2024 5-Year Review: Summary & Evaluation of **Central California Coast Steelhead**

National Marine Fisheries Service
West Coast Region

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5-Year Review: Central California Coast Steelhead

Species Reviewed	Distinct Population Segment
Steelhead (*Oncorhynchus mykiss*)	**Central California Coast (CCC) Steelhead**

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ACRONYMS

AIS	Aquatic Invasive Species
CCC	Central California Coast
CDFW	California Department of Fish and Wildlife
CMP	CDFW/NMFS Coastal Monitoring Program
DPS	Distinct Population Segment. Plural: DPSs.
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit. Plural: ESUs
FMEP	Fisheries Management and Evaluation Plan
GSA	Groundwater Sustainability Agencies
GSP	Groundwater Sustainability Plan
HGMP	Hatchery Genetic Management Plan
MAUCRSA	Medicinal and Adult-Use Cannabis Regulation and Safety Act
NFIP	National Flood Insurance Program
NMFS	National Marine Fisheries Service
SGMA	Sustainable Groundwater Management Act
SWFSC	Southwest Fisheries Science Center
TMDL	Total Maximum Daily Load. Plural: TMDLs
TRT	Technical Recovery Teams. Plural: TRTs
TDC	Thiamine Deficiency Complex
U.S.	United States of America
USACE	United States Army Corps of Engineers
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 historical 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, declining 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 (United States Fish and Wildlife Service [USFWS] and NMFS 2006; NMFS 2020b). After completing this review, the Secretary must determine if any species should be: (1) removed from the list; (2) have its status changed from endangered to threatened; or (3) have its status changed from threatened to endangered. If, in the 5-year review, a change in classification is recommended, the recommended change will be further considered in a separate rule-making process. The most recent 5-year review analysis for West Coast salmon and steelhead occurred in 2016 (NMFS 2016a). This document describes the results of the 2023 review of ESA-listed Central California Coast (CCC) steelhead.

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; and
- 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; and
- a rulemaking.

1.1.1 Background on salmonid listing determinations

The ESA defines “species” to include subspecies and distinct population segments (DPS) of vertebrate species. A species may be listed as threatened or endangered. To identify taxonomically recognized species of Pacific salmon, 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 the 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 taxonomic species. We consider an ESU as constituting a DPS and, therefore, a species under the ESA (56 FR 58612).

Under the DPS policy, a DPS of steelhead must be discrete from other populations, and it must be significant to its taxon.

Artificial propagation programs (hatcheries) are common throughout the range of ESA-listed West Coast salmon and steelhead. Prior to 2005, our policy was to include in the listed ESU or DPS only those hatchery fish deemed essential for conservation of a species. We revised that approach in response to a court decision (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 Policy[1]). This policy establishes criteria for including hatchery stocks in ESUs and DPSs. In addition, it (1) provides direction for considering hatchery fish in extinction risk assessments of ESUs and DPSs; (2) requires that hatchery fish determined to be part of an ESU or DPS be included in any listing of the ESU or DPS; (3) affirms our commitment to conserving natural salmon and steelhead populations and the ecosystems upon which they depend; and (4) affirms our commitment to fulfilling trust and treaty obligations with regard to the harvest of some Pacific salmon and steelhead populations, consistent with the conservation and recovery of listed salmon ESUs and steelhead DPSs.

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

Because the new Hatchery Listing Policy changed the way we considered hatchery fish in ESA listing determinations, we completed new status reviews and ESA listing determinations for West Coast salmon ESUs on June 28, 2005 (70 FR 37160), and for steelhead DPSs on January 5, 2006 (71 FR 834). On December 7, 2011, we announced the availability of the 5-year reviews and listing recommendations for four DPSs of steelhead (76 FR 76386). On May 26, 2016, we

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

published our most recent 5-year reviews and listing determinations for 17 ESUs of Pacific salmon, 10 DPSs of steelhead, and the southern DPS of eulachon (*Thaleichthys pacificus)* (81 FR 33468).

1.2 Methodology used to complete the review

On October 4, 2019, we announced the initiation of the 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 (Southwest Fisheries Science Center [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 2022); reporting by the regional biologists regarding hatchery programs; findings in the 2016 Final Coastal Multispecies Recovery Plan for California Coastal Chinook Salmon, Northern California Steelhead and Central California Coast Steelhead (NMFS 2016c) and technical reports prepared in support of the Final Coastal Multispecies Recovery Plan; the listing record (including designation of critical habitat and adoption of protective regulations); recent biological opinions issued for the CCC steelhead; 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

Central California Coast steelhead was originally defined as an ESU, and later revised to a DPS. Due to identified threats to genetic integrity caused by hatchery activities, and population declines in Santa Cruz County, San Francisco Bay tributaries, and the Russian River, CCC steelhead was originally determined to be in danger of extinction (Busby et al. 1996 in Spence 2016). Upon review of new information, NMFS (1997) concluded that the ESU was not presently in danger of extinction but was likely to become so in the foreseeable future. Following this, CCC steelhead was listed as a threatened species in 1997 (62 FR 43937) (Table 1).

Subsequently, NMFS revised the listing under the DPS policy described above, and reaffirmed that the steelhead only DPS was a threatened species under the ESA (71 FR 834, January 5, 2006; Table 1).

Table 1. Summary of the listing history under the Endangered Species Act for the CCC steelhead DPS

Salmonid Species	ESU/DPS Name	Original Listing	Revised Listing(s)
Steelhead (*O. mykiss*)	Central California Coast Steelhead	**FR Notice:** 62 FR 43937 **Date:** 8/18/1997 **Classification:** Threatened	**FR Notice:** 71 FR 834 **Date:** 1/5/2006 **Re-classification:** Threatened

1.3.3 Associated rulemakings

The ESA requires NMFS to designate critical habitat, to the maximum extent prudent and determinable, for species it lists under the ESA. Critical habitat is defined as: (1) specific areas within the geographical area occupied by the species at the time it is listed, on which are found those physical or biological features essential to the conservation of the species, and which may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by the species at the time it is listed, upon a determination by the Secretary that such areas are essential for the conservation of the species. We designated critical habitat for CCC steelhead in 2005.

Section 9 of the ESA prohibits the take of species listed as endangered. The ESA defines take to mean harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct. For threatened species, the ESA does not automatically prohibit take. Instead, it authorizes the agency to adopt regulations it deems necessary and advisable for species conservation and to apply the take prohibitions of section 9(a)(1) through ESA section 4(d). In 2000, NMFS adopted 4(d) regulations for threatened salmonids that prohibit take except in specific circumstances. In 2005, we revised our 4(d) regulations for consistency between ESUs and DPSs, and, to take into account our Hatchery Listing Policy (Table 2).

Table 2. Summary of rulemaking for 4(d) protective regulations and critical habitat for the CCC steelhead DPS.

Salmonid Species	ESU/DPS Name	4(d) Protective Regulations	Critical Habitat Designations
Steelhead (*O. mykiss*)	Central California Coast Steelhead	**FR notice:** 65 FR 42422 **Date:** 7/10/2000 **Revised:** 6/28/2005 (70 FR 37160)	**FR notice:** 70 FR 52488 **Date**: 9/2/2005

1.3.4 Review History

Table 3 lists the numerous scientific assessments of the status of the CCC steelhead DPS. These assessments include status reviews conducted by our Northwest and Southwest Fisheries Science Centers and technical reports prepared in support of recovery planning for this DPS.

Table 3. Summary of previous scientific assessments for the CCC steelhead DPS.

Salmonid Species	ESU/DPS Name	Document Citation
Steelhead (*O. mykiss*)	Central California Coast Steelhead	SWFSC 2022 NMFS 2016a Williams et al. 2016 Spence et al. 2012 Williams et al. 2011 Spence et al. 2008 Bjorkstedt et al. 2005 Good et al. 2005 Busby et al. 1996

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 December 2023, NMFS issued the 2021-2022 Recovering Threatened and Endangered Species Report to Congress with updated recovery priority numbers. The number for the CCC steelhead DPS remained unchanged (NMFS 2023).

1.3.6 Recovery Plan or Outline

Table 4. Recovery Priority Number and Endangered Species Act Recovery Plans for the CCC steelhead DPS.

Salmonid Species	ESU/DPS Name	Recovery Priority Number	Recovery Plans/Outline
Steelhead (*O. mykiss*)	Central California Coast Steelhead	3C	**Title:** Final Coastal Multispecies Recovery Plan Available at: https://www.fisheries.noaa.gov/resource/document/final-coastal-multispecies-recovery-plan-california-coastal-chinook-salmon **Date:** 2016 **Type:** Final **FR Notice:** 81 FR 70666

2 · Review Analysis

In this section we review new information to determine whether the CCC steelhead DPS delineation remains appropriate.

2.1 Delineation of species under the Endangered Species Act

Is the species under review a vertebrate?

DPS Name	YES	NO
Central California Coast Steelhead	X	

Is the species under review listed as a DPS?

DPS Name	YES	NO
Central California Coast Steelhead	X	

Was the DPS listed prior to 1996?

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

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

In 1991, NMFS issued a policy explaining how the agency would apply the definition of "species" in evaluating Pacific salmon populations for listing consideration under the ESA (56 FR 58612). Under this policy, a group of Pacific salmon populations is considered a "species" under the ESA if it represents an ESU that meets the two criteria of: (1) being substantially reproductively isolated from other populations of the same taxonomically recognized species; and (2) representing an important component in the evolutionary legacy of the taxonomic species. The 1996 joint NMFS-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 taxonomically recognized species. Accordingly, in listing the CCC steelhead DPS under the DPS policy in 1997, we used the joint DPS policy to delineate the DPS under the ESA.

2.1.1 Summary of relevant new information regarding delineation of the CCC Steelhead DPS

DPS Delineation

This section provides a summary of information presented in SWFSC 2022: Viability Assessment for Pacific Salmon and Steelhead Listed Under the Endangered Species Act: Southwest.

The CCC steelhead DPS includes all naturally spawned anadromous *O. mykiss* (steelhead) originating below natural and manmade impassable barriers from the Russian River to and including Aptos Creek, and all drainages of San Francisco and San Pablo bays eastward to Chipps Island at the confluence of the Sacramento and San Joaquin rivers. The CCC steelhead DPS also includes steelhead from the following artificial propagation programs: The Don Clausen Fish Hatchery Program and the Kingfisher Flat Hatchery Program (Monterey Bay Salmon and Trout Project) (71 FR 834; 85 FR 81822).

We found no new information that would justify a change in the delineation of the CCC steelhead DPS (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 hatchery membership of this DPS. They considered changes in hatchery programs that occurred since the last 5-year review (e.g., some have been terminated while others are new) and made recommendations about the inclusion or exclusion of specific programs. They also noted 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.

As described above, the CCC steelhead DPS includes steelhead from two artificial propagation programs: The Don Clausen Fish Hatchery Program and The Kingfisher Flat Hatchery Program (Monterey Bay Salmon and Trout Project) (NMFS 2016a; 71 FR 834; 85 FR 81822). The Don Clausen Fish Hatchery Program (also known as the Russian River Steelhead Integrated Harvest Program (RRSIHP)) uses two facilities; the Don Clausen Fish Hatchery, which is located at the Lake Sonoma Dam and is also known as the Warm Springs Hatchery, and the Coyote Valley Fish Facility and egg collection facility at Lake Mendocino in the Upper Russian River watershed. Progeny from eggs collected at both facilities (Don Clausen/Warm Springs Hatchery and the Coyote Valley Fish Facility) are reared at the Don Clausen/Warm Springs Hatchery facility. The Kingfisher Flat Hatchery Program uses the Kingfisher Flat Hatchery located on Scott Creek in Santa Cruz County.

As part of this 5-year review, we re-evaluated the membership of these hatchery programs within the CCC steelhead DPS. In this re-evaluation we considered whether the hatchery programs are still operational and if so, whether they have been substantially modified. The Don Clausen Fish Hatchery Program continues to be operational, has not been substantially modified, and continues to propagate steelhead that are part of this DPS.

The steelhead program at the Kingfisher Flat Hatchery has not been implemented since the winter of 2013-2014, but has not been terminated and could resume CCC steelhead propagation in the future. As such, we have determined that both The Don Clausen Fish Hatchery Program and The Kingfisher Flat Hatchery Program should remain included in the CCC steelhead DPS, and, therefore, no changes to hatchery membership are warranted.

2.2 Recovery Criteria

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

Evaluating a species for potential changes in ESA listing 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 best available scientific information and other considerations as appropriate. For the final Coastal Multispecies Recovery Plan (NMFS 2016c), NMFS adopted the viability criteria metrics defined by the North Central California Coast Domain Technical Recovery Team as the biological recovery criteria for the threatened CCC steelhead DPS.

