Science, Service, Stewardship

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

National Marine Fisheries Service
West Coast Region

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5-Year Review: California Central Valley Species

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

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1 · General Information

1.1 Introduction

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

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

1.1.1 Background on Salmonid Listing Determinations

The ESA defines species to include subspecies and distinct population segments (DPS) of vertebrate species. A species may be listed as threatened or endangered. To identify taxonomically recognized species of Pacific salmon species, NMFS utilizes the Policy on Applying the Definition of Species under the ESA to Pacific Salmon (56 FR 58612). Under this policy, we identify population groups that are evolutionarily significant units (ESUs) within taxonomically recognized species. We consider a group of populations to be an ESU if it is substantially reproductively isolated from other populations within the taxonomically recognized species and represents an important component in the evolutionary legacy of the species. We consider an ESU as constituting a DPS and, therefore, a species under the ESA (56 FR 58612). Under the DPS policy (61 FR 4722) 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 United States (U.S.) District Court decision in 2001 and on June 28, 2005, announced a final policy addressing the role of artificially propagated Pacific salmon and steelhead in listing determinations under the ESA (70 FR 37204) (Hatchery Listing Policy).[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 5-year reviews and ESA listing determinations for West Coast salmon ESUs on June 28, 2005 (70 FR 37160), and for steelhead DPSs on January 5, 2006 (71 FR 834). On August 15, 2011, we published our 5-year reviews and listing determinations for 11 ESUs of Pacific salmon and 6 DPSs of steelhead from the Pacific Northwest (76 FR 50448). On May 26, 2016, we published our 5-year reviews and listing determinations for 17 ESUs of Pacific salmon, 10 DPSs of steelhead, and the southern DPS of eulachon (*Thaleichthys pacificus*) (81 FR 33468).

1.2 Methodology Used to Complete the Review

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

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

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 using the four criteria – abundance, productivity, spatial structure, and diversity. By applying 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 delineations. At the end of this process, the science teams prepared reports detailing the results of their analyses (SWFSC 2023).

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

This report reflects the best available scientific information, including the work of the Southwest Fisheries Science Center (SWFSC)(SWFSC 2023); the report of the regional biologists regarding hatchery programs; recovery plans for the species in question; technical reports prepared in support of recovery plans for the species in question; the listing record (including the designation of critical habitat and adoption of protective regulations); recent biological opinions issued for the CCV 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 the information considered.

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

1.3.1 Federal Register Notice Announcing Initiation of This Review

84 FR 53117; October 4, 2019

1.3.2 Listing History

In 1998, NMFS listed CCV steelhead under the ESA and classified it as a threatened species (Table 1). In 2006, following the development of NMFS' Hatchery Listing Policy (70 FR 37204, June 28, 2005), we re-evaluated the status of this DPS and determined that the DPS continued to warrant listing as a threatened species. Furthermore, we determined that the Coleman National Fish Hatchery (CNFH) and Feather River Hatchery (FRH) stocks of CCV steelhead should be part of the DPS (Table 1).

Table 1. Summary of the listing history under the Endangered Species Act for the CCV Steelhead DPS.

Salmonid Species	ESU/DPS Name	Original Listing	Revised Listing(s)
Steelhead (*O. mykiss*)	California Central Valley Steelhead	**FR Notice:** 63 FR 13347 **Date:** 03/19/1998 **Classification:** Threatened	**FR Notice:** 71 FR 834 **Date:** 01/05/2006 **Re-affirmation:** 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 CCV 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, 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 CCV Steelhead DPS.

Salmonid Species	ESU/DPS Name	4(d) Protective Regulations	Critical Habitat Designations
Steelhead (*O. mykiss*)	California Central Valley Steelhead	**FR notice:** 65 FR 42422 **Date:** 7/10/2000	**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 CCV Steelhead DPS. These assessments include status reviews conducted by our SWFSC and technical reports prepared in support of recovery planning for this DPS.

Table 3. Summary of previous scientific assessments for CCV Steelhead DPS.

Salmonid Species	ESU/DPS Name	Document Citation
Steelhead *(O. mykiss)*	California Central Valley Steelhead	Johnson et al. 2023 NMFS 2016a Williams et al. 2016 Williams et al. 2011 Lindley et al. 2007 Lindley et al. 2006 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 productivity, spatial distribution, diversity, abundance, and trends) and recovery potential (major threats understood, management actions exist under 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. NMFS assigned CCV steelhead a recovery priority number of 3C, as reported in NMFS 2019a and shown in Table 4. In December 2023, NMFS issued the 2021-2022 Recovering Threatened and Endangered Species Report to Congress with updated recovery priority numbers. The number for CCV steelhead remained unchanged (NMFS 2023).

1.3.6 Recovery Plan or Outline

Table 4. Recovery Priority Number and Endangered Species Act Recovery Plans for the CCV Steelhead DPS.

Salmonid Species	ESU/DPS Name	Recovery Priority Number	Recovery Plans/Outline
Steelhead *(O. mykiss)*	California Central Valley Steelhead	3C	**Title:** Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-run Chinook Salmon and Central Valley Spring-run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead Available at: http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/california_central_valley/california_central_valley_recovery_plan_documents.html **Date:** 2014 **Type:** Final **FR Notice:** 79 FR 42504

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2 · Review Analysis

In this section, we review new information to determine whether the CCV 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
California Central Valley Steelhead	X	

Is the species under review listed as a DPS?

DPS Name	YES	NO
California Central Valley Steelhead	X	

Was the DPS listed prior to 1996?

DPS Name	YES	NO	Date Listed if Prior to 1996
California Central Valley 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 stocks for listing consideration under the Endangered Species Act (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, which meets the two criteria of being substantially reproductively isolated from other con-specific populations, and it represents an important component in the evolutionary legacy of the biological species. The 1996 joint NMFS/Fish and Wildlife Service (USFWS) DPS policy (61 FR 4722) affirmed that a stock (or stocks) of Pacific salmon is considered a DPS if it represents an ESU of a biological species. Accordingly, in listing the CCV steelhead DPS under the DPS policy in 1998, 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 CCV Steelhead DPS

DPS Delineation

This section summarizes information presented in SWFSC 2023: *Viability assessment for Pacific salmon and steelhead listed under the Endangered Species Act: Southwest* - Central Valley Recovery Domain.

We found no new information that would justify a change in the delineation of the CCV steelhead DPS (SWFSC 2023).

Membership of Hatchery Programs

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

In preparing this report, our hatchery management biologists reviewed the best available information regarding the 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 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 before any official change in hatchery membership.

At the 2016 5-year review, we defined the CCV steelhead DPS as including all naturally spawned anadromous *O. mykiss* (steelhead) originating below natural and manmade impassable barriers from the Sacramento and San Joaquin Rivers and their tributaries, excluding fish originating from San Francisco and San Pablo Bays and their tributaries; as well as steelhead from the following artificial propagation programs: the Coleman National Fish Hatchery Program and the Feather River Fish Hatchery Program (70 FR 37160, June 28, 2005).

Since 2016, we added the Mokelumne River Hatchery Program (MRH) to the CCV steelhead DPS because fish in this program are genetically most similar to Feather River Fish Hatchery (FRFH) Program steelhead, which are included in the DPS (85 FR 81822, December 17, 2020).

The addition or removal of an artificial propagation program from an ESU/DPS does not necessarily affect the listing status of the ESU/DPS. The addition of an artificial propagation program to an ESU/DPS represents our determination that the artificially propagated stock is no more divergent relative to the local natural population(s) than what would be expected between closely related natural populations within the ESU/DPS (70 FR 37204, June 28, 2005). We relied on the Hatchery Listing Policy in our 2020 Final Rule on Revisions to Hatchery Programs as Part of Pacific Salmon and Steelhead Species Listed under the Endangered Species Act (85 FR 81822; December 17, 2020).

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 criteria).

NMFS identified biological recovery criteria based on the viability criteria and guidance provided by the Central Valley Technical Recovery Team (CVTRT) (Lindley et al. 2007). For the CCV steelhead DPS, the recovery plan consists of biological objectives and criteria that are applied at the Population, Diversity Group, and ESU/DPS levels (NMFS 2014a). In that recovery plan, NMFS adopted and expanded on the viability criteria defined by the CVTRT (Lindley et al. 2007) as the biological recovery criteria for the DPS.

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

2.2.1 Final, Approved Recovery Plan Containing Objective, Measurable Criteria

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

DPS Name	YES	NO
California Central Valley Steelhead DPS	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
California Central Valley Steelhead DPS	X	

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

DPS Name	YES	NO
California Central Valley Steelhead DPS	X	

2.2.3 List The Biological Recovery Criteria As They Appear In The Recovery Plan

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

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/DPS viability.

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

For the purposes of recovery planning and development of recovery criteria, the NMFS-appointed CVTRT delineated 81 independent populations within the CCV steelhead DPS and separated them into six diversity groups based on climatological, hydrological, and geological characteristics: Basalt and Porous Lava, Central Western California, Northern Sierra Nevada, Northwestern California, Southern Sierra Nevada, and Suisun Bay Tributaries (Figure 1). Because recovery can be reached without the Suisun Bay Tributaries and Central Western California Diversity Groups, NMFS did not consider these two diversity groups to be steelhead recovery units and did not develop recovery criteria for them (NMFS 2014a).

Recovery strategies outlined in the Central Valley Salmon and Steelhead Recovery Plan (NMFS 2014a) are targeted on achieving, at a minimum, the biological viability criteria for the remaining four diversity groups in the DPS in order to have these four groups at viable (low risk) status with representation of all the major life history strategies present historically, and with the abundance, productivity, spatial structure, and diversity attributes required for long-term persistence. The plan recognizes that, at the diversity group 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 group viability, and hence DPS viability. The CVTRT recovery criteria, as described in Lindley et al. (2007), are hierarchical in nature, with ESU/DPS level criteria being based on the status of natural-origin CCV steelhead populations. The population extinction risk criteria are summarized below. A detailed description of the CVTRT viability criteria and their derivation (Lindley et al. 2007) can be found in the Central Valley Salmon and Steelhead Recovery Plan (NMFS 2014a).

The CVTRT assessed population viability using the four viable salmonid population parameters (abundance, productivity, spatial structure and diversity) (McElhany et al. 2000) and two sets of population viability criteria, expressed in terms of extinction risk. The first set of criteria looks at direct estimates of extinction risk from population viability models. If data are available, and analyses exist and are deemed reasonable for individual populations, such assessments may be efficient for assessing extinction risk. In addition, the CVTRT also provided simpler criteria. The simpler criteria include population size (and effective population size), population decline, catastrophic rate and effect, and hatchery influence. The CVTRT viability criteria are generally expressed relative to a particular risk threshold—a 5 percent risk of extinction over a 100-year period.

A key element of the recovery strategy is the focus of actions on watersheds that can support viable populations and contribute to meeting the diversity group standards for distribution and redundancy called for in the recovery plan (NMFS 2014a). To assess their potential to contribute to species recovery, watersheds in the four diversity groups that supported historical populations were placed into three categories, based on their potential to support populations with low risk of extinction. The three categories are Core 1, Core 2, and Core 3. Of highest priority are "Core 1" populations, which have been identified based on their known ability or potential to meet the low extinction risk criteria. "Core 2" populations are assumed to have the potential to meet the moderate risk of extinction criteria. "Core 3" populations are present intermittently and depend on straying from other nearby populations for their existences. Recovery of "Core 3" populations is likely to provide increased life history diversity to the DPS and to buffer against local catastrophic occurrences. Watersheds that support the species, historical and current populations, and watershed classifications are presented in Table 5.

Figure 1. Diversity Groups for the CCV Steelhead DPS in the Central Valley Domain (NMFS 2014a).

Table 5. CCV steelhead presence, risk of extinction, and recovery priority classification of watersheds with historical and current populations of CCV steelhead. "Core 1" populations—known ability or potential to meet the low extinction risk criteria; "Core 2" populations—assumed to have the potential to meet the moderate extinction risk criteria; "Core 3" populations—present on an intermittent basis and depend on straying from other nearby populations for their existences. "Primary" populations—top priority for reintroduction; "Candidate" populations—possible areas for reintroduction; "Non-candidate" populations—areas where reintroduction should not be attempted. "NA" is not applicable (NMFS 2014a).

Diversity Group	River, Creek or Sub-Reach	Historical Spawning	Current Spawning	Population Extinction Risk (from Williams et al. 2011, Lindley et al. 2007)	Recovery Priority Classification
Basalt and Porous Lava	Battle Creek	Yes	Yes	High	Core 1
Basalt and Porous Lava	Cow Creek	Yes	Yes	Uncertain	Core 2
Basalt and Porous Lava	Mainstem Sacramento River (below Keswick)	No	Yes	Uncertain	Core 2
Basalt and Porous Lava	Little Sacramento River	Yes	No	NA	Candidate
Basalt and Porous Lava	McCloud River	Yes	No	NA	Primary
Basalt and Porous Lava	Pit River	Yes	No	NA	Non-Candidate
Basalt and Porous Lava	Redding Area Tributaries	Yes	Yes	Uncertain	Core 2
Northwestern California	Putah Creek	Yes	Yes	Uncertain	Core 2
Northwestern California	Stony Creek	Yes	Yes	Uncertain	Core 3
Northwestern California	Thomes Creek	Yes	Yes	Uncertain	Core 2
Northwestern California	Cottonwood/Beegum	Yes	Yes	Uncertain	Core 2
Northwestern California	Clear Creek	Yes	Yes	Uncertain	Core 1
Northern Sierra Nevada	Cosumnes River	Yes	Yes	Uncertain	Core 3
Northern Sierra Nevada	Mokelumne River (below Comanche)	No	Yes	High	Core 2
Northern Sierra Nevada	Mokelumne River (above Pardee)	Yes	No	NA	Candidate
Northern Sierra Nevada	American River (below Nimbus)	No	Yes	High	Core 2
Northern Sierra Nevada	Upper American (above Folsom)	Yes	No	NA	Candidate
Northern Sierra Nevada	Auburn Ravine	No	Yes	Uncertain	Core 2
Northern Sierra Nevada	Dry Creek	Yes	Yes	Uncertain	Core 3
Northern Sierra Nevada	Feather River (below Oroville)	No	Yes	High	Core 2
Northern Sierra Nevada	West Branch Feather (above Oroville)	Yes	No	NA	Non-Candidate
Northern Sierra Nevada	North Fork Feather (above Oroville)	Yes	No	NA	Candidate
Northern Sierra Nevada	Middle Fork Feather (above Oroville)	Yes	No	NA	Non-Candidate
Northern Sierra Nevada	South Fork Feather (above Oroville)	Yes	No	NA	Non-Candidate
Northern Sierra Nevada	Bear River	Yes	Yes	Uncertain	Core 3
Northern Sierra Nevada	Yuba River (below Englebright)	No	Yes	Uncertain	Core 2
Northern Sierra Nevada	North, Middle, South Yuba Rivers (above Englebright)	Yes	No	NA	Primary
Northern Sierra Nevada	Butte Creek	Yes	Yes	Uncertain	Core 2
Northern Sierra Nevada	Big Chico	Yes	Yes	Uncertain	Core 2
Northern Sierra Nevada	Deer Creek	Yes	Yes	Uncertain	Core 1

Diversity Group	River, Creek or Sub-Reach	Historical Spawning	Current Spawning	Population Extinction Risk (from Williams et al. 2011, Lindley et al. 2007)	Recovery Priority Classification
Northern Sierra Nevada	Mill Creek	Yes	Yes	Uncertain	Core 1
Northern Sierra Nevada	Antelope Creek	Yes	Yes	Uncertain	Core 1
Southern Sierra Nevada	Calaveras River (below New Hogan)	No	Yes	Uncertain	Core 1
Southern Sierra Nevada	Upper Calaveras River (above New Hogan)	Yes	No	NA	Non-Candidate
Southern Sierra Nevada	Stanislaus River (below Goodwin)	No	Yes	Uncertain	Core 2
Southern Sierra Nevada	Upper Stanislaus River (above New Melones)	Yes	No	NA	Candidate
Southern Sierra Nevada	Tuolumne River (below La Grange)	No	Yes	Uncertain	Core 2
Southern Sierra Nevada	Upper Tuolumne River (abv La Grange and Don Pedro)	Yes	No	NA	Candidate
Southern Sierra Nevada	Merced River (below Crocker Huffman)	No	Yes	Uncertain	Core 2
Southern Sierra Nevada	Upper Merced River (above New Exchequer)	Yes	No	NA	Candidate
Southern Sierra Nevada	San Joaquin River (below Friant)	No	No	NA	Candidate
Southern Sierra Nevada	Upper San Joaquin (above Friant)	Yes	No	NA	Candidate

The Central Valley Salmon and Steelhead Recovery Plan (NMFS 2014a) includes biological recovery criteria based on the VSP concept. The biological recovery criteria ensure that recovery of salmonid populations is attained by addressing not only abundance, but also productivity, spatial structure, and diversity (Lindley et al. 2007). The Central Valley Salmon and Steelhead Recovery Plan includes the following recovery criteria:

DPS-Level Criteria:

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

To meet the recovery criteria for this DPS and thereby delist the species, the Central Valley Salmon and Steelhead Recovery Plan calls for at least nine populations at a low risk of extinction distributed throughout the Central Valley as outlined above, as well as additional populations at a moderate risk of extinction (NMFS 2014a). The current viability of CCV steelhead populations is described in greater detail in SWFSC (2023).

