects of commonly applied chemical insecticides, herbicides, and fungicides, which are authorized for use per Environmental Protection Agency label criteria: All West Coast salmonids are identified as jeopardized by at least one of the chemicals identified in Table 5. Most are identified as being jeopardized by many of the chemicals. See Table 5 for a list of the substances that either jeopardize CCC coho salmon and/or adversely modify their critical habitat.

Table 5: List of commonly applied chemical insecticides, herbicides, and fungicides that either jeopardize CCC coho salmon and/or adversely modify their critical habitat.

Chemical Insecticides, Herbicides, Fungicides	Does it Jeopardize CCC Coho Salmon Species?	Does it Adversely Modify CCC coho Salmon Critical Habitat?	Citation
2,4-D	Yes	No	NMFS 2011
Chlopyrifos	Yes	Yes	NMFS 2017
Diazinon	Yes	Yes	NMFS 2017
Malathion	Yes	Yes	NMFS 2017
Diflubenzuron	Yes	Yes	NMFS 2015
Naled	Yes	Yes	NMFS 2010
Fenbutatin oxide	Yes	Yes	NMFS 2015
Propargite	Yes	Yes	NMFS 2010
Phosmet	Yes	Yes	NMFS 2010

Chemical Insecticides, Herbicides, Fungicides	Does it Jeopardize CCC Coho Salmon Species?	Does it Adversely Modify CCC coho Salmon Critical Habitat?	Citation
Methomyl	Yes	Yes	NMFS 2009
Pendimethalin	Yes	Yes	NMFS 2012b
Trifluralin	Yes	Yes	NMFS 2012b
Phorate	Yes	Yes	NMFS 2010
Oryzalin	Yes	Yes	NMFS 2012b
Ethoprop	Yes	Yes	NMFS 2010
Chlorohalonil	No	Yes	NMFS 2011

Storm water runoff is the primary way that non-point source pollution is conveyed to waterways, where it may affect salmonids and their habitat. Pollutants in storm water are reflective of their source areas and land use. For example, agricultural areas often contribute current and legacy agricultural use pesticides, nutrients from crops and livestock, and elevated levels of suspended sediments and turbidity from land management to water bodies; urbanized areas contribute general-use pesticides sold in stores and legacy pesticides from their former (often agricultural) land uses, nutrients from lawn and garden care, and elevated levels of suspended sediment and turbidity from land-disturbing activities. Storm water runoff can also carry geologic signatures from their source areas, for example, elevated selenium from the southern Central Valley in California, or elevated levels of nickel around the San Francisco Bay. Roads and streets contribute additional storm water contaminants (e.g., Polycyclic Aromatic Hydrocarbons, oils, greases, and various heavy metals associated with vehicles). They often provide a pathway to waterways via their ditches and other systems used to drain storm water from private lands.

Published work has identified storm water from roadways and streets as particularly problematic, causing a high percentage of rapid mortality of adult coho salmon in the wild (Scholz *et al.* 2011) and in laboratory settings (McIntyre *et al.* 2018). Subsequent laboratory studies showed this mortality also occurs in juvenile coho salmon (Chow *et al.* 2019) and unpublished examinations of juvenile steelhead and Chinook salmon by NMFS Northwest Fisheries Science Center and partners indicates mortality of up to 40 percent for steelhead and up to 10 percent for Chinook (J. McIntyre and N. Scholz, unpublished results, 2020) (Figure 6). Recent research has identified a degradation product of tires (6PPD) as the causal factor in this mortality at concentrations of less

than a part per billion (Peter *et al.* 2018; Tian *et al.* 2021). This contaminant is widely used by multiple tire manufacturers and the tire dust and shreds that are its source have been found to be ubiquitous where both rural and urban roadways drain into waterways (Feist *et al.* 2017; Sutton *et al.* 2019). Fortunately, other recent literature has shown that the mortality impacts can be prevented by infiltrating 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; Fardel *et al.* 2020). These types of green infrastructure or low-impact development practices are commonly included in new construction projects in some urban(izing) areas, but are often lacking in existing infrastructure. Also, many redevelopment or routine maintenance projects in roadway or urban development settings do not require mitigation of this pollution source. Pollution from these roads and streets remains a concern for coho salmon, as well as for Chinook salmon and steelhead.

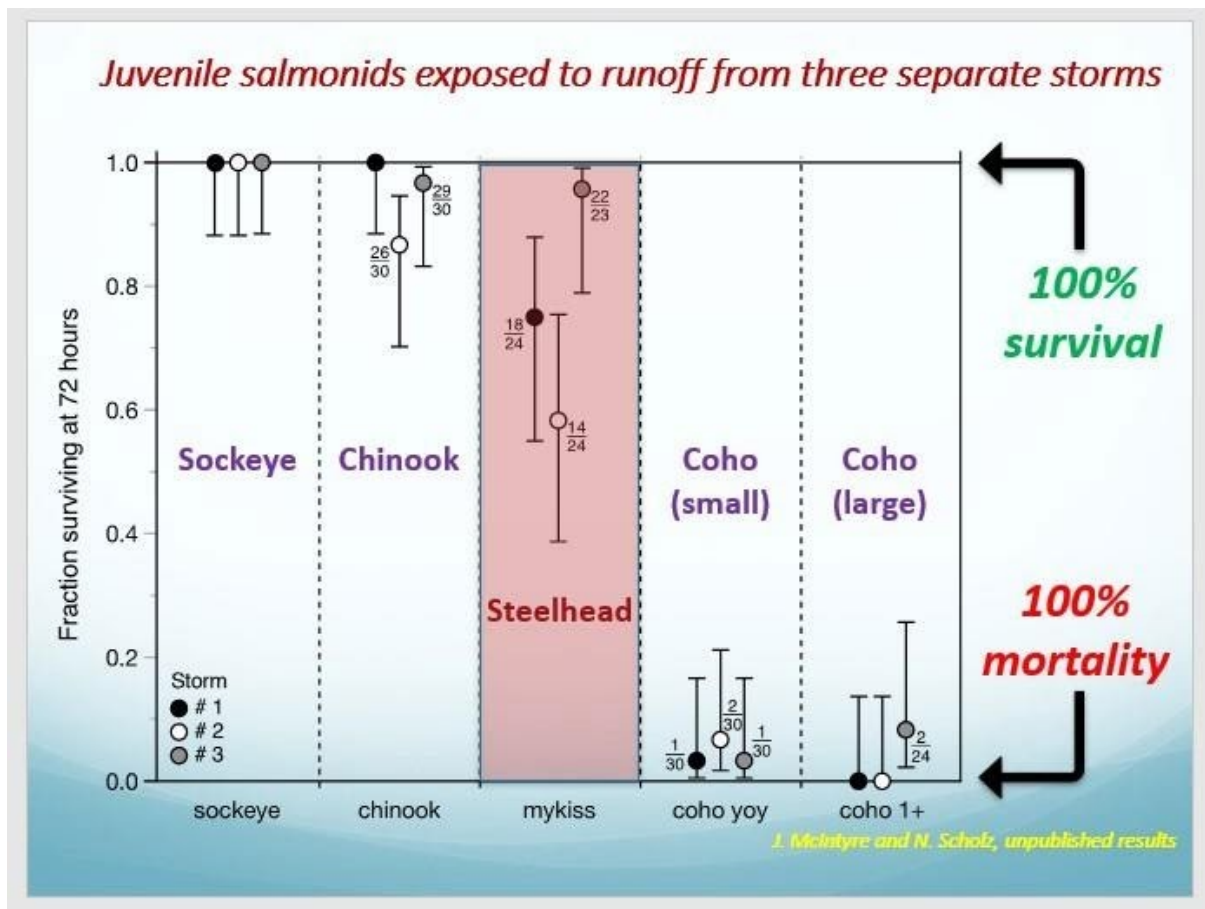


Figure 6: Mortality rates of juvenile salmonids exposed to runoff from three separate storms (J. McIntyre and N. Scholz, unpublished results).