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

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

DPS Name	YES	NO
Central California Coast Steelhead	X	

2.2.2 Adequacy of recovery criteria

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

DPS Name	YES	NO
Central California Coast Steelhead	X	

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

DPS Name	YES	NO
Central California Coast Steelhead	X	

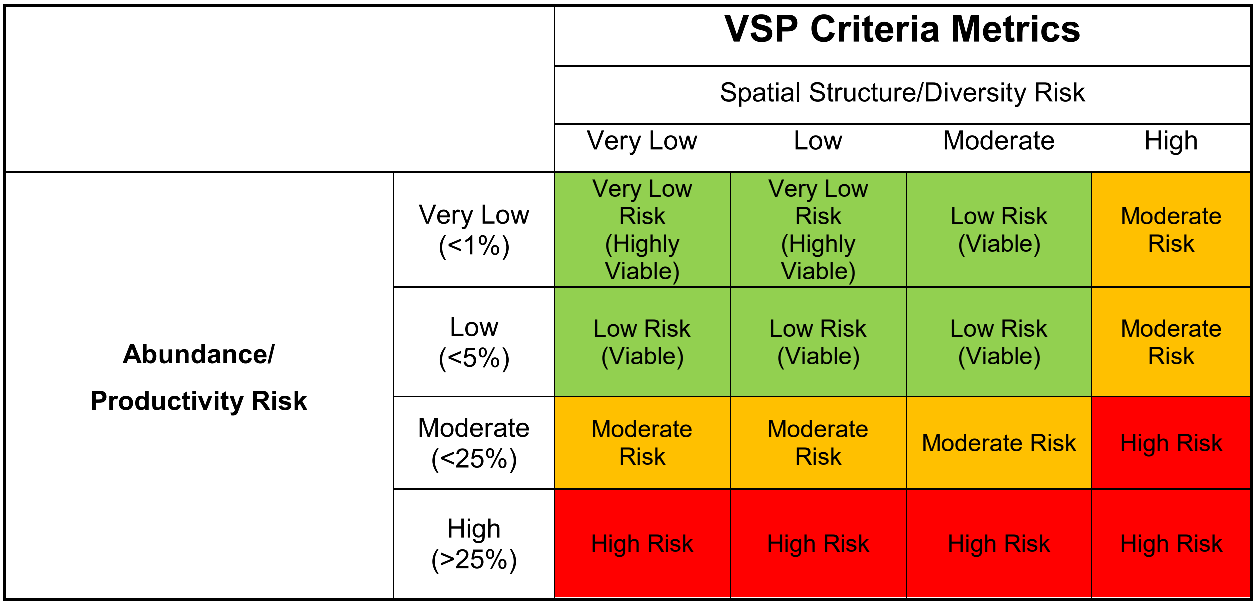
2.2.3 List the biological recovery criteria as they appear in the recovery plan

For the purposes of reproduction, steelhead typically exhibit a metapopulation structure (Schtickzelle and Quinn 2007, McElhany et al. 2000). Rather than interbreeding as one large aggregation, ESUs and DPSs function as a group of demographically independent populations separated by areas of unsuitable spawning habitat. For conservation and management purposes, it is important to identify the independent populations that make up a 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 (McElhaney et al. 2000) is based on the biological parameters of abundance, productivity, spatial structure, and diversity for an independent salmonid population to have a negligible risk of extinction over a 100-year time frame. 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 McElhaney et al. (2000) VSP concepts (Bjorkstedt et al. 2005; Spence et al. 2008). The final Coastal Multispecies Recovery Plan (NMFS 2016c) adopted the North Central California Coast Domain TRT viability criteria as the biological recovery criteria for the threatened CCC steelhead DPS. These criteria metrics describe population extinction risk over a 100-year time frame (Figure 1).



		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 from NMFS (2016c), adapted from Bjorkstedt et al. (2005) and Spence et al. (2008).

For recovery planning and development of recovery criteria, the North-Central California Coast Domain Technical Recovery Team (TRT) led by the NMFS Southwest Fisheries Science Center (SWFSC) identified independent populations within the CCC steelhead DPS and grouped them into genetically similar diversity strata (Spence et al. 2008, Spence et al. 2012). The DPS is composed of five diversity strata: Interior, North Coastal, Coastal San Francisco Bay, Interior San Francisco Bay, and Santa Cruz Mountains (Figure 2).

Figure 2. Central California Coast Steelhead DPS and Diversity Strata.

Recovery strategies outlined in the 2016 Final Coastal Multispecies Recovery Plan (NMFS 2016c) are targeted on achieving, at a minimum, the biological viability criteria for each major diversity stratum in the DPS in order to have all five 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 to support 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 and identifies particular combinations of various populations that are the most likely to result in achieving diversity strata viability, and hence DPS viability.

The TRT recovery criteria are hierarchical in nature, with ESU/DPS level criteria being based on the status of natural-origin steelhead assessed at the population level. Population extinction risk criteria (from Spence et al. 2008) are summarized below. A detailed description of the TRT viability criteria and their derivation (Spence et al. 2008 and Spence et al. 2012) can be found in Appendix C of the 2016 Final Coastal Multispecies Recovery Plan (NMFS 2016c).

The four ESU viability criteria are:

(1) low Extinction Risk Criteria: For the essential independent populations selected to be viable, the low extinction risk criteria for effective population size, population decline, catastrophic decline, hatchery influence and density-based spawner abundances must be met according to Spence et al. (2008);

AND

(2) moderate Extinction Risk Criteria: Spawner density abundance targets have been achieved for Supporting Independent populations;

AND

(3) redundancy and Occupancy Criteria: Spawner density and abundance targets for dependent populations, which are the occupancy goals for each of those populations, have been achieved (See the discussion of Spence et al. (2008) in NMFS 2016c);

AND

(4) for the Pinole Creek, San Pedro Creek, Drakes Bay, Wildcat Creek, and Codornices Creek dependent populations, that did not have IP developed for them by the SWFSC, confirm presence of steelhead juveniles and/or adults for at least one-year class over four generations (*i.e.*, a 16-year period).

Selected populations in all five diversity strata must be achieving these criteria in order for the DPS to meet biological recovery criteria.

The Final Coastal Multispecies Recovery Plan (NMFS 2016c) identifies a set of most likely scenarios to support *Viable* (low risk) populations at the diversity stratum level.

North Coastal Diversity Stratum

1. The Austin Creek and Green Valley Creek populations (Russian River), and Lagunitas Creek, Salmon Creek, and Walker Creek populations must reach at least *Viable* (low risk) status;
2. The Estero Americano Creek population must reach at least moderate risk status;
3. Supporting dependent populations in Dutch Bill, Freezeout, Hulbert, Porter, Sheephouse, and Willow creeks (Russian River) and Redwood Creek and Pine Gulch populations must reach established redundancy and occupancy criteria (Table 1 in Volume IV of the Final Coastal Multispecies Recovery Plan (NMFS 2016c)); and
4. Supporting dependent populations in Drakes Bay tributaries must contribute to redundancy and occupancy criteria with confirmed presence of steelhead juveniles and/or adults for at least one-year class over four generations.

Interior Diversity Stratum

1. The Dry Creek, Maacama Creek, Mark West Creek, and Upper Russian River populations must reach at least *Viable* (low risk) status; and
2. Supporting dependent populations in Crocker Creek, Gill Creek, Miller Creek, and Sausal Creek must reach established redundancy and occupancy criteria (Table 1 in Volume IV of the Final Coastal Multispecies Recovery Plan (NMFS 2016c)).

Coastal San Francisco Bay Diversity Stratum

1. The Corte Madera Creek, Guadalupe River, Novato Creek, San Francisquito Creek, and Stevens Creek populations must reach at least *Viable* (low risk) status;
2. The San Mateo Creek population must reach at least moderate risk status; and
3. Supporting dependent populations in Miller Creek and Arroyo Corte de Madera Creek must reach established redundancy and occupancy criteria (Table 1 in Volume IV of the Final Coastal Multispecies Recovery Plan) (NMFS 2016c)).

Interior San Francisco Bay Diversity Stratum

1. The Alameda Creek, Coyote Creek, Green Valley/Suisun Creek, Napa River, Petaluma River, and Sonoma Creek populations must reach at least *Viable* (low risk) status;
2. The San Leandro Creek and San Lorenzo Creek populations must reach at least moderate risk status;
3. A supporting dependent population in San Pablo Creek must reach established redundancy and occupancy criteria (Table 1 in Volume IV of the Final Coastal Multispecies Recovery Plan (NMFS 2016c)); and
4. Supporting dependent populations in Codornices Creek, Pinole Creek, and Wildcat Creek must contribute to redundancy and occupancy criteria with confirmed presence of steelhead juveniles and/or adults for at least one-year class over four generations.

Santa Cruz Mountains Diversity Stratum

1. The Aptos Creek, Pescadero Creek, Pilarcitos Creek, San Gregorio Creek, San Lorenzo River, Scott Creek, Soquel Creek and Waddell Creek populations must reach at least *Viable* (low risk) status;
2. The Laguna Creek population must reach at least moderate risk status;
3. Supporting dependent populations in Gazos Creek, San Vicente Creek, and Tunitas Creek must reach established redundancy and occupancy criteria (Table 1 in Volume IV of the Final Coastal Multispecies Recovery Plan (NMFS 2016c)); and
4. A supporting dependent population in San Pedro Creek must contribute to redundancy and occupancy criteria with confirmed presence of steelhead juveniles and/or adults for at least one-year class over four generations.

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 previous viability assessment (Spence 2016) identified scarcity of quantitative population data as an important data gap limiting our ability to assess a change in the status of the CCC steelhead DPS. The current viability assessment (Spence 2022 in SWFSC 2022) identifies lack of information on steelhead abundance as an ongoing challenge for assessing the status of the DPS.

For example, monitoring of coastal populations in the North-Coastal Stratum has been focused on coho salmon spawning (e.g., redd abundance) and, due to variations in run timing and habitat uses between coho salmon and steelhead, does not encompass the full temporal and spatial extent of spawning for steelhead. As such, the data have limited utility for assessing trends and provide essentially "minimum" estimates of abundance. Similarly, population-level estimates of abundance are non-existent for all populations in the Interior and Coastal San Francisco Bay strata; thus, the status of these strata remains highly uncertain. Many populations within these two San Francisco Bay strata no longer have access to large portions of their historical habitat due to dams and other passage barriers, and it is likely these populations are at high risk of extinction.

In some populations, monitoring has improved or has continued (e.g., in the Russian River basin and in Scott Creek); however, while helpful, these data continue to be limited for the purposes of assessing overall viability. For example, the implementation of the California Department of

Fish and Wildlife (CDFW)/NMFS Coastal Monitoring Program (CMP) in the Russian River basin since the previous viability assessment (Spence 2016) has provided estimates of steelhead abundance in the watershed (combined natural and hatchery-origin abundance ranging from approximately about 800–2,000 over 3 years), but as population estimates are not produced for individual populations within the basin, direct comparison with recovery targets is not yet possible. Similarly, new information from 8 years of CMP implementation in the Santa Cruz Mountains Diversity Stratum has improved our understanding of steelhead populations in this geographic area. However, like the programs in the North Coast Diversity Stratum, all but one of these programs is focused on coho salmon. Due to this, these programs do not encompass the full spatial and temporal extent of steelhead spawning, making them insufficient to determine CCC steelhead population condition in these watersheds.

Of all the monitoring being performed throughout the entire DPS, only that performed in Scott Creek (the Scott Creek life-cycle monitoring program), within the Santa Cruz Mountains Diversity Stratum, provides a sufficient set of data. In summary, while data availability for this DPS remains generally poor, the new information for CCC steelhead available since the previous viability assessment (Spence 2016) indicates that overall extinction risk is moderate and has not changed appreciably since the prior assessment.

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 manmade factors affecting its continued existence. Section 4(b)(1)(A) requires us to make determinations solely on the basis of the best scientific and commercial data available, after conducting a review of the status of the species and taking into account efforts to protect such species. Below we discuss new information relating to each of the five factors as well as efforts being made to protect the species.

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 the 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 concerns about this habitat condition remain; (3) population-specific key protective measures and major restoration actions taken since the 2016 5-year review toward achieving the recovery plan viability criteria adopted by NMFS in the Final Coastal Multispecies Recovery Plan (NMFS 2016c) 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 the following: 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.

North Coastal Diversity Stratum

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

For the five independent CCC steelhead populations comprising the North Coastal Diversity Stratum determined to be essential to recovery of the DPS (Austin Creek, Green Valley Creek, Lagunitas Creek, Salmon Creek, and Walker Creek), the primary habitat concerns, as reported in the 2016 5-year review (NMFS 2016a), continue to be:

- Impaired instream habitat complexity, disconnected floodplain habitat, reduced and degraded winter refugia, and stream simplification (e.g., reduced large woody debris, canopy cover, and riffle/run/pool diversity). These impairments are largely resulting from the effects of floodplain development. (e.g., Lagunitas Creek and Walker Creek populations)
- Instream water flow is decreased throughout the diversity stratum due to surface and groundwater diversions. Water extraction is primarily for residential use and for agriculture. Impaired instream water flow results in dewatered reaches and diminished water quality in the reaches that are not completely dewatered. (All populations)
- Diversity stratum wide estuary water quality impairment (increased temperatures and decreased oxygen) and habitat impairment due to lack of stream flow, urbanization, and past land use practices that have filled wetlands, altered hydrology, reduced submerged aquatic vegetation, and introduced contaminants. (All populations)
- Diversity stratum wide poor access to spawning and juvenile rearing habitat due to the presence of instream barriers (including dams) that either prevent or delay access to upstream habitat. (All populations)

In addition, major emergent habitat concerns since the prior 5-year review include:

- Wildfire-induced habitat impacts, including sedimentation, loss of riparian cover, and loss of instream wood. The Walbridge Fire burned approximately 12,931 acres within this stratum in

2020, resulting in impairment and loss of instream and riparian habitat affecting the Austin Creek population in this stratum. See Listing Factor E for a broader discussion of the impacts of increasing wildfire risk.

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

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

- Impairment and destruction of instream and riparian habitat within reaches of the Austin Creek watershed affected by the Walbridge Fire.
- Riparian corridor impairment, bank destabilization, and contribution of fine sediments to valley floor reaches of Walker Creek due to nearby and upstream grazing practices.
- Impaired habitat complexity (e.g., impaired wetlands, and poor quantity and quality of large wood) within the Russian River and Walker Creek estuaries resulting from floodplain development.
- 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.

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

Since adoption of the Final Coastal Multispecies Recovery Plan in 2016 (NMFS 2016c), and the previous 5-year review (NMFS 2016a), the following key measures and restoration actions have been implemented in the North Coastal Diversity Stratum:

- In 2018 and 2019, to create habitat for juvenile steelhead and coho salmon, the Salmon Protection and Watershed Network (SPAWN) enhanced a 0.5-mile reach of floodplain in Lagunitas Creek. The project removed over 10,000 cubic yards of fill, numerous abandoned buildings, and invasive plants. Then, the floodplain was contoured to create side channels, large woody debris was installed, and the riparian corridor was revegetated with over 9,000 native plantings.
- In 2016, the U.S. National Park Service at Point Reyes National Seashore removed 5 miles (500 tons) of wooden oyster racks and 1 acre of aquaculture debris from Drakes Estero to restore eelgrass habitat (San Francisco Estuary Institute [SFEI] 2020). This restoration benefits native species, including CCC steelhead.