2.3 Updated Information and Current Species' Status

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

Updated Biological Risk Summary

For full analysis of VSP criteria for CCV steelhead see the SWFSC Viability Assessment (Johnson et al. 2023). Key summaries taken from the document are below.

Population trend data remain extremely limited for the CCV steelhead DPS. The total hatchery populations from CNFH, FRFH, and MRH have significantly increased since the 2010 and 2015 viability assessments. In fact, CNFH returns have steadily increased 15 percent per year over the last decade. Additional data are now available for Cottonwood, Antelope, Cow, Deer, and Mill Creeks, and Yuba, Stanislaus, and Tuolumne Rivers. Like all monitoring surveys, these data have limitations. For example, redd surveys can inflate steelhead estimates because redds can be created by non-anadromous *O. mykiss*. Also, some video weirs are not operated over the entire duration of steelhead migration. Since CCV steelhead are data deficient and these data represent the best available information, steelhead populations in these systems were evaluated using the viability criteria initially described in Lindley et al. (2007). Here, we present the population extinction risk levels determined by applying the viability criteria to the 17 populations for which adult abundance data were available (Table 6); the full evaluation and supporting data are described in Johnson et al. (2023).

Table 6. CCV Steelhead Population Extinction Risk for populations with available abundance data (adapted from Johnson et al. 2023).

Overall risk is determined by the highest risk score among each of the four criteria: population size, population decline, hatchery influence, and catastrophe.

Steelhead population	Extinction Risk	Criteria with Highest Risk Score
American River	Moderate	Population size
Antelope Creek	High	Population size
Battle Creek	Moderate	Population size and hatchery influence
Clear Creek	Moderate	Population size
CNFH	High	Hatchery influence
Cottonwood Creek	High	Population size
Cow Creek	High	Population size
Deer Creek	Moderate	Population size
Feather River	High	Population decline
Feather River Fish Hatchery	High	Hatchery influence
Mill Creek	Moderate	Population size
Mokelumne River	High	Population size
Mokelumne River Hatchery	High	Hatchery influence
Nimbus Fish Hatchery	High	Hatchery influence
Stanislaus River	High	Population size
Tuolumne River	High	Population size
Yuba River	Moderate	Population size

Currently, no CCV steelhead populations satisfy the low extinction risk criteria. Of the 17 populations evaluated, 11 are at high extinction risk, and 6 are at moderate extinction risk (Table 6). Twelve of the populations are at high or moderate extinction risk based on population size, indicating low abundance of natural-origin CV steelhead.

Looking broader than the individual population level, Chipps Island midwater trawl data provide information on the trend in abundance for the CCV steelhead DPS as a whole. The updated trawl data through 2019 indicate that the production of natural-origin steelhead remains very low relative to hatchery production. The catch-per-unit effort has fluctuated and generally increased over the past decade, but the proportion of the catch that is adipose fin-clipped (100% of hatchery steelhead production have been adipose fin-clipped starting in 1998) has increased steadily, reaching 96 percent during the drought in 2015. This information suggests that the vast majority of CCV steelhead outmigrating from the Sacramento-San Joaquin Delta (Delta) are of hatchery-origin.

The viability of the CCV steelhead DPS appears to have slightly improved since the 2010 and 2015 viability assessments. This modest improvement is driven by an increase in adult returns to hatcheries from their recent lows, but the abundance of natural-origin CV steelhead adults across Central Valley rivers remains less certain. Improvements to the total population sizes at CNFH, FRH, and MRH do not warrant a downgrading of the DPS extinction risk. Instead, the lack of improved natural production, as estimated by juvenile migrants exiting the river systems at Chipps Island, low natural population abundance, and large hatchery influence in the Southern Sierra Nevada Diversity Group are cause for concern.

2.3.2 ESA Listing Factor Analysis

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

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

Significant habitat restoration and protection actions at the federal, state, 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 years to decades to demonstrate such increases in viability (Ford 2022).

Current Status and Trends in Habitat

Below, we summarize information on the current status and trends in habitat conditions by diversity group since our 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 greatest 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 established by the CVTRT (Lindley et al. 2007) and adopted by NMFS in the Central Valley Salmon and Steelhead Recovery Plan (NMFS 2014a) as efforts that substantially address a key concern noted in above #1 and # 2, or, that represent a noteworthy conservation strategy; (4) key regulatory measures that are either adequate, or, inadequate and contributing substantially to the key concerns summarized above; and (5) recommended future recovery actions over the next 5 years toward achieving population viability, including: key near-term restoration actions that would address the key concerns summarized above; projects to address monitoring and research gaps; fixes or initiatives to address inadequate regulatory mechanisms, and addressing priority habitat areas when sequencing priority habitat restoration actions.

Following the diversity group-specific summaries, we then summarize information on the current status and trends in habitat conditions for areas that are shared by multiple diversity groups, including the Sacramento River downstream of the Red Bluff Diversion Dam (RBDD) (the Middle Sacramento River) and the Bay/Delta.

Basalt and Porous Lava Diversity Group

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

For the four CCV steelhead populations (Battle Creek, Cow Creek, Mainstem Sacramento River below Keswick Dam, and Redding Area Tributaries) comprising the Basalt and Porous Lava Diversity Group, the primary habitat concerns reported in the previous 5-year review (NMFS 2016a) continue to be:

- Blocked access to historical habitat in the McCloud River, Pit River, and Upper Sacramento River by the construction of the Shasta and Keswick Dams.
- Water diversions or hydroelectric operations in all watersheds. Reduction in flow, change in flow regime, and loss of seasonal water variability due to diversions and dams retaining water effect all populations.
- Antiquated fish screens, fish ladders, and diversion dams on streams (all populations).
- Alterations to river channels from historic occurrences such as gold mining, forestry, agriculture, and gravel mining (all populations).
- Reduction in available quality spawning gravel due to dams or other artificial structures altering natural sediment transportation and controlling flow (all populations, Schmidt and Wilcock 2008).
- Loss of historical floodplain habitat, loss of riparian function, and loss of habitat complexity for juvenile rearing and migratory corridors (all populations).

A major emergent habitat concern since the 2016 5-year review is the increased frequency and severity of drought and large, unprecedented wildfires throughout the diversity group's habitat. This increase is partly due to an increase in the number of people at the wildland-urban interface and climate change. Droughts reduce stream flows, and large fires cause significant reduction and loss of riparian habitat, as well as increased landslides and sediment input to the waterway with the subsequent loss of spawning habitat (Maina and Siirila-Woodburn 2020, Dunham et al. 2003).

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

There are no additional population-specific geographic areas of concern identified beyond the Battle Creek, Cow Creek, Mainstem Sacramento River below Keswick Dam, and Redding Area Tributaries enumerated above under key emergent and ongoing habitat concerns.

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

The protective measures and restoration actions addressing population-specific habitat concerns in the Basalt and Porous Lava diversity group since the 2016 5-year review include:

- Continued progress on the Battle Creek Salmon and Steelhead Restoration Project (NMFS 2005) with the initiation of the contracting phase for multiple major barrier removals. The North Battle Creek Feeder Diversion Dam ladder was repaired (U.S. Bureau of Reclamation).[2]
- The Cypress Avenue Bridge North Side Channel Habitat Restoration and Enhancement Project was completed in 2017, restoring access to 1.5 acres of side channel rearing habitat in the Upper Sacramento River (USBR 2020).
- The River Garden Farms Salmon Rearing Habitat Project, completed in 2017, installed 25 salmon refugia structures where juvenile salmonids can avoid predators and utilize improved rearing conditions in the Upper Sacramento River.
- The Kapusta 1a Side Channel Project, completed in April of 2018, restored river access to upper river salmonid rearing habitat near Sacramento RM 288 (USBR 2020).
- The Reading Island Side Channel Project was completed in late 2019, creating 11,500 linear feet of perennial habitat for salmon and steelhead near Sacramento RM 275 (USBR 2020).
- The Lake California Side Channel Reconnection Project was completed in late 2017, reconnecting side-channel habitat to the Upper Sacramento River between RM 269 and 270 (USBR 2020).

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

The Central Valley Salmon and Steelhead Recovery Plan (NMFS 2014a) and the 2016 5-year review did not identify inadequate regulatory mechanisms as a priority issue affecting CCV steelhead recovery in the Basalt and Porous Lava diversity group. Various federal, state, and county regulatory mechanisms are in place to minimize or avoid habitat degradation caused by human use and development. However, the implementation and effectiveness of regulatory mechanisms have not been adequately documented. ***See Listing Factor D: Inadequacy of Existing Regulatory Mechanisms in this document for details on this listing factor.***

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

The greatest opportunities to advance CCV steelhead population viability in the Basalt and Porous Lava diversity group are to:

- Complete the Battle Creek Restoration Project to restore 48 miles of historical steelhead habitat.
- Continue Upper Sacramento gravel augmentation to create and maintain steelhead spawning habitat in the mainstem Sacramento River.

[2] Battle Creek Restoration Project status available at: https://www.usbr.gov/mp/battlecreek/status.html

Northwestern California Diversity Group

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

For the five populations comprising the Northwestern California Diversity Group (Putah Creek, Stony Creek, Thomes Creek, Cottonwood/Beegum Creek, and Clear Creek), the primary habitat concerns reported in the previous 5-year review (NMFS 2016a) continue to be:

- Blocked access to historical habitat in the upper Clear Creek watershed and upper Stony Creek (Clear Creek Population and Stony Creek Population).
- Altered flow regimes in all watersheds caused by water management or hydroelectric operations in most watersheds.
- Antiquated fish screens, fish ladders, and diversion dams on streams, such as the Corning Canal Siphon and Black Butte Dam (all populations).
- Alterations to river channels from historic occurrences such as: gold mining, forestry, agriculture, and gravel mining (all populations).
- Reduction in available quality spawning gravel due to dams or other manmade structures altering natural sediment transportation and controlling flow (all populations, Schmidt and Wilcock 2008).

A major emergent habitat concern since the 2016 5-year review is the increased frequency and severity of large, unprecedented wildfires throughout the diversity group, partly resulting from an increase in the number of people at the wildland-urban interface and climate change. The 2018 Carr Fire in the Clear Creek watershed caused a significant reduction and loss of riparian habitat, as well as increased landslides and sediment input to the waterways with the subsequent loss of spawning habitat (Maina and Siirila-Woodburn, 2020, Dunham et al. 2003) (Clear Creek population).

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

The primary population-specific geographic area of concern since the 2016 5-year review is the Clear Creek watershed and the habitat damage from the 2018 Carr Fire (Clear Creek population).

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

- Winters Putah Creek River Parkway Project: Completed channel realignment in 2018 to increase water quality and reduce high water temperatures (NMFS 2017a, Putah Creek population).
- Continued implementation of CVPIA-funded spawning gravel augmentation for the Clear Creek population in 2016, 2017, 2018, and 2019.
- Completion of the 2019 Biological Opinion (NMFS 2019b) for Phase 3 of the Clear Creek Floodplain Restoration Project to realign Clear Creek to its natural channel alignment with completion of construction scheduled for the end of 2020 (NMFS 2017b, Clear Creek population).

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

The Central Valley Salmon and Steelhead Recovery Plan (NMFS 2014a) and the 2016 5-year review did not identify inadequate regulatory mechanisms as a priority issue affecting CCV steelhead recovery in the Northwestern California Diversity Group. 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 since the 2016 5-year review. However, the implementation and effectiveness of regulatory mechanisms have not been adequately documented. ***See Listing Factor D: Inadequacy of Existing Regulatory Mechanisms in this document for details.***

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

The greatest opportunities to advance CCV steelhead population viability in the Northwestern California diversity group are to:

- Continue implementation of Clear Creek restoration actions: gravel augmentation, flow management, and temperature regulation (Clear Creek population).
- Evaluate water releases from Black Butte Dam, water exchanges with the Tehama-Colusa Canal, and interim and long-term water diversion solutions (Stony Creek population).
- Develop and implement a spawning gravel augmentation plan in Beegum Creek (Cottonwood/Beegum Creek populations).
- Evaluate and improve passage at the Corning Canal siphon and at the two small seasonal push-up diversion dams near Paskenta and Henlyville (Thomes Creek population).
- Conduct an anadromous fish passage feasibility study in Putah Creek to assess upstream habitat conditions and operational alternatives (Putah Creek population)

Northern Sierra Nevada Diversity Group

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

For the twelve CCV steelhead populations (Cosumnes River, Yuba River, Dry Creek, Bear River, Butte Creek, Big Chico Creek, Deer Creek, Mill Creek, American River, Auburn Ravine, Feather River, and Antelope Creek) comprising the Northern Sierra Diversity Group, the primary habitat concerns reported in the previous 5-year review (NMFS 2016a) continue to be:

- Blocked access to historical habitat in the upper watersheds by the construction of large dams in the American River (Nimbus and Folsom Dams), Feather River (Oroville Dam), and the Yuba River (Englebright Dam), and the creation of new spawning populations that historically did not exist below those dams.
- Water diversions or hydroelectric operations in all watersheds. Reduction in flow, change in flow regime, and loss of seasonal water variability due to dams and diversions retaining water (all populations).

- Reduction in available quality spawning gravel due to dams or other artificial structures altering natural sediment transportation and controlling flow (all populations, Schmidt and Wilcock 2008).
- Antiquated fish screens, fish ladders, and diversion dams on streams (all populations).
- Alterations to river channels from the gold mining era, forestry, agriculture, and urbanization of watersheds (all populations).
- Loss of historical floodplain habitat, loss of riparian function, loss of habitat complexity for juvenile rearing and migratory corridors (all populations).
- Levee construction and maintenance projects that do not incorporate fish-friendly designs, thereby reducing habitat quality and/or quantity (Cosumnes, American, Bear, Yuba, Feather, and Butte populations).

A major emergent habitat concern since the 2016 5-year review is the increased frequency and severity of large, unprecedented wildfires throughout the diversity group, partly resulting from an increase in the number of people at the wildland-urban interface and climate change. The 2018 Camp Fire caused significant habitat damage in the Butte Creek watershed that caused significant reduction and loss of riparian habitat, as well as increased landslides and sediment input to the waterways with the subsequent loss of spawning habitat (Maina and Siirila-Woodburn 2020, Dunham et al. 2003) (Butte Creek population).

During February 2017, heavy precipitation and high flows in the Feather River basin resulted in extensive erosion and major damage to the main Flood Control Spillway and Emergency Spillway area at the California Department of Water Resources' Oroville Dam in Butte County, California. In response to erosion and concrete chute loss in the mid-section of the main Flood Control Outlet Spillway, the California Department of Water Resources (DWR) increased operation of the Emergency Spillway, which resulted in backcutting and erosion that threatened the dam's stability. DWR then increased flow in the damaged Flood Control Outlet Spillway to relieve pressure on the Emergency Spillway, which led to the loss of the lower portion of the main Flood Control Outlet Spillway chute. This caused significant erosion under and adjacent to the Flood Control Outlet Spillway. This emergency lead to extensive amounts of turbidity, flood flows, and fluctuating flows in the Lower Feather River downstream of Orvoville Dam and the Fish Barrier Dam. As flood flows recede, off-channel pools become disconnected from the river and any fish within these isolated pools become stranded.

DWR and California Department of Fish and Wildlife (CDFW) mobilized significant personnel and resources to implement fish rescues in response to the Oroville Dam Spillway incident. The effort included flying the river on multiple days to identify stranding pools using real-time mapping, and then deploying crews to over 50 miles of river daily to areas in most need of rescue efforts. The results of these fish rescues are described in White et al. (2017). To summarize, approximately 87 CCV steelhead, both adults and juveniles, were collected during rescue efforts, 41 percent of which were adipose fin-clipped, indicating they were hatchery-origin steelhead from the FRH.

Another consequence of the Oroville Dam Spillway incident was the mobilization of suspended sediment and spawning gravel during extremely high flows released during the emergency.

DWR has implemented a number of conservation measures to improve habitat conditions in the Feather River following the spillway incident. In August 2017, DWR completed the addition of 5,000 cubic yards of spawning gravel in the low flow channel of the Feather River to benefit both Central Valley spring-run Chinook salmon and CCV steelhead. DWR also removed a gravel plug from Moe's side channel to reconnect the channel to the Feather River and restore the channel's normal function.