3. National Flood Insurance Program and Federal Emergency Management Agency

The National Flood Insurance Program (NFIP) is a Federal benefit program that extends access to Federal monies or other benefits, such as flood disaster funds and subsidized flood insurance,

in exchange for communities adopting local land use and development criteria consistent with Federally established minimum standards. Under this program, development within floodplains continues to be a concern because it facilitates development in floodplains without mitigation for impacts on natural habitat values.

All West Coast salmon species, including 27 of the 28 species listed under the ESA, are negatively affected by an overall loss of floodplain habitat connectivity and complex channel habitat. The reduction and degradation of habitat has progressed over decades as flood control and wetland filling occurred to support agriculture, silviculture, or conversion of natural floodplains to urbanizing uses (e.g., residential and commercial development). Loss of habitat through conversion was identified among the factors for decline for most ESA-listed salmonids. “NMFS believes altering and hardening stream banks, removing riparian vegetation, constricting channels and 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 56253 Nov. 1, 1999).”

Development proceeding in compliance with NFIP minimum standards ultimately impacts floodplain connectivity, flood storage/inundation, hydrology, and to habitat-forming processes. Development consequences of levees, stream bank armoring, stream channel alteration projects, and floodplain fill, combine to prevent streams from functioning properly and result in degraded habitat. Most communities (counties, towns, cities) in 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 18 listed species of salmon and steelhead (Chinook salmon, steelhead, chum salmon, coho salmon, sockeye salmon) (NMFS 2008b, 2016b).

4. California’s Sustainable Groundwater Management Act

California’s Sustainable Groundwater Management Act (SGMA) was signed into law in January, 2015, during the height of the state’s historic drought. SGMA required medium and high priority groundwater basins to form local Groundwater Sustainability Agencies (GSAs) by 2017, and develop and begin implementing a Groundwater Sustainability Plan (GSP) by 2022 that achieves 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 by advising GSAs to consider and avoid streamflow depletion impacts to salmon and steelhead habitat. However, 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, every GSA has 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 that seen during the depths of our recent historic drought, as 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. To counter this approach, NMFS has commented consistently within every basin during the past 5 years of GSP development that proposed streamflow depletion thresholds consistent with historic drought conditions are likely to degrade salmonid migration, spawning, and rearing habitat and harm ESA-listed species. 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 (Sonoma Creek) developed a “preliminary” model during GSP development that estimated groundwater pumping caused 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. California’s Department of Water Resources (DWR) is currently evaluating the submitted GSPs for consistency with the Act/regulations, with final determinations expected in early 2024. Given the lack of response by DWR 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.

Harvest

1. California Freshwater Fishing Regulations

The 2021-2022 California State Sport Fishing Regulations allow catch and release or retention of wild and hatchery salmon and/or steelhead in nearly all anadromous streams in California. Partial protection measures have been established by the California Fish and Game Commission to provide fishing opportunities while reducing threats to Federally listed salmonids. These partial protection measures include low-flow closures in some watersheds within the ESU, and catch and release handling measures, reduced bag limits, limited fishing days, geographic limits, gear restrictions, and fishing prohibitions. Recreational angling is popular across all ESUs and DPSs, yet its impact remains uncertain despite restrictions through modifications of the angling regulations. CDFW, in cooperation with NMFS, implemented two measures that lowered the chance of incidental CCC coho salmon catch and harvest during recreational freshwater fishing. First, CDFW no longer fin clips conservation hatchery program-released coho salmon in the CCC coho salmon ESU. This change was initiated to reduce confusion for anglers who may legally keep adipose fin-clipped steelhead, which look similar to endangered coho salmon. Second, starting in 2015, CDFW amended California sport fishing regulations to include a low-flow fishing closure (as mentioned above) along the Sonoma and Mendocino county coasts. These regulations are intended to minimize over-exploitation of ESA-protected adult steelhead when streamflows recede to a level where capture rates climb sharply, and should have a similar effect in lowering the inadvertent bycatch of CCC coho salmon during the same low flow conditions. However, the bycatch of CCC coho salmon by fishers targeting steelhead is still a

concern during fall/winter baseflow conditions south of San Francisco, where no numeric low flow restrictions exist in watersheds supporting coho salmon.

Recreational, commercial, and tribal fisheries can be managed in a way that protects listed salmon and steelhead and allows them to recover. The 4(d) rule does not prohibit the take of listed fish in fisheries if a fishery management agency develops a Fisheries Management and Evaluation Plan (FMEP) and NMFS approves it. If an FMEP is implemented accordingly, the take of listed species in the fisheries will be covered under the ESA. The primary goal of an FMEP is to devise biologically based fishery management strategies that ensure the conservation and recovery of listed ESUs. Development and finalization of FMEPs for California are recommended and necessary to authorize these fisheries under the ESA. These plans ensure proper fisheries management of sensitive stocks by establishing a more formal program to minimize the take of Federally listed salmonids.

Finally, species identification and proper handling and release techniques, when incidental capture of listed salmonids occurs, are critical to reduce the likelihood of injury and/or death. Improving angling outreach remains a priority to educate anglers on handling techniques, the reporting of poaching and other illegal activities, and their contributions to species population monitoring. Other efforts to improve angler conservation awareness and handling and release skills can be found in NOAA Fisheries Scaling Back Your Impact: Best Practices for Inland Fishing.¹⁰

2. Pacific Fishery Management Council Harvest Management

Since 1977, salmon fisheries in the exclusive economic zone (EEZ) (3 to 200 nautical miles offshore) off Washington, Oregon, and California have been managed under salmon Fishery Management Plans (FMPs) of the Pacific Fishery Management Council (PFMC). While all species of salmon fall under the jurisdiction of the current plan (Pacific Fishery Management Council 2019), it currently contains fishery management objectives only for Chinook, coho, pink (odd-numbered years only), and any salmon species listed under the ESA that is measurably impacted by PFMC fisheries.

The constraints on the take of ESA-listed species authorized under incidental take statements and reasonable, prudent alternatives are collectively referred to as consultation standards. These constraints take a variety of forms, including FMP conservation objectives, limits on the time and area during which fisheries may be open, ceilings on fishery impact rates, and reductions from base period impact rates. NMFS may periodically revise consultation standards and annually issues a guidance letter reflecting the most current information. Ocean fishery management actions for CCC coho salmon beyond those already adopted are not necessary.

¹⁰ <https://media.fisheries.noaa.gov/2021-01/scaling-back-your-impact-catch-and-release.pdf> and <https://www.fisheries.noaa.gov/west-coast/recreational-fishing/recreational-fisheries-west-coast>

Listing Factor D: Conclusion

The NMFS 2012 CCC Coho Salmon ESU Recovery Plan (NMFS 2012a) and the previous 5-year review identified inadequate regulatory mechanisms as contributing substantially to the decline of the CCC coho salmon ESU. Based on the improvements noted above, we conclude that the risk to the species' persistence because of the adequacy of existing regulatory mechanisms has decreased slightly. However, despite improvement in the adequacy of regulatory mechanisms within the ESU, a number of concerns remain regarding existing regulatory mechanisms:

- Lack of implementation and enforcement of existing regulations, including the Clean Water Act's "no net wetland loss" policy. Improving wetland protection within the CCC coho salmon ESU will likely be critical in future recovery efforts.
- USACE continues to lack a comprehensive and consistent process to address the cumulative effects of the continued development of waterfront, riverine, coastal, and wetland properties.
- NFIP implementation in California may also be incrementally and permanently diminishing floodplain habitat form and function to the detriment of CCC coho salmon.
- Lack of regulations or mitigation regarding the infiltration of road runoff through soil media containing organic matter to remove road-runoff contaminants for existing infrastructure, and many redevelopment or routine maintenance projects in roadway or urban development settings.

Recommended Future Actions

Habitat

- Improve regulations to require minimization or mitigation of road-runoff containments in existing infrastructure, re-development, and routine maintenance projects.