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

The Final Coastal Multispecies Recovery Plan (NMFS 2016c) and the previous 5-year review (NMFS 2016a) identified inadequate regulatory mechanisms as contributing substantially to the decline of the CCC steelhead DPS. Although many regulatory mechanisms and conservation efforts were in place when this DPS 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 North Coastal Diversity Stratum, various federal, state, and county 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 the California Sustainable Groundwater Management Act. However, the implementation and effectiveness of regulatory mechanisms has not been adequately documented. **See Listing Factor D: Inadequacy of Existing Regulatory Mechanisms in this document for details.**

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

The greatest opportunities to advance recovery of CCC steelhead in the North Coastal Diversity Stratum are to:

- 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.
- Exclude livestock from Walker Creek and replant streambanks and riparian areas. Remove invasive species from the riparian areas and replace with native vegetation.
- Restore and protect active channel areas, floodways, and floodplains to accommodate natural fluvial processes.
- 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.
- Remedy existing complete and partial barriers to passage.
- Continue to work with State agencies to minimize impacts from cannabis operations on listed salmonids.
- Implement improved flow regime in the Russian River which would benefit improved rearing in the estuary, as required in the 2008 Biological Opinion (NMFS 2008) through interagency consultation with the United States Army Corps of Engineers (USACE) and Sonoma Water.

Interior Diversity Stratum

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

For the four independent CCC steelhead populations comprising the Interior Diversity Stratum (Dry Creek, Maacama Creek, Mark West Creek, and Upper Russian River), the primary habitat concerns across the diversity stratum, as reported in the 2016 5-year review (NMFS 2016a), continue to be:

- Decreased instream water flow due to surface and groundwater extractions. Water extraction is primarily for residential and agricultural use. Impaired instream water flow results in dewatered reaches and diminished water quality in the reaches that are not completely dewatered. (All populations)
- Estuary water quality impairment (increased temperatures and decreased oxygen) and habitat impairment due to lack of stream flow, urbanization, and past land use practices that have filled wetlands, altered hydrology, reduced submerged aquatic vegetation, and introduced contaminants. (All populations)
- Poor access to spawning and juvenile rearing habitat due to the presence of instream barriers (including dams) that either prevent or delay access to upstream habitat. (Upper Russian River and Dry Creek populations)
- Impaired instream habitat complexity, disconnected floodplain habitat, reduced and degraded winter refugia, and stream simplification (e.g., reduced large woody debris, canopy cover, and riffle/run/pool diversity) resulting, largely from past floodplain development and past timber harvest operations. (Dry Creek, Mark West Creek, and Upper Russian River populations)

In addition to the primary habitat concerns identified in the previous 5-year review (NMFS 2016a), major emergent habitat concerns affecting the Interior Diversity Stratum are:

- Wildfire-induced habitat impacts including sedimentation, loss of riparian cover, and loss of instream wood. Since the previous 5-year review (NMFS 2016a), multiple large wildfires (Nuns, Tubbs, Redwood Valley, River, Kincade, Walbridge, Glass) have burned approximately 173,016 acres burned within this stratum, with approximately 3,090 acres of these 173,016 acres having been burned more than once since the last 5-year review, resulting in impacts to portions of the Russian River watershed and its tributaries. See Listing Factor E for a broader discussion of the impacts of increasing wildfire risk.
- Chronic turbidity and suspended sediment issues associated with Lake Mendocino flow releases, which are significantly contributing to poor mainstem spawning and rearing conditions (e.g., reduced spawning gravel quantity and quality, and reduced food availability and foraging area) for salmonids (including CCC steelhead) in the Russian River (NMFS 2008b.

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

There are no additional population-specific geographic areas of concern beyond the Dry Creek, Maacama Creek, Mark West Creek, and Upper Russian River concerns specifically identified above.

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

Since adoption of the Recovery Plan in 2016 (NMFS 2016c), and the previous 5-year review (NMFS 2016a), the following key measures and restoration actions have been implemented in the Interior Diversity Stratum:

- Implementation of forecast informed reservoir operation (FIRO) at Lake Mendocino. The use of FIRO helps water managers manage the storage within, and releases from Lake Mendocino. This helps support instream flows for CCC steelhead in the Russian River downstream of the reservoir.
- In 2016, the Mill Creek Dam Fish Passage Project opened up 11.2 miles of high-quality habitat (62% of the creek), within the Dry Creek Population Mill Creek, tributary to the Russian River tributary. The project restored passage over and around the dam through the construction of a low-gradient side channel and a roughened ramp.
- In 2008, NMFS issued a biological opinion to the U.S. Army Corps of Engineers for reservoir and water supply operations in the Russian River (NMFS 2008b). Conditions of this 2008 biological opinion require the phased enhancement of approximately 6 miles of stream habitat in the Russian River watershed to support threatened steelhead, threatened Chinook salmon, and endangered coho salmon. To help establish partnerships with private landowners necessary to facilitate these habitat enhancement actions, NMFS, in 2016, completed a Safe Harbor Agreement with willing landowners in the Russian River tributary, Dry Creek. The agreement engages landowners supporting habitat enhancement, while also providing assurances that the enhancement actions will not result in new land use restrictions. At the time of this 5-year review, approximately 4.5 of the 6 miles have been completed, and additional restoration actions are being planned for future implementation.
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- In 2018, Trout Unlimited constructed the Yellowjacket Creek Fish Passage Project within the Maacama Creek population in partnership with Jackson Family Wines. The passage project opens up 1.9 miles of spawning and rearing habitat. In 2019, Jackson Family Wines entered into the second ESA Section 10 Safe Harbor Agreement in the country, with NMFS to ensure these fish passage, fish flows, and habitat improvements on Jackson Family Wines properties remain in perpetuity.

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

The Final Coastal Multispecies Recovery Plan (NMFS 2016c) and the previous 5-year review identified inadequate regulatory mechanisms as contributing substantially to the decline of the CCC steelhead DPS. Although many regulatory mechanisms and conservation efforts were in place at the time this DPS 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 Interior Diversity Stratum, various federal, state, and county regulatory mechanisms are in place to minimize or avoid habitat degradation caused by human use and development. Many of these mechanisms have been improved and updated in the past 5 years, such as full implementation of CDFW sport fishing regulations supporting low-flow fishing closures, and the enactment of cannabis regulations and the California Sustainable Groundwater Management Act. However, the implementation and effectiveness of regulatory mechanisms has not been adequately documented.

See Listing Factor D: Inadequacy of Existing Regulatory Mechanisms in this document for details.

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

The greatest opportunities to advance recovery of CCC steelhead in the Interior Diversity Stratum are to:

- Implement improved flow regime for Dry Creek and the Upper Russian River populations as required in the 2008 Biological Opinion (NMFS 2008) through interagency consultation with USACE and Sonoma Water.
- Improve reservoir management strategies to ensure adequate water quality and flow conditions for juvenile and adult steelhead habitat production capacity in the upper Russian River.
- Reduce upper Russian River turbidity and temperature issues associated with Lake Mendocino in the next Russian River biological opinion. This action will greatly support the recovery of Interior Diversity stratum steelhead by improving the quality of spawning and rearing habitat.

Coastal San Francisco Bay Diversity Stratum

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

For the five independent CCC steelhead populations comprising the Coastal San Francisco Bay Diversity Stratum (Corte Madera Creek, Guadalupe River, Novato Creek, San Francisquito Creek, and Stevens Creek), the primary habitat concerns, as reported in the 2016 5-year review (NMFS 2016a), continue to be:

- Large and small physical structures that impair or completely block access to steelhead movement, including access to upper watershed spawning and rearing habitat. These structures range from relatively low barriers that cause partial or seasonal impediments to large dams that cause year-round complete barriers to movement and migration. (All populations)
- Impaired instream habitat complexity, disconnected floodplain habitat, reduced and degraded winter refugia, and stream simplification (e.g., reduced large woody debris, canopy cover, and riffle/run/pool diversity) resulting, largely, from past and ongoing floodplain development (urban and agricultural development) and reservoir operations. (All populations)
- Decreased instream water flow and impaired water quality due to surface and groundwater extractions, including large reservoirs. Impaired instream water flow results in dewatered reaches and diminished water quality in the reaches that are not completely dewatered. (All populations)
- Estuary and instream water quality impairment (increased temperatures, increased turbidity, and decreased oxygen) and habitat impairment due to lack of stream flow, urbanization, and past land use practices that have filled wetlands, altered hydrology, reduced submerged aquatic vegetation, and introduced pollution and contaminants. (All populations)

In addition to the primary habitat concerns identified in the previous 5-year review (NMFS 2016a), a major emergent habitat concern since the 2016 5-year review affecting the Coastal San Francisco Bay Diversity Stratum is the impact of prolonged drought conditions and climate change effects on instream flows and temperatures, which may be worsening surface water quantity and quality and exacerbating the effects of ongoing threats such as water development and urbanization.

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

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

- High concentrations of suspended sediment in Stevens Creek Reservoir releases (Smith 2018) that impair habitat; decreasing prey sources, and reducing predation, forage, spawning, and rearing success.
- Passage and rearing impaired by Lake Alamaden and its associated diversion structure which impede steelhead passage, impair sediment transport, and degrade (increase) stream temperatures (note this location is distinguished from Almaden Reservoir and is near the confluence of Los Gatos and Alamitos creeks).
- Passage and rearing impaired in San Francisquito Creek by urban floodplain development and passage impediments (NMFS 2016c).
- Reduced surface water flow in Corte Madera Creek downstream of Phoenix Lake (NMFS 2016c).
- Releases from Stafford Dam are insufficient to maintain watershed processes and support steelhead migration and juvenile steelhead rearing in Novato Creek downstream of the dam (NMFS 2016c).
- Habitat impaired and constrained by urban development, reservoir operations, and historic agricultural operations within the Guadalupe River, Stevens Creek, San Francisquito Creek, Corte Madera Creek, and Novato Creek populations
- Water quality and quantity impaired by the combined effects of drought, surface water and groundwater extraction, and urbanization in Stevens Creek and the Guadalupe River (Leicester and Smith 2016; Smith 2018). Impacts include trash and other pollution that washes into waterways.

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

Since adoption of the Recovery Plan in 2016 (NMFS 2016c), and the previous 2016 5-year review (NMFS 2016a), the following key measures and restoration actions have been implemented in the Coastal San Francisco Bay Diversity Stratum:

- Implementation of actions in the San Francisquito Creek watershed by Stanford University, San Mateo resource Conservation District, and partners to improve passage, and restore and protect riparian and near-stream habitat (e.g., Stanford University Low Flow Crossing removal, 2017; Lagunita Diversion Dam Removal, 2018; Alpine Road Stabilization and Restoration, 2017).

- Planning, by Stanford University, for the proposed future modification of Stanford University's Searsville Dam on San Francisquito Creek to, among other actions, provide CCC steelhead access to above-dam reaches, improve flood protection, and restore stream habitat. Actions have been planning related (e.g., public outreach, resource agency technical assistance coordination, alternatives development and review, etc.) and are preceding permit applications, which are expected within the next 5 years.

4) Key Regulatory Mechanisms Since the 2016 5-year Review

The Final Coastal Multispecies Recovery Plan (NMFS 2016c) and the previous 5-year review (NMFS 2016a) identified inadequate regulatory mechanisms as contributing substantially to the decline of the CCC steelhead DPS. Although many regulatory mechanisms and conservation efforts were in place at the time this DPS 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 Coastal San Francisco Diversity Stratum, various federal, state, and county regulatory mechanisms are in place to minimize or avoid habitat degradation caused by human use and development. Many of these mechanisms have been improved and updated in the past 5 years, such as the enactment of the California Sustainable Groundwater Management Act. However, the implementation and effectiveness of regulatory mechanisms has not been adequately documented. **See Listing Factor D: Inadequacy of Existing Regulatory Mechanisms in this document for details.**

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

The greatest opportunities to advance recovery of CCC steelhead in the Coastal San Francisco Diversity Stratum are to:

- Identify and address source(s) of chronic high concentrations of suspended sediment releases from Stevens Creek Reservoir.

- Improve reservoir releases from Phoenix Lake to support all life stages of steelhead in Corte Madera Creek (NMFS 2016c).

- Improve reservoir releases from Stafford Lake to support all life stages of steelhead in Novato Creek (NMFS 2016c).

- In the Guadalupe River watershed, improve passage, rearing, and habitat conditions by restoring, to riverine conditions, the reach of stream containing Lake Alamaden and its associated diversion structure (NMFS 2016c) (note this location is distinguished from Almaden Reservoir and is near the confluence of Los Gatos and Alamitos creeks).

- Restore seasonally appropriate surface water flow in reservoir-affected streams (e.g., Guadalupe River and Stevens Creek watersheds).

- Treat urban runoff and collect and remove trash from heavily urbanized streams (e.g., Guadalupe River, Stevens Creek, San Francisquito Creek watersheds) to improve surface water quality.
- Implement the Searsville Restoration Project on San Francisquito Creek to improve flows, sediment transport, habitat complexity to downstream reaches, restore the reservoir reach to a riverine condition, and restore steelhead access to above-dam reaches.

Interior San Francisco Bay Diversity Stratum

1) Population-Specific Key Emergent of Ongoing Habitat Concerns Since the 2016 5-year Review

For the seven independent essential CCC steelhead populations (Alameda Creek, Coyote Creek, Green Valley/Suisun Creek, Napa River, Petaluma River, San Leandro Creek, and Sonoma Creek) comprising the Interior San Francisco Bay Diversity Stratum, the primary habitat concerns, as reported in the 2016 5-year review (NMFS 2016a), continue to be:

- Large and small physical structures that impair or completely block access to steelhead movement, including access to upper watershed spawning and rearing habitat. These structures range from relatively low barriers that cause partial or seasonal impediments to large dams that cause year-round complete barriers to movement and migration. (All populations)
- Impaired instream habitat complexity, disconnected floodplain habitat, reduced and degraded winter refugia, and stream simplification (e.g., reduced large woody debris, canopy cover, and riffle/run/pool diversity) resulting, largely, from past and ongoing floodplain development (urban and agricultural development) and reservoir operations. (All populations)
- Decreased instream water flow and impaired water quality due to surface and groundwater extractions, including large reservoirs. Water extraction is primarily for residential and agriculture use. Impaired instream water flow results in dewatered reaches and diminished water quality in the reaches that are not completely dewatered. (Coyote Creek, Green Valley/Suisun Creek, Napa River, Sonoma Creek)
- Estuary and instream water quality impairment (increased temperatures and decreased oxygen) and habitat impairment due to lack of stream flow, urbanization, and past land-use practices that have filled wetlands, altered hydrology, reduced submerged aquatic vegetation, and introduced pollution and contaminants. (All populations)

In addition to the primary habitat concerns identified in the previous 5-year review (NMFS 2016a), a major emergent habitat concern affecting the Interior San Francisco Bay Diversity Stratum is wildfire-induced habitat impacts, including sedimentation, loss of riparian cover, and loss of instream wood. Since the last 5-year review (NMFS 2016a), multiple wildfires (Alameda, Nuns, Tubbs, Atlas, Glass, Hennessey) have burned approximately 309,844 acres burned within this stratum, with approximately 7,762 acres of these 309,844 acres having been burned more than once in the past 5 years. These wildfires have resulted in impacts to portions of the Green Valley/Suisun Creek, Napa River, Sonoma Creek, and Alameda Creek watersheds. See Listing Factor E for a broader discussion of the impacts of increasing wildfire risk.