Another newly recognized, emergent habitat area of concern is the Butte Slough Outfall Gates facility, located at the historical mouth of Butte Creek at the Sacramento River. Butte Creek is connected to the Sacramento River at the Butte Slough Outfall Gates and the downstream end of the Sutter Bypass, a remnant flood basin habitat (Garman 2013). Butte Creek historically entered the Sacramento River at the Butte Slough Outfall Gates location but is now diverted downstream for roughly 25 miles through the Sutter Bypass (Cordoleani et al. 2018). Butte Slough Outfall Gate facility operational constraints pose fish passage challenges for adult salmonids trying to enter Butte Creek through Butte Slough, resulting in large numbers of fish blocked at the gates waiting to pass (Nichols 2022). In 2018, a fish kill occurred in the area, likely caused by exposure to poor water quality, and 48 adult Chinook salmon carcasses were found by the downstream gates of the facility. Genetic samples indicate that the 48 fish were Butte Creek-origin spring-run Chinook salmon. Prior to 2018, it was not well documented that adult or juvenile salmonids were still actively using the facility as a migration corridor. Since 2018, preliminary research from the SWFSC has shown that juvenile spring-run Chinook salmon still outmigrate through this facility (Notch et al. 2022). Because CCV steelhead originating from Butte Creek likely migrate through Sutter Bypass and the Butte Slough Outfall Gates on their adult immigration to Butte Creek, NMFS assumes that the Butte Slough Outfall Gate facility also acts as a passage impediment to steelhead.

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

The primary population-specific geographic area of concern since the 2016 5-year review is the Butte Creek watershed and the damage caused by the 2018 Camp Fire (State of California Watershed Emergency Response Team Report 2018) to the habitat of the Butte Creek population. Butte Creek also has the passage impediment of Butte Slough Outfall Gates as an emergent concern for that geographic area.

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

- Modified the lower Deer Creek falls fish ladder in 2016 to improve upstream passage to the upper 6 miles of spawning habitat (NMFS 2014b, Deer Creek population).
- Continued real-time coordinated operations of the DeSabla Centerville Federal Energy Regulatory Commission (FERC) Project No. 803 to reduce water temperature-related effects on the Butte Creek spring-run Chinook salmon population, which provides benefits for over-summer-rearing steelhead.
- Initiated discussions on the feasibility of re-introducing CCV steelhead as part of a larger reintroduction effort targeting spring-run Chinook salmon above Englebright Dam (Yuba River population). Agencies and organizations participating in discussions include NMFS, U.S. Forest Service, Yuba Water Agency, CDFW, Trout Unlimited, American Rivers,

California Sportfishing Protection Alliance, Placer County Water Agency, and the South Yuba River Citizens League.

- Completed upwards of 5,000 linear feet of streambank stabilization in Butte Creek after the Camp Fire in 2018 to help preserve the watershed and water quality as much as possible (Butte Creek population).
- Completed gravel augmentation and side-channel construction throughout the lower American River in 2016, 2017, and 2019 through the Lower American River Anadromous Fish Habitat Restoration Program and the Water Forum (NMFS 2015b).
- Completed the Yuba River Canyon Salmon Habitat Restoration Project in 2018, which rehabilitated 8.29 acres of river channel and alluvial bar habitat (NMFS 2017d).
- Deer Creek Irrigation District (DCID) completed improvements in 2019 at their dam by adding a roughened rock ramp, re-profiling the diversion canal, and reconstructing the fish screen diversion head gates and diversion flow monitoring device. This allows for improved upstream and downstream fish passage (NMFS 2014b, Deer Creek population).
- Ward Dam fish passage improvements were completed in 2015. Due to recent sedimentation issues since the modifications, the addition of bendway weirs to prevent sedimentation is being planned (NMFS 2018a, Mill Creek population).
- Fish Passage and Habitat Improvement for Dry Creek project included removing an old earthen dam and fish ladder located on upper Dry Creek, allowing steelhead to access 5 miles of habitat that was previously blocked (NMFS 2018a). Completed in 2020 (Dry Creek Population).
- In 2019, the Penryn Road at Secret Ravine Culvert Upgrade Project, where an under-sized and damaged culvert was removed and replaced with a single-span concrete bridge, accommodated fish passage and full channel capacity (NMFS 2018a, Auburn Ravine population).

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

The Central Valley Salmon and Steelhead Recovery Plan (NMFS 2014a) and the 2016 5-year review did not identify inadequate regulatory mechanisms as a priority issue affecting CCV steelhead recovery in the Northern Sierra Nevada Diversity Group. Various federal, state, and county regulatory mechanisms are in place to minimize or avoid habitat degradation caused by human use and development. However, the implementation and effectiveness of regulatory mechanisms have not been adequately documented. ***See Listing Factor D: Inadequacy of Existing Regulatory Mechanisms in this document for details.***

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

The greatest opportunities to advance CCV steelhead population viability in the Northern Sierra diversity group are to:

- Improve instream flows on Mill, Deer, and Antelope Creeks.

- Implement the Stanford Vina Ranch Irrigation Company Fish Passage Project (Deer Creek population).
- Provide access to historical habitat through reintroduction of the Yuba River population above Englebright Dam as a mechanism to increase the population's spatial structure and reduce the risk of extinction.
- Develop and implement a steelhead reintroduction plan to re-colonize historical habitats above Nimbus and Folsom Dams: conduct feasibility study; conduct habitat evaluations; conduct 3-5 year pilot testing program; and implement long-term fish passage (American River population).
- Modify Daguerre Point Dam to provide unobstructed volitional upstream passage of adult steelhead and to minimize predation of juveniles moving downstream (Yuba River population).
- Modify Sunset Pumps to provide unimpeded upstream passage of adult steelhead and minimize predation of juveniles moving downstream (Feather River population).
- Modify the Butte Slough Outfall Gates Facility to allow for safe and effective volitional fish passage (Butte Creek Population).
- Reintroduce steelhead to the Yuba River above Englebright Dam.

Southern Sierra Nevada Diversity Group

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

For the six CCV steelhead populations (Merced River, Tuolumne River, Stanislaus River, San Joaquin River, Mokelumne River, and Calaveras River) comprising the Southern Sierra Diversity Group, the primary habitat concerns reported in the previous 5-year review continue to be:

- Blocked access for all six historical populations comprising the Southern Sierra Nevada Diversity Group to historical watershed spawning habitat in the Upper Calaveras River, Mokelumne River, Upper Stanislaus River, Upper Tuolumne River, Merced River, and San Joaquin River by the construction of the Camanche Dam, Pardee Dam, New Hogan Dam, Goodwin Dam, La Grange and New Don Pedro Dams, the Crocker-Huffman Dam, and Friant Dam (all populations).
- Low summer base flows and high summer temperatures in all the major tributaries and in the mainstem of the San Joaquin River impacting all six of the populations (San Joaquin, Stanislaus, Tuolumne, Calaveras, Mokelumne, and Merced River populations).
- Reduced available quality spawning gravel due to dams or other artificial structures altering natural sediment transportation and controlling flow (all populations, Schmidt and Wilcock 2008).
- Altered flow regimes in all watersheds caused by water management or hydroelectric operations (all populations).
- Antiquated fish screens, fish ladders, and diversion dams on streams (all populations).

- Altered river channels from the gold mining era, forestry, agriculture, and urbanization of watersheds (all populations).
- Lost historical floodplain habitat, riparian function, and habitat complexity for juvenile rearing and migratory corridors (all populations).
- Reduced habitat quality and/or quantity due to levee construction and maintenance projects that do not incorporate fish-friendly designs (all populations).

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

There are no additional population-specific geographic areas of concern identified beyond the Upper Calaveras River, Upper Stanislaus River, Upper Mokelumne River, Upper Tuolumne River, Merced River, and San Joaquin River enumerated above under key emergent and ongoing habitat concerns.

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

- Continued design of major fish passage projects in the upper San Joaquin River, led by the San Joaquin River Restoration Program (SJRRP), with construction scheduled to begin between 2020 and 2024 (SJRRP Funding Constrained Framework).
- Completion of floodplain restoration in spawning and holding reaches of the San Joaquin River below Friant Dam, through the Sycamore Island Pond Isolation Project (DWR 2018).
- Continued analysis on temperature, rearing habitat (SJRRP 2018a, Appendix F), and functional flows (SJRRP 2018b Appendix B) to identify how the SJRRP can best use allotted annual flows and funds to maximize habitat restoration benefit for juveniles and adults.
- Continued biannual meeting of the San Joaquin River Fisheries Advisory Technical Team (SJRFATT) to tackle how to shape annual spring and fall pulse flows in the various San Joaquin River tributaries to benefit steelhead. SJRFATT is a multi-agency group consisting of NMFS, USFWS, CDFW, California Environmental Protection Agency (EPA), and East Bay Municipal District (EBMUD).
- Implementation of the final 2019 Calaveras River Habitat Conservation Plan (HCP), including measures designed to maintain a viable steelhead population and maintain adequate habitat conditions upstream of Bellota. These measures are in the planning or early implementation phases. During the implementation phase, a permanent fishway, a NMFS-approved fish screen, and other improvements made at the Calaveras River Headworks facility will improve fish passage. In addition, there will also be year-round flows above Bellota weir that will maintain adequate habitat conditions for *O. mykiss*. (Calaveras River population).
- Completion of the Stanislaus River Channel and Floodplain Salmonid Habitat Rehabilitation Project at Rodden Road which rehabilitated side channel habitat and added spawning gravel back into the channel in 2017 (NMFS 2018b, Stanislaus River population).

- Completion of the Goodwin Canyon Salmonid Spawning Gravel Addition Project in 2016 as required in NMFS' 2009 Central Valley Project/State Water Project (CVP/SWP) operations Biological Opinion (Stanislaus River population).
- Implemented flows and temperature criteria in the Stanislaus River pursuant to NMFS' CVP/SWP operations Biological Opinion, now implementing 2019 CVP/SWP flows (Stanislaus River population).
- Completion of the Stanislaus River Salmonid Habitat Restoration Project at Buttonbush in 2016, restoring side channel habitat and floodplain habitat (NMFS 2016b, Stanislaus River population).
- Completion of the Lower Mokelumne River Spawning Habitat Improvement Project (consulted in 2015, annual through 2019), adding spawning gravel into the river (NMFS 2015c, Mokelumne River population).
- Implementation of the Joint Settlement Agreement (JSA) Flows, which was an agreement between USFWS, CDFW, and EBMUD. The JSA coordinates on flows, monitoring, habitat restoration, and hatchery operations. It includes a comprehensive monitoring and applied research program integrated with a well-coordinated program to adaptively manage water and power supply operations, flood control, hatchery operations, and ecosystem rehabilitation actions in the lower Mokelumne River (Mokelumne River population).
- Completion of the Dos Rios Ranch Floodplain Restoration and Hidden Valley Ranch Restoration in 2018, restoring access to 1,000 acres of floodplain habitat in the Tuolumne River at the confluence of the San Joaquin River (NMFS 2013b).
- Completion of the Dennett Dam Removal in 2018, allowing better access to 37 miles of habitat upstream (NMFS 2018c, Tuolumne River population).
- Completion of the Henderson Park Restoration Project in 2016, which included 15 acres of floodplain habitat and 8 acres of new spawning habitat, created through gravel augmentation (NMFS 2012a, Merced River).
- Completion of the Ruddle Diversion Fish Screen Installation Project in 2016, which reconfigured the inlet and installed a state of the art fish screen (NMFS 2010a, Merced River).

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

The Central Valley Salmon and Steelhead Recovery Plan (NMFS 2014a) and the 2016 5-year review did not identify inadequate regulatory mechanisms as a priority issue affecting CCV steelhead recovery in the Southern Sierra Nevada diversity group. Various federal, state, and county regulatory mechanisms are in place to minimize or avoid habitat degradation caused by human use and development. However, the implementation and effectiveness of regulatory mechanisms have not been adequately documented. ***See Listing Factor D: Inadequacy of Existing Regulatory Mechanisms in this document for details.***

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

The greatest opportunities to advance recovery of CCV steelhead in the Southern Sierra Diversity Group are to:

- Complete major SJRRP fish passage projects in the upper San Joaquin River to provide volitional passage for both adult and juvenile steelhead, improve the river's capacity for SJRRP restoration flows, and significantly improve the floodplain and rearing habitat for outmigrating juveniles (San Joaquin River population).
- Continue to utilize detailed temperature, rearing habitat, and functional flows studies to identify how the SJRRP can best use flows and funds to maximize benefit for specific habitat restoration projects for juveniles and adults (San Joaquin River population).
- Examine the potential of over-dam passage of steelhead into the Eastside tributaries. Studies have shown there could be adequate habitat above major rim dams of the San Joaquin River tributaries (all populations).
- Continue the biannual San Joaquin River Fisheries Advisory Technical Team (SJRFATT) efforts to coordinate flows between the river and tributaries to benefit steelhead outmigrating juveniles and upstream migration (all populations).
- Monitor for adult steelhead returning to the Eastside tributaries and mainstem San Joaquin River (all populations).
- Reintroduce the CCV steelhead Tuolumne River population above La Grange and New Don Pedro Dams.
- Reintroduce the CCV steelhead Merced River population above Crocker Huffman and New Exchequer Dams.
- Reintroduce the CCV steelhead Stanislaus River population above Goodwin Dam.

Downstream Habitat Shared by Multiple Diversity Groups

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

Of the four steelhead diversity groups present within the California Central Valley, three of those diversity groups must travel through the Middle Sacramento River (Northern Sierra, Northwestern California, and Basalt and Porous Lava group), and all four diversity groups must travel through the Bay-Delta to enter into the ocean. These shared habitat areas serve an important function to steelhead migration and rearing. The shared habitat areas are broken into two groups: the Middle Sacramento River (RBDD to Sacramento, including Sutter and Yolo Bypass); and the Bay-Delta (Tidal Delta, Estuary, and Bays). These discrete geographic areas comprise a significant portion of designated critical habitat for CCV steelhead. Given their importance, the following geographic areas remain a concern, as do the site-specific habitat features that continue to pose a threat to the recovery of the CCV steelhead DPS:

- Middle Sacramento River: The Middle Sacramento River is the reach of the river that runs from RBDD to the I Street Bridge in Sacramento. Juvenile steelhead use this habitat to rear and as a migratory route to the Delta. Given their complementary function as rearing habitats and migratory corridors, the Sutter and Yolo Bypasses are included in the description of the Middle Sacramento River geographic area. Specific habitat features in the Middle Sacramento River that continue to pose a threat to the viability of steelhead include:

- Flood-control infrastructure in the Middle Sacramento River prevents high flows from entering floodplains, diminishing both natural flood storage capacity and the processes that sustain healthy riverside forests and wetlands (Opperman et al. 2009). This degradation and isolation of rearing habitats has resulted in a more than 90 percent reduction of the historical juvenile rearing habitat across the Central Valley tributaries to the San Francisco Bay Delta Estuary (Herbold et al. 2018).
- Access to the Sutter and Yolo Bypasses is limited to high-flow events, when river stage is sufficient to overtop the respective flood control weirs. While inundated, the Yolo Bypass represents some of the most important seasonal floodplain habitat available for native fishes in the region (Takata et al. 2017, Johnston et al. 2018).
- Unscreened or poorly screened diversions in the Middle Sacramento River can entrain or impinge juvenile steelhead, leading to injury or even mortality of affected fish. The California Fish Passage Assessment Database has identified 685 unscreened diversions diverting directly from the Sacramento River (CFPAD 2020).
- The Middle Sacramento River has high exposure to both agricultural and urban stormwater run-off. While the exact risks of exposure to the thousands of contaminants are unknown, based on recent studies of salmonids in the Pacific Northwest, severe physiological impacts are possible, especially with repeated spawner exposure (McIntyre et al. 2018).

- Bay-Delta: The Bay-Delta geographic area includes the tidal Sacramento River downstream of the I Street Bridge in Sacramento City, the Sacramento-San Joaquin Delta, and the Suisun, San Pablo and San Francisco bays. The Bay-Delta and its habitats are an important area for outmigrating steelhead, serving as an area of transition where fish can acclimate to saltier conditions, and nursery areas where fish can forage and grow to improve their chance of ocean survival (Bottom 2002, Moyle et al. 2008). Specific habitat features in the Bay-Delta that continue to pose a threat to the viability of steelhead include:
  - Freshwater flows continue to be highly altered, and levels of floodplain inundation have remained poor in the Delta (San Francisco Estuary Partnership 2019).
  - Construction of and continued maintenance of Delta levees has contributed to the loss or isolation of 93 percent of floodplain and wetland rearing habitat (Herbold et al. 2018). Flood levee construction has an important human impact on Delta outflow, increasing the efficient conveyance of water through the Delta system (MacVean et al. 2018).
  - CVP and SWP operations, including upstream reservoir releases and diversions at the export facilities in the South Delta, result in significantly modified hydrologic conditions in the Delta (Cummins et al. 2008). Current operations of the CVP and SWP per the 2019 Biological Assessment (USBR 2019), 2019 Biological Opinion (NMFS 2019c), and 2019 CDFW Incidental Take Permit include a suite of measures intended to avoid or minimize impacts of water operations to salmonids.