The following actions would lead to regulation improvements

- SGMA: Continue NMFS engagement as a stakeholder in GSP implementation.¹¹
- SGMA: NMFS should ensure they have the staff expertise necessary to evaluate groundwater/surface water hydrologic models to ensure they are properly developed, and use those models to quantify streamflow depletion impacts resulting from groundwater management activities.
- SGMA: NMFS should maintain coordination with CDFW, the State Water Resources Control Board, and environmental organizations whose goals and objectives for minimizing streamflow depletion impact ESA-listed salmon and steelhead.
- SGMA: Require GSAs to use streamflow depletion sustainable management criteria that

¹¹ This action is also part of the SIS CCC coho salmon Action Plan.

avoid adversely impacting salmon/steelhead migration, spawning, and rearing habitat, and do not harm ESA-listed species. Criteria consistent with historic drought conditions (i.e., summer/fall 2014), are likely to degrade salmon and steelhead habitat and harm these species.

- Increase overall industry oversight through MAUCRSA to improve instream habitat quality for CCC coho salmon and eradicate unregulated cannabis operations.
- Increase the use of wind turbines and improvements in pond-refilling management for frost protection.

Harvest

- Develop FMEPs that: (1) incorporate delisting criteria; (2) determine impacts of fisheries management in terms of VSP parameters; (3) do not limit the attainment of population-specific criteria; (4) annually estimate the commercial and recreational fisheries bycatch and mortality rate; (5) are specifically designed to monitor and track catch and mortality of wild and hatchery salmon and steelhead stemming from recreational fishing in freshwater and the marine habitats; and (6) provide for adaptive management options as needed to ensure actual fisheries impacts do not exceed those consistent with recovery goals.
- Implement South Central Coast Special Low Flow Closures restriction for recreational fisheries in rivers south of San Francisco Bay that would additionally reduce bycatch and unintentional take of CCC coho salmon.

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 WGII 2022). Long-term trends in warming have continued at global, national, and regional scales. Global surface temperatures in the last decade (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 (IPCC WGI 2021). The vast majority of this warming has been attributed to anthropogenic releases of greenhouse gases (IPCC WGI, 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 WGII 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 WGI, 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 (both flow and temperature), and improving growth opportunity in both freshwater and marine environments are strongly advocated in the recent literature (Siegel and Crozier 2020).

Salmon and Steelhead Habitat Changes

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 collected hundreds of papers documenting the major themes relevant for salmon. Here we describe habitat changes relevant to Pacific salmon and steelhead.

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, which will lead 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 unprecedented wildfires throughout the CCC coho salmon ESU (Figure 4, Figure 5). Forest fires affect salmon streams by altering sediment load, channel structure, and stream temperature through the removal of the tree canopy.

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. Intense fire can produce extensive areas of water-repellant soils, which combine with widespread vegetation loss to reduce water infiltration and create an elevated runoff response to precipitation events (USFS 2018). 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.

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 existing trend toward more extensive and severe forest fires and the continued expansion of fires into higher elevation and wetter forests (Alizedeh 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.

Freshwater Environments

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 ground water 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.* 2020; Myers *et al.* 2018).

Streams with intact riparian corridors and that lie in mountainous terrain are likely to be more resilient to changes in air temperature. These areas may provide refuge from climate change for 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 highest. Flat lowland areas, which commonly contain migration corridors, generally scored lowest, and thus were prioritized for conservation and restoration. Still, 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.

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. Since then, most independent coho salmon populations have rebounded somewhat after reaching their low point during the height of the drought in 2013-2014 (SWFSC 2022).

Still, the drought has had lasting impacts past 2015. In water years 2017 and 2018, rainfall was plentiful and, while summer streamflow conditions increased, 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 in the recovery of CCC coho salmon.

In 2020-2022, California experienced a historically severe drought. All habitat in the CCC coho salmon ESU is categorized as in an exceptional drought (the most severe rating possible) by the National Integrated Drought Information System and NOAA (Figure 7).¹² For 2021-2022, California is on target to be in another severe drought. In spring 2021, many CCC coho streams that are usually flowing with water were already dry or almost dry. Many juvenile coho died, and others continue to die due to stranding during drought conditions. Areas that had recent wildfires

¹² <https://www.drought.gov/states/california>

showed varied effects to the streams. In some areas, the low streamflow conditions paired with a loss of riparian vegetation from wildfires resulted in increased drying of the streams and/or increased water temperatures. In other areas, such as Scott Creek, streamflow was higher than expected during a severe drought, due to lower evapotranspiration. The impacts on the affected coho salmon populations will not be fully apparent until monitoring occurs when they return as adults.

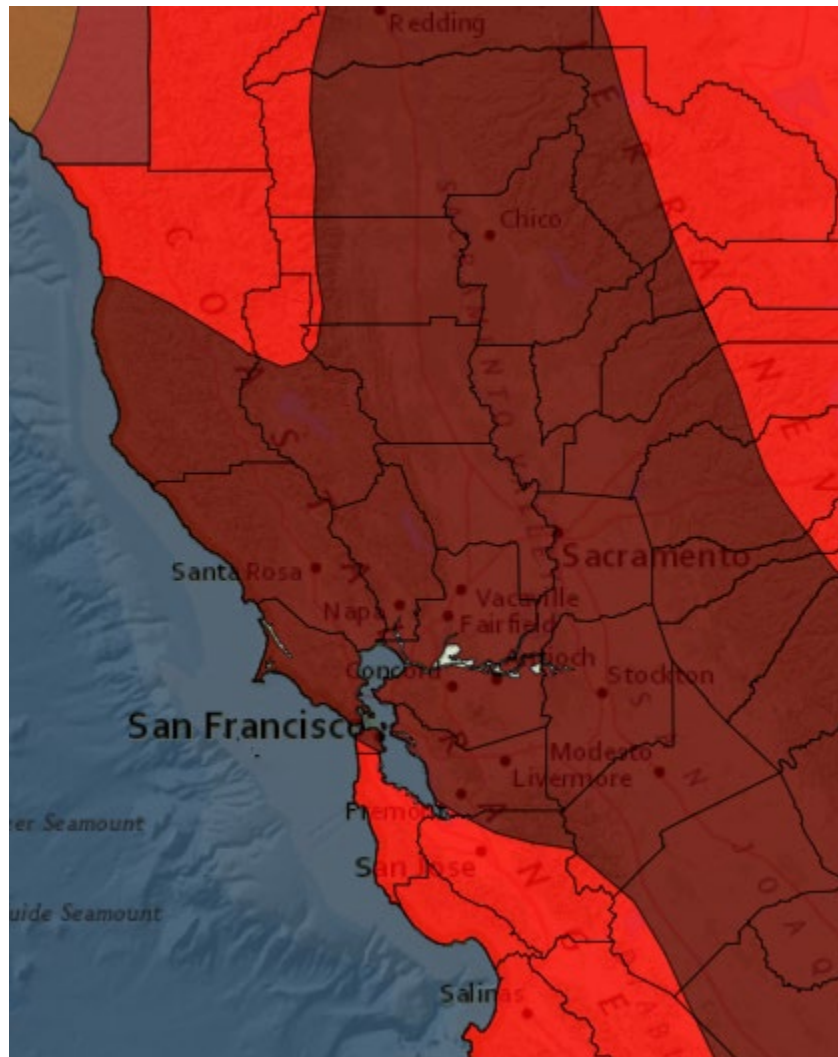


Figure 7: Drought Monitoring Conditions for California. The darker the color the more severe the drought conditions. The dark red areas are in an exceptional drought. The bright red areas are in an extreme drought. Credit: National Integrated Drought Information System and NOAA (2021).