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

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

- In Coyote Creek, a major emergent habitat concern since the 2016 5-year review (NMFS 2016a) is potentially worsening surface water and habitat conditions due to the combined effects of drought, water withdrawals, and urbanization (including passage barriers), which may be worsening and may be degrading the condition of this steelhead population (Smith 2020a, 2020b).
- Impairment (sedimentation and loss of cover) and destruction of instream and riparian habitat within portions of the Green Valley/Suisun Creek, Napa River, Sonoma Creek, and Alameda Creek watersheds due to wildfires.
- The Anderson Dam Seismic Retrofit Project presents new challenges to the remnant population of steelhead in Coyote Creek. Anderson Dam on Coyote Creek has been determined to be seismically unsound and the Federal Energy Regulatory Commission (FERC) has ordered that the reservoir be maintained at or below the level of the lowest outlet (for reservoirs, this is often described as dead pool) until the dam is re-built. Reservoir draining began in 2019 as an emergency action, and construction of the replacement dam is expected to continue through at least 2030. Until the dam is replaced and refilled, surface water conditions (e.g., temperature, and quantity of flows) in downstream reaches are expected to be seasonally problematic for steelhead, especially during warm weather and low rainfall years. NMFS continues to work with FERC and the reservoir owner (Santa Clara Valley Water District) to minimize effects of the draining action and to develop the larger dam replacement project in such a way that it supports CCC steelhead in Coyote Creek.
- Impaired or blocked access to upper watershed spawning and rearing habitat within the Napa River, Alameda Creek, and Coyote Creek. For more on impaired or blocked access affecting populations within this diversity stratum also see the recovery plan for CCC steelhead (NMFS 2016c).
- Habitat impaired and constrained by urban development, (all populations), reservoir operations, (Napa River, Alameda Creek, and Coyote Creek), and current and historic agricultural operations (Petaluma River, Sonoma Creek, Napa River, Green Valley Creek, Suisun Creek, and Coyote Creek). For more on habitat impairments affecting populations within this diversity stratum also see the recovery plan for CCC steelhead (NMFS 2016c).

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

Since adoption of the Recovery Plan in 2016 (NMFS 2016c), and the previous 2016 5-year review (NMFS 2016a), the following key measures and restoration actions have been implemented in the Interior San Francisco Bay Diversity Stratum:

- In 2020, the York Creek Dam Removal project resulted in the removal of a 120-year-old dam on York Creek, a tributary to the Napa River. This project restored steelhead access to 2 miles of stream, restored sediment and debris transport to downstream reaches, and installed 38 large woody debris structures within approximately 3,600 feet of stream (NMFS 2020a).
- In 2021, Santa Clara Valley Water District partnered with the City of San Jose and others to replace the Singleton Road Low Flow crossing on Coyote Creek with a free-span railroad car bridge. This interim repair, which will remain in place until the City of San Jose is able to fund a permanent channel spanning bridge, removed the downstream-most severe passage impediment on Coyote Creek, improving steelhead access to approximately 17 miles of habitat downstream of Anderson Dam.
- Significant actions have been undertaken to restore fish passage and provide suitable streamflow conditions in the Alameda Creek watershed, the largest tributary to South San Francisco Bay. The San Francisco Public Utilities Commission (SFPUC) completed construction of a replacement dam on Calaveras Creek in June 2019. The new reservoir has improved operations compared to the previous reservoir and provides water releases for steelhead fish passage, spawning and juvenile rearing. In 2019, the SFPUC also completed construction of a fish ladder and screen at the Alameda Creek Diversion Dam. This new ladder provides access to at least 4 miles of high-quality spawning and rearing habitat above the diversion. A new operations plan for this diversion has been adopted by the SFPUC, which improves downstream flows for steelhead. In lower Alameda Creek, the Alameda County Water District (ACWD) installed a fish ladder at their upper inflatable diversion dam in 2019 and a second fish ladder was completed at the Bay Area Rapid Transit (BART) weir in fall 2021. These two fish ladders restore access for adult steelhead to return to the upper Alameda Creek watershed for the first time in over 50 years. ACWD also consolidated their water diversion intakes, installed screens to prevent fish entrainment, and adopted a bypass flow plan to support fish migration through lower Alameda Creek.
- In 2018, Sonoma Land Trust, working with San Francisco Bay Joint Venture Project and the San Francisco Bay Restoration Authority developed the Restoration Strategy for the Lower Sonoma Creek. This plan will accelerate current land protection and habitat restoration projects on 5,000 acres, provide information to the redesign of State Route 37 so that the new highway design is compatible with restoration objectives, and provide flood management and public access benefits associated with wetland restoration (SFEI 2020).

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

The Final Coastal Multispecies Recovery Plan (NMFS 2016c) and the previous 5-year review (NMFS 2016a) identified inadequate regulatory mechanisms as contributing substantially to the decline of the CCC steelhead DPS. Although many regulatory mechanisms and conservation efforts were in place at the time this DPS 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 Interior San Francisco Diversity Stratum, various federal, state, and county regulatory mechanisms are in place to minimize or avoid habitat degradation caused by human use and development. Many of these mechanisms have been improved and updated in the past 5 years, such as California State Cannabis regulation and the California Sustainable Groundwater Management Act. However, the implementation and effectiveness of regulatory mechanisms has not been adequately documented. ***See Listing Factor D: Inadequacy of Existing Regulatory Mechanisms in this document for details***.

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

The greatest opportunities to advance recovery of CCC steelhead in the Interior San Francisco Bay Diversity Stratum are to:

- restore seasonally appropriate surface water flow in reservoir-affected streams (e.g., Coyote Creek, Green Valley/Suisun Creek, and Napa River watersheds);
- treat urban runoff and collect and remove trash from heavily urbanized streams (e.g., Alameda Creek, Coyote Creek, and San Leandro Creek) to improve surface water quality;
- minimize impacts to CCC steelhead in Coyote Creek during the interim seismic safety condition requiring the reservoir to be kept at or below the level of the lowest outlet (i.e., dead pool storage level) by providing surface water flows, when possible, relocating steelhead, when needed, and enhancing habitat and passage; and
- develop and implement measures into the Anderson Dam Seismic Retrofit project that will address potential watershed-scale, population-level effects, including effects related to impaired surface water flows, sediment transport, passage, and habitat quantity and condition.

Santa Cruz Mountains Diversity Stratum

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

For the eight independent essential CCC steelhead populations (Aptos Creek, Pescadero Creek, Pilarcitos Creek, San Gregorio Creek, San Lorenzo River, Scott Creek, Soquel Creek, and Waddell Creek) comprising the Santa Cruz Mountains Diversity Stratum, the primary habitat concerns, as reported in the 2016 5-year review (NMFS 2016a), continue to be:

- Impaired instream and estuarine habitat complexity, impaired floodplain access, and stream simplification (e.g., large woody debris, canopy cover, and riffle/run/pool diversity), and impaired substrate condition throughout this diversity stratum resulting, largely, from urbanization and legacy effects of historical timber harvest operations. (All populations)

- Impaired instream water flow (diversity stratum wide) due to surface diversions and groundwater extraction, primarily for residential and agricultural use. This impaired instream water flow results in dewatered reaches and diminished water quality in the reaches that are not completely dewatered. (All populations)
- Impaired lagoon access, habitat, and water quality condition due to partial filling and rerouting for road building, railroad construction, and agricultural practices. (All populations)

In addition to the primary habitat concerns identified in the previous 5-year review (NMFS 2016a), a major emergent habitat concern affecting the Santa Cruz Mountains Diversity Stratum is wildfire-induced habitat impacts, including sedimentation, loss of riparian cover, and loss of instream wood. Since the last 5-year review (NMFS 2016a), the CZU wildfire complex burned approximately 81, 992 acres within this stratum, resulting in impacts to portions of the Pescadero Creek, Scott Creek, Waddell Creek, San Lorenzo River, Gazos Creek, and San Vicente Creek watersheds. See Listing Factor E for a broader discussion of the impacts of increasing wildfire risk.

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

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

- Impairment (sedimentation and loss of cover) and destruction of instream and riparian habitat within portions of the Pescadero Creek, Scott Creek, Waddell Creek, and San Lorenzo River watersheds due to the 2020 CZU Lightning Complex Fire.
- Impaired lagoon condition within Pilarcitos Creek, San Gregorio Creek, Pescadero Creek, Soquel Creek, and the San Lorenzo River.

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

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

- The Butano Creek Channel Hydrologic Reconnection Project located in the Pescadero Creek watershed. This project dredged approximately 1.5 miles of sediment-laden channel in Butano Creek; providing steelhead access to over 10 miles of upstream spawning habitat and reconnecting Butano Creek to the Pescadero Creek estuary. This project will also improve water quality; alleviating steelhead kills regularly caused by poor water quality.
- San Mateo Resource Conservation District 100 Ponds Projects is constructing, repairing, and enhancing 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.
- Installation of five channel complexity features on Butano Creek (tributary to Pescadero Creek). Four of the installations are channel spanning large wood debris, while one is a roughened ramp, designed to address the creek's incision. The project gives salmonids access to the floodplain and complex mainstem habitat.

- The San Vicente Creek Large Wood Habitat Enhancement Project was implemented in 2017. This project included felling 48 standing redwood trees into San Vicente Creek to improve habitat complexity.
- In 2019, the Upper Zayante Creek Stream Wood Enhancement Project was completed, which included 18 wood structures installed in over 1 mile of habitat in Upper Zayante Creek, tributary to the San Lorenzo River to retain sediment, develop riffles, create, pools, and provide cover habitat for CCC coho salmon and CCC steelhead. The Lower Scott Creek Floodplain and Habitat Enhancement Project Phases 1-3 were completed between 2014 and 2017. This project included installation and enhancement of multiple instream wood complexes and 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 Southern Coho Salmon Captive Broodstock Program monitoring and outplanting sites are located.

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

The Final Coastal Multispecies Recovery Plan (NMFS 2016c) and the previous 5-year review identified inadequate regulatory mechanisms as contributing substantially to the decline of the CCC steelhead DPS. Although many regulatory mechanisms and conservation efforts were in place at the time this DPS 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. Various federal, state, and county regulatory mechanisms are in place to minimize or avoid habitat degradation caused by human use and development. Many of these mechanisms have been improved and updated in the past 5 years, such as California State cannabis regulation and the California Sustainable Groundwater Management Act. However, the implementation and effectiveness of regulatory mechanisms has not been adequately documented. ***See Listing Factor D: Inadequacy of Existing Regulatory Mechanisms in this document for details.***

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

The greatest opportunities to advance recovery of CCC steelhead in the Santa Cruz Mountains Diversity Stratum are to:

- Improve estuary management and support/restore estuary habitat and function (including lagoon barrier formation and breach timing) in Pilarcitos Creek, San Gregorio Creek, Pescadero Creek, Soquel Creek, and the San Lorenzo River by removing fill and infrastructure and developing alternative methods of flood control.
- Restore and protect active channel area(s), floodways, and floodplains to accommodate natural fluvial processes. Focus on areas affected by urbanization in the Santa Cruz Mountains areas.

Listing Factor A Conclusion

New information available since the last 5-year review indicates there is improvement in freshwater and estuary habitat conditions because of restoration and habitat protection. However, while barrier removal and remediation has occurred within the DPS in the past 5 years, partial and complete passage barriers remain throughout the DPS, including large dams that block access to headwater habitat (e.g., Coastal and Interior San Francisco Bay strata). Urban development occurs in each of the strata, which complicates restoration opportunities and results in persistent impacts to habitat and water quantity and quality. Also, in some strata (e.g., Interior, Coastal San Francisco Bay, and Interior San Francisco Bay strata), existing water quantity and quality impairments have been exacerbated by the coupled effects of drought and ongoing water use, including dams. Habitat concerns remain in several subbasins of this DPS, particularly with regard to passage barriers, stream flow, water temperature, and turbidity in areas that exceed water quality standards due to anthropogenic causes, including effects related to dam operations (e.g., turbidity and temperature effects in the Interior, Coastal San Francisco Bay, and Interior San Francisco Bay strata). As described in detail in Section 4 (Recommendations for Future Actions), there remain numerous opportunities for habitat and surface water flow restoration or protection throughout the range of this DPS. This DPS will not reach viable status without additional habitat protection or restoration actions throughout the CCC steelhead geographic-area. Considering the mix of improved habitat conditions and ongoing habitat impairments and associated causes, we conclude that the risk to the species' persistence because of habitat destruction or modification has not changed significantly since the 2016 5-year review.

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

Harvest

Overfishing

Overfishing as a threat to CCC steelhead survival has diminished significantly since the initial listing of the DPS. Ocean harvest of steelhead is rare and an insignificant source of mortality for the DPS, and recreational fishing in freshwater is limited to catch and release of wild fish and retention of hatchery produced fish (NMFS 2016a). Sport fishing regulation changes implemented prior to the previous 5-year review to better protect salmonids along portions of the California Coast have remained in place. Since the 2016 5-year review, additional low-flow closures have been implemented. Effective January 2022, the low-flow closure period for California coastal streams in Mendocino, Sonoma, and Marin counties has been expanded by 2 months (previously a 6-month-long period from October 1 through March 31; now extended to an 8-month period from September 1 through April 30). These protections included low-flow closures and complete seasonal closures in some populations to reduce effects of ongoing drought, and to reduce problematic harvest (e.g., previous harvest/take allowances revised to catch and release only on Sonoma Creek). For CCC steelhead this includes populations within the streams of Interior and Coastal San Francisco Bay diversity strata.

