*Science, Service, Stewardship*

# 2024 5-Year Review: Summary & Evaluation of **Northern California Steelhead**

National Marine Fisheries Service
West Coast Region

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5-Year Review: Northern California Steelhead

| Species Reviewed | Distinct Population Segment |
|---|---|
| **Steelhead** (*Oncorhynchus mykiss*) | *Northern California (NC) steelhead* |

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# Acronyms

| | |
|---|---|
| AIS | Aquatic Invasive Species |
| CDFW | California Department of Fish and Wildlife |
| CCC | Central California Coast |
| CMP | Coastal Management Plan |
| CVFF | Coyote Valley Fish Facility |
| DCFH | Don Clausen Fish Hatchery |
| DPS | Distinct Population Segment |
| ESA | Endangered Species Act |
| ESU | Evolutionarily Significant Unit |
| FMEP | Fisheries Management and Evaluation Plan |
| GSA | Groundwater Sustainability Agencies |
| GSP | Groundwater Sustainability Plan |
| FIPs | Functionally Independent Populations |
| HGMP | Hatchery and Genetic Management Plan |
| LCM | Life-Cycle Monitoring |
| MAUCRSA | Medicinal and Adult-Use Cannabis Regulation and Safety Act |
| MMPA | Marine Mammal Protection Act |
| NFIP | National Flood Insurance Program |
| NMFS | National Marine Fisheries Service |
| NPDES | National Pollution Discharge Elimination System |
| PCBs | Polychlorinated Biphenyls |
| PIPs | Potentially Independent Populations |
| RCP | Representative Concentration Pathway |
| SGMA | Sustainable Groundwater Management Act |
| SWFSC | Southwest Fisheries Science Center |
| TMDL | Total Maximum Daily Loads |
| TRT | Technical Recovery Teams |
| TDC | Thiamine Deficiency Complex |
| U.S. | United States of America |
| USACE | United States Army Corps of Engineers |
| USFS | United States Forest Service |
| USFWS | United States Fish and Wildlife Service |
| VSP | Viable Salmonid Population |

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# 1. General Information

## 1.1 Introduction

Many West Coast salmon and steelhead (*Oncorhynchus spp.*) stocks have declined substantially from their historic numbers and now are at a fraction of their historical abundance. Several factors contribute to these declines, including: overfishing, loss of freshwater and estuarine habitat, hydropower development, poor ocean conditions, and hatchery practices. These factors collectively led to 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 2020). 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. This document describes the results of the 2024 review of ESA-listed Northern California steelhead (NC 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;
- A recommendation on whether reclassification of the species is indicated.

A 5-year review is not:

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

### 1.1.1 Background on salmonid listing determinations

The ESA defines species to include subspecies and distinct population segments (DPSs) of vertebrate species. A species may be listed as threatened or endangered. To identify taxonomically recognized species of salmon, NMFS uses 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, the policy: (1) provides direction for considering hatchery fish in extinction risk assessments of ESUs and DPSs; (2) requires that hatchery fish determined to be part of an ESU or DPS be included in any listing of the ESU or DPS; (3) affirms our commitment to conserving natural salmon and steelhead populations and the ecosystems upon which they depend; and (4) affirms our commitment to fulfilling trust and treaty obligations with regard to the harvest of some Pacific salmon and steelhead populations, consistent with the conservation and recovery of listed salmon ESUs and steelhead DPSs.

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

Because the new Hatchery Listing Policy changed the way we considered hatchery fish in ESA listing determinations, we completed new status reviews and ESA listing determinations for West Coast salmon ESUs on June 28, 2005 (70 FR 37160), and for steelhead DPSs on January 5, 2006 (71 FR 834). On December 7, 2011, we noticed the availability of the 5-year reviews and listing recommendations for 4 DPSs of steelhead (76 FR 76386). On May 26, 2016, we published

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

our most recent 5-year reviews and listing determinations for 17 ESUs of Pacific salmon, 10 DPSs of steelhead, and the southern DPS of eulachon (*Thaleichthys pacificus*) (81 FR 33468). NMFS determined in the 2016 review that the ESA-listing status for the NC Steelhead DPS should remain as classified at that time. NMFS also concluded that, based on the best information available, no adjustments to the range of the species was necessary.