Marine and Estuarine Environments

Along with warming stream temperatures and concerns about sufficient groundwater to recharge streams, a recent study projects a nearly complete loss of existing tidal wetlands along the U.S. West Coast due to sea-level rise (Thorne *et al.* 2018). California and Oregon showed the

greatest threat to tidal wetlands (100 percent), while 68 percent of Washington tidal wetlands are expected to be submerged. Coastal development and steep topography prevent horizontal migration of most wetlands, causing the net contraction of this crucial 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. In particular, there will be dramatic changes in both predators and prey of Pacific salmon, affecting both salmon life history traits and relative abundance. Siegel and Crozier (2019) observe that changes in marine temperature are likely to have a number of physiological consequences on fishes themselves. For example, in a study of small planktivorous fish, Gliwicz *et al.* (2018) found that higher ambient temperatures increased the distance at which fish reacted to prey. Numerous fish species (including many tuna and sharks) demonstrate regional endothermy, which in many cases augments eyesight by warming the retinas. However, Gliwicz *et al.* (2018) suggest that ambient temperatures can similarly affect fish that do not demonstrate this trait. Climate change is likely to reduce the availability of biologically essential omega-3 fatty acids produced by phytoplankton in marine ecosystems. Loss of these lipids may induce cascading trophic effects, with distinct impacts on different species depending on compensatory mechanisms (Gourtay *et al.* 2018). Reproduction rates of many marine fish species are also likely to be altered with temperature (Veilleux *et al.* 2018). The ecological consequences of these effects and their interactions add complexity to predictions of climate change impacts in marine ecosystems.

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, groundfish) will likely affect salmon indirectly through their interactions as predators and prey. Similarly, increasing frequency and duration of harmful algal blooms may affect salmon directly, depending on the toxin (e.g., saxitoxin vs. domoic acid), but will also affect their predators (seabirds and mammals). The full effects of these ecosystem dynamics are not known but will be complex.

Thiamine Deficiency

Ocean conditions remain a critical component to salmon survival and reproductive success since they spend the majority of their lives in the ocean. Thiamine deficiency can occur in adult Chinook salmon and influence their reproductive success and the health of their progeny (Harder *et al.* 2018). In fall and winter of 2019, Chinook salmon populations in the Central Valley of California (fall-, spring-, and late fall-run) were diagnosed with thiamine deficiency complex (TDC) (SWFSC 2022). This diagnosis was based on high rates of early life stage mortality observed in hatcheries and rapid recovery of juveniles exhibiting aberrant swimming behaviors

following thiamine treatment by the USFWS California-Nevada Fish Health Center (Foott 2020). The primary hypothesis for TDC in Central Valley salmon is that a reorganization of food webs in the central California Current resulted in the dominance of northern anchovy in salmon diets (SWFSC, 2022). Northern anchovy possess thiaminase, an enzyme that breaks down vitamin B1, and diets high in northern anchovy can cause thiamine deficiency in their consumers, which can appear as high mortality or serious sublethal effects in subsequent progeny (SWFSC 2022). It is unclear the extent to which female Sacramento River winter-run Chinook salmon have low concentrations of thiamine in their eggs that would result in acute mortality and/or latent effects in their progeny in the wild (SWFSC 2022). Current research aims to gain a better understanding of this emerging stressor and potential treatment options to mitigate these nutritional deficiencies. Coho salmon that returned to northern California hatcheries in the winter of 2021-2022 may have also experienced thiamine deficiency. Further research is needed to discover the impact of TDC in CCC coho salmon.

Impacts on Salmon

Within the historical range of climate variability, less suitable conditions for salmonids (e.g., warmer temperatures, lower streamflows) 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 incubation and emergence timing for eggs, and egg survival in locations where the greatest warming occurs, although several factors impact intergravel temperature and oxygen (e.g., groundwater influence) as well as sensitivity of eggs to thermal stress (Crozier *et al.* 2020). Changes in temperature and flow regimes may alter the amount of habitat and food available for juvenile rearing. This, in turn, could lead to a restriction in 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, phenological diversity 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 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 is highly 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. 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.

Species-Specific Climate Effects

CCC coho salmon comprise the southern limit of distribution for coho salmon, and thus already face numerous limiting factors from climate change impacts. Nearly all life stages are sensitive to climate change impacts. The estuary life stage is affected by sea level rise, increasing temperature, and flooding due to the importance of estuary breaching dynamics for this life stage (Figure 8). Juveniles are also highly sensitive to climate change due to stream and sea surface temperature. 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. Thus, this ESU ranks very highly sensitive to cumulative life cycle impacts caused by climate change. In addition, historic habitat alterations are expected to reduce the resilience of coho salmon to climate change over time, so this ESU also exhibits high sensitivity to other stressors such as water quality and reduced habitat quality and quantity.

Climate change affects the ESU's adaptive capacity. Since this ESU is at the southern range limit for coho salmon, it may be limited in its ability to modify its life history. The CCC coho salmon ESU is, therefore, ranked low for adaptive capacity and is vulnerable to increased risk of extinction as existing threats are exacerbated by climate change effects. Ongoing, long-term efforts to improve habitat conditions and maintain genetic diversity will be needed to aid resilience over time.

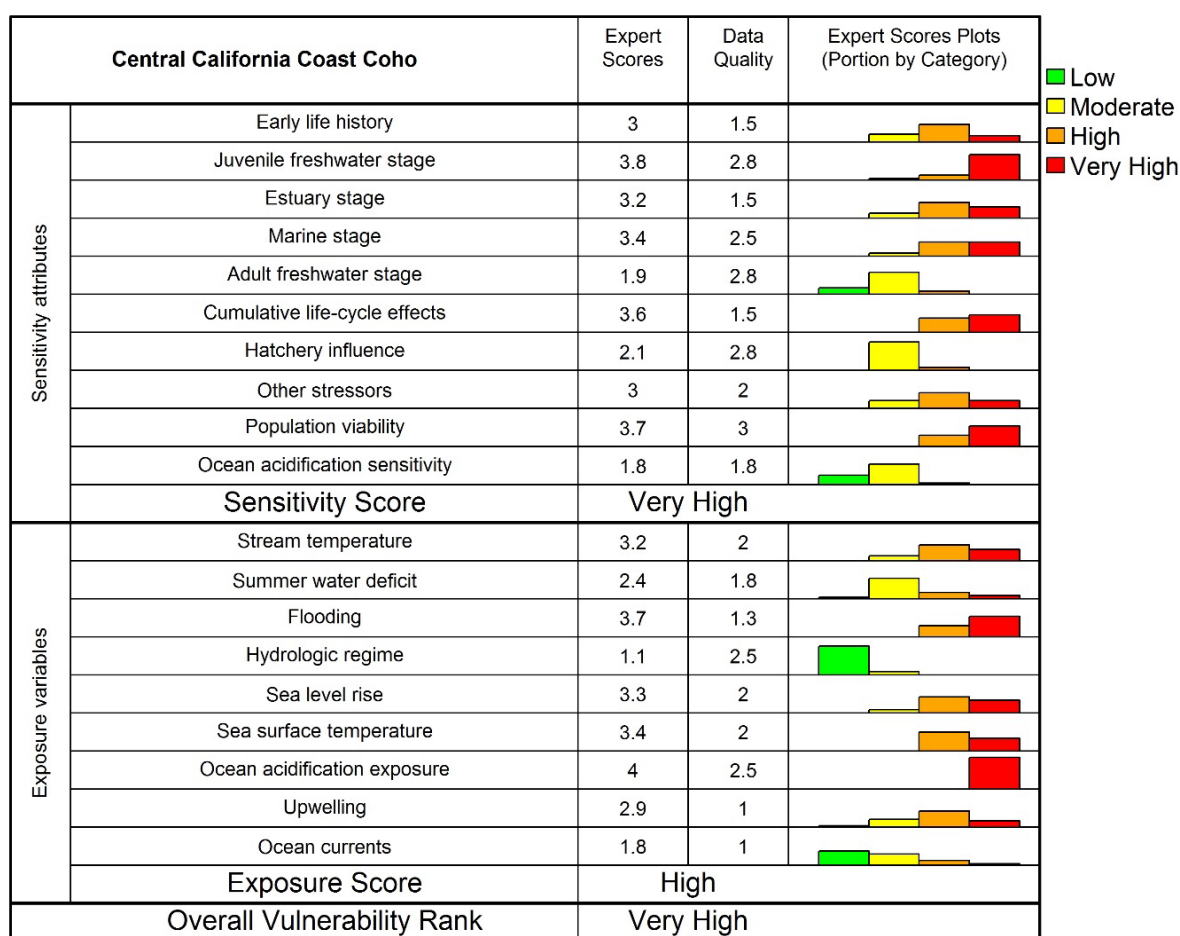


Figure 8: CCC coho salmon Climate Effects Exposure and Vulnerability (Crozier et al. 2019).