Illegal Harvest

Freshwater poaching or unintentional take of CCC steelhead may occur. Where current abundance is below the "high risk" threshold (as described in Spence et al. 2008), losing adult fish to poaching could significantly impact population productivity and genetic diversity. There is no new information to suggest the overall risk of illegal harvest has increased since the initial listing of the species and since the previous 5-year review (NMFS 2016a). Spence et al. (2008) identified the CCC steelhead DPS as largely lacking sufficient data to determine extinction risk, but identified several CCC steelhead populations as being at high risk, including the following independent essential populations: San Leandro Creek, San Lorenzo Creek, and Alameda Creek. Abundance data continues to be limited throughout the DPS (Spence 2022) and the aforementioned populations are believed to remain at high risk. Data on illegal harvest rates is not available throughout the DPS; however, where occurring, particularly in high risk populations (e.g., San Leandro Creek, San Lorenzo Creek, and Alameda Creek), illegal harvest likely further impairs the viability of these populations by reducing abundance, productivity, and spatial structure and genetic diversity. Therefore, if occurring, illegal harvest may be posing a risk to the species' continued persistence, but we are unable to determine if there has been any change in this effect since the last 5-year review.

Research and Monitoring

Take of CCC steelhead under ESA sections 10(a)(1)(A) and 4(d) for scientific research and monitoring 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. During permitting, authorized mortality rates associated with scientific research and monitoring are generally capped at 0.5%, and actual mortality rates are typically only a fraction of what is authorized. As a result, the mortality levels that research causes are very low throughout the DPS. In addition, the effects research has on CCC steelhead are spread out over various reaches, tributaries, and areas across their range, and thus no area or population is likely to experience a disproportionate amount of loss. Therefore, scientific research 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 steelhead.

The majority of the requested take for naturally produced CCC steelhead juveniles has primarily been (and is expected to continue to be) capture via screw traps, electrofishing units, beach seines, fyke nets, minnow traps, hook and line angling, and hand or dip netting, with smaller numbers collected as a result of other seines, trawling, and those intentionally sacrificed. Adult take has primarily been (and is expected to continue to be) capture via weirs or fish ladders, with smaller numbers captured via hand or dip nets, hook and line angling, and those unintentionally captured by seining and other methods that target juveniles. Database records (NMFS APPS database; https://apps.nmfs.noaa.gov/) show that from 2015 through 2019 mortality rates for screw traps are typically less than 1% and backpack electrofishing are typically less than 3%. 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 3%. Also, a small number of adult fish may die as an unintended result of research because of interactions with trawl sampling equipment. However, the absolute numbers of mortalities caused by research remain low relative to abundance, with only four adult and just over 1,200 juvenile naturally produced CCC steelhead killed in total from 2015 through 2019.

Overall, research impacts remain minimal and geographically well distributed throughout the North-Central California Coast. Therefore, the overall effect on listed populations has not changed substantially, and we conclude that the risk to the species' persistence because of utilization related to scientific studies has changed little since the previous 5-year review (NMFS 2016a).

Listing Factor B Conclusion

Since the last 5-year review, ocean harvest continues to have a negligible impact on the DPS, and research and monitoring activities continue to have minimal impact. With a relatively small number of individuals affected by research and monitoring relative to the species' abundance, and the dispersed nature of research activities, the impacts from this source of mortality is not considered to be a limiting factor for this DPS. Regarding illegal recreational harvest, limited information continues to be available, so we are unable to determine if there has been any change in this effect since the last 5-year review. As identified in the previous 5-year review, if occurring, illegal harvest may be having adverse effects on population viability, particularly in high risk populations. The risk to the species' persistence because of overutilization remains essentially unchanged since the previous 5-year review (NMFS 2016a), with legal harvest and research/monitoring as a source of mortality continuing to have little to no impact on the recovery of the CCC steelhead DPS, and illegal harvest having an unknown impact on individual populations and the DPS as a whole.

Recommended Future Actions

Work with regulatory partners (i.e., CDFW) to identify where illegal harvest is occurring and determine if illegal harvest is having adverse effects on population viability, particularly in high risk populations.

Listing Factor C: Disease and Predation

Disease

Many common diseases exist in the wild that affect steelhead populations but increased individual resistance and natural ecological dynamics limit disease outbreaks and any resulting population-level impacts. No new information has emerged since listing or since the previous 5-year review (NMFS 2016a) that would suggest disease impacts have elevated in the time since, or that disease impacts are more than a minor factor in the present depressed state of the CCC steelhead DPS.

Predation

Marine Mammals

While both pinnipeds and killer whales (*Orcinus orca*) prey on ESA-listed salmonids in the eastern Pacific Ocean, killer whales are known to selectively prey on Chinook salmon, so they are not considered a major predator of steelhead (Hanson et al. 2021). The pinniped species that prey on CCC steelhead 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 in 1972, these pinniped stocks along the West Coast of the United States have steadily increased in abundance (Carretta et al. 2019).

In California, these pinnipeds occur in the marine environment, coastal bays, estuaries, and seasonally in the American, Sacramento[2] and other rivers. With pinniped numbers along the West Coast increasing (Carretta et al. 2019), and pinniped predation pressure on salmonids increasing elsewhere (northeastern Pacific Ocean [Chasco et al. 2017a, Chasco et al. 2017b]), there is the potential that this risk may be increasing. However, there are no qualitative or quantitative assessments of pinnipeds (number of seasonal animals) in California, nor are there predation rates on steelhead populations in California. This lack of information makes it difficult to discern the current status of this risk to CCC steelhead. Due to the potential for increased pinniped numbers to result in increased predation of salmonids, including CCC steelhead, we recommend that quantitative studies be implemented in California to help identify the status of this risk factor to CCC steelhead and other ESA-listed salmon and steelhead in the state.

Non-Marine Mammal Predation

Predation by generalist predators is a persistent, potentially increasing threat to CCC steelhead. An indirect effect of urbanization is the resultant increase in opportunistic, generalist predators (e.g., western gulls or raccoons) that utilize anthropogenic resources (e.g., landfills, garbage), increase their local carrying capacity, and result in greater numbers of predators that may prey upon steelhead. For example, Osterback et al. (2013) indicate that predation by western gulls may be greater than previously estimated. Introduced aquatic predators are also present throughout the DPS and present a potentially significant source or predation. For example, striped bass regularly occur in San Francisco and Tomales Bays, occasionally occur in coastal lagoons, and are found year round in the lower Russian River. Similarly, nearly all watersheds in the DPS support populations of introduced largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieu*), or spotted bass (*Micropterus punctulatus*). The predation threat to CCC steelhead by generalist predators is thought to be unchanged since the last 5-year review in 2016 (NMFS 2016a) and not a major factor limiting CCC steelhead persistence and recovery across their range; however, with increased urbanization and the likely related increase in generalist predators, additional studies at the population and DPS levels may be warranted to better understand the predatory impacts on CCC steelhead.

Listing Factor C Conclusion

No new information has emerged since listing or since the previous 5-year review (NMFS 2016a) that would suggest disease impacts are more than a minor factor affecting the condition of the CCC steelhead DPS. While pinniped and generalist predators are known to prey upon CCC steelhead, and the numbers of predators are expected to be increasing, we lack sufficient qualitative or quantitative information to determine if predation of CCC steelhead is increasing. Further study of pinniped and generalist predation on CCC steelhead is warranted.

Recommended Future Actions

- Expand, develop, fund, and implement monitoring in California to identify pinniped and generalist predator predation on CCC steelhead in select areas (e.g., river mouths/migratory pinch points), and quantitatively assess predation impacts on CCC steelhead stocks.

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[2] E-mail to Robert Anderson, NMFS, from Erica Meyers, California Department of Fish and Wildlife, December 16, 2020.

- Evaluate the effects of marine mammal salmon predators on ESA recovery goals for listed salmonids, including the CCC Steelhead DPS.
- Develop, fund, and implement studies to assess the predation risk posed by generalist fish and avian predators. Focus these studies in urbanized watersheds and other watersheds where habitat and surface water alterations have impaired habitat.

Listing Factor D: Inadequacy of Existing Regulatory Mechanisms

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

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 steelhead. 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 steelhead instream habitat, especially during summer months when flows are lowest and irrigation demand highest. This groundwater-surface water relationship largely goes unrecognized and unanalyzed during local and state permitting processes. Another factor that limits the State's environmental protection efforts is the number of illegal/unregulated cultivation operations that remain on the landscape. Many growers object to the cost associated with permitting a "legal" grow operation, which may incentivize growers to avoid state regulation. Appreciable improvements in instream habitat quality for salmon and steelhead and other native aquatic resources may not be realized unless industry oversight is improved and expanded.

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 steelhead 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 steelhead 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. 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 Envirormental 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. California Forest Practices/California 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 DPS) provide additional no-cut buffer protections to certain Class II-Standard watercourses. The rules do not apply to the southern portion of the CCC steelhead DPS where timber harvest occurs (i.e., portions of 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 steelhead 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. Given the recent increased level of wildfire frequency and severity, the revision of salvage logging practices to protect CCC steelhead is advisable.

4. Flood Protection Practices

In recent decades, Federal and local entities have recognized the issues caused by past flood control practices and are acting to avoid perpetuating these problems into the future. Positive efforts include implementing designs that integrate fluvial geomorphology with hydraulic engineering, remove hydraulic constrictions, restore floodplains, and provide fish passage. In addition, climate change and the associated threats of sea level rise and more severe and frequent flooding has again made flood control a priority for many local governments and private citizens. This renewed focus on flood control can be seen as a positive or negative trend, depending on the approach taken. Rebuilding flood control structures in-kind will perpetuate ongoing habitat impacts. However, applying current knowledge regarding the resiliency of natural ecosystems to climate change and the ability of healthy ecosystems to support flood protection should integrate ecosystem considerations into flood control designs – potentially resulting in habitat restoration at a grand scale, and significantly improved flood risk management. To guide future flood control projects in a direction that results in improvements to both habitat and flood protection, increased regulatory oversight would be useful to ensure flood control projects are designed to achieve long-term hydraulic, geomorphic, and ecological sustainability. Resource agencies should play an active role in informing communities and local flood control entities (through outreach and regulation) of how innovative flood control approaches can provide environmental benefits, long-term sustainability and cost-savings to flood protection efforts. Interagency review and coordination, and stakeholder involvement are likely to be integral to achieving these goals.

5. Habitat Focus Areas

The Russian River watershed (Coastal and Interior strata) was selected as the first Habitat Focus Area under NOAA's Habitat Blueprint. This was an important step to increase the effectiveness of NOAA's habitat conservation science and management efforts by identifying places where NOAA offices work to meet multiple habitat conservation objectives on a watershed scale. As part of NOAA's Habitat Focus Area, NOAA has been working to rebuild Russian River salmonids to sustainable levels through habitat protection and restoration. NOAA's National Weather Service has been improving frost, rainfall, and river forecasts in the Russian River watershed through improved data collection and modeling. NOAA's Office of Oceanic and Atmospheric Research is working to increase community resiliency to flooding damage through improved planning and water management strategies.

Regulatory Mechanisms Resulting in Inadequate or Decreased Protection

We remain concerned about the adequacy of existing habitat regulatory mechanisms to protect water quality from excess sediment and toxicity, ensure adequate instream flows, and prevent loss of habitat due to habitat conversions and decreased access to floodplains. 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 (TMDL)[3], filling of wetlands, point source permitting, the regulation of stormwater, and other provisions related to the protection of U.S. waters.

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

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[3] 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.

appropriate. Each state also issues National Pollution Discharge Elimination System 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.[4] 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 regulated under the Toxic Substances Control Act;[5] 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 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. In addition to implementation by the states and EPA, the USACE also implements the Federal Clean Water Act through its Section 404 Program, which regulates the dredging and filling of waters of the United States. The USACE Clean Water Act Section 404 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."

Stormwater Runoff

Stormwater runoff is the primary way that non-point source pollution is conveyed to waterways, where it may affect salmonids and their habitat. Pollutants in stormwater are reflective of their source areas and land use. 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. Stormwater 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 stormwater contaminants such as Polycyclic Aromatic Hydrocarbons (PAHs), oils and greases, various heavy metals such as copper and zinc, and other toxic substances such as tire particles (containing 6PPD-quinone).

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[4] 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.

[5] 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.

Fish embryos and larvae exposed to PAHs have been documented to experience adverse changes in heart physiology and morphology, including pericardial and/or yolk sac edema leading to heart failure or impaired swimming performance, even with only temporary exposure to low concentrations (Hicken et al. 2011, Brette et al. 2014, Incardona and Scholz 2017). Exposure of some PAHs to sunlight has been observed to increase toxicity to invertebrates (Pelletier et al. 1997, Swartz et al. 1997) and resulted in as little as 2 µg/L becoming toxic to calanoid copepods (Duesterloh et al. 2002). Impacts to phytoplankton and zooplankton communities have also been reported in the literature (Sibley et al. 2004, Bestari et al. 1998a).

Heavy metals such as copper and zinc are also well-documented contaminants in storm water from roadways (CA DTSC 2021, Caltrans 2003a, 2003b, 2000) and have been shown to detrimentally affect salmonids and their habitat at very low, environmentally realistic levels. These low levels are noted to impact the resistance of fishes to disease, cause hyperactivity, impair respiration, disrupt osmoregulation and calcium levels and/or impact olfactory performance leading to disruption in critical fish behaviors at concentrations that are at, or just slightly above, ambient concentrations (Eisler 2000, Hecht et al., 2007).

The tire particle associated 6PPD-quinone has only recently been identified as a source of mortality for salmon and steelhead, although it has been in use for many decades and may be responsible for observations of toxicity whose cause was previously listed as unknown. Tire-derived products used by agencies and municipalities, such as asphalt rubber paving, fill for overpass construction or surface area covers for porous walkways, paths and bike trails, may also contribute harmful chemicals to waterways (CA DTSC 2022). This contaminant is widely used by multiple tire manufacturers and the tire dust and shreds that produce it have been found to be ubiquitous where both rural and urban roadways drain into waterways (Sutton et al. 2019, Feist et al. 2017). Potential impact levels in a waterbody depend on roadway utilization (traffic density and average speeds) and road density (Feist et al. 2017, Peter et al. 2022) as well as the specific drainage patterns from the roadways. Symptoms of morbidity to *O. mykiss* exposed to untreated urban storm water runoff containing 6PPD-quinone were noticeable within hours, and they did not recover when transferred to clean water (French et al. 2022). Levels of 6PPD-quinone that have been found in laboratory studies to cause impacts to salmonids are realistic and documented in the environment (Challis et al. 2021, Johannessen et al. 2022).