- The Bay Delta hosts many non-native species, which can "negatively affect native species by disrupting food webs, altering ecosystem function, introducing disease, or displacing native species" (Mount et al. 2012).

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

No additional population-specific geographic areas of concern are identified for the Middle Sacramento River and Bay/Delta beyond the issues enumerated above under key emergent and ongoing habitat concerns in each diversity group.

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

The following protective measures and restoration actions addressing population-specific habitat concerns in Middle Sacramento and Bay-Delta shared habitat regions since the previous 5-year review include:

- California EcoRestore, established in 2015, is a state-sponsored portfolio of critical habitat restoration and enhancement projects in the Delta, Suisun Marsh, and Yolo Bypass region. As of May 2020, the total combined acreage of completed and planned projects is over 30,000 acres (California EcoRestore 2020); some individual projects are described below. Another clearinghouse summarizing projects in the Delta, many of which may benefit salmonids, is EcoAtlas (CWMW 2020): https://www.ecoatlas.org/regions/ecoregion/bay-delta/projects.
    - The Decker Island Tidal Habitat Restoration Project, which restored 140 acres of tidal wetland habitat along the Sacramento River, was completed in 2018 (all populations).
    - The Tule Red Tidal Restoration Project was completed in 2019, restoring 420 acres of self-sustaining tidal habitat on the eastern edge of Grizzly Bay in the Suisun Marsh (all populations).
    - The Winter Island Tidal Habitat Restoration Project was completed in 2019, restoring unrestricted tidal activity to 589 acres of estuarine-rearing habitat near the confluence of the Sacramento and San Joaquin Rivers (California EcoRestore 2020) (all populations).
    - The Yolo-Flyway Farms Tidal Habitat Restoration Project was completed in 2018, reestablishing access to 359 acres of tidal freshwater and seasonal wetlands at the southern end of the Yolo Bypass in the northwestern Delta (all populations).
- The Knights Landing Outfall Gates, although completed in 2015, includes operation of a positive fish barrier downstream of the Colusa Basin Drain (CBD), which didn't begin until 2016. This structure consists of a metal picket weir and concrete wing walls that limit the potential for adult salmonids to enter the CBD (NMFS 2015a). The picket weirs were damaged in 2017/2018 storms, but have since been repaired, restoring the intended function of the fish barrier to keep fish in the Sacramento River and block them from entering the CBD through the Knights Landing Outfall Gates (Northern Sierra, Northwestern California, and Basalt and Porous Lava populations).
- The Wallace Weir Fish Rescue Facility, completed in 2018, consists of a barrier and fish rescue facility. This permanent barrier at Wallace Weir serves to limit adult salmon entering

the CBD via the Knights Landing Ridge Cut, and the adjacent fish rescue facility allows for the relocation of fish otherwise stranded at the weir (NMFS 2016c) (Northern Sierra, Northwestern California, and Basalt and Porous Lava populations).

- The Fremont Weir Adult Fish Passage Modification Project was completed in 2019, where a new fish passage structure was constructed at the Fremont Weir. The new structure widened and deepened the existing fish ladder to improve passage of salmon and sturgeon (NMFS 2017c) (Northern Sierra, Northwestern California, and Basalt and Porous Lava populations).
- The Reclamation District 2035 (RD 2035) and Woodland-Davis Clean Water Agency (WDCWA) combined diversion and fish screen facility was completed on September 13, 2016. This project screened a previously unscreened 400 cfs water diversion on the Sacramento River (NMFS 2013a) (Northern Sierra, Northwestern California, and Basalt and Porous Lava populations).
- The Meridian Farms Water Company Fish Screen Project (Phase 2), completed in 2020, screened three previously unscreened pumps along the middle Sacramento River, significantly reducing the risk of steelhead impingement and entrainment at those water diversions (NMFS 2014c) (Northern Sierra, Northwestern California, and Basalt and Porous Lava populations).
- The Bullock Bend Mitigation Bank was established in 2016, reconnecting 120 acres of off-channel salmon-rearing habitat to the Sacramento River through a breach in the farm berm that allows for the natural flooding of the area.
- Current operations of the CVP and SWP per the 2019 Biological Assessment (USBR 2019), 2019 Biological Opinion (NMFS 2019c), and 2019 CDFW Incidental Take Permit include a suite of measures intended to avoid or minimize impacts of Delta water operations to salmonid migratory and rearing habitat, for example:
    - closing the Delta Cross Channel during the peak juvenile outmigration period to limit routing of juvenile salmonids from the mainstem Sacramento River into the interior Delta where survival is lower, and
    - minimizing entrainment of salmonids by limiting negative flows in Old and Middle Rivers, a metric used to indicate how export pumping at Banks and Jones Pumping Plants influences hydrodynamics in the south Delta.
- The 2019 CDFW Incidental Take Permit requires the SWP to take additional measures in the Delta to improve habitat, including, for example:
    - installing a barrier at Georgiana Slough to further limit routing of juvenile salmonids from the mainstem Sacramento River into the interior Delta, and
    - improving hydrodynamic conditions in the Delta for salmonid outmigration with a spring outflow action.

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

The Central Valley Salmon and Steelhead Recovery Plan (NMFS 2014a) and the 2016 5-year review identified inadequate regulatory mechanisms as a priority issue affecting CCV steelhead recovery in the Middle Sacramento and Bay-Delta shared habitat regions. Various federal, state, and county regulatory mechanisms are in place to minimize or avoid habitat degradation caused by human use and development. However, the implementation and effectiveness of regulatory mechanisms have not been adequately documented. ***See Listing Factor D: Inadequacy of Existing Regulatory Mechanisms in this document for details.***

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

The greatest opportunities to advance CCV steelhead population viability in the Middle Sacramento and Bay-Delta shared habitat regions are to:

- Implement measures to restore access to floodplains and the flood control bypasses of the Middle Sacramento River to accommodate increased steelhead floodplain rearing potential and aquatic food web production (Northern Sierra, Northwestern California, and Basalt and Porous Lava groups).
- Operate CVP/SWP export facilities and associated project infrastructure to maximize the efficiency of salvage operations at the export facilities while maintaining and enhancing the function of the Sacramento River and Delta as a migration corridor and freshwater and estuarine rearing habitat free of obstructions with suitable cover, forage, and water quality (all populations).
- Construct the Fremont Weir Big Notch to allow increased adult fish passage out of the Yolo Bypass (Northern Sierra, Northwestern California, and Basalt and Porous Lava groups).
- Repair the Knights Landing Outfall Gates after the malfunction in 2017/2018, to prevent adult steelhead from getting trapped in the Colusa Basin Drain (Northern Sierra, Northwestern California, and Basalt and Porous Lava groups).

DPS Summary

The risk to the species' persistence because of habitat destruction or modification has decreased in some regards since the previous 5-year review. However, major habitat concerns remain in this DPS including, but not limited to: (1) impassable dams, water diversions, and hydroelectric operations on almost every major river in the Central Valley; (2) antiquated fish screens, fish ladders, and diversion dams on streams throughout the Sacramento River basin; (3) levee construction and maintenance projects that do not incorporate fish-friendly designs; (4) unprecedented catastrophic wildfires; and (5) low flows due to recent drought. All of those issues and operations reduce the habitat quality and/or quantity for steelhead.

Listing Factor A Conclusion

While some conservation measures have been successful in improving habitat conditions for the CCV steelhead DPS since it was listed in 1998, fundamental problems with the quality of the remaining habitat remain since the previous 5-year review in 2016 (NMFS 2016a). Overall, major habitat expansion and restoration for CCV steelhead has not occurred as of this review, and because of that, the loss of historical habitat and the degradation of remaining habitat continue to be major threats to the persistence of CCV steelhead DPS.

2.3.2.2 Listing Factor B: Overutilization For Commercial, Recreational, Scientific, Or Educational Purposes

Harvest

Ocean harvest of steelhead is rare and is likely an insignificant source of mortality for CCV steelhead.

Since the early 1990s, anglers fishing for steelhead in anadromous portions of California waters have been required to purchase a steelhead report card. The anglers must report information on the dates and locations of fishing, the number of adult steelhead kept, the number of adult steelhead released, the origin of the fish caught (hatchery or wild), and the number of hours fished (Jackson 2007, CDFW 2016). While anglers are required to report this information, average compliance rates are low, approximately 30 percent (CDFW 2016). Poor reporting of report card data and other data deficiencies precludes a rigorous assessment of harvest impacts.

California prohibits retention of natural-origin steelhead. Fishing effort estimates are not available from report card data for recent years (post-2014). CDFW performs angler surveys on Central Valley streams, and data from these surveys are used to estimate steelhead harvest and fishing effort; however, these estimates do not appear to be regularly reported. No direct information is readily available on the level of CCV steelhead fishery impacts. Given this relatively sparse information, it is difficult to conclude whether the level of harvest impacts on CCV steelhead has changed appreciably in recent years. There has been little change to fishing regulations in California's Valley district in recent years.

There is some concern over hooking and handling stress causing mortality of ESA-listed steelhead parr and smolts on popular rivers, such as the American and Feather Rivers. High water temperatures during the summer and fall likely contribute to increased levels of mortality. CDFW has proposed a study on the American River to evaluate the extent of this problem.

Scientific Research and Monitoring

Take under ESA sections 10(a)(1)(A) and 4(d) for scientific research and monitoring for CCV steelhead remains low in comparison to their abundance. Much of the work being conducted is to fulfilling state and federal agency obligations under the ESA to ascertain the species' status. Authorized mortality rates (i.e., lethal take allowed under the permits NMFS issues) associated with scientific research and monitoring are generally capped at 0.5 percent of total abundance across the West Coast Region for all listed salmonid ESUs and DPSs. As a result, the mortality levels that research causes are very low throughout the region. In addition, and as with all other listed salmonids, the effects research has on the California Central Valley salmonids are spread out over various reaches, tributaries, and areas across all of their ranges, and thus, no area or population is likely to experience a disproportionate amount of loss. Therefore, the research program, as a whole, has only a very small impact on overall population abundance, a similarly small impact on productivity, and no measurable effect on spatial structure or diversity for CCV steelhead.

The majority of the requested take for naturally produced juveniles has primarily been (and is expected to continue to be) capture via screw traps, electrofishing units, beach seines, hand or dip netting, hook and line sampling, incline plane traps, and midwater trawls, with smaller numbers collected as a result of capture via fyke nets, minnow traps, trammel or hoop nets, weirs, other seines, trawling, fish screens, and those intentionally sacrificed. Adult take has primarily been (and is expected to continue to be) capture via fish ladders, hook and line angling, and weirs, with smaller numbers captured via trawls, fyke nets, or hand or dip nets, and other methods targeting juveniles, such as screw traps or seining, which may unintentionally capture adults. Database records (NMFS APPS database; https://apps.nmfs.noaa.gov/) show that from 2015 through 2019, mortality rates for screw traps were typically less than one percent and backpack electrofishing were typically less than three percent. Unintentional mortality rates from seining, hand or hoop netting, fyke nets, minnow traps, weirs, and hook and line methods are also limited to no more than three percent. 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 6 adult and 42 juvenile naturally-produced CCV steelhead killed in total from 2015 through 2019.

Overall, research impacts remain minimal and geographically well distributed throughout the California Central Valley, Sacramento-San Joaquin Rivers Delta and San Francisco Bay. 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

Ocean harvest and freshwater exploitation rates are likely insignificant sources of mortality for CCV steelhead. Restrictions in place in 2016 have continued. Scientific research continues to have minimal impact on the DPS. Due to the small number of individuals affected 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. The risk to the species' persistence because of overutilization remains essentially unchanged since the 2016 5-year review, with harvest and research/monitoring sources of mortality continuing to have little to no impact on the recovery of the CCV steelhead.

2.3.2.3 Listing Factor C: Disease and Predation

Predation

Predation is an ongoing threat to this DPS throughout all Central Valley rivers, but especially in the mainstem Sacramento River, the mainstem San Joaquin River, and in the Delta, where there are high densities of non-native fish (e.g., striped bass, large-mouth bass, and catfish species) that predate on outmigrating juvenile salmon (Michel et al. 2020). Some native species, such as Sacramento pikeminnow, also predate on outmigrating juvenile salmonids (Stompe et al. 2020); however, native fish in general have been declining in abundance, especially in the Delta (Moyle and Williams 1990, Feyrer and Healey 2003). Salmonids in the ocean and estuaries are common prey for harbor seals and sea lions, although the population impacts on CCV steelhead are unknown.

In the Sacramento River, San Joaquin River, and Delta, the presence of artificial structures, such as water diversions, contribute to high predator densities, which results in predator "hotspots" (Demetras et al. 2013, Lehman et al. 2019, Sabel et al. 2016). For example, steps since 2010 have reduced juvenile salmonid predation in the CVP and SWP fish collection facilities in the southern Delta. The steps include studies on the use of electric barriers and carbon dioxide, netting, aquatic weed control, electrofishing, a fishing incentive program, construction of a fishing pier, refurbishment of the Curtis Landing fish salvage release site, and completion of the Little Baja and Manzo Ranch fish salvage release sites in 2018 (DWR 2018). In addition to those measures, ongoing research aims to determine the level of pre-screen loss of protected fish species due to predation within Clifton Court Forebay (CCF, DWR 2018).

Survival studies of migrating juvenile salmonids have shown particularly low survival and high predation rates through the Delta (Williams et al. 2016). In addition, the hydrology of the Delta is influenced by CVP and SWP water project operations, which has created favorable conditions for non-native predators (e.g., decreased salinity, decreased turbidity, and increased non-native freshwater vegetation) (Conrad et al. 2016, Henderson et al. 2019, Michel 2019). Available data has provided valuable information regarding aspects of predation ecology in the Delta; however, it does not provide unambiguous and comprehensive estimates of fish predation rates on juvenile salmonids nor on population-level effects for juvenile steelhead migrating through the Delta (Grossman et al. 2016). Likewise, despite regional estimates of predator densities and predation 'hot spots' having been identified in the Delta (Michel et al. 2020), there has yet to be a comprehensive estimate of predation rates on juvenile salmon for the entire Bay Delta.

In the San Joaquin River watershed, the Stanislaus River Non-native Predator Research Program is currently researching the impacts of non-native predatory fishes on salmonids in the Southern Sierra diversity group (FISHBIO 2019, NMFS 2020b). Managing predator populations is one potential tool for decreasing predation pressure on juvenile salmon. However, for predator management or removal to be successful in a given location, several circumstantial factors (higher baseline survival of prey-salmon, understanding of sufficient and ephemeral density manipulations of predators, more predator extraction, and understanding of the extent of compensatory effects from predators) must exist first, which rarely do (Michel et al. 2020). Habitat restoration, or improvement with flow management, is the preferred tool for decreasing predation pressure on juvenile salmon and is much more likely to be successful. For example, studies in the Sacramento River indicate that juvenile salmonid survival increases with increased flows, which decreases the time juveniles spend migrating through predation hotspots (Henderson et al. 2019, Notch et al. 2020).

Marine Mammals

Pinniped populations on the West Coast have increased significantly since the Marine Mammal Protection Act (MMPA) was enacted in 1972. The four main marine mammal predators of salmonids in the eastern Pacific Ocean are California sea lions (*Zalophus californianus*), Steller sea lions (*Eumetopias jubatus*), harbor seals (*Phoca vitulina richardii*), and fish-eating (Resident) killer whales (*Orcinus orca*).

Recent research since the last 5-year review suggests that predation pressure on ESA-listed salmon and steelhead from seals, sea lions, and killer whales has been increasing in the northeastern Pacific Ocean over the past few decades (Chasco et al. 2017a, Chasco et al. 2017b). Models developed by Chasco et al. (2017a) estimate that consumption of Chinook salmon in the eastern Pacific Ocean by three species of seals and sea lions and Resident killer whales may have increased from 5 to 31.5 million individual salmon of varying ages since the 1970s, even as fishery harvest of Chinook salmon has declined during the same time (Marshall et al. 2016, Chasco et al. 2017a, Ohlberger et al. 2019). This same modeling suggests that these increasing trends have continued across all regions of the northeastern Pacific since the last 5-year review. Using a juvenile-to-adult conversion for pinnipeds, Chasco et al. (2017a) estimate that the biomass of Chinook salmon consumed in central California by these marine mammals may have increased almost tenfold from 1975 to 2015.

The increase in the number of Resident killer whales appears to be predominantly driven by the Northern Resident population, which does not feed off the coast of California. Southern Resident killer whales, which do seasonally feed off the coast of California, must consume a substantial amount of Chinook salmon to maintain their population. However, this group of whales has decreased in size in recent years. Resident killer whale selection for larger-adult Chinook salmon prey may be contributing to the decreased size at return and productivity of these ESUs in Washington, Oregon, and California (Lewis 2015, Ohlberger et al. 2019).