Invasive Species

Aquatic invasive species (AIS) are organisms (plants, animals, or pathogens) that impact the diversity or abundance of native species, the ecological stability of infested waters, and/or the commercial, agricultural, aquaculture, or recreational activities dependent on such waters. The myriad of pathways in which AIS can enter and are transported to coastal marine, estuarine, and riverine areas pose a significant management challenge. In coastal marine and freshwater environments, AIS have had major negative effects on the receiving communities where they often outcompete native species, reduce species diversity, change community structure, reduce productivity and disrupt food web function by altering energy flow among trophic levels (Cohen and Carlton 1995; Cohen and Carlton 1998; Ruiz *et al.* 2000; Stachowicz and Byrnes 2006). There are multiple mechanisms of impact that directly affect salmonids, such as predation and infection (disease and parasitism), and indirectly such as competition, hybridization, and habitat alterations (Mack *et al.* 2000; Simberloff *et al.* 2005).

We need to understand the role of AIS in the decline of threatened and endangered fish across

multiple scales (i.e., individual populations, communities, and ecosystem process) in order to effectively manage and recover these species and systems in the face of global climate change and the full suite of stressors. In California, approximately half of the freshwater species, which include aquatic invasive plants, animals, and pathogens, are introduced; and as many as 40 introduced species may be present in individual watersheds. Despite the abundance of AIS (plants and invertebrate taxa), there is limited information to assess their impacts on aquatic ecosystems. Thus, the associated implications for habitats occupied by threatened and endangered salmonids are difficult to determine (Sanderson *et al.* 2009). More studies are needed to specifically investigate the impacts of AIS on ESA-listed salmonid populations, their designated critical habitat, and species recovery.

NMFS recognizes the threat that AIS pose, which may reduce the number of juvenile salmonids before they transition to adulthood. The cumulative AIS impacts are potentially quite large and should be considered in conjunction with the more commonly addressed impacts on salmonids. AIS control and management is necessary in areas where the AIS are already established to prevent their further spread and lessen their impacts on native ecosystems.

New Zealand Mudsnail (*Potamopyrgus antipodarum*)

The New Zealand mudsnail is rapidly invading California, in large part because of people not cleaning their field/fishing gear or boats when moving from one to a different aquatic location. Once established, the snail will quickly overpopulate an area due to an absence of natural predators. As their population grows, the snails can disrupt the aquatic food chain by displacing other native benthic species, which limits food availability for juvenile salmon and steelhead. One research study found that when rainbow trout were fed New Zealand Mudsnails exclusively, 54 percent of the mudsnails passed through the digestive tract still alive (Vinson and Baker 2008). In addition, the trout lost 0.48 percent of their initial body weight every day, which was nearly equal to the impact of starvation (Vinson and Baker 2008). Education and outreach campaigns and signage have brought awareness to the practices needed to clean and remove snails from field gear and boats before going to a new location.

Japanese Knotweed (*Fallopia japonica*)

Since the 2016 5-year review, Japanese knotweed has been observed in the greater San Francisco Bay Area, especially in the Lagunitas Creek watershed. Japanese knotweed is known as one of the world's most invasive species.¹³ It can grow almost anywhere, and once established it is challenging to eradicate because it can re-sprout from a root fragment the size of a fingernail (0.7 grams). It prefers wetter areas, such as floodplains, wetlands, and riparian zones. Using herbicides has been proven to be the only way to successfully kill the weed. Japanese knotweed poses a significant threat to riparian and watershed health via establishing a monoculture with rapid growth, dense stands, and broad leaves that block the sun from native plants and tree

¹³ <https://www.nps.gov/articles/japanese-knotweed-eradication-efforts-continue-along-lagunitas-creek.htm>

seedlings. Coho salmon are threatened by Japanese knotweed's ability to alter overhanging vegetation along the creek which cools streams and provides coho salmon critical food resources as insects fall from the overhanging leaves. In 2018, County, State, Federal and non-governmental organizations joined together to form the Marin Knotweed Action Team. The action team has currently treated all known in-stream populations of Japanese knotweed within the Lagunitas watershed.¹⁴ Current eradication efforts appear to have been successful and Japanese knotweed is currently a low threat to the CCC coho salmon ESU.

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, and how the hatchery fish within the ESU 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.

Conservation-based captive broodstock programs can provide the needed boost in numbers, distribution, and genetic fitness as unoccupied habitats are restored and threats are abated. Captive Broodstock Programs utilize traditional hatchery programs to: (1) temporarily rear and enhance the survival of captured wild fish for release; or (2) improve the populations' genetic diversity, abundance, and fitness via spawning guided by NOAA geneticists. The USACE's DCFH Captive Broodstock Program, the Scott Creek/Kingfisher Flat Conservation Program, and the Scott Creek Captive Broodstock program service various diversity strata and populations north and south of San Francisco Bay. The programs receive technical and financial assistance from NMFS, CDFW, and local partners. The SWFSC provides genetic analysis and guidance to implement various life-stage release strategies for both programs, and each program is adaptively managed by a multi-agency, multi-stakeholder Technical Advisory Committees and a monitoring network. Since coho salmon captive broodstock programs were instituted in 2001/2002, increases in the number of ocean-returning adults and naturally spawned offspring have been observed in the Russian River.

Don Clausen Fish Hatchery Captive Broodstock Program

The DCFH Captive Broodstock Program has successfully increased adult returns to the Russian River from only ten adults in 2001 to nearly 800 adults in 2017-2018, with natural reproduction occurring in most tributaries (California Sea Grant 2020) (Figure 9). With support and guidance from NOAA's SWFSC, regional expansion of the program to other CCC coho salmon populations (i.e., Scott and Redwood creeks, and Garcia and Navarro rivers) has facilitated recovery stocking efforts in various watersheds across the species' range from Mendocino to

¹⁴ <https://ucanr.edu/sites/MarinKnotweedActionTeam/update/>

Santa Cruz counties. Conservation-based captive broodstock programs can provide the needed boost in numbers, distribution, and genetic fitness as unoccupied habitats are restored and threats are abated. The intent of the program is to prevent extinction and improve genetic diversity by supplementing coho salmon population numbers or reintroducing extirpated populations or year classes. Program success includes improving genetic diversity in the Russian River, re-introducing coho to formerly extirpated Walker Creek, and supplementing population numbers in all watersheds except the Gualala River (which remains extirpated). Other achievements include evaluating and validating the use of Remote Site Incubators for on-stream incubation and monitoring remotely via Parental Based Tagging. Ongoing effects of domestication and fitness need to be weighed against the population status and the potential for habitat capacity to sustain a viable population. Overall, this program reduces the extinction risk of coho salmon in the CCC coho salmon ESU by improving abundance, spatial structure, and diversity in the three diversity strata from the Russian River north to the Navarro River.