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

Fortunately, other recent literature has shown that the mortality impacts can be limited by infiltrating the road runoff through soil media containing organic matter, which results in removal of contaminants (Fardel et al. 2020, Spromberg et al. 2016, McIntyre et al. 2015, McIntyre et al. 2018). Drainage systems that incorporate soil media for biofiltration of runoff are commonly included in new construction projects 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.

Therefore, pollution from these roads and streets remains a concern for steelhead, as well as toxic compounds in stormwater runoff from other non-point sources.

Section 404 Fill Permitting

Another challenge to Clean Water Act implementation relates to the permitting of fill. Under the Clean Water Act, the federal government has a “no net wetland loss” policy. While well-intentioned, this policy has been largely ineffective at preserving the amount and, more importantly, the ecological functions of wetland habitat in the U.S. (Dahl and Stedman 2013). Additionally, application of the “no net wetland loss” policy can, in some cases, restrict restoration of impaired habitat by limiting or precluding placement of beneficial fill. For example, the USACE’s implementation of this policy may impede placement of beneficial fill important for restoring impaired wetlands or waters (e.g., such as occur in former on-channel quarry areas, channels subject to anthropogenically caused scour/degradation, where human-induced land subsidence requires fill for restoration purposes, etc.).

A variety of factors, including inadequate staffing, training, and in some cases regulatory limitations on land uses (e.g., agricultural activities) and policy direction, result in ineffective protection of aquatic habitats important to migrating, spawning, and rearing steelhead. The deficiencies are particularly acute during large-scale flooding events, such as those associated with El Niño conditions, which can put additional strain on federal and state agencies implementing the Clean Water Act Section 404 and 401 programs. For example, at the federal level, the USACE lacks a comprehensive and consistent process to address the cumulative effects of continued waterfront, riverine, coastal, and wetland development, and USACE guidelines do not identify a methodology for assessing specific impacts or cumulative impacts.

The Clean Water Act is, therefore, not effectively protecting fishery resources, particularly regarding non-point sources of pollution and limitations of the “no wetland loss” policy. Leveraging existing state and federal authorities and partnerships will be critical to the protection of existing CCC steelhead habitat and restoration of impaired CCC steelhead habitat.

2. Federal Insecticide, Fungicide and Rodenticide Act (FIFRA)

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) provides for federal regulation of pesticide distribution, sale, and use. All pesticides distributed or sold in the United States must be registered (licensed) by the EPA. Before the EPA may register a pesticide under FIFRA, the applicant must show, among other things, that using the pesticide according to specifications "will not generally cause unreasonable adverse effects on the environment." NMFS has performed a series of consultations on the effects of 32 commonly applied chemical insecticides, herbicides, and fungicides, authorized for use per EPA label criteria (NMFS 2009, 2010, 2011, 2012, 2015, 2017, 2021). Of these 32 commonly applied chemical insecticides, herbicides, and fungicides, 18 have been determined to jeopardize the Central California Coast Steelhead DPS and adversely modify critical habitat for the Central California Coast Steelhead DPS (2,4-D, Carbaryl, Carbofuran, Chlorpyrifos, Diazinon, Diflubenzuron, Fenbutatin Oxide, Malathion, Methamidophos, Methomyl, Methyl Parathion, Naled, Oryzalin, Pendimethalin, Phorate, Phosmet, Propargite, and Trifluralin) and 3 have been found to adversely modify critical habitat for the Central California Coast Steelhead DPS but not jeopardize the CCC steelhead DPS (Chlorothalonil, Diuron, and Methidathion) (NMFS 2009, 2010, 2011, 2012, 2015, 2017).

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.

Nearly all West Coast salmon species, including 27 of the 28 species listed under the ESA, are negatively affected by an overall loss of floodplain habitat connectivity and complex channel habitat. The reduction and degradation of habitat has progressed over decades as flood control and wetland filling occurred to support agriculture, 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 42422); “Activities affecting this habitat include…wetland and floodplain alteration” (64 FR 50394).

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 2008a, 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 threshold for concern. This means that the requirement to address 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.

At the time of finalization of this 5-year review, DWR has not responded to any of NMFS' comments or direct attempts to coordinate on this issue. DWR is planning to release further guidance on SGMA and streamflow depletion in 2024.

5. California Freshwater Fishing Regulations

The 2022-2023 California State Sport Fishing Regulations allow catch and release of wild steelhead and retention of hatchery 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. As mentioned above in Listing Factor B, starting in 2015, CDFW amended California sport fishing regulations to include a low-flow fishing closure along the Sonoma and Mendocino county coasts. Since the 2016 5-year review, additional low-flow closures have also been implemented. Effective January 2022, the low-flow closure period for California coastal streams in Mendocino, Sonoma, and Marin counties has been extended by 2 months (previously October 1 through March 31; now September 1 through April 30).Low-flow closures also occur in the following creeks and rivers where CCC steelhead occur: Upper Penitencia Creek, Coyote Creeks, Pescadero Creek, Aptos Creek, Soquel Creek, San Lorenzo River, and coastal Santa Cruz County streams between the San Lorenzo River and Waddell Creek. These regulations are intended to minimize over-exploitation of ESA-protected adult steelhead when streamflows recede to a level where capture rates climb sharply.

Since the last 5-year review, sport fishing regulations were proposed by NMFS in 2021 for the Russian River to increase the daily bag limit of two adult hatchery steelhead per day to a four adult hatchery steelhead per day bag limit in the entire Russian River; however, CDFW has not supported this proposal thus far. These regulation changes proposed by NMFS to reduce the proportion of hatchery origin fish on natural spawning grounds, could have a small increase in incidental bycatch of wild steelhead, but are estimated to improve the overall fitness of wild stock in multiple steelhead populations throughout the Interior and Coastal strata.

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 (see 1.3.3 Associated rulemakings, above) 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. The primary goal of an FMEP is to devise biologically based fishery management strategies that ensure the conservation and recovery of listed species. These plans ensure proper fisheries management of sensitive stocks by establishing a more formal program to minimize the take of Federally listed salmonids. If an FMEP is implemented accordingly, the take of listed species in the fisheries will be covered under the ESA. There is not an FMEP in place for CCC steelhead, so the management benefits and fishing-related ESA take coverage benefits afforded by FMEPs are not currently realized for CCC steelhead. The CDFW is aware that an FMEP to cover fishing related take of CCC steelhead is not in place and has begun working with NMFS to develop an FMEP.

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.[6]

Listing Factor D: Conclusion

The Final Coastal Multispecies Recovery Plan and the previous 5-year review identified inadequate regulatory mechanisms as contributing to the decline of the CCC steelhead DPS. 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 DPS, 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. 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, and in some cases, may also constrain restoration actions. Improving wetland protection and habitat restoration within the CCC steelhead DPS will likely be critical in future recovery efforts.
- NFIP implementation in California may also be incrementally and permanently diminishing floodplain habitat form and function to the detriment of CCC steelhead.
- Lack of regulations or mitigation requirement 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 contribute to poor water quality affecting CCC steelhead and other salmonids.
- The California State Groundwater Management Act administered by DWR may support groundwater management at 2014 drought-related levels, which will continue ongoing surface water impairments for CCC steelhead and other salmonids. Revision of groundwater management standards, as recommended by NMFS, and DWR's coordination with NMFS will be critical to conservation and recovery of CCC steelhead and other listed salmonids.

Recommended Future Actions

The following actions would lead to improved effectiveness of regulatory mechanisms:

Habitat

- Improve regulations to minimize or mitigate for road-runoff containments resulting from existing infrastructure, re-development, and routine maintenance projects.
- Clean Water Act: Improve Clean Water Act implementation procedures to better allow beneficial fill actions important for habitat restoration.

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[6] 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

- NFIP: Initiate and complete Section 7 consultation regarding National Flood Insurance Program implementation in California.

- SGMA: Continue NMFS engagement as a stakeholder in GSP implementation.
- 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 steelhead.
- SGMA: Call for 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 steelhead habitat and harm these species.
- 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 to ensure actual fisheries impacts do not exceed those consistent with recovery goals.

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

Climate Change

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

Updated projections of climate change are similar to or greater than previous projections (IPCC 2021). NMFS is increasingly confident in our projections of changes to freshwater and marine systems because every year brings stronger validation of previous predictions in both physical and biological realms. Retaining and restoring habitat complexity, access to climate refuges (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

A major emergent habitat concern since the 2016 5-year review is the increased frequency and severity of large unprecedented wildfires throughout the CCC steelhead DPS. California Department of Forestry and Fire Prevention (CalFire) statistics show that 18 of the 20 largest wildfires in California history have occurred since 2003, and the eight largest fires on record have all occurred since 2017 (CalFire 2022). The frequency and severity of wildfires is affected by climate conditions. Climate change will impact forests of the western U.S. with increased drought severity and forest fire (Halofsky et al. 2020). Holden et al. (2018) examined environmental factors contributing to observed increases in the extent of forest fires throughout the western U.S., and 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). 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 et al. 2021).

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 (United States Forest Service 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. Large and frequent wildfires often burn riparian habitat, instream wood structures, and upland vegetation. The reduction in upland vegetation results in increased landslides and sediment input to affected waterways (Maina and Siirila-Woodburnm 2019; Dunham et al. 2003), and the reduction in riparian and instream wood decreases riparian cover and channel complexity; resulting in effects such as increased exposure to high levels of suspended sediment and reduced cover, which increase potential for injury (e.g., tissue damage from exposure to erosive sediments), decrease prey production (i.e., decrease forage success), and decrease spawning and rearing success. Consequently, the increased wildfire risk poses an increased risk to CCC steelhead and other listed salmonids.

Freshwater Environments

With climate change, low summer flows are likely to become lower, more variable, and less predictable Siegel and Crozier (2019). Most stream habitats will likely remain suitable for salmonids in the near future, with some becoming too warm (Isaak et al. 2018). 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.

These climate-change-driven effects to instream flow will affect freshwater environments, and consequently CCC steelhead habitat. Decreased water temperature suitability and decreased habitat quantity and quality are expected in basins susceptible to the effects of increased temperatures or where decreased or altered precipitation patterns are expected. For CCC steelhead, affects to freshwater environments may affect freshwater spawning, rearing, and migration habitat.

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 (NMFS 2016a). 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 steelhead.

In 2020-2022, California experienced a historically severe drought. All habitat in the CCC steelhead DPS was categorized as being in either an exceptional or extreme drought condition by the National Integrated Drought Information System and NOAA (Figure 3).[7] For 2021-2022, California drought conditions persisted. In spring 2021, many CCC steelhead streams that are usually flowing with water were already dry or almost dry. Areas that had recent wildfires 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 CCC steelhead populations will not be fully apparent until monitoring occurs when they return as adults.

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[7] https://www.drought.gov/states/california

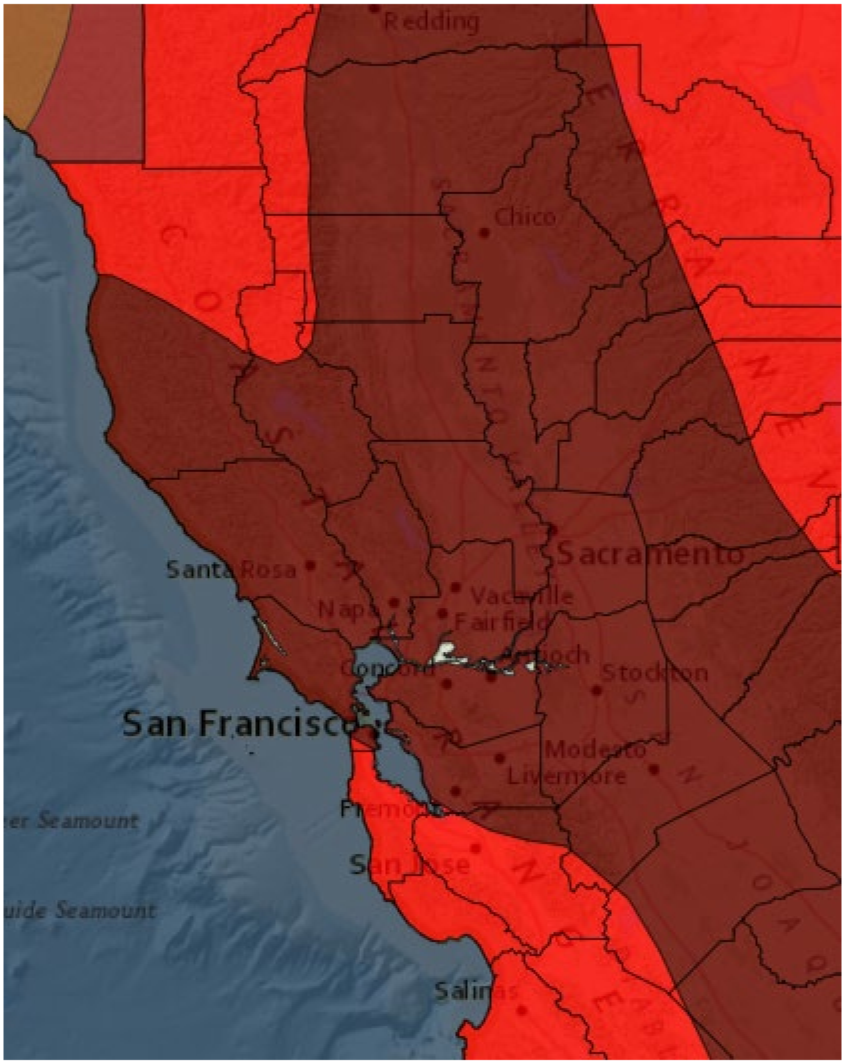


Figure 3. Drought Monitoring Conditions for California. The darker the color the more severe the drought conditions. The dark red areas are in an exceptional drought. The bright red areas are in an extreme drought. Credit: National Integrated Drought Information System and NOAA (2021).