## 1.2 Methodology used to complete the review

On October 4, 2019, we announced the initiation of 5-year reviews for 17 ESUs of salmon and 11 DPSs of steelhead in Oregon, California, Idaho, and Washington (84 FR 53117). We requested that the public submit new information on these species that has become available since our 2015-2016 5-year reviews (NMFS 2016a). In response to our request, we received information from federal and state agencies, Native American Tribes, conservation groups, fishing groups, and individuals. We considered this information, as well as information routinely collected by our agency, during the 5-year review process.

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

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

This report reflects the best available scientific information, including: the work of the Southwest Fisheries Science Center (SWFSC)(SWFSC 2022); reporting by the regional biologists regarding hatchery programs; findings in the 2016 Final Coastal Multispecies Recovery Plan for California Coastal Chinook Salmon, Northern California Steelhead and Central California Coast Steelhead (NMFS 2016b) and technical reports prepared in support of the recovery plan; the listing record (including designation of critical habitat and adoption of protective regulations); recent biological opinions issued for NC steelhead; information submitted by the public and other government agencies; and the information and views provided by the geographically-based management teams. The report describes the agency's findings based on all of the information considered.

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

### 1.3.1 Federal Register Notice announcing initiation of this review

84 FR 53117; October 4, 2019

### 1.3.2 Listing history

NMFS published its final rule listing the NC steelhead ESU as threatened on June 7, 2000 (65 FR 36074; Table 1). Subsequently, NMFS revised the listing under the DPS policy described above, and reaffirmed that the NC steelhead-only DPS was a threatened species under the ESA (71 FR 834, January 5, 2006; Table 1).

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

| Salmonid Species | ESU/DPS Name | Original Listing | Revised Listing(s) |
|---|---|---|---|
| **Steelhead** (*O. mykiss*) | Northern California Steelhead | **FR Notice:** 65 FR 36074<br>**Date:** 6/7/2000<br>**Classification:** Threatened | **FR Notice:** 71 FR 834<br>**Date:** 1/5/2006<br>**Re-classification:** Reaffirmed 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. NMFS designated NC Steelhead DPS critical habitat in 2005 (70 FR 52488, Table 2).

Section 9 of the ESA prohibits the take of species listed as endangered. The ESA defines take to mean harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct. For threatened species, the ESA does not automatically prohibit take. Instead, it authorizes the agency to adopt regulations it deems necessary and advisable for species conservation and to apply the take prohibitions of section 9(a)(1) through ESA section 4(d). In 2000, NMFS promulgated 4(d) protective 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. Summary of rulemaking for 4(d) protective regulations and critical habitat for the NC Steelhead DPS.**

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

### 1.3.4 Review History

Table 3 lists the numerous scientific assessments of the status of the NC Steelhead DPS. These assessments include status reviews conducted by our Northwest and Southwest Fisheries Science centers and technical reports prepared in support of recovery planning for these species.

**Table 3. Summary of previous scientific assessments for the NC Steelhead DPS.**

| Salmonid Species | ESU/DPS Name | Document Citation |
|---|---|---|
| **Steelhead**<br>(*O. mykiss*) | Northern California Steelhead | SWFSC 2022<br>NMFS 2016a<br>Williams et al. 2016<br>Spence et al. 2012<br>Williams et al. 2011<br>Spence et al. 2008<br>Bjorkstedt et al. 2005<br>Good et al. 2005<br>Adams 2000<br>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. For determining a recovery priority for recovery plan development and implementation, we assess demographic risk (based on the listing status and species' condition in terms of its productivity, spatial distribution, diversity, abundance, and trends) and recovery potential (major threats understood, management actions exist under U.S. authority or influence to abate major threats, and certainty that actions will be effective) to assign a Recovery Priority number from 1 (high) to 11 (low). Additionally, if the listed species is in conflict with construction or other development projects or other forms of economic activity, then they are assigned a 'C' and are given a higher priority over those species that are not in conflict. Table 4 lists the recovery priority number for the subject species that was in effect when this 5-year review began (NMFS 2019). In December 2023, NMFS issued the 2021-2022 Recovering Threatened and Endangered Species Report to Congress with updated recovery priority numbers. The number for the NC steelhead DPS remained unchanged (NMFS 2023).