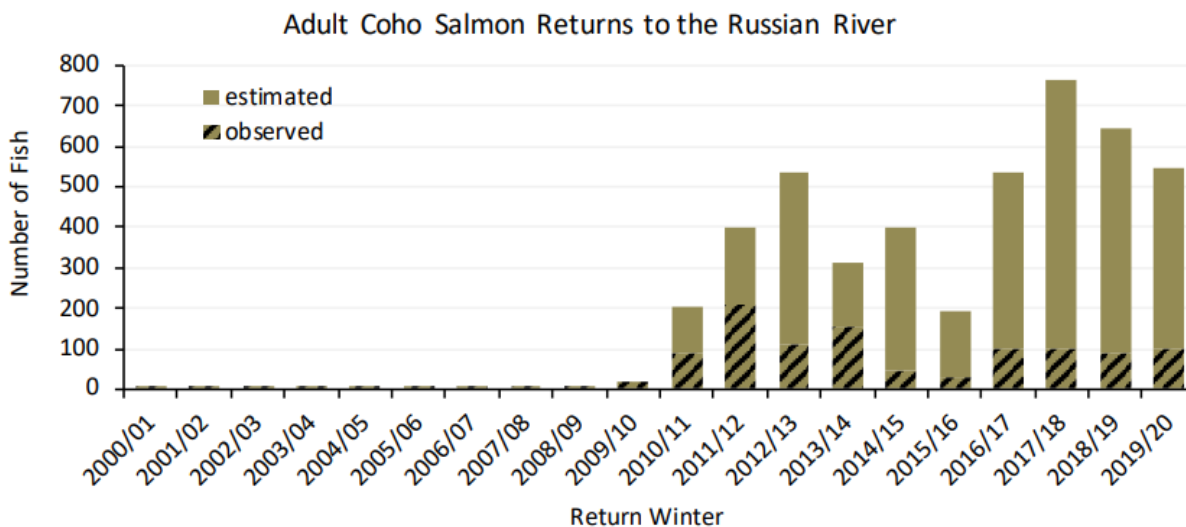


Figure 9: Estimated annual adult hatchery coho salmon returns to the Russian River, winter return seasons 2000/01-2019/20. Methods for estimating the total number varied between years (California Sea Grant, 2020).

NMFS issued a Section 10(a)(1)(A) enhancement permit in 2020 for the DCFH Broodstock Program, which formally authorizes regional expansion to support the reintroduction of coho salmon throughout the northern portion of the CCC coho salmon ESU. The HGMP is formally called the *Russian River Coho Captive Broodstock Program Hatchery Genetic Management Plan* (CDFW and USACE, 2017). Since 2008, surplus broodstock have been utilized in reintroduction efforts outside of the Russian River, with several hundred surplus adult captive-reared broodstock released annually to each of Walker and Salmon creeks in Marin and Sonoma counties, and small numbers of coho salmon returning to both watersheds annually. In 2018, NMFS and CDFW collaborated with local landowners and non-governmental organizations to captively rear southern Mendocino County coho salmon, and in December 2020

the first cohort of several hundred captive-reared adult coho salmon were released to the Garcia and Navarro rivers. Subsequent monitoring by CDFW documented program fish spawning with other captive-reared, as well as native origin adults in both watersheds.

The Section 10(a)(1)(A) and accompanying HGMP issued to the USACE guide the program operations until 2029, at which time an assessment must be conducted to determine if hatchery supplementation should be continued or terminated (CDFW and USACE, 2017).

Scott Creek/Kingfisher Flat Conservation Program and the Scott Creek Captive Broodstock Program

The combined Scott Creek/Kingfisher Flat Conservation Program and Scott Creek Captive Broodstock Program began in 2002 in response to extirpation of year classes and entire populations within the Santa Cruz Mountains. Currently, the programs operate at three facilities. The primary facility, Kingfisher Flat Conservation Hatchery, is located in the Scott Creek watershed, Santa Cruz County, while captive broodstock are held at the SWFSC's laboratory in Santa Cruz, California and the DCFH in Sonoma County, California.

Since 2002, several changes have been made to increase program performance, including: (1) adjustments to the husbandry and spawning protocols for captive broodstock; (2) outbreeding with Russian River and Olema Creek coho salmon to counter increasing rates of relatedness; and (3) implementation of different juvenile coho salmon release strategies. While these adjustments have improved operations and in-hatchery survival, natural and hatchery-origin returns of adult coho salmon to Scott Creek have remained low since the last 5-year review (2016). This 5-year period has encompassed a series of catastrophic habitat disturbances, including the end of the 2012-16 drought, the return of warm ocean temperatures in the northeast Pacific Ocean in 2019, and most recently, the CZU Lightning Complex Fire in August 2020. Despite these challenging conditions, other successes have been noted, including relatively high freshwater survival of juvenile releases, observed dispersal of program fish into neighboring watersheds, occurrence of natural-origin juvenile coho salmon in other watersheds of the Santa Cruz Mountains, and record spawning, egg collection, and fry production in 2020. As noted in the previous 5-year review, the combined program remains essential for the preservation and recovery coho salmon genetics and population recovery south of San Francisco. In 2020, the SWFSC submitted a final HGMP for the combined program. Because of the scarcity of natural-origin fish in regional streams, the program currently relies on genetically managed captive broodstock. The HGMP outlines a phased approach where the proportion of natural-origin fish incorporated into the annual spawning matrix increases over time as populations begin to recover.

Listing Factor E: Conclusion

Climate Change

CCC coho salmon has a high risk of overall climate vulnerability based on its high risk for biological sensitivity, high risk for climate exposure, and moderate capacity to adapt. Life-stage sensitivity attributes for CCC coho salmon scored high for both juvenile and adult freshwater

stages. CCC coho salmon ESU are at the southern distributional limit of the species and thus already face numerous limiting factors stemming from climate effects. The likely four most important threats to the species from climate change are estuary breaching dynamics, hydrologic changes, fog dynamics, and shifts in smolt and adult migration timing (Crozier *et al.* 2019).

Invasive Species

NMFS recognizes the threat that AIS poses, which may reduce the number of juvenile salmonids before they transition to adulthood. The cumulative AIS impacts are potentially quite large and should be considered in conjunction with the more commonly addressed impacts on salmonids. Control and management are necessary in areas where AIS are already established to prevent their further spread and lessen their impacts on native ecosystems. In addition, more studies are needed to specifically investigate the impacts of AIS on ESA-listed salmonid populations, their designated critical habitat, and species recovery.

Hatchery Effects

In general, hatchery programs can provide short-term demographic benefits to salmon and steelhead, such as increases in abundance during periods of low natural abundance. They also can help preserve genetic resources until limiting factors can be addressed. However, the long-term use of artificial propagation may pose risks to natural productivity and diversity. The magnitude and type of risk depend 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., domestication selection, outbreeding depression), broodstock collection effects (e.g., to population diversity), and facility effects (e.g., water withdrawals, effluent discharge) (NMFS 2018).

The coho hatchery programs in this ESU are not traditional production style or scale hatchery programs. They are conservation broodstock programs guided by genetic management and used as a stop-gap to prevent extinction via increasing abundance, occupancy and distribution, and improving genetic diversity while reducing domestication. Since 2016, an HGMP has been finalized for the DCFH Captive Broodstock Program (86 FR 37286), and in 2020 the SWFSC drafted an HGMP drafted for the combined Scott Creek/Kingfisher Flat Conservation Program and Scott Creek Captive Broodstock Program (SWFSC *In prep.*). These CCC coho captive broodstock programs are a low threat to the CCC coho salmon ESU.

Recommended Future Actions

- Prioritize tributary habitat projects that improve habitat resiliency to climate change. Actions to restore riparian vegetation, streamflow, and floodplain connectivity and re-aggrade incised stream channels can ameliorate temperature increases, base flow decreases, and peak flow increases, thereby improving population resilience to some effects of climate change.

- Continue to implement the HGMP for the DCFH Broodstock Program and monitor progress towards performance objectives.
- Enhance the utility of Remote Site Incubators in expanding conservation hatchery outplanting as one possible tool for reintroduction of coho salmon to watersheds where they have been extirpated. Implementing this tool could prove successful where hatchery space is limited, or rearing and transportation of later life stage releases to remote locations is infeasible.
- Together with CDFW, develop a re-introduction strategy for the Gualala River population utilizing broodstock from adjacent populations in the Navarro Point-Gualala Point Diversity Strata.
- Complete the HGMP and issue a permit for the combined Scott Creek/Kingfisher Flat Conservation Program and Scott Creek Captive Broodstock Program.
- Implement outreach and education efforts to prevent the spread of AIS species, such as New Zealand Mudsail, and increase the eradication of Japanese Knotweed.