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 and steelhead, affecting both 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, numerous fish species (including many tuna and sharks) demonstrate regional endothermy, which in many cases augments eyesight by warming the retinas. 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. Gliwicz et al. (2018) also suggest that ambient temperatures can similarly affect fish that do not demonstrate this trait. Climate change is also likely to affect the physiology of both prey and predator species, including salmon and steelhead, by reducing 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 and steelhead 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 and steelhead survival and reproductive success since they spend the majority of their lives in the ocean. Thiamine (vitamin B1) deficiency can occur in adult Chinook salmon and influence their reproductive success and the health of their progeny (Harder et al. 2018). In January 2020, early life stage (unfed fry) Chinook salmon from multiple 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 erratic swimming behaviors and high rates of early life stage mortality observed for unfed fry in hatcheries. Thiamine deficiency was confirmed with the rapid recovery of symptomatic fry 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). Laboratory studies have now linked fry mortality rates to egg thiamine concentrations for Central Valley Chinook salmon (Mantua et al., in prep), with thiamine dependent fry mortality estimated to have reached ~50% for the most impacted populations in the 2020-2023 period (Miles Daniels, U.C. Santa Cruz, personal communication). Sublethal effects have been reported for salmonids in other systems. In 2022, low thiamine levels were observed in steelhead sampled at Mad River Hatchery and Warm Springs Hatchery (Russian River) (SWFSC unpublished data). Further research is needed to determine the effect of thiamine deficiency on populations of CCC steelhead.

Impacts on Salmon and Steelhead

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 steelhead, 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 (Martin et al. 2017). 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 salmonids within the marine environment, and carryover effects from the freshwater experience (Holsman et al. 2012; Burke et al. 2013). It is generally accepted that salmonid 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 salmonids and the risk of salmonids being preyed upon (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.

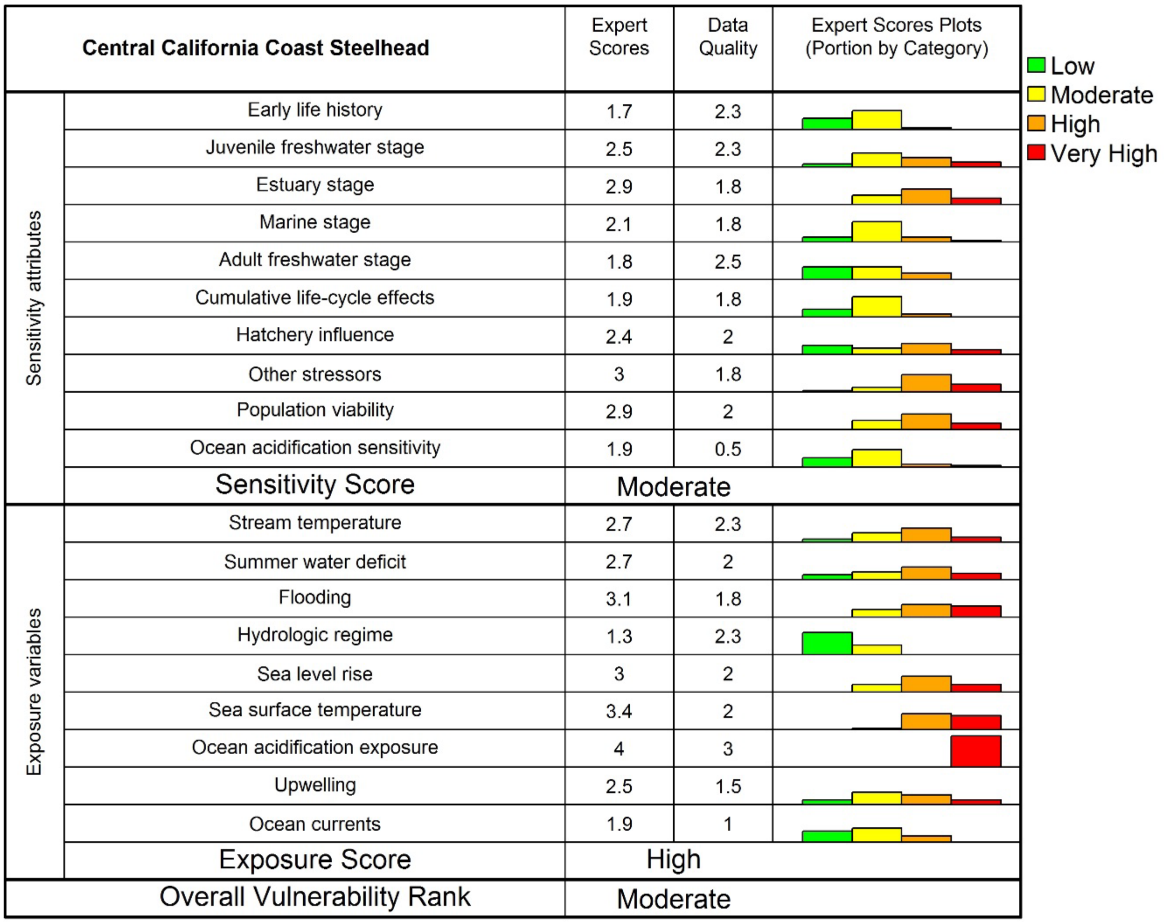
At the individual scale, climate impacts on salmonids in one life stage generally affect body size or timing in the next life stage and negative impacts can accumulate across multiple life stages (Healey 2011; Wainwright and Weitkamp 2013; Gosselin et al. 2021). Changes in winter precipitation will likely 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 or DPS (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). Salmon and steelhead 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. 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).

Species Specific Climate Effects (from Crozier et al. 2019)

Climate Effects on Abundance and Distribution – CCC steelhead ranked high in exposure to climate change effects, particularly sea surface temperature, sea level rise, flooding, and ocean acidification. Sea level rise is expected to impact important lagoon habitats for juvenile rearing, and flooding may increase the risk of redd scour. Exposure to summer water deficit and stream temperatures were only considered moderate, given that migration and spawn timing do not coincide with the highest temperatures and lowest flows in these watersheds. Because of the extended period juveniles spend in freshwater and lagoon environments they are very sensitive to water quality and habitat access during these stages, and the freshwater juvenile and estuary life stages were ranked moderate for sensitivity to climate change effects. Other extrinsic factors such as highly altered watersheds (e.g., dams, urbanization, water diversions, agriculture), small population sizes, and hatchery influence increase the likelihood of rapid extirpation when faced with climate change impacts, so CCC steelhead were ranked as having high sensitivity to climate change impacts when combined with these other stressors.

Climate Effects Adaptive Capacity – CCC steelhead were ranked moderate in adaptive capacity (Figure 4) because of the rainbow trout populations in the headwaters of its natal streams, which can produce individuals that take on an anadromous life form. This presents a potential source of extensive life history variation, such that if conditions become unfavorable for anadromous fish the DPS would likely shift towards a higher proportion of resident fish.



	Central California Coast Steelhead	Expert Scores	Data Quality	Expert Scores Plots (Portion by Category)
Sensitivity attributes	Early life history	1.7	2.3	
	Juvenile freshwater stage	2.5	2.3	
	Estuary stage	2.9	1.8	
	Marine stage	2.1	1.8	
	Adult freshwater stage	1.8	2.5	
	Cumulative life-cycle effects	1.9	1.8	
	Hatchery influence	2.4	2	
	Other stressors	3	1.8	
	Population viability	2.9	2	
	Ocean acidification sensitivity	1.9	0.5	
	Sensitivity Score	Moderate		
Exposure variables	Stream temperature	2.7	2.3	
	Summer water deficit	2.7	2	
	Flooding	3.1	1.8	
	Hydrologic regime	1.3	2.3	
	Sea level rise	3	2	
	Sea surface temperature	3.4	2	
	Ocean acidification exposure	4	3	
	Upwelling	2.5	1.5	
	Ocean currents	1.9	1	
	Exposure Score	High		
Overall Vulnerability Rank		Moderate		

Figure 4. CCC steelhead Climate Effects Exposure and Vulnerability (Crozier et al. 2019)

Hatchery Effects

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. The effects of hatchery fish on the status of an ESU or DPS depends upon which of the four key attributes—abundance, productivity, spatial structure, and diversity—are currently limiting the ESU/DPS, and how the hatchery fish within the ESU/DPS affect each of the attributes (70 FR 37204). To acknowledge and adequately minimize these risks to CCC steelhead, NMFS assisted program operators with the completion of Hatchery Genetic Management Plan (HGMP) for the Don Clausen Fish Hatchery Program, and the development of an HGMP for the Kingfisher Flat Hatchery Program.

The Don Clausen Fish Hatchery Program HGMP includes hatchery operations and management of the Don Clausen Fish Hatchery (DCFH) on Dry Creek and the Coyote Valley Fish Facility (CVFF) in the upper Russian River (CDFW and USACE 2021). Implementation of this Program is a collaborative effort among USACE, CDFW and NMFS with input from a Technical Advisory Committee (TAC). The Program is intended to meet the mandated responsibility to mitigate for habitat that has been lost due to the construction of Coyote Valley Dam in 1959 and Warm Springs Dam in 1982. Currently, each program may produce and release up to 200,000 smolts, though CVFF may release up to 300,000 once performance targets for the program are accomplished. All program rearing occurs at DCFH below Lake Sonoma at Warm Springs Dam in the lower river, while CVFF is an egg collection facility at Lake Mendocino in the upper Russian River watershed.

At the time of the previous 5-year review there were concerns about the amount of hatchery-derived CCC steelhead in the Russian River on natural spawning grounds and the potential for interbreeding between hatchery-derived CCC steelhead and wild CCC steelhead, and the potential for genetic consequences within the affected populations in the watershed (Williams et al. 2011, Spence 2016). Since the last 5-year review, monitoring performed in the Russian River (CDFW and USACE 2021) has provided evidence that hatchery-origin steelhead constitute roughly 50% of all CCC steelhead on natural spawning grounds in the Russian River and that these hatchery fish are being observed throughout the basin. Thus, previous concerns (Williams et al. 2011, Spence 2016) appear well founded. Consequently, the steelhead program is being revised to be operated as an integrated program as defined by the California Hatchery Scientific Review Group (CA HSRG 2012) and the Pacific Northwest Hatchery Scientific Review Group (HSRG 2004a and 2004b) where the natural environment drives the adaptation and fitness of a composite population of fish that spawn both in the hatchery and in the wild (i.e., naturally in the stream). Integration of the two components of the composite population is achieved by incorporating natural-origin fish into the broodstock along with hatchery-origin fish at each facility, and controlling the proportion of the total natural spawning escapement consisting of hatchery-origin fish. Program integration is expected to increase adult abundance, productivity, and fitness while minimizing the genetic divergence of hatchery fish from the naturally spawning population, into the various independent and dependent populations in the Russian River watershed.

The Kingfisher Flat Fish Steelhead Hatchery Program was operated by the Monterey Bay Salmon and Trout Project (MBSTP) for several decades. The program closed after the 2013-14 winter run. Historically, the steelhead hatchery program produced approximately 45,000 steelhead smolts annually, which were then planted into various streams throughout the greater Monterey Bay area. In later years of the program, the smolt releases were limited to the two source populations, the San Lorenzo River (approximately 40,000 smolts) and Scott Creek (approximately 5,000 smolts). In the hatchery, the progeny of these two source populations were kept isolated from one another. Eggs were also harvested from a few adult females for use by local schools as part of the regional Salmon and Trout Education Program. MBSTP has initiated the development of a HGMP for a revised steelhead program focused on the San Lorenzo River (MBSTP in prep.). NMFS will continue to provide technical assistance to MBSTP during the development of their HGMP and permit application including measures to minimize or avoid impacts to CCC steelhead in regional streams.

In the last 5-year review (NMFS 2016a), hatchery programs were determined to be having a limited effect on the DPS. Since that time, hatchery programs have continued to have a limited effect on the DPS and, with the development of HGMPs for the hatcheries operating in the CCC steelhead DPS, the effect of these hatcheries on the DPS is expected to be further reduced.

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 been shown to have 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 invertebrates 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 that AIS pose potential risk and 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. In areas where AIS are already established, control and management to prevent their further spread and lessen their impacts on native ecosystems will reduce the risk to salmonids and aid their recovery. The following discusses New Zealand Mudsnail (*Potamopyrgus antipodarum*), an AIS persisting in the CCC steelhead DPS since the last 5-year review (2016a), and Japanese Knotweed (*Fallopia japonica*), an AIS that has emerged as a concern in the DPS since the last 5-year review.

New Zealand Mudsnail (*Potamopyrgus antipodarum*)

The New Zealand mudsnail is rapidly invading California, in large part due to poorly cleaned field/fishing gear or boats when moving between aquatic locations. 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, limiting food availability for juvenile salmon and steelhead. Research 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 (NMFS 2016a), 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.[8] 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. Japanese knotweed establishes a monoculture with rapid growth, dense stands, and broad leaves that block the sun from native plants and tree seedlings. Steelhead are threatened by Japanese knotweed's ability to alter overhanging vegetation along the creek. The overhanging vegetation cools streams and provides steelhead with 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.[9] Current eradication efforts appear to have been successful and Japanese knotweed is currently a low threat to the CCC steelhead DPS.

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[8] https://www.nps.gov/articles/japanese-knotweed-eradication-efforts-continue-along-lagunitas-creek.htm

[9] https://ucanr.edu/sites/MarinKnotweedActionTeam/update/

Listing Factor E Conclusion

Based on the above: climate change is expected to have an ongoing, potentially increasing, threat to CCC steelhead; hatcheries are expected to have an ongoing low threat to a potentially beneficial effect on CCC steelhead; stormwater runoff is expected to have an ongoing threat to CCC steelhead; and invasive species are expected to pose an ongoing, potentially worsening, threat to CCC steelhead.

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.
- Support and protect instream flows, especially in reaches downstream of reservoirs or in basins with overdrawn groundwater basins. Actions should include groundwater protection, habitat enhancement, and reservoir releases that support adequate quantity and quality (including temperature) of surface water for all life stages of CCC steelhead.
- Control and manage AIS where they are already established to prevent their further spread and lessen their impacts on native ecosystems.
- Study the effects of AIS on ESA-listed salmonid populations, their designated critical habitat, and species recovery.
- Continue to implement, and expand, outreach and education efforts to prevent the spread of AIS species, such as New Zealand Mudsnail, and increase the eradication of Japanese Knotweed.
- Implement the Hatchery Genetic Management Program for CCC steelhead at the Coyote Valley and Don Clausen facilities;
- Develop and implement a Hatchery Genetic Management Program for CCC steelhead at the Kingfisher Flat Hatchery Program.