### 1.3.6 Recovery Plan or Outline

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

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

# 2 · Review Analysis

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

## 2.1 Delineation of species under the Endangered Species Act

**Is the species under review a vertebrate?**

| ESU/DPS Name | YES | NO |
|---|---|---|
| Northern California steelhead | X | |

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

| ESU/DPS Name | YES | NO |
|---|---|---|
| Northern California steelhead | X | |

**Was the ESU/DPS listed prior to 1996?**

| ESU/DPS Name | YES | NO | Date Listed if Prior to 1996 |
|---|---|---|---|
| Northern California steelhead | | X | n/a |

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

In 1991, NMFS issued a policy explaining how the agency would delineate DPSs of Pacific salmon for listing consideration under the Endangered Species Act (ESA) (56 FR 58612). Under this policy, a group of Pacific salmon populations is considered an "evolutionarily significant unit" (ESU) if it is substantially reproductively isolated from other con-specific populations, and it represents an important component in the evolutionary legacy of the biological species. The 1996 joint NMFS-Fish and Wildlife Service (FWS) 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 NC steelhead DPS under the DPS policy in 2000, 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 NC steelhead DPS

**DPS Delineation**

This section summarizes information presented in SWFSC (2022): Viability Assessment for Pacific Salmon and Steelhead Listed under the Endangered Species Act: Southwest.

Previous viability assessments of NC steelhead status had suggested that potential delineation changes may be warranted for coastal California DPSs (Williams et al. 2016). However, no changes in the current geographic delineation of the NC steelhead DPS are being proposed, because the Biological Review Team's analysis of genomic data and the broader question of DPS delineations across all the California DPSs has not yet been conducted. Therefore, the existing NC steelhead DPS delineation remains unchanged since the last 5-year review in 2016 (NMFS 2016a), and remain the same for this 5-year review (SWFSC 2022).

**Membership of Hatchery Programs**

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

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

The NC steelhead DPS was defined as including all naturally spawned anadromous *O. mykiss* (steelhead) originating below natural and manmade impassable barriers in California coastal river basins from Redwood Creek to and including the Gualala River (71 FR 834, January 5, 2006). There are no hatchery programs included in the NC steelhead DPS. While Mad River Hatchery produces juvenile steelhead for release into the Mad River, they are currently not considered part of the DPS. However, in the future, changes in hatchery management may warrant another evaluation of this determination (SWFSC 2022).

## 2.2 Recovery Criteria

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

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

For Pacific salmon, Technical Recovery Teams (TRTs), appointed by NMFS, define criteria to assess biological viability for each listed species. NMFS develops criteria to assess progress toward alleviating the relevant threats (listing factor [threats] criteria). NMFS adopts the TRT's viability criteria as the biological criteria for a recovery plan, based on the best available scientific information and other considerations as appropriate. For the Final Coastal Multispecies Recovery Plan for California Coastal Chinook Salmon, Northern California Steelhead and Central California Coast Steelhead (NMFS 2016b), NMFS adopted the viability criteria metrics defined by the North Central California Coast Domain TRT as the biological recovery criteria for the threatened NC steelhead DPS.

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

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

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

| ESU/DPS Name | YES | NO |
|---|---|---|
| Northern California steelhead | X | |

### 2.2.2 Adequacy of recovery criteria

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

| ESU/DPS Name | YES | NO |
|---|---|---|

| | | |
|---|---|---|
| Northern California steelhead | X | |

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

| ESU/DPS Name | YES | NO |
|---|---|---|
| Northern California steelhead | 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 viability. Independent populations are a core group of extinction-resistant and highly resilient populations. Dependent populations provide connectivity among independent populations, as well as temporary source populations and genetic refugia in the event of catastrophic loss of neighboring independent populations. The