Other Recommendations

Research, Monitoring and Evaluation

The CDFW/NMFS Coastal Monitoring Program (CMP), described in Adams *et al.* (2011) (e.g., CDFW Fish Bulletin 180), draws on the viable salmonid populations framework of McElhany *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 that can include adult estimates that include redd count surveys of stream reaches using a statistically valid sampling design expanded to adult estimates based on spawner:red ratio, redd surveys, and estimates that are not expanded to adult estimates (e.g., no spawner:red ratio estimates available), and weir counts. The viability assessment conducted by SWFSC informs this 5-year review and assesses progress to meeting viability targets at the population and ESU/DPS level in terms of extinction risk.

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 a number of salmon and steelhead populations. These data are approaching or exceeding the four generations needed to evaluate recovery plan downlisting and delisting criteria (e.g., Mendocino coast, Scott Creek LCM station in Santa Cruz Co., Lagunitas/Olema Creek in Marin Co.). These data have also improved our ability to assess the status of smaller populations, which were poorly understood before the implementation of CMP (e.g., Caspar Creek, Little River, Redwood Creek [Marin Co.]).

Unfortunately, lapses in funding have resulted in some programs being interrupted (e.g., Navarro

and Garcia rivers in Mendocino County, and recently portions of Lagunitas Creek in Marin County) or discontinued with no resumption in sight (e.g., Santa Cruz Mountain Diversity Stratum; some populations on the Mendocino Coast with long time series [Caspar Creek, Little River]). Furthermore, spatial coverage has been lacking in the southern monitoring area and remains highly patchy in other geographies. Some sampling efforts generally target coho salmon and so do not encompass the entire spatial or temporal extent of spawning for other listed species, and several populations identified as essential to recovery are not currently monitored.

Intermittent implementation and methodological issues continue to hinder the assessment of a number of populations. CMP nonetheless provides a substantially better basis for informing NMFS' recovery and viability criteria compared with previous assessments and status reviews and will increase greatly in value as these time series become longer. Additionally, funding to monitor and evaluate the sustainability and fitness of populations or runs enhanced by the conservation hatchery program stockings is needed to inform progress towards performance targets for these programs. In short, long-term dedicated resources to support California's monitoring program and critical science questions are needed.

2.4 Synthesis

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

We review the status of the species and evaluate whether any one of the five factors, as identified in ESA section 4(a)(1) suggests that 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 man-made factors affecting a species continued existence. We then make a determination based solely on the best available scientific and commercial information, taking into account efforts by states and foreign governments to protect the species.

Updated Biological Risk Summary

The available data for populations within the CCC coho salmon ESU indicate that all independent and dependent populations remain far below recovery targets for abundance and, in some cases, are below high-risk thresholds established by the TRTs. The current status of the populations is progressively worse moving north to south in the ESU. Recent data from the Lost-Coast-Navarro Point and Navarro Point-Gualala Point diversity strata suggest slight improvement in the status of independent populations since the last status review (Spence 2016),

with most populations having rebounded somewhat since low levels reached during California's multi-year drought between 2011 and 2015. However, for dependent populations in these strata, while the abundance of some populations has improved slightly since the previous status review, long-term trends have generally continued downward and remain a concern.

Assessment of independent populations in the Coastal and Santa Cruz Mountain diversity strata remains difficult due to the scarcity of reliable data, though the establishment of a rigorous monitoring program in the Russian River basin is a positive development. Though coho salmon numbers remain low in the Russian River population, fish are reproducing naturally in several once extirpated watersheds that have received plants of surplus fish from the ongoing captive rearing program at DCFH. The extremely low numbers of coho salmon in the Santa Cruz Mountain Diversity Stratum, the high dependence of population persistence on the ongoing captive rearing program, and loss of genetic diversity in the hatchery broodstock, which has necessitated infusion of out-of-stratum broodstock from other watersheds into the program, remain major concerns.

In summary, while our review indicates that conditions for some CCC coho salmon populations have improved slightly since the last status review, the long-term trends while very low have generally remained stable. The CCC coho salmon ESU continues to be in danger of extinction (SWFSC 2022).

ESA Listing Factor Analysis

- **Listing Factor A (habitat):** We conclude that since the last 5-year review, the risk to CCC coho salmon persistence because of habitat conditions has not improved and is high. 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 CCC coho salmon persistence because of overutilization and scientific study remains low. No direct take occurred in any commercial or recreational fishery, and the amount of take for scientific study is limited.
- **Listing Factor C (disease and predation):** We conclude that since the last 5-year review, the risk to CCC coho salmon persistence because of disease or predation remains low. But given the lack of information currently available in California, further study of pinniped predation interactions is warranted to determine whether these impacts are limiting the recovery of ESA-listed salmon and steelhead in the state.
- **Listing Factor D (inadequacy of existing regulatory mechanisms):** New information available since the last 5-year review indicates that the adequacy of a number of regulatory mechanisms has improved slightly, with more mechanisms showing the

potential for some improvement, and less mechanisms making the protection and recovery of CCC coho salmon challenging.

- **Listing Factor E (other manmade or natural factors):** We conclude that since the last 5-year review, the overall risk to CCC coho salmon persistence because of other manmade and natural factors remains high because of the major threats of climate change, droughts, wildfires and ocean conditions. CCC coho salmon are especially vulnerable to the projected impacts of changing climate, because of their long freshwater residence time and relatively strict life-history patterns. Since 2016, an HGMP has been finalized for the DCFH Captive Broodstock Program (86 FR 37286), and in 2020 the SWFSC drafted an HGMP for the combined Scott Creek/Kingfisher Flat Conservation Program and Scott Creek Captive Broodstock Program. These CCC coho captive broodstock programs are a low threat to the CCC coho salmon ESU.

Conclusion

Although conservation efforts for coho salmon have reduced some threats for this ESU, the threats described in section 2.3.2 (five listing factors) above have, with few exceptions, remained unchanged since the previous 2016 5-year review (NMFS 2016). 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 CCC 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, greatly impacting CCC 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 streamflows during dry periods. Recent local and state regulatory efforts may help mitigate the impact of climate change on streamflow, with the state's SGMA perhaps the most promising. However, the two-decade timeframe for full implementation of the act suggests the expected benefits may not be rapidly forthcoming. Overall, California has been a leader in addressing climate change through innovative technology and regulation, but international solutions are likely necessary given the global nature and extent of the issue.

2.4.1 ESU Delineation and Hatchery Membership

- The SWFSC's assessment (SWFSC 2022) found that no new information had become available that would justify a change in the delineation of the CCC coho salmon ESU.
- Our review of new information since the 2016 5-year review and re-evaluation of the three hatchery stocks and programs (DCFH Captive Broodstock Program, Scott Creek/Kingfisher Flat Conservation Program, and Scott Creek Captive Broodstock

Program) found these hatchery programs continuing to be operational and propagate stocks that are part of the CCC coho salmon ESU according to our Hatchery Listing Policy (70 FR 37204). However, for clarity, we recommend the following:

- The combined Scott Creek/Kingfisher Flat Conservation Program and the Scott Creek Captive Broodstock Program be collectively renamed the Southern Coho Salmon Captive Broodstock Program.¹⁵

2.4.2 ESU Viability and Statutory Listing Factors

- The SWFSC’s assessment of updated information (SWFSC 2022) does not indicate a change in the biological risk category of CCC coho salmon since the time of the last status review (Spence 2016; Williams *et al.* 2016).
- This review of ESA section 4(a)(1) factors indicates that the collective risk to the CCC coho salmon’s persistence has not changed significantly since our previous 2016 5-year review (NMFS 2016).