On a Pacific coast-wide scale, converting juvenile Chinook salmon into adult equivalents, Chasco et al. (2017a) estimated that by 2015, pinnipeds consumed double the amount of Chinook salmon of Resident killer whales, and six times more than the combined commercial and recreational catches. In California, pinnipeds occur seasonally in the American River and the Sacramento River; however, there are no qualitative or quantitative assessments of pinnipeds (i.e., number of seasonal animals) in these systems. In the Columbia River basin, recent research found that survival of adult spring-summer Chinook salmon through the estuary and lower Columbia River is negatively impacted by higher sea lion abundance for populations with run timing that overlaps with seasonal increases in Steller and California sea lions (Rub et al. 2019, Sorel et al. 2020). Whether increasing sea lion populations in California are associated with decreased survival of any ESA-listed salmonid ESU or DPS through estuarine and freshwater migration corridors in the state is currently unknown. There have not been any assessments of predation on Pacific salmon and steelhead populations in California estuaries/rivers to date.

Most authors have focused research on Chinook salmon because they have the highest energy value for predators (O'Neill et al. 2014). However, some study authors have found that pinnipeds like harbor seals can significantly impact other species of salmon (Thomas et al. 2016) and steelhead (Moore et al. 2021) through the consumption of outmigrating juveniles. Harbor seal predation data specific to California is not currently available, so whether predation of outmigrating juveniles is a threat to ESA-listed salmonids in California rivers and estuaries is currently unknown.

Invasive Species

A number of studies have concluded that many established non-native species (including smallmouth bass, channel catfish, and American shad) pose a threat to the recovery of ESA-listed Pacific salmon. These threats are not restricted to direct predation alone (described above), as non-indigenous species compete directly and indirectly for resources, significantly altering food webs and trophic structure, and even potentially altering evolutionary trajectories (Sanderson et al. 2009). The Bay-Delta is no exception, as it hosts many non-native species.

These non-native species can negatively affect native species by disrupting food webs, altering ecosystem function, introducing disease, or displacing native species (Mount et al. 2012).

In addition to the threat posed by non-native and invasive fish species, there is growing concern regarding the proliferation of invasive aquatic weeds in the Delta (Conrad et al. 2020). Historically, the conditions in the Delta were highly variable, favoring native plants, which are adapted to the seasonal fluctuations in ambient salinity. However, water project operations now maintain the Delta in an artificial freshwater condition to accommodate agricultural and municipal water diversions (Moyle et al. 2010). This artificially managed freshwater environment is now more favorable for invasive aquatic weeds, which are generally less salinity tolerant (Borgnis and Boyer 2016). From 2008 to 2014, the total invaded area of submersed and floating aquatic vegetation (SAV/FAV) in the Delta increased by 60 percent, from 7,100 acres to 11,360 acres (Ta et al. 2017). This overall trend of increasing SAV/FAV area negatively impacts native fish species where the beds of non-native SAV and FAV create habitat that disproportionately favors non-native fishes, such as black bass and sunfish (Brown and Michniuk 2007, Conrad et al. 2016).

Nutria (*Myocastor coypus*) is a mammal species that is newly invasive to the South Delta and San Joaquin River as of 2017. Since their discovery, their known population has increased dramatically[3]. It is unknown whether nutria will become an issue for salmonid populations, but they have the ability to dramatically alter wetlands if the population is not maintained.

Disease

Renibacterium salmoninarum is the causative agent of bacterial kidney disease (BKD), a serious disease problem of wild and cultured salmonids worldwide. BKD is one of the most prevalent diseases of cultured salmonids (Fryer and Sanders, 1981) and in spite of its economic impacts, there are limited effective methods for controlling BKD (Wiens and Kaatari 1989). Control of the bacteria by use of antibiotics is difficult due to its slow growth, and conventional vaccine strategies are ineffective or may actually worsen the disease state. Furthermore, the bacteria can be passed between fish in the same water system (horizontal transmission) and from one generation to the next via infected eggs (vertical transmission), and cannot be eliminated using egg disinfection techniques. When hatchery stocks are infected, they can become lifelong carriers. Once established in a hatchery broodstock, it can lead to chronic disease and high mortality levels, and is extremely difficult to eliminate.[4] As a result, the most effective method of control is preventing movements of live fish that are infected. Other management strategies designed to control BKD include good hygiene, reducing stress, quarantine of infected stocks, culling of infected broodstock, and/or total hatchery depopulation followed by disinfection.

In January 2017, fish health assessments at CNFH detected the presence of *Renibacterium salmoninarum* in adult CCV steelhead used as hatchery broodstock. As described under Listing Factor E below (Hatchery Impacts), this detection prevented the continuation of an ongoing effort to identify a more appropriate steelhead broodstock source for the Nimbus Fish Hatchery, which currently uses an out-of-basin stock, originating from Coastal watersheds. Efforts to assess

[3] Current information on nutria available here: (https://wildlife.ca.gov/Conservation/Invasives/Species/Nutria)
[4] Email from Jay Rowan (CDFW) to Amanda Cranford (NMFS). January 30, 2017.

the potential for replacing the out-of-basin steelhead broodstock at Nimbus Fish Hatchery are likely to shift towards *O. mykiss* in the Upper American River, upstream of Nimbus and Folsom Dams.

In early 2020, staff at several hatcheries in California's Central Valley noticed that recently hatched Chinook salmon fry were exhibiting abnormal behaviors, such as swimming in circles, and dying at elevated rates. At that time, there were also reports of high mortality among naturally produced juvenile Chinook salmon in some Central Valley rivers. State and federal fish pathologists were brought in to help identify the cause. After rigorous testing, it was determined that pathogens were unlikely to have caused the early life stage mortality. The USFWS CA-NV Fish Health Center (located at Coleman National Fish Hatchery) began looking into nutritional deficiencies, specifically a vitamin B1 deficiency known as Thiamine Deficiency Complex (TDC) (Foott 2020). Symptomatic juvenile Chinook salmon at CNFH were treated using thiamine baths. The juveniles improved in condition almost immediately following treatment. Other hatcheries throughout the Central Valley began treatments as well, with similar results.

Scientists hypothesize that TDC is the result of an ecological chain of events that led adult Central Valley salmonids in the ocean to feed heavily on northern anchovy concentrated off the central California Coast. Marine surveys off the West Coast in 2019 identified the highest abundances of northern anchovy off central and southern California since systematic surveys began in 1983. The 2019 annual report of the California Cooperative Oceanic Fisheries Investigations called it a "novel anchovy regime." In 2019, other typical salmonid prey, such as krill, fell to unusually low levels, and reports from fishermen indicated salmon off California's coast fed almost exclusively on northern anchovy in the months before returning to their home rivers. Anchovies produce an enzyme called thiaminase, which breaks down thiamine in salmonids, and its overabundance in their diet is suspected of contributing to TDC. This diversion from what is typically a more diverse diet explains how salmon were exposed to increased levels of thiaminase, leading to thiamine deficiency. Adult salmonids that are thiamine deficient produce offspring with TDC, often resulting in elevated early life stage mortality.

The extent to which TDC has affected naturally produced steelhead in the Central Valley is currently unknown. Many ongoing monitoring efforts target later life stages (not recently emerged fry) and, therefore, are unlikely to detect early life stage mortality associated with TDC. Researchers from the NMFS SWFSC, along with agency and university partners, have initiated a rapid-response scientific investigation into the extent, cause, effects, and potential treatment of thiamine deficiency in returning adult Chinook salmon and their offspring (Mantua et al. 2021). An effort is also underway to begin cooperative research with fishermen and others to understand shifts in the marine food web that may contribute to thiamine deficiency. The intent of this collaborative research is to help develop predictive and preventative measures to identify and possibly reduce the risk of thiamine deficiency.

While TDC was documented in a number of Central Valley Chinook salmon stocks during 2020, it is unknown whether thiamine deficiency is affecting CCV steelhead. As part of the rapid-response investigation described above, steelhead eggs are being collected from hatchery broodstock to assess egg thiamine concentration levels.[5] This assessment will provide insights into whether TDC is a factor affecting the CCV steelhead DPS. In addition, research from the Great Lakes suggests that *O. mykiss* may be more vulnerable to mortality at the same thiamine levels as Chinook salmon. Therefore, the thresholds developed for Chinook salmon in the Central Valley may not be protective of steelhead. Research is underway to quantify the impacts of TDC in steelhead.

Listing Factor C Conclusion

No new information is available since the previous 5-year review to indicate that there has been an increase in the level of predation on steelhead. At this time, we do not have information available that would allow us to quantify the change in extinction risk due to predation.

There is limited information on disease rates. Disease rates have continued to fluctuate within the range observed in past review periods, and the impact of this factor does not appear to have changed since the last 5-year review. Overall, we conclude that the risk to the species' persistence because of disease is low.

2.3.2.4 Listing Factor D: Inadequacy of Existing Regulatory Mechanisms

Various federal, state, county, and tribal regulatory mechanisms are in place to reduce habitat loss and degradation caused by human use and development and harvest impacts. New information available since the 2016 5-year review indicates that the adequacy of a number of regulatory mechanisms has improved. For this review, we focus our analysis on regulatory mechanisms for habitat and for harvest that have either improved for CCV steelhead, or are still causing the most concern in terms of providing adequate protection for CCV steelhead.

Habitat

Habitat concerns are described throughout Listing Factor A as having either a system-wide influence, or more localized influence, on the populations and Diversity Groups that comprise the species. The habitat conditions across all habitat components (tributaries, mainstems, estuary, and marine) considered important to recover the listed CCV steelhead are influenced by a wide array of federal, state, and local regulatory mechanisms. The influence of regulatory mechanisms on listed salmonids and their habitat resources is largely based on the underlying ownership of the land and water resources as federal, state, or private holdings.

Climate change is a factor affecting habitat conditions across all land or water ownerships, the effects of which are discussed under Listing Factor E: Other natural or man-made factors affecting its continued existence. We reviewed summaries of national and international regulations and agreements governing greenhouse gas emissions. The findings indicate that while the number and efficacy of such mechanisms have increased in recent years, there has not yet been a substantial deviation in global emissions from the past trend, and that upscaling and acceleration of far-reaching, multilevel, and cross-sectoral climate mitigation would reduce future climate-related risks (IPCC 2014, IPCC 2018). These findings suggest that current regulatory mechanisms, both in the U.S. and internationally, are inadequate to address the rate at

[5] Egg thiamine values for California salmonids including CCV steelhead are available here: https://oceanview.pfeg.noaa.gov/projects/salmon_thiamine/hatchery_ccv

which climate change is negatively impacting habitat conditions for many ESA-listed salmon and steelhead.

The federal government manages nearly 47 percent of land in California (Novan 2018). The freshwater habitats for the CCV steelhead within the Sacramento and San Joaquin River basins are managed by three primary federal agencies: the U.S. Forest Service (USFS), the Bureau of Land Management (BLM), and the U.S National Park Service (NPS). Water management adds in other federal agencies, such as the U.S. Bureau of Reclamation (USBR) and the U.S. Army Corp of Engineers (Corps).

The upper Sacramento River watershed is managed mostly by the USFS for multiple uses, including timber production, grazing, and recreation. Large stands of mixed conifer forest are also privately owned and used for commercial timber production. The upper San Joaquin River watershed is managed by BLM, the NPS, and, in some places, the USFS. The upper Tuolumne and Merced Rivers are managed by NPS, and the areas above the rim dams are BLM land. In the more arid portions of the basins, high desert forest and sagebrush lands are managed by BLM, while the alluvial valleys in the lower watersheds are mostly privately owned and used for irrigated agriculture and cattle ranching, with some refuges managed by USFWS to maintain the Pacific Flyway.

Most of the Sacramento and San Joaquin Valleys are used for agriculture, with more than 13 million acres of land used for a combination of crops and pasture land (Novan 2018). Water deliveries from the Sacramento River and several of its tributaries are managed by USBR, primarily through the operation of the CVP, a complex, multi-purpose network of dams, reservoirs, canals, hydroelectric power plants, and other water-related facilities.

The San Joaquin River system is owned and managed by both private landowners and USBR. Most tributaries are privately owned and managed, while only one major tributary, the Stanislaus River, is federally managed by USBR as part of the CVP system. Once Friant Dam was completed in the 1940s, the mainstem San Joaquin River was only intermittently connected to the Delta until 2016, when the San Joaquin River Restoration Program began releasing water from Friant Dam to reconnect the river year-round.

The Corps is responsible for flood protection, construction and maintenance of levees, and ensuring the navigable waterways of the Central Valley.

Central Valley Project /State Water Project Water Operations Regulatory Compliance

CVP/SWP water operations met regulatory compliance with the ESA under two temporally distinct regulatory environments. First, from 2016-2019, the coordinated long-term operation of the CVP/SWP followed the regulatory standards set in the ESA biological opinions issued by NMFS (NMFS 2009) and USFWS (USFWS 2008). No major changes to CVP/SWP water operations occurred during the 2016-2019 period relative to the previous 5-year review evaluation period (2011-2015); the CVP/SWP operated continuously under the regulatory context set in the 2008 and 2009 biological opinions.

The regulatory context changed in February 2020 when USBR signed a Record of Decision (ROD) for the Long-term Operations of the CVP/SWP, in response to USBR's and DWR's 2016 joint request to reinitiate the ESA consultation on the coordinated long-term operation of the CVP/SWP. The 2020 ROD is based on USBR's December 2019 Final Environmental Impact Statement and biological opinions completed in October 2019 from the USFWS and NMFS (NMFS 2019c) to meet obligations under the ESA. Given the shift to CVP/SWP water operations under the 2020 ROD, and the slow progress implementing steelhead science actions under the 2020 ROD, the degree to which water operations and the conditions fish experience changed under the new operations remains to be determined. Still, the DPS likely suffered declines in abundance due to two years of serious drought from 2020 to 2021, where we know that heavily monitored Chinook salmon populations suffered significant losses. In 2019, CDFW issued an Incidental Take Permit under the California Endangered Species Act to exempt CVP/SWP operations from take prohibitions of the California Endangered Species Act. Additionally, operations in 2022-2024 were governed by a jointly-produced Interim Operations Plan that harmonized the operations identified in the 2019 Biological Assessments (USBR 2019) and the 2019 CDFW Incidental Take Permit.

Operations of the CVP and SWP per the 2019 Biological Assessment (USBR 2019), 2019 Biological Opinion (NMFS 2019c), and 2019 CDFW Incidental Take Permit include a suite of measures intended to avoid or minimize impacts of Delta water operations to salmonid migratory and rearing habitat, for example:

- implementing a program to accelerate steelhead research and monitoring to develop juvenile population abundance estimates, and consider using these estimates to develop revised incidental take levels and scale juvenile steelhead salvage and loss to a population abundance estimate.
- closing the Delta Cross Channel during the core juvenile outmigration period to limit routing of juvenile salmonids from the mainstem Sacramento River into the interior Delta where survival is lower.
- managing entrainment of salmonids by limiting negative flows in Old and Middle Rivers, a surrogate used to estimate how export pumping at Banks and Jones Pumping Plants influences hydrodynamics in the south Delta.
- implementing additional measures in the Delta, including, for example:
    - installing a barrier at Georgiana Slough to further limit the routing of juvenile salmonids from the mainstem Sacramento River into the interior Delta, and
    - improving hydrodynamic conditions in the Delta for salmonid outmigration with a spring outflow action.

Components of CVP/ SWP water operations address CCV steelhead by partially addressing a number of the threats to recovery associated with CVP/SWP operations by managing salvage and loss at the CVP and SWP export facilities through the implementation of loss thresholds. Loss thresholds trigger prescribed reductions in water exports when they are exceeded. The loss thresholds are specifically intended to provide targeted protections for San Joaquin River basin and Sacramento River basin steelhead populations by protecting individuals from being lost at the pumps by reducing exports when salvage and loss limits are exceeded. This is a minimization measure that does not specifically address population survival. There is ongoing litigation over the 2019 biological opinion and USBR's 2020 ROD. In 2021, USBR and NMFS reinitiated consultation on the 2019 biological opinion, and will continue to evaluate and address the potential impact of project operations on CCV steelhead. During the consultation period, the CVP and SWP are operating according to a combination of court-ordered Interim Operations Plans, the state incidental take permit, and the Federal ROD and biological opinions. The 2024 Interim Operations Plan included a spring outflow requirement for April and May that provided protections for steelhead, and other species, migrating through the Delta.

Water Infrastructure Improvements for the Nation Act

In December 2016, the United States Congress (Congress) passed the Water Infrastructure Improvements for the Nation Act (WIIN Act, 2016). Subtitle J of the WIIN Act relates to California water issues and covers a wide range of topics, including funding, infrastructure, research, and potential operational changes to CVP and SWP water management. Sections 4001-4003 of the WIIN Act contain the provisions most likely to affect the implementation of CVP and SWP operations in the Delta, and thus potentially affect migratory and rearing conditions for salmonids.