Other Recommendations

Research, Monitoring and Evaluation

California Coastal Monitoring Program

The CMP, described in Adams et al. 2011 (e.g., CDFW Fish Bulletin 180), draws on the viable salmonid populations framework of McElhaney et al. 2000 to assess salmonid viability in terms of the four population metrics: abundance, productivity, spatial structure, and diversity. The CMP can be used to generate adult estimates based on a variety of methods, including redd counts, spawner:redd ratios, and weir counts.

The 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. Unfortunately, lapses in funding have resulted in some programs, including those in the Santa Cruz Mountain Diversity Stratum, being interrupted or discontinued with no resumption in sight. Additionally, some sampling efforts generally target primarily coho salmon and do not encompass the entire spatial or temporal extent of spawning for other listed species (e.g., CCC steelhead), and several populations identified as essential to recovery are not currently monitored, including San Francisco Bay Area CCC steelhead streams.

Intermittent implementation and methodological issues continue to hinder 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 5-year reviews and will increase greatly in value as these time series become longer. Long-term dedicated resources to support California's monitoring program and critical science questions are needed.

We, therefore, recommend the following actions related to the CMP:

- allocate long-term dedicated resources to support California's monitoring program;
- expand the spatial extent of CMP monitoring with the use of sonar cameras and other methods to improve adult return information for selected populations that are not currently monitored; and
- implement quantitative studies to confirm population status. (Interior and Coastal San Francisco Bay diversity strata).

Other Research Priorities

- 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 implement plans to increase stream flows and reduce water temperatures in key streams with the greatest potential to support salmon and steelhead during ongoing drought and climate change.

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 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 manmade 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

As described in Spence (2022 in SWFSC 2022) and in sections 2.3.1 and Other Recommendations, above, the scarcity of monitoring data for CCC steelhead makes it difficult to determine whether or not CCC steelhead abundance has changed appreciably since the last 5-year review (NMFS 2016a). Though it is likely that many populations may be at high risk of extinction, especially those where historical habitat is now inaccessible due to dams and other large barriers, we lack sufficient abundance data to determine population condition. For example, in the Interior San Francisco Bay and Coastal San Francisco Bay diversity strata, where migration barriers and habitat impairments are most prevalent in the DPS and steelhead populations are believed to be in poorer condition than elsewhere in the DPS, the lack of consistent data throughout these strata prevents population-level estimates of abundance. Where monitoring does occur, it is typically structured to capture CCC coho salmon abundance data, not CCC steelhead data and lacks sufficient resolution to determine population condition. For example, monitoring in the North-Coastal and Santa Cruz Mountains diversity strata is designed primarily to quantify coho salmon abundance and, due to differences in spatial and temporal habitat use patterns between CCC coho salmon and CCC steelhead, these data have limited utility for assessing CCC steelhead abundance trends. Similarly, in the Russian River watershed, where monitoring data is relatively robust, population-level data is not yet available and direct comparison with recovery targets is not yet possible (Spence 2022 in SWFSC 2022). While we do not have evidence indicating that the extinction risk has increased since the last 5-year review (NMFS 2016a), it is important to highlight that due to data limitations, the status of CCC steelhead remains highly uncertain.

ESA Listing Factor Analysis

Listing Factor A (habitat): We conclude that the risk to CCC steelhead persistence due to degraded habitat conditions is high, and has not changed appreciably since the previous 5-year review. Habitat and passage improvement remain priority objectives throughout this DPS, particularly with regard to habitat quality and access, streamflow, and water temperature in anthropogenically impaired areas.

Listing Factor B (overutilization): We conclude that the risk to CCC steelhead persistence due to overutilization and scientific study is low and has not changed appreciably since the previous 5-year review. 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 the risk to CCC steelhead persistence due to disease or predation is low and has not changed appreciably since the previous 5-year review. We do, however, acknowledge that information on pinniped predation of ESA-listed salmon and steelhead in California (including CCC steelhead) is limited, and recommend that further study of pinniped predation interactions in California be implemented to determine whether these impacts are limiting the recovery of ESA-listed salmon and steelhead in the state (including CCC steelhead).

Listing Factor D (inadequacy of existing regulatory mechanisms): We conclude that the risk to CCC steelhead persistence due to the inadequacy of existing regulatory mechanisms is moderate and has decreased slightly since the previous 5-year review. New information available since the previous 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 fewer mechanisms making the protection and recovery of CCC steelhead challenging.

Listing Factor E (other manmade or natural factors): We conclude that the risk to CCC steelhead persistence due to other manmade and natural factors is high and has increased slightly since the previous 5-year review because of the major threats of climate change, droughts, wildfires and poor ocean conditions. CCC steelhead are vulnerable to the projected impacts of changing climate because of their anadromous life cycle which exposes them to climate induced habitat alterations that affect all stages of their life history.

Conclusion

Although conservation efforts for CCC steelhead have reduced some threats for this DPS, the threats described in section 2.3.2 (five listing factors) above have, with few exceptions, remained unchanged since the previous 5-year review (NMFS 2016a). Improvements have been made in small fish passage barriers, and numerous habitat restoration projects have improved habitat conditions. Conversely, habitat problems are still common throughout the region, legacy effects persist in many areas, new urban growth threatens existing habitat, and many more habitat improvements and protections are likely important to achieve viability. Similarly, legal harvest remains an insignificant source of mortality for the DPS, but data on illegal harvest is limited and insufficient to determine if illegal harvest is impairing the DPS, and while some existing regulatory mechanisms have been expanded (e.g., expansion of low-flow fishing closures), existing regulatory mechanisms could be further improved to better protect CCC steelhead. In particular, ongoing impacts from urbanization and diversion facilities (including small diversions as well as large dams) continue to impair habitat and limit species viability, and ongoing threats associated with urban expansion are expected to continue to adversely affect the DPS.

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 steelhead habitat have been widespread and will continue. Shifts in oceanographic dynamics, such as sea-surface temperatures, wind patterns, and coastal upwelling, can alter migration patterns and decrease food availability, greatly impacting CCC steelhead 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; however, the timeframe for implementation 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 key to reduce threats to CCC steelhead linked to climate change, given the global nature and extent of the issue.

After considering the biological viability of the CCC steelhead DPS and the current status of its ESA section 4(a)(1) factors, we conclude that the risk to the persistence of the CCC steelhead DPS has not changed significantly since the 2016 5-Year Review (NMFS 2016a).

2.4.1 DPS 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 steelhead DPS.

- The West Coast Regional Office's 2023 review of new information since the previous 5-year review regarding the DPS membership status of various hatchery programs indicates no changes in the CCC steelhead DPS membership are warranted.

- After re-evaluating the status of the hatchery stocks and programs as part of this 5-year review to determine whether they are still operational, and if so, whether they have been substantially modified, we found the Don Clausen Hatchery Program continuing to be operational and propagating stocks that are part of the CCC steelhead DPS according to our Hatchery Listing Policy (70 FR 37204, June 28, 2005). We also found that the Kingfisher Flat Hatchery has not been implemented since the winter of 2013-2014, but has not been terminated and could resume propagating stocks that are part of the CCC steelhead DPS according to our Hatchery Listing Policy (70 FR 37204, June 28, 2005).

2.4.2 DPS 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 steelhead since the time of the last viability assessment (Spence 2016; Williams et al. 2016).

- Our analysis of ESA section 4(a)(1) factors indicates that the collective risk to the persistence of CCC steelhead has not changed significantly since our previous 5-year review (NMFS 2016a).

3 · Results

3.1 Classification

Listing Status:
Based on the information identified above, we recommend that the CCC steelhead DPS remain listed as threatened.

DPS 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 steelhead DPS.

Hatchery Membership:
For the CCC steelhead DPS, we do not recommend any changes to the hatchery program membership.

3.2 New Recovery Priority Number

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

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

4 · Recommendations for Future Actions

In our review of the five listing factors, we identified several actions critical to improving the status of the CCC steelhead DPS. NMFS 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 to improve passage, habitat, flows, and population viability for CCC steelhead. Passage improvements are important 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 and estuarine habitat complexity, and the geomorphic and watershed processes that support habitat function. Flow protections and improvements are important to protect all life stages and habitat, and should support base (low) flows, natural-type hydrographs, and groundwater resources. Improved population monitoring is important to better understand the status of populations and the DPS.

To guide our recommendations for future actions, we focus on populations that need viability improvement according to DPS-, diversity stratum-, and population-level recovery criteria; the best available scientific information concerning DPS status; the role of the independent populations in meeting DPS and diversity stratum viability; limiting factors and threats; and the likelihood of action effectiveness. 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 high priority actions.

General Actions

- Monitoring - Expand funding and implementation of the California Coastal Salmonids Monitoring Program for CCC steelhead. Funding and implementation of coordinated programs is important to enable the tracking of the status of CCC steelhead populations, evaluate the effectiveness of restoration and mitigation efforts within the DPS, and to ensure the monitoring program will meet data needs to conduct 5-year reviews for all ESA listed species. This is a high priority action - without additional monitoring data, evaluations of viability and status of this DPS will continue to be subject to high uncertainty.

- Passage - Prioritize and implement passage projects that improve steelhead access to habitat, including headwater habitat which can help improve diversity and resiliency by providing access to more habitat, including stream reaches supporting reliable base flows and suitable temperatures, which can help ameliorate the effects of climate change.

- Habitat - Prioritize and implement habitat enhancement projects that restore riparian vegetation, streamflow, and floodplain connectivity and re-aggrade incised stream channels.

Listing Factor A:

- Remedy existing complete and partial barriers to passage. Focus on areas subjected to past urban, rural, and timber development in the San Francisco Bay area and Santa Cruz Mountains area.

- Improve estuary management and support/restore estuary habitat and function (including lagoon barrier formation and breach timing) in coastal Sonoma, San Mateo and Santa Cruz counties by removing fill and infrastructure, and developing alternative methods of flood control.

- Restore and protect active channel area(s), floodways, and floodplains to accommodate natural fluvial processes. Focus on areas affected by urbanization in the San Francisco Bay and Santa Cruz Mountains areas.

- Implement innovative and sustainable green infrastructure and low-impact design (LID) projects to manage pollutants, support ecosystem and infrastructure resiliency, and protect steelhead habitat. LID projects are those that result in the infiltration, evapotranspiration or use of stormwater in order to protect water quality, and include installing rain gardens, bioretention facilities, and pervious pavement. If applied at a broad scales, LID technology, policies, and watershed programs may protect and/or restore hydrologic and ecological functions in watersheds and support infrastructure protection and maintenance, thereby simultaneously protecting water quality and habitat for ESA listed species, and protecting necessary infrastructure. Efforts should focus on the greater San Francisco Bay area characterized by aging infrastructure and increasing climate-change-related flood risk.

- Protect and restore surface water flow, quality, and temperature:
    - Support and protect instream flows, especially in reaches downstream of reservoirs or in basins with overdrawn groundwater basins. Actions should include groundwater protection, habitat enhancement, and reservoir releases that support adequate quantity and quality (including temperature) of surface water for all life stages of CCC steelhead.
    - Remove impervious surfaces, and create or expand flood retention land and groundwater recharge basins to reduce the flashiness of hydrographs and increase summer baseflow.
    - Implement and enforce AB 2121, which codified (in sections 1259.2 and 1259.4 of the California Water Code) CDFW and NMFS' Water Diversion Guidelines to ensure protective flows for all life stages of steelhead and other salmonids.
    - Address sources of high suspended sediment concentrations conveyed by water released from Lake Mendocino, Russian River, California.

Listing Factor B:

- Work with regulatory partners (e.g., CDFW) to identify where illegal harvest is occurring and determine if illegal harvest is having adverse effects on population viability, particularly in high risk populations.

Listing Factor C:

- Expand, develop, and implement monitoring in California to identify pinniped predation interactions in select areas (e.g., river mouths/migratory pinch points), and quantitatively assess predation impacts on steelhead stocks.
- Implement studies to quantify predatory impacts of generalist predators on CCC steelhead.

Listing Factor D:

- Develop water conservation measures at local and State levels to include a drought management plan for each watershed that is triggered by minimum flow values.
- The State should prioritize completion of Total Maximum Daily Loads (TMDLs) for all CCC steelhead occupied water bodies that do not meet State water quality standards.
- Develop Fisheries Management and Evaluation Plans (FMEPs) that (1) incorporate delisting criteria, (2) determine impacts of fisheries management in terms of Viable Salmonid Population (VSP) parameters, (3) do not limit 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.
- Continue to work with state agencies to minimize impacts from cannabis operations on listed salmonids and to allow modification of salvage logging operations to protect burned but otherwise live and healthy trees.

Listing Factor E:

- Climate Change Effects:
    - Support resiliency to climate change by allowing a full range of habitat for salmonids to exploit as environmental conditions shift. Maximize habitat connectivity, increase in-stream complexity, shelter, substrate condition, and habitat diversity for all life stages. Focus on areas subject to urban, rural, and timber development in the San Francisco Bay area and Santa Cruz Mountains area.
- Hatchery management:

  - Implement the HGMP for CCC steelhead at the Coyote Valley and Don Clausen facilities;
  - Develop and implement a HGMP for CCC steelhead at the Kingfisher Flat Hatchery Program.
- Monitoring:
  - Implement adult population monitoring for each core population, including those in San Francisco Bay tributaries.
  - Study how CCC steelhead use estuary habitats in San Francisco Bay.
  - Where CCC steelhead co-occur with CCC coho, expand survey duration, timing, and watershed extent to better capture steelhead data.
- Control and manage AIS:
  - Continue to implement, and expand, outreach and education efforts to prevent the spread of AIS species, such as New Zealand Mudsnail, and increase the eradication of Japanese Knotweed.

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5.1 Federal Register Notices

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

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NATIONAL MARINE FISHERIES SERVICE
5-YEAR REVIEW

Central California Coast Steelhead

Current Classification: Threatened

Recommendation resulting from the 5-Year Review

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

Review Conducted By (Name and Office):

West Coast Region Central California Coast Steelhead DPS Evaluation Team

REGIONAL OFFICE APPROVAL:

Lead Regional Administrator, NOAA Fisheries

Approve RUVELAS.PENNY.1365830491 Digitally signed by RUVELAS.PENNY.1365830491 Date: 2024.11.25 14:09:25 -08'00' 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 RAUCH.SAMUEL.DEAN.1365850948 Digitally signed by RAUCH.SAMUEL.DEAN.1365850948 Date: 2024.12.03 12:39:33 -05'00' Date: _______