¹⁵ Initially, the conservation program consisted of two separate, but related efforts; however, because the goals of these two efforts were aligned and interrelated regarding the conservation and recovery of extant and functionally extirpated populations throughout the Santa Cruz Mountains Diversity Stratum, the two separate efforts have been consolidated.

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3. Results

3.1 Classification

Listing Status:

Based on the information identified above, we recommend that the CCC coho salmon ESU remain classified as an endangered species.

ESU Delineation:

The SWFSC's viability assessment (SWFSC 2022) found that no new information has become available that would justify a change in the delineation of the CCC coho salmon ESU.

Hatchery Membership:

For the CCC coho salmon ESU, we recommend that the combined Scott Creek/Kingfisher Flat Conservation Program and the Scott Creek Captive Broodstock Program be collectively renamed the Southern Coho Salmon Captive Broodstock Program for the reasons explained above (Subsection 2.1.1: Membership of Hatchery Programs; Subsection 2.4.1: ESU Delineation and Hatchery Membership).

3.2 New Recovery Priority Number

Since the previous 2016 5-year review, NMFS revised the recovery priority number guidelines and twice evaluated the numbers (NMFS 2019a, NMFS 2022). Table 4 indicates the number in place for the CCC coho salmon ESU at the beginning of the current review (1C).

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 1C.

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4. Recommendations for Future Actions

In our review of the five listing factors, we identified several actions critical to improving the status of the CCC coho salmon ESU. NMFS also provided a number of recommended actions in the 2016 5-year review that are still relevant at this time. In this review, we focus on the most important actions to pursue over the next 5 years. Improving conditions for CCC coho salmon, particularly in consideration of climate change, requires improved passage, habitat diversity, improved streamflows, and population viability. Passage improvements are needed to remedy both partial and complete barriers to migration and reach-scale movement of adults and juveniles. Habitat improvements should include attention to in-stream, floodplain and estuarine habitat complexity, and the geomorphic and watershed processes that support habitat function. Flow protections and improvements are needed to protect all life stages and habitat, and should support base (low) flows, natural-type hydrographs, and groundwater resources. Improved population monitoring is needed to better understand the status of populations and the ESU.

We are directing our efforts at populations that need viability improvement according to ESU-, diversity stratum-, and population-level recovery criteria, the best available scientific information concerning ESU status, the role of the independent populations in meeting ESU and diversity stratum viability, limiting factors and threats, and the likelihood of action effectiveness to guide our recommendations for future actions. NMFS is coordinating with the federal, state, tribal, and local implementing entities to ensure that risk factors and actions identified in the recovery plan and the actions identified in key consultations in this geography are addressed.

The following identifies the most important actions to pursue over the next 5 years. Please review each individual listing factor for a complete list of the needed high priority actions.

General Actions

- Implement the actions identified in the 2021-2025 CCC Coho Salmon Species in the Spotlight (SIS) Action Plan (NMFS 2021).¹⁶
- Fund CMP monitoring of CCC coho salmon ESU. Focus on continuing long-term datasets.
- Enhance the utility of Remote Site Incubators in expanding conservation hatchery outplanting as one possible tool for reintroduction of coho salmon to watersheds where they have been extirpated. Implementation utilizing this tool could prove successful where hatchery space is limited, or rearing and transportation of later life stage releases to remote locations is infeasible.

¹⁶ CCC coho Species in the Spotlight Webpage: <https://www.fisheries.noaa.gov/resource/document/species-spotlight-priority-actions-2021-2025-central-california-coast-coho-salmon>

- Together with CDFW, develop a re-introduction strategy for the Gualala River utilizing broodstock from adjacent populations in the Navarro Point-Gualala Point Diversity Strata.

Listing Factor A: See Section 2.3.2 discussion on Listing Factor A for a complete list of needed recovery actions by diversity stratum.

- Focus on flow restoration efforts to restore flows for fish, while providing water supply and regulatory certainty for human needs.
- Retain, recruit and actively input large wood into streams.
- Design and implement restoration projects to create or restore alcove, floodplain, backwater channel, ephemeral tributary, or seasonal habitats.
- Restore and protect dry season flows, by encouraging water conservation and winter diversions (off-stream storage).
- Minimize new road construction within floodplains, riparian areas, or upon unstable soils or other sensitive areas. Design new roads that are hydrologically disconnected from the stream network.
- Promote the re-vegetation of the native riparian plant community within inset floodplains and riparian corridors.

Listing Factor B:

- Increase species identification signage in areas where steelhead fishing occurs to reduce any unintentional capture of coho salmon.

Listing Factor C:

- Expand, develop, and implement monitoring efforts in California to identify pinniped predation interactions in select areas (e.g., river mouths, migratory pinch points), and quantitatively assess predation impacts by pinnipeds on Pacific salmon and steelhead stocks.
- Develop and evaluate a long-term management strategy to reduce pinniped predation on ESA-listed species in select areas (e.g., river mouths/migratory pinch points).
- Implement the CCC steelhead HGMP to reduce any predation threat to Russian River CCC coho salmon.
- Implement studies to better understand the risk of avian and fish predation on CCC coho salmon.

Listing Factor D: See Section 2.3.2 discussion on Listing Factor D for a complete list of needed actions.

- SGMA: Continue NMFS engagement as a stakeholder in GSP implementation.¹⁷
- SGMA: NMFS should ensure they have the staff expertise necessary to evaluate groundwater/surface water hydrologic models to ensure they are properly developed, and use those models to quantify streamflow depletion impacts resulting from groundwater management activities.
- SGMA: NMFS should maintain coordination with CDFW, the State Water Resources Control Board, and environmental organizations whose goals and objectives for minimizing streamflow depletion impact ESA-listed salmon and steelhead.
- SGMA: Require GSAs to use streamflow depletion sustainable management criteria that avoid adversely impacting salmon/steelhead migration, spawning, and rearing habitat, and do not harm ESA-listed species. Criteria consistent with historic drought conditions (i.e., summer/fall 2014), are likely to degrade salmon and steelhead habitat and harm these species.
- Improve regulations to require minimization or mitigation of road runoff containments in existing infrastructure, re-development and routine maintenance projects.
- Implement South Central Coast Special Low Flow Closures restriction for recreational fisheries in rivers south of San Francisco Bay that would additionally reduce bycatch and unintentional take of CCC coho salmon.

Listing Factor E:

- Climate Change Effects:
 - Prioritize tributary habitat projects that improve habitat resiliency to climate change. Actions to restore riparian vegetation, streamflow, and floodplain connectivity and re-aggrade incised stream channels can ameliorate temperature increases, base flow decreases, and peak flow increases, thereby improving population resilience to some effects of climate change.
- Invasive Species Effects:
 - Continue outreach and education efforts to prevent the spread of AIS species such as New Zealand Mudsnail and the eradication of Japanese Knotweed.
- Hatchery Effects:
 - Continue to implement the HGMP for the DCFH Broodstock Program and

¹⁷ This action is also part of the SIS CCC coho salmon Action Plan.

monitor progress towards performance objectives.

- Complete the HGMP and issue a permit for the combined Scott Creek/Kingfisher Flat Conservation Program and Scott Creek Captive Broodstock Program.

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**NATIONAL MARINE FISHERIES SERVICE
5-YEAR REVIEW**

Current Classification:

Recommendation resulting from the 5-Year Review

☐ Downlist to Threatened
☐ Uplist to Endangered
☐ Delist
☐ No change is needed

Review Conducted By (Name and Office):

REGIONAL OFFICE APPROVAL:

Lead Regional Administrator, NOAA Fisheries

Approve _____ Date: _____

Cooperating Regional Administrator, NOAA Fisheries

☐ Concur ☐ Do Not Concur ☐ N/A

Signature _____ Date: _____

HEADQUARTERS APPROVAL:

Assistant Administrator, NOAA Fisheries

☐ Concur ☐ Do Not Concur

Signature _____ Date: _____