- Section 4001 ("Operations and reviews") includes provisions related to Delta Cross Channel operations, as well as the potential for flexibility in inflow-toexport ratio (I:E ratio) requirements during water transfers.
- Sections 4002 ("Scientifically supported implementation of Old and Middle River (OMR) flow requirements") and 4003 ("Temporary operational flexibility for storm events") introduced the potential for flexibility in flow requirements in Old and Middle Rivers (OMR flows).

The WIIN Act provisions in Sections 4001-4003 did not govern Delta operations during Water Year 2017 due to the extremely wet hydrology. In May 2018, the CVP and SWP used Section 4001(b)(7) of the WIIN Act to adopt a 1:1 I:E ratio for a transfer of water from the Stanislaus River to south of the Delta. Additional exports of approximately 50 TAF occurred above the 3:1 required I:E ratio to recover water released on the Stanislaus River by local irrigation districts (Oakdale Irrigation District and South San Joaquin Irrigation District) for transfer south of the Delta (DOSS 2018). No WIIN Act provisions from Sections 4001-4003 were implemented during water year (WY) 2019 since OMR flows were not a controlling regulatory factor when qualifying storms occurred that year. Hydrological conditions were such that the physical capacity of the CVP and SWP export facilities was limiting water exports during the time of year that Section 4003 was in effect (DOSS 2019). No WIIN Act provisions from Sections 4001-4003 were implemented in WY 2020 or WY 2021 through December 15, 2021. Per Section 4013, the provisions in Sections 4001-4003 expired five years after enactment, on December 16, 2021.

The I:E ratio flexibility implemented during May 2018 resulted in higher exports, but also higher San Joaquin River inflow. Compared to operations without the WIIN Act provision, this action was expected to result in improved migratory conditions for salmonids in the mainstem San Joaquin River route in the Delta, and degraded migratory conditions for salmonids in the interior channels of the south Delta in the vicinity of the export facilities. Overall, given the balance of effects in May 2018 and no other uses of WIIN Act operational flexibility, the WIIN Act did not appreciably change the quality of migratory corridor and rearing habitat for Central Valley salmonids.

Implementation of the WIIN Act was anticipated to limit the risk that insufficient flows in the south Delta pose to CCV steelhead recovery. And while uses of WIIN Act operational flexibility since the last 5-year review have not appreciably degraded the quality of migratory and rearing habitat for Central Valley salmonids beyond what was considered for the implementation of CVP/ SWP water operations, it remains to be seen whether future applications will provide adequate protection to address the threats to CCV steelhead recovery in the south Delta. Given this uncertainty, regulatory mechanisms governing instream flow in the south Delta may be inadequate to address the risk posed by insufficient flows on the likelihood of achieving CCV steelhead recovery.

Federal Power Act and Energy Policy Act

The Federal Power Act (FPA) (16 U.S.C. §§ 791 et seq.) is the primary federal statute governing the regulation of hydroelectric power, whereas the Energy Policy Act (42 USC §13201 et seq.) addresses energy production in the United States more broadly. The Federal Energy Regulatory Commission (FERC) and Bureau of Ocean Energy Management (BOEM) interact with NMFS over the licensing and re-licensing of non-federal energy projects. In rivers and streams, FERC has jurisdiction over non-federal hydroelectric projects. In estuary and marine environments, BOEM has jurisdiction over wind, gas, and oil energy projects and FERC has jurisdiction over non-federal tide or current-related (hydrokinetic) energy projects. These energy projects affect NMFS trust resources in the Pacific Ocean, offshore of Washington, Oregon, and California. FERC and BOEM use several types of approval processes to guide the collection of data, development of applications, and issuance of licenses, permits and other approvals.

Since the 2016 5-year review, NMFS has participated in review of 32 active (existing and proposed) FERC, BOEM, and Marine Hydrokinetic/Marine Wind Energy (MHK/MWE) projects in California. There are three MHK/MWE projects under consideration, all of which are either proposed or relatively recent, so their impact on NMFS trust resources is not fully known. The 23 FERC projects have not had any significant changes as they have progressed through the stages of FERC relicensing proceedings. In addition, none of those 23 FERC projects have completed the process for issuance of a license. Therefore, none of the potential environmental protection, mitigation, and enhancement conditions have been realized, especially those that would enhance, protect, and benefit NMFS trust resources. Finally, per their existing licenses, all of the current FERC projects' facilities and operations have continued to negatively impact NMFS' trust species and degrade their habitats.

Because the status of the 23 Central Valley FERC projects has not changed significantly since the last 5-year review, we conclude that the FERC licensing process continues to be inadequate to improve fish passage above/below impassable barriers, and the impacts of hydroelectric power projects continue to threaten the likelihood of achieving CCV steelhead recovery. Because of the very long license duration (30-50 years), it is extremely important for NMFS to thoroughly analyze the long-term project effects to species and their habitats.

California State Forest Practices

At the time of salmon and steelhead listings, the State Forest Practice Rules for California 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 were the 2010 Anadromous Salmonid Protection Rules and the 2012 Road Rules. These rules have resulted in expanded stream-buffer widths, less damaging road and harvest techniques, and limits on riparian harvesting that will 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 woody debris volume or abating upslope erosion sources. The State Forest Practice Rules have also made changes to the cumulative watershed effects analysis of proposed timber harvest practices.

With the continued application of the State Forest Practice Rules enacted in 2010 and 2012, this regulatory mechanism continues to adequately address the potential effects associated with timber harvest in the State of California to minimize the risks to CCV steelhead recovery.

California Water Action Plan

Issued by Governor Brown in January 2014, the California Water Action Plan sets forth ten priority actions that guide the state's effort to create more resilient, reliable water systems and to restore critical ecosystems. Action 4 specifically addresses the instream flow needs of imperiled salmonids, stating, "the State Water Resources Control Board and the Department of Fish and Wildlife will implement a suite of individual and coordinated administrative efforts to enhance flows statewide in at least five stream systems that support critical habitat for anadromous fish." As part of implementing Action 4, CDFW's Instream Flow Program has supported flow enhancement activities. It is developing flow criteria in five priority streams throughout the state that support critical habitat for threatened and endangered anadromous salmonids, including Mill Creek (Tehama County), which is designated as critical habitat for CCV steelhead.

To set instream flow prescriptions, CDFW uses the California Environmental Flows Framework (CEFF), a consistent and defensible approach to identifying ecological flow needs for rivers and streams. The CEFF utilizes historical flow records and site-specific instream habitat analysis to quantify ecologically relevant flow characteristics (flow magnitude, frequency, duration, timing, and rate of change) at the individual stream reach. The identified flow characteristics then inform flow patterns supportive of five identified "functional flow components" (fall pulse flow, wet-season baseflow, wet-season peak flow, spring recession flows, and dry-season baseflow) that inform habitat suitability for various life-stages of anadromous salmonids. However, the CEFF does not specifically consider groundwater-surface flow interactions or adequately address essential habitat forming or migratory attraction flows (Cowan et al. 2021; Maher et al. 2021). The resulting ecological flow recommendations will be used in water management, planning, and decision-making processes, and may include being submitted to the State Water Resources Control Board (SWRCB) pursuant to Public Resources Code §10000-10005. Flow recommendations for Mill Creek remain in development.

Other critical Water Action Plan components identified under Action 4 that specifically address steelhead habitat include managing headwaters for multiple benefits, restoring coastal watersheds, eliminating barriers to fish migration, assessing fish passage at large dams, and achieving ecological goals within San Francisco Bay and the Sacramento/San Joaquin River Delta.

While the Water Action Plan has established a process and regulatory mechanism that could help to address the threat caused by the variable low flows affecting CCV steelhead rearing and migratory habitat, the plan has had little effect to date on the species or on the likelihood of achieving CCV steelhead recovery.

Sustainable Groundwater Management Act

California's Sustainable Groundwater Management Act (SGMA) was signed into law in January 2015, during the height of a historic drought. Per SGMA regulations, groundwater basins with unsustainable groundwater usage were required to form local Groundwater Sustainability Agencies (GSA) by 2017, and develop and begin implementing a Groundwater Sustainability Plan (GSP) by 2022 that achieves sustainable groundwater conditions no later than 2042. DWR continues to work with local groundwater users to achieve compliance with these requirements. On January 18, 2024, DWR completed the initial GSP reviews for all basins that were required to submit plans by January 31, 2022. DWR's determinations can be viewed on the SGMA Portal. As of January 2024, 71 basins had approved GSPs, 13 basins had incomplete GSPs, and 6 were determined to be inadequate.

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 most waterways overlying SGMA basins contain federally designated critical habitat for ESA-listed salmonids, NMFS actively participated as a stakeholder in many GSP development processes throughout the state by urging GSAs to properly consider streamflow depletion impacts to salmon and steelhead habitat. However, a provision in SGMA legislation allows GSAs to avoid addressing undesirable results occurring before January 1, 2015, and the vast majority of GSAs are interpreting that language as allowing streamflow depletion rates consistent with summer 2014 as an appropriate and legal management objective. Considering that 2014 was the third year in the driest 4-year stretch in California's recorded history (Hanak et al. 2016), NMFS has voiced the concern that streamflow depletion thresholds consistent with 2014 are inappropriate and unlikely to adequately protect ESA-listed salmonids or their habitat. NMFS is currently coordinating with DWR, CDFW, other state regulatory agencies, and interested stakeholders to ensure that appropriate streamflow depletion thresholds protective of salmon and steelhead are included in all applicable GSPs developed throughout the state.

While SGMA represents a significant first step in the accounting and management of California's groundwater, several improvements still remain to be made. As such, we remain concerned that the protection of ground and surface waters afforded by SGMA remains inadequate to address the potential streamflow depletions that otherwise pose a threat to CCV steelhead recovery.

National Flood Insurance Program

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 have 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,July 10, 2000); "Activities affecting this habitat include…wetland and floodplain alteration" (64 FR 50394, September 16, 1999).

Development proceeding in compliance with NFIP minimum standards ultimately results in impacts to floodplain connectivity, hydrology, habitat-forming processes, and inundation through flood storage. Development consequences of levees, stream bank armoring, stream channel alteration projects, and floodplain fill combine to prevent streams from functioning properly and result in degraded habitat. 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 (including Chinook salmon, steelhead, chum salmon, coho salmon, sockeye salmon) (NMFS 2008, NMFS 2016d).

In 2011, the Federal Emergency Management Agency (FEMA) was sued by the Coalition for a Sustainable Delta and Kern County Water Agency. These groups asserted that implementation of the NFIP in the Sacramento-San Joaquin Delta requires section 7 consultation, alleging that the NFIP results in development-related impacts to species and habitat that might otherwise not occur. NMFS continues to work with FEMA and NFIP-participating communities in California as FEMA implements the NFIP. In 2019, NMFS and FEMA agreed to pursue a programmatic approach to securing ESA section 7 compliance for the implementation of the NFIP in the State of California.

While the NFIP has not been formally evaluated for its effects on the CCV steelhead DPS or its designated critical habitat, increases in floodplain connectivity and floodplain quantity would support the species' recovery (NMFS 2014a), and the NFIP, as currently implemented, systemically allows a pattern of adverse effects that incrementally and permanently diminish floodplain habitat values (connectivity, complexity, hyporheic connection and streamflow recharge, refugia, and prey base). Therefore, it is reasonable to conclude that the NFIP does not adequately address floodplain development impacts that continue to limit CCV steelhead DPS recovery.

Clean Water Act

The Federal Clean Water Act addresses the development and implementation of water quality standards, the development of Total Maximum Daily Loads (TMDLs),[6] point source permitting, the regulation of stormwater, and other provisions related to the protection of U.S. waters. The Clean Water Act's water quality standards and discharge permitting are administered by the State of Oregon and State of California with oversight by the U. S. Environmental Protection Agency (EPA). State water quality standards are set to protect beneficial uses, which include several categories of salmonid use. Together the State and Federal clean water acts regulate the level of pollution within streams and rivers in California.

Each state has a water quality section 401 certification program that reviews projects that will discharge into waters of the U.S. and issues certifications that the proposed action meets State water quality standards and other aquatic protection regulations, if appropriate. Each state also issues National Pollution Discharge Elimination System (NPDES) permits under section 402 for discharges from industrial point sources, waste-water treatment plants, construction sites, and municipal stormwater conveyances, with established parameters for the allowance of mixing zones if the discharged constituent(s) do(es) not meet existing water quality standards at the 'end of the pipe.' TMDLs set pollution targets and allocate load reductions sufficient to meet water quality standards. These constituents may be pesticides, such as dieldrin, which are regulated under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA, see below); industrial chemicals, such as polychlorinated biphenyls (PCBs) regulated under the Toxic Substances Control Act;[7] or physical parameters of water quality, such as temperature for which numeric water quality standards have been developed. Numerous toxicants have yet to be addressed in a TMDL.

Since the 2016 5-year review, overall trends for water quality do not show improvements across the Central Valley. The State's Stream Pollution Trends Monitoring Program showed a significant increase in pyrethroid concentration in the Central Valley. Many surface waters are polluted as water is discharged from agricultural operations, urban/suburban areas, and industrial sites. These discharges transport pollutants such as pesticides, sediment, nutrients, salts, pathogens, and metals into surface waters. Although conditions in most streams, rivers, and estuaries throughout the state are much improved from 40 years ago, the rate of improvement has slowed over time (SFEP 2015). Contaminants such as polybrominated diphenyl ethers have increased over time, and many potentially harmful chemicals and contaminants of emerging concern (e.g., pharmaceuticals) have yet to be addressed (Phillips et al. 2020). Legacy pollutants such as mercury and polychlorinated biphenyls directly and indirectly affect endangered fish populations and their designated critical habitat (Wood et al. 2010; Davis et al. 2018).

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[6] 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.

[7] The Toxic Substances Control Act (TSCA) of 1976 provides EPA 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.

In particular, recent research has identified stormwater runoff from roadways causing significant mortalities in salmonids due to effluent toxicity (McIntyre et al. 2018). The array of toxicity is variously attributed to metals from motor vehicle brake pads; vulcanizing agents in tire rubber (Tian et al. 2020), Polycyclic Aromatic Hydrocarbons (PAHs) from vehicle emissions of oil, grease, and exhaust; as well as residential pesticide use. Although the tire particle-associated 6PPD-quinone has only recently been identified, it is widely used by tire manufacturers, and tire dust has been found where urban and rural roadways drain into waterways (Feist et al. 2017, Sutton et al. 2019). 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.

As of the 2014 and 2016 California Integrated Report (CWA 303(d) list and 305(b) Report), in California, approximately 9,493 miles of rivers/streams and some 513,130 acres of lakes/reservoirs are listed as impaired by irrigated agriculture through section 303(d) of the Clean Water Act (CSWRCB 2017). Of these, approximately 2800 miles, or approximately 28 percent, have been identified as impaired by pesticides. In recent years, NMFS scientists have investigated the direct and indirect effects of pesticides on individual ESA-listed species, the food webs on which they depend, and at the population level (Baldwin et al. 2009, Laetz et al. 2009, Macneale et al. 2010). Emphasis on wastewater treatment plant upgrades and new legislative requirements, development and implementation of total maximum daily load programs (i.e., pathogens, selenium, pesticides, pyrethroids, methylmercury, heavy metals, salts, nutrients), and adoption of new water quality standards (i.e., Basin Plans), all aid in protecting beneficial uses for aquatic wildlife.

Water quality pollution poses important challenges for the conservation and recovery of ESA-listed species and their habitat. Innovative and sustainable solutions such as green infrastructure and low-impact design are needed to manage pollutants as close to the source as possible. If these solutions can be applied at a broader scale, low-impact design technology, policies, and watershed-scale programs have the potential to maintain and/or restore hydrologic and ecological functions in a watershed (Spromberg et al. 2016), thereby improving water quality for ESA-listed species and the ecosystem on which the species depend.

In its current state, the Clean Water Act is inadequate to protect water quality, as demonstrated by the increase in contaminants found by the State's Stream Pollution Trends Monitoring Program. Although the Clean Water Act has been a driver for improving conditions in most streams, rivers, and estuaries in the State relative to 40 years ago, deteriorating water quality trends continue to pose a significant threat to CCV steelhead recovery.

Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) and Toxics

NMFS has performed a series of consultations on the effects on 28 West Coast species of the use of commonly applied chemical insecticides, herbicides, and fungicides according to the criteria in pesticide labels authorized under FIFRA by EPA. All West Coast salmonids are identified as jeopardized by at least one of the following chemicals; most are identified as being jeopardized by many of the chemicals. The chemicals whose use under EPA-approved labels found to jeopardize or adversely modify critical habitat for California Central Valley steelhead DPS are:

- 2,4-D (NMFS 2011)

- Diflubenzuron (NMFS 2015d)
- Naled (NMFS 2010b)
- Fenbutatin oxide, and Propargite (NMFS 2015d)
- Phosmet (NMFS 2010b)
- Pendimethalin and Trifluralin (NMFS 2012b)
- Phorate (NMFS 2010b)
- Oryzalin (NMFS 2012b)
- Dimethoate (NMFS 2010b)
- Chlorohalonil (NMFS 2011)
- Diuron (NMFS 2011)

The issuance of jeopardy biological opinions on prior proposed FIFRA registrations indicates that FIFRA standards alone would be insufficient to promote species recovery. In recent years, EPA and pesticide registrants have adopted mitigation measures recommended by NMFS as a result of ESA consultation on chemicals such as organophosphates and carbamates that could affect this species. This represents an improvement in the effectiveness of FIFRA regulatory measures. However, there is a backlog of pesticide ingredients that are in use that have not yet undergone ESA consultation[8]. Until this backlog is addressed, and until the recommendations of any resulting biological opinions are implemented, the FIFRA standards are likely not sufficient to provide adequate protections for CCV steelhead, which could reduce the likelihood of achieving species recovery.

San Joaquin River Restoration Program

The San Joaquin River Restoration Settlement Act (Public Law 111-11) requires habitat restoration, an allotted flow schedule, and fish passage through the SJRRP area. The improvements provided by this program will vastly increase the amount of spawning, holding, and rearing habitat available for CCV steelhead in the San Joaquin River. Since 2016, the flows required by the San Joaquin River Restoration Settlement Act have reconnected roughly 120 miles of the San Joaquin River from Friant Dam to the confluence with the Merced River. This is the longest stretch of time the San Joaquin River has been allowed to connect with the rest of the Central Valley system since the completion of Friant Dam in the 1950s, with the exception of a few years (SJRRP 2016). In the drought years of 2014, 2015, and 2022, USBR delivered water from Friant Dam to Mendota Pool to fulfill obligations to the San Joaquin River Exchange Contractors Water Authority instead of using water conveyed through the Delta Mendota Canal from the CVP. The deliveries took priority to SJRRP flows and left the river disconnected from late spring to early winter when the river was reconnected.

[8] See EPA, ESA Workplan Update: Nontarget Species Mitigation for Registration Review and Other FIFRA Actions, Nov. 2022, https://www.epa.gov/system/files/documents/2022-11/esa-workplan-update.pdf)

Harvest

As stated in the listing factor B discussion, ocean harvest of steelhead is rare, and is likely an insignificant source of mortality for CCV steelhead. Regulatory mechanisms to protect CCV steelhead from ocean fisheries are not warranted.

California Inland Harvest Management

The California State Sport Fishing Regulations prohibit retention of natural-origin steelhead. Retention of hatchery-origin steelhead is allowed in most 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 in the Central Valley include limited fishing days, geographic limits, and gear restrictions (i.e., barbless hooks). Recreational angling is popular across the DPS, yet its impact remains uncertain despite restrictions through modifications of the angling regulations. Development and finalization of Fisheries Management Evaluation Plans for California are recommended to ensure proper fisheries management of sensitive stocks by establishing a more formal program to minimize the take of federally listed salmonids.

Finally, when incidental capture of listed salmonids occurs, species identification and proper handling and release techniques 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 NMFS Scaling Back Your Impact: Best Practices for Inland Fishing catch and release brochure (NMFS 2020c).

Listing Factor D Conclusion

We conclude that the risk to the species' persistence because of the inadequacy of existing regulatory mechanisms generally has not changed since the last 5-year review. A number of concerns remain regarding existing regulatory mechanisms, including:

- The inappropriate use of a baseline streamflow depletion condition that is unlikely to provide adequate species or habitat protection.
- An imbalance in the suite of floodplain development incentives and disincentives that favor continued development, and disconnection of the natural floodplain and riparian habitats.
- An inability to address a slowing positive trend, and sometimes a negative trend, in water quality and associated habitat condition.

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

Climate Change

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

Updated projections of climate change are similar to or greater than previous projections (IPCC WGI 2021). NMFS is increasingly confident in our projections of changes to freshwater and marine systems because every year brings stronger validation of previous predictions in both physical and biological realms. Retaining and restoring habitat complexity, access to climate refuges (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. This section describes habitat changes relevant to Pacific salmon and steelhead, and how these changes result in the varied specific mechanisms impacting these species in subsequent sections.

Forests

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

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

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

Freshwater Environments

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

> Cooper et al. (2018) examined whether the magnitude of low river flows in the western U.S., which generally occur in September or October, are driven more by summer conditions or the prior winter's precipitation. They found that while low flows were more sensitive to summer evaporative demand than to winter precipitation, interannual variability in winter precipitation was greater. Malek et al. (2018) predicted that summer evapotranspiration is likely to increase in conjunction with declines in snowpack and increased variability in winter precipitation. Their results suggest that low summer flows are likely to become lower, more variable, and less predictable.

And later describe the projected impacts of climate change on groundwater:

> The effect of climate change on groundwater availability is likely to be uneven. Sridhar et al. (2018) coupled a surface-flow model with a ground-flow model to improve predictions of surface water availability with climate change in the Snake River basin […] Projections using [Representative Concentration Pathway] RCP 4.5 and 8.5 emission scenarios suggested an increase in water table heights in downstream areas of the basin and a decrease in upstream areas.

As cited in Siegel and Crozier (2019), Isaak et al. (2018) examined recent trends in stream temperature across the Western U.S. using a large regional dataset. Stream warming trends paralleled changes in air temperature and were pervasive during the low-water warm seasons of 1996-2015 (0.18-0.35°C/decade) and 1976-2015 (0.14-0.27°C/decade). Their results show how continued warming will likely affect the cumulative temperature exposure of migrating sockeye salmon, *O. nerka,* and the availability of suitable habitat for brown trout, *Salmo trutta,* and rainbow trout, *O. mykiss*. Isaak et al. (2018) concluded that most stream habitats will likely remain suitable for salmonids in the near future, with some becoming too warm. However, in cases where habitat access is currently restricted by dams and other barriers, 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 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 numerous species, including Pacific salmon. 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. Analyzed features include large temperature gradients, high canopy cover, large relative stream width, low exposure to solar radiation, and low levels of human modification. They created an index of refuge potential for all streams in the region, with mountain area streams scoring the highest. Flat lowland areas, which commonly contain migration corridors, were generally scored the lowest, and thus were prioritized for conservation and restoration. However, forest fires can increase stream temperatures dramatically in short time-spans by removing riparian cover (Koontz et al. 2018). Streams that lose their snowpack with climate change may see the largest increases in stream temperature due to the removal of temperature buffering (Yan et al. 2021). These processes may threaten some habitats that are currently considered refugia.

A strong and persistent warming trend and large year-to-year variations in precipitation are among the most notable features of California's climate in recent decades (Figure 2). For both the Pacific Northwest and California, water year 2015 stands out as the warmest year on record, while water year 2018 is the second warmest year on record for California. California's surface air temperatures in water years 2014-2018 were all much warmer than the 1981-2010 average.

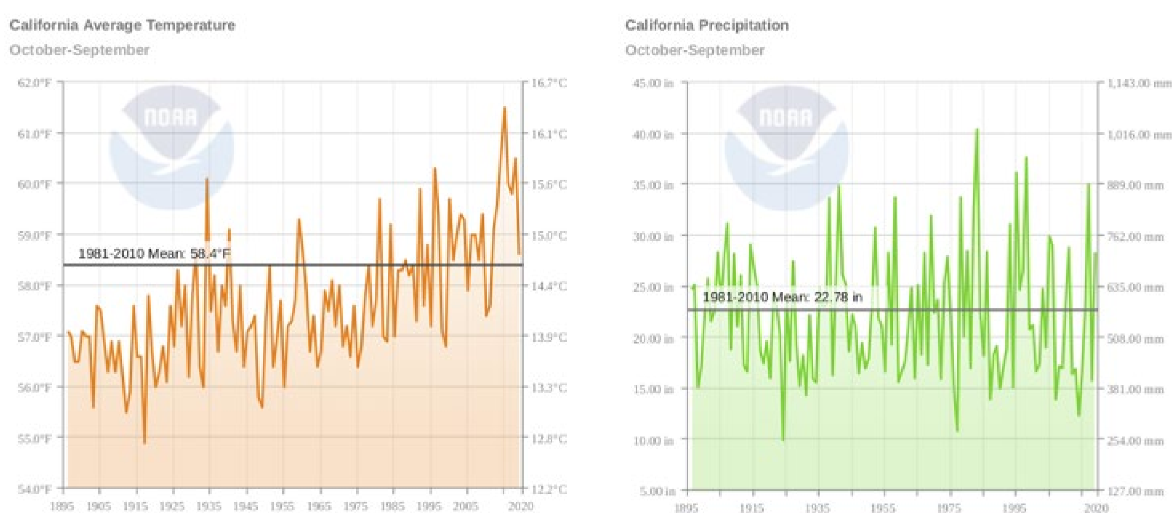

Figure 2. Water year (October-September) surface air temperature (left panel) and precipitation (right panel) for California.

Each panel shows the historical average for 1981-2010 with the black horizontal line. These figures show US Climate Division Data and were created at https://www.ncdc.noaa.gov/cag/regional/time-series.

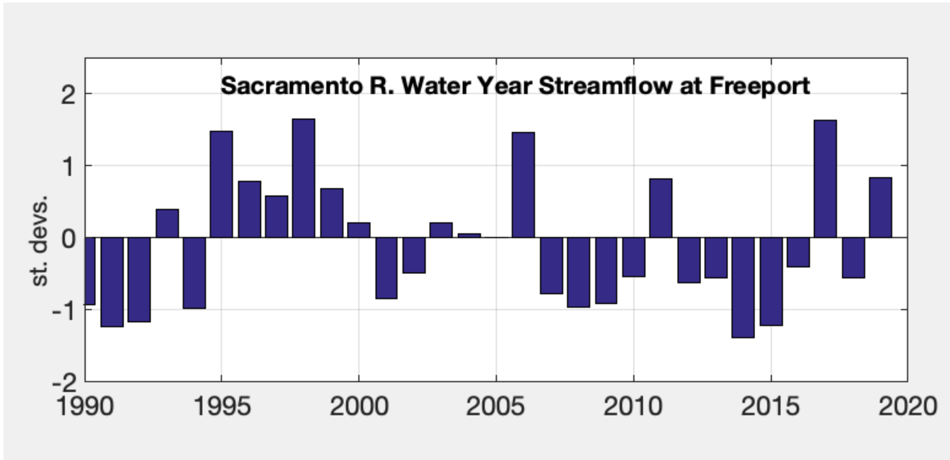

Figure 3. Water year streamflow anomalies (normalized with respect to the 1981-2010 mean and standard deviation) for the Sacramento River.

Data for this figure were downloaded from the USGS (waterdata.usgs.gov).

A broad-brush overview of water year streamflow variations in northern California is provided in Figure 3, where stream gage data indicate substantially more low-flow than high-flow years from 2000 through 2019. The Sacramento River had above-average water years in 2006, 2011, 2017, and 2019; with below-average water years from 2001-02, 2007-10, 2012-15 and 2018. In 2016, streamflow was a bit below average in the Sacramento River. California's multiyear drought of 2012-2015 was especially notable for the persistence and magnitude of above-average surface temperatures, below-average precipitation, below-average snowpack, and below-average streamflow throughout the state.

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%), 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, salmon life history traits, and relative abundance. Siegel and Crozier (2019) observe that changes in marine temperature are likely to have a number of physiological consequences on fishes themselves. For example, in a study of small planktivorous fish, Gliwicz et al. (2018) found that higher ambient temperatures increased the distance at which fish reacted to prey. Numerous fish species (including many tuna and sharks) demonstrate regional endothermy, which in many cases augments eyesight by warming the retinas. However, Gliwicz et al. (2018) suggest that ambient temperatures can similarly affect fish that do not demonstrate this trait. Climate change is likely to reduce the availability of biologically essential omega-3 fatty acids produced by phytoplankton in marine ecosystems. Loss of these lipids may induce cascading trophic effects, with distinct impacts on different species depending on compensatory mechanisms (Gourtay et al. 2018). Reproduction rates of many marine fish species are also likely to be altered with temperature (Veilleux et al. 2018). The ecological consequences of these effects and their interactions add complexity to predictions of climate change impacts in marine ecosystems.

Perhaps the most dramatic change in physical ocean conditions will occur through ocean acidification and deoxygenation. It is unclear how sensitive salmon and steelhead might be to the direct effects of ocean acidification because of their tolerance of a wide pH range in freshwater (although see Ou et al. 2015 and Williams et al. 2019); however, impacts of ocean acidification and hypoxia on sensitive species (e.g., plankton, crabs, rockfish, groundfish) will likely affect salmon indirectly through their interactions as predators and prey. Similarly, increasing frequency and duration of harmful algal blooms may affect salmon directly, depending on the toxin (e.g., saxitoxin vs. domoic acid), but will also affect their predators (seabirds and mammals). The full effects of these ecosystem dynamics are not known but will be complex.

Impacts on Salmon and Steelhead

Currently, more than half of all anadromous Pacific salmon and steelhead DPSs remaining in Oregon, Washington, Idaho and California (as defined in Weitkamp et al. 1995, Busby et al. 1996, Hard et al. 1996, Gustafson et al. 1997, Johnson et al. 1997, Myers et al. 1998) are listed as threatened or endangered under the ESA (Crozier et al. 2019). Climate change threatens salmon and steelhead throughout their life history in diverse ways in the various habitats on which they depend (Crozier et al. 2021). Anthropogenic factors, especially migration barriers, habitat degradation, and hatchery influence, have reduced the adaptive capacity of most steelhead and salmon populations (Crozier et al. 2019). Nearly all listed ESUs and DPSs are expected to face high exposures to projected increases in stream temperature, sea surface temperature, and ocean acidification. 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 these listed units, highlighting how sensitive they are to climate drivers (Lindley et al. 2009, Williams et al. 2016, Ford 2022). In some cases, the combined and potentially additive effects of poorer climate conditions for fish and intense anthropogenic impacts caused population declines that led to these population groups being listed under the ESA (Crozier et al. 2019).

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

In freshwater, year-round increases in stream temperature and changes in flow will affect physiological, behavioral, and demographic processes in salmonids, 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 in locations where the greatest warming occurs, may affect egg survival, although several factors impact intergravel temperature and oxygen (e.g., groundwater influence) as well as sensitivity of eggs to thermal stress (Crozier et al. 2020). Changes in temperature and flow regimes may alter the amount of habitat and food available for juvenile rearing, which could restrict juvenile distribution, further decreasing productivity through density dependence. For migrating adults, predicted changes in freshwater flows and temperatures will likely increase exposure to stressful temperatures for many salmon and steelhead populations, alter migration travel times, and increase thermal stress accumulation for ESUs or DPSs with early-returning (i.e., spring- and summer-run) phenotypes associated with longer freshwater holding times (Crozier et al. 2020, FitzGerald et al. 2020). 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. However, some ESA-listed salmon and steelhead populations may be able to use cool-water refuges and run-timing plasticity to reduce thermal exposure (Keefer et al. 2018, Barnett et al. 2020).

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

Still, phenological diversity can contribute to metapopulation-level resilience by reducing the risk of a complete mismatch. For example, Carr-Harris et al. (2018) explored phenological diversity of marine migration timing in relation to zooplankton prey for sockeye salmon from the Skeena River of Canada. They found that sockeye migrated over more than 50 days, with different populations encountering distinct prey fields, and recommended that managers maintain and augment such life-history diversity. Synchrony between terrestrial and marine environmental conditions (e.g., coastal upwelling, precipitation and river discharge) has increased in spatial scale, causing the highest levels of synchrony in the last 250 years (Black et al. 2018). A more synchronized climate combined with simplified habitats and reduced genetic diversity may be leading to more synchrony in the productivity of populations across the range of salmon (Braun et al. 2016). For example, salmon productivity (recruits/spawner) has also become more synchronized across Chinook populations from Oregon to the Yukon (Kilduff et al. 2014, Dorner et al. 2018). Other Pacific salmon species (Stachura el al. 2014) and Atlantic salmon (Olmos et al. 2020) also have demonstrated synchrony in productivity across a broad latitudinal range. Salmon historically maintained relatively consistent returns across variation in annual weather through the portfolio effect (Schindler et al. 2015), in which different populations are sensitive to different climate drivers. Applying this concept to climate change, Anderson et al. (2015) emphasized the additional need for populations with different physiological tolerances. Loss of the portfolio increases volatility in fisheries and ecological systems, as demonstrated for Fraser River and Sacramento River stock complexes (Freshwater et al. 2019, Munsch et al. 2022).

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, how selection on multiple traits interact, and whether those traits are linked genetically. While genetic diversity may help populations respond to climate change, the remaining genetic diversity of many populations is highly reduced compared to historic levels. For example, Johnson et al. (2018) compared genetic variation in Chinook salmon from the Columbia River basin between contemporary and ancient samples. A total of 84 samples determined to be Chinook salmon were collected from vertebrae found in ancient middens and compared to 379 contemporary samples. Results suggest a decline in genetic diversity, as demonstrated by a loss of mitochondrial haplotypes as well as reductions in haplotype and nucleotide diversity. Genetic losses in this comparison appeared larger for Chinook salmon from the mid-Columbia than those from the Snake River basin. In addition to other stressors, modified habitats and flow regimes may create unnatural selection pressures that reduce the diversity of functional behaviors (Sturrock et al. 2020). Managing to conserve and augment existing genetic diversity may be increasingly important with more extreme environmental change (Anderson et al. 2015), though the low levels of remaining diversity present challenges to this effort (Freshwater et al. 2019).

Species-Specific Climate Effects

The following species-specific information on climate vulnerability is summarized from Crozier et al. (2019). Those authors conducted a climate vulnerability assessment that included all anadromous Pacific salmon and steelhead population units listed under the ESA, including CCV steelhead. Using an expert-based scoring system, Crozier et al. (2019) ranked 20 attributes to help assign one of four overall vulnerability categories for each listed unit: ***very high***, ***high***, ***moderate***, or ***low*** (Figure 4). Attributes captured biological sensitivity, or the strength of linkages between CCV steelhead and the present climate; climate exposure, or the magnitude of projected change in local environmental conditions; and adaptive capacity, or the ability to modify phenotypes to cope with new climatic conditions.

CCV steelhead ranked ***high*** in climate exposure attributes overall because of ***high*** rankings for exposure to flooding and sea surface temperature, and a ***very high*** ranking in exposure to ocean acidification. California Central Valley steelhead ranked ***moderate*** in overall sensitivity, with the estuary stage being the main intrinsic contributing factor (Crozier et al. 2019).

	California Central Valley Steelhead	Expert Scores	Data Quality	Expert Scores Plots (Portion by Category)
Sensitivity attributes	Early life history	1.6	2.8	
	Juvenile freshwater stage	2.1	2.8	
	Estuary stage	2.5	1.8	
	Marine stage	1.6	1.3	
	Adult freshwater stage	1.5	2.8	
	Cumulative life-cycle effects	2.1	2.5	
	Hatchery influence	3.1	2	
	Other stressors	2.9	2	
	Population viability	2.1	2	
	Ocean acidification sensitivity	1.9	0.5	
	Sensitivity Score	Moderate		
Exposure variables	Stream temperature	2.8	2.3	
	Summer water deficit	2.6	2	
	Flooding	3.2	1.8	
	Hydrologic regime	1.9	1.8	
	Sea level rise	2.2	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. California Central Valley Steelhead Climate Effects Exposure and Vulnerability (from Crozier et al. 2019).

Hatchery Impacts

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

The operation of hatchery programs that affect the CCV steelhead DPS have changed over time, and these changes have likely reduced adverse effects on ESA-listed species. Specifically, many of the Central Valley steelhead hatchery programs are implementing improved steelhead management techniques, such as:

- Rehabilitation and release of post-spawned steelhead kelts to encourage iteroparity (i.e., multiple reproductive cycles over the course of a lifetime).
- Factorial spawning of adult steelhead broodstock, allowing individual crosses to be separated and tracked.
- Genetic parentage analysis of hatchery broodstock and their resulting progeny.
- Collection of adult steelhead broodstock that are greater than 16 inches (18 inches for some programs) in order to increase likelihood that broodstock are anadromous *O. mykiss*.
- Experimental in-river releases of juvenile steelhead to reduce straying.
- Experiments with late-release groups to increase likelihood of smoltification.

Conversely, hatchery practices have diminished the biocomplexity CCV steelhead since the early 1980s, with potential adverse effects on population stability and resilience (Huber et al. 2024). Huber et al. (2024) compiled *O. mykiss* hatchery release data between 1948 and 2017 for all four Central Valley steelhead hatcheries and found that individuals have been released at increasingly similar numbers, biomass, body sizes, times, and locations over time. Since the late 1990s and early 2000s, steelhead have almost exclusively been released as age-1 smolts in February and March (Huber et al. 2024). This limited-release portfolio for a hatchery-dominated DPS likely limits the species' ability to respond and adapt to an increasingly variable environment (Huber et al. 2024)

One of the "Issues of Greatest Importance for Management of California's Salmon and Steelhead Hatcheries" identified in the California Hatchery Scientific Review Group report (2012) is that several steelhead programs have seriously underperformed. While the level of hatchery production has remained relatively constant over the years, the returns of hatchery-origin steelhead adults have varied greatly and do not appear to be driven by annual production levels. The recent hatchery reforms described above have been implemented to improve the performance of these steelhead programs, while reducing impacts to the CCV steelhead DPS.

As noted in the previous 5-year review (NMFS 2016a), the Nimbus Fish Hatchery steelhead program is not part of the CCV steelhead DPS. This is because the steelhead propagated at Nimbus Fish Hatchery have diverged significantly from the native Central Valley fish. As a result, efforts are underway to identify an alternative steelhead broodstock for Nimbus Fish Hatchery that would contribute to, or would not detract from the recovery of the CCV steelhead DPS. *O. mykiss* in the Upper American River are the most indigenous source population available for use as steelhead broodstock. Although these fish currently exist above several artificial migration barriers, there is evidence of life-history plasticity within *O. mykiss* populations in the Central Valley, and investigations in other watersheds have demonstrated the ability of resident rainbow trout to produce anadromous offspring, even after decades of reproductive isolation from anadromous spawners. For these reasons, it is hypothesized that *O. mykiss* in the Upper American River still possess the capacity to produce anadromous offspring, capable of migrating to the ocean and returning as adult steelhead.

CCV steelhead from CNFH were also considered during efforts to identify a more appropriate broodstock source for Nimbus Fish Hatchery. The 2016 5-year review briefly described the transfer of steelhead eggs from CNFH to Nimbus Fish Hatchery to assess their performance as an alternative broodstock source and to track the growth and survival of these fish relative to that of the Nimbus Fish Hatchery stock. The data produced to date for paired releases that occurred during 2015 and 2016 suggest that there is no detectable difference in the proportion of Nimbus Fish Hatchery and CNFH-origin steelhead smolts successfully migrating out of the Lower American River (Brodsky et al. 2016). Although additional paired releases were planned for subsequent years, the presence of *Renibacterium salmoninarum*, also known as Bacterial Kidney Disease, in steelhead from CNFH precluded the transfer of steelhead eggs or juveniles to Nimbus Fish Hatchery. Due to the prevalence of BKD in steelhead from CNFH, fisheries managers determined that *O. mykiss* from the Upper American River are likely to be a more appropriate broodstock source for the Nimbus Fish Hatchery steelhead program.

Recent investigations show that all Upper American River *O. mykiss* sampled upstream of Folsom Dam share ancestry with other populations in the CCV steelhead DPS, with limited introgression from out-of-basin sources in some areas (Abadía-Cardoso et al. 2019). Furthermore, some Upper American River populations have retained adaptive genomic variation associated with a migratory life history, supporting the hypothesis that these populations display adfluvial migratory behavior. Together, these results indicate that some Upper American River *O. mykiss* populations represent genetically appropriate sources from which fisheries managers could potentially develop a new broodstock for the Nimbus Fish Hatchery steelhead program to reestablish a native anadromous population in the Lower American River and contribute to recovery of the threatened CCV steelhead DPS (Abadía-Cardoso et al. 2019).

CDFW has committed to completing HGMPs for all hatchery operations in the Central Valley by 2026 (Newsom 2024). The Nimbus Fish Hatchery steelhead program will ideally set forth implementation of recommendations from the California Hatchery Scientific Review Group (2012) to include: 1) parentage-based tagging plus 100 percent adipose fin-clip marking of program fish, 2) transition from out-of-basin sources of fish to Central Valley sources (to include the Upper American River above Folsom Dam), and 3) 100 percent of Nimbus Hatchery program fish should receive an additional distinguishing external mark or coded-wire tag, until a native broodstock has been established.

Listing Factor E Conclusion

The conclusion for listing factor E considers hatchery impacts and impacts related to climate change, drought, and wildfires.

The recent reforms implemented by hatchery programs that produce CCV steelhead have likely reduced impacts to ESA-listed species. Many of these reforms are intended to improve the performance of the steelhead programs and increase the potential for anadromy in *O. mykiss* that are spawned and produced in Central Valley hatcheries. While hatchery practices have likely improved since the last 5-year review, the high proportion of hatchery-origin steelhead juveniles that exit the Delta annually, discussed in section 2.3.1, indicates that the CCV steelhead DPS is currently dominated by hatchery production. While hatchery effects continue to present risks to the persistence of the CCV steelhead DPS, we conclude that they pose less risk as compared to the 2016 5-year review.

Conversely, climate-related factors have pushed the effects of listing factor E the other way since the last 5-year review. The Central Valley experienced a severe drought from 2012 through

2016, which likely reduced the already limited habitat quality and range for CCV steelhead. Additionally, large wildfires emerged as a major habitat concern since 2016. In particular, the Carr Fire (2018) in the Clear Creek watershed and the Camp Fire (2018) in the Butte Creek watershed have reduced habitat quality. The increasing risks from climate change, drought, and wildfires described above outweigh the hatchery practice improvements. Thus, we conclude that other natural or manmade factors negatively affecting the continued existence of CCV steelhead have increased since the 2016 5-year review.

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.

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

Using the best available information, Johnson et al. (2023) concluded in their viability assessment that the status of CCV steelhead appears to have slightly improved since the 2010 and 2015 viability assessments, when it was concluded that the DPS was in danger of extinction. This modest improvement is driven by the increase in adult returns to hatcheries, but the abundance of natural-origin CV steelhead adults across Central Valley rivers remains less certain. Improvements to the total population sizes of CNFH, FRH, and MRH does not substantially change the DPS' extinction risk. In fact, the lack of improved natural production, low natural population abundance, and high hatchery influence in the Southern Sierra Nevada diversity group is cause for concern.

Summary descriptions of how the five ESA listing factors have changed since the 2016 5-year review are presented in Table 7 below.

Table 7. Summary of how each listing factor for CCV Steelhead has changed since the 2016 5-year review.

Listing Factor	Change since 2016
A. Present or threatened destruction, modification, or curtailment of its habitat or range	Habitat supporting this DPS remains in a highly truncated and degraded state and it is unlikely that habitat quantity or quality have substantially changed since the last 5-year review in 2016.

Listing Factor	Change since 2016
B. Overutilization for commercial, recreational, scientific, or educational purposes	The risk to the species' persistence because of overutilization remains essentially unchanged since the 2016 5-year review, with harvest and research/monitoring sources of mortality continuing to have little to no impact on the recovery of the CCV steelhead.
C. Disease or predation	The impact of listing factor C does not appear to have changed since the 2016 5-year review.
D. Inadequacy of existing regulatory mechanisms	The risk to the species' persistence because of the inadequacy of existing regulatory mechanisms did not change since the 2016 5-year review.
E. Other natural or manmade factors affecting its continued existence	The adverse impacts from listing factor E have increased since the 2016 5-year review due to climate change,wildfires, and drought.

2.4.1 DPS Delineation and Hatchery Membership

- The SWFSC's assessment (Johnson et al. 2023) found that no new information had become available that would justify a change in the delineation of the CCV steelhead DPS.
- Our review of new hatchery information since the 2016 5-year review indicates that no change in the hatchery program membership of the CCV steelhead DPS is warranted.

2.4.2 DPS Viability and Statutory Listing Factors

- The SWFSC's assessment of updated information (Johnson et al. 2023) does not indicate a change in the biological risk category for CCV steelhead since the time of the last review (Williams et al. 2016).
- Our analysis of the five ESA section 4(a)(1) factors indicates the threats to CV steelhead have increased to a small degree since the last 5-year review (NMFS 2016a). Listing factors A through D have not worsened or improved since the last 5-year review. Listing factor E has seen improvements in some respects (e.g. hatcheries), but on balance has worsened given the increasing impacts related to climate change, wildfires, and drought.
- Based on the viability analysis (Johnson et al. 2023) and the evaluation of the five ESA listing factors, we conclude that the overall risk to the species has not changed to an extent that would support a change in the current threatened lising status.

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3 · Results

3.1 Classification

Listing Status:

Based on the information identified above, we determined that no reclassification for the CCV steelhead DPS is appropriate, and therefore:

The CCV steelhead DPS should remain listed as threatened.

DPS Delineation:

The SWFSC's assessment (Johnson et al. 2023) found that no new information has become available that would justify a change in the delineation of the CCV steelhead DPS.

Hatchery Membership:

For the CCV 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 and twice evaluated the numbers (NMFS 2019a, NMFS 2023). Table 4 indicates the numbers in place at the beginning of the current review. In December 2023, the recovery priority number of 3C for the CCV steelhead DPS remained unchanged in the FY 2021–2022 Report to Congress (NMFS 2023).

As part of this 5-year review, we reevaluated the recovery priority number based on the best available information, including the new viability assessment (SWFSC 2023). We conclude that the current recovery priority number remain 3C.

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4 · Recommendations for Future Actions

Implementation of the actions identified herein represent the most important actions to pursue over the next 5 years toward achieving viability. We are directing our efforts at populations that need viability improvement according to DPS-, Diversity Group-, and population-level recovery criteria, the best available scientific information concerning DPS status, the role of the independent populations in meeting DPS and Diversity Group viability, limiting factors and threats, and the likelihood of action effectiveness to guide our recommendations for future actions. NMFS is coordinating with the federal, state, tribal, and local implementing entities to ensure that risk factors and actions are addressed that were identified in the Central Valley Salmon and Steelhead Recovery Plan (NMFS 2014a), and the actions identified in the 2019 Biological Assessment (USBR 2019), 2019 Biological Opinion (NMFS 2019c, 2020 Incidental Take Permit, Yuba Reintroduction Working Group, San Joaquin River Restoration Program, and others.

The greatest opportunities to advance recovery are to:

- Complete the Battle Creek Restoration Project and implement the full restoration flows.
- Conduct additional research to understand the extent to which genes associated with the heritable components of anadromy could be lost from *O. mykiss* populations with low steelhead numbers, thus placing steelhead at a greater risk of extinction (Pearse et al. 2019). One of the greatest challenges in managing for resilient steelhead populations in regulated Central Valley rivers lies in understanding how water project operations and related changes to habitats and ecosystems promote, maintain, or suppress the expression and survival of the anadromous life history form of *O. mykiss*.
- Implement the 2019 CVP/SWP Biological Opinion's Steelhead Monitoring Program (NMFS 2019c). Conduct steelhead life-cycle monitoring in designated watersheds. This monitoring should be directed at the goal of developing overall abundance and ideally be able to help determine population viability for steelhead populations with unknown viability.
- CCV steelhead hatchery managers should consider the management actions identified in Huber et al. (2024) and implement actions to improve the biocomplexity and stability of CCV steelhead.
- Ensure that Central Valley steelhead hatcheries develop and implement HGMPs and collect a full set of biological data, including scale samples, length, weight, sex, origin, and state of maturity, from a subset of all returning fish. Study hatchery smolt survival using modern tagging methods, such as PIT tags and/or acoustic tags. Standardize the terminology used among hatcheries to report different life-history forms.
- Investigate the development of non-lethal methods to determine the life history of individual *O. mykiss*.
    - The management of steelhead in the Central Valley is currently hampered by the inability to conclusively determine if individual fish have made an ocean migration and are steelhead protected under the ESA.

- Reintroduce CCV steelhead to historical spawning and rearing habitats in the McCloud River, the upper Yuba River watershed, and the upper sections of the Stanislaus, Tuolumne, and/or Merced Rivers.

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5 · References

5.1 Federal Register Notices

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

February 7, 1996 (61 FR 4722). Notice of Policy: Policy Regarding the Recognition of Distinct Vertebrate Population Segments Under the Endangered Species Act.

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NATIONAL MARINE FISHERIES SERVICE
5-YEAR REVIEW

California Central Valley Steelhead DPS

Current Classification: Threatened

Recommendation resulting from the 5-Year Review

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

Review Conducted By (Name and Office):

West Coast Region California Central Valley 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 14:09:49 -08'00' Date: ________

Cooperating Regional Administrator, NOAA Fisheries

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

Signature____ Date: _______

HEADQUARTERS APPROVAL:

Assistant Administrator, NOAA Fisheries

[x] Concur [ ] Do Not Concur

Signature RAUCH.SAMUEL.DEAN.1365850948 Digitally signed by RAUCH.SAMUEL.DEAN.1365850948 Date: 2024.12.03 12:40:09 -05'00' Date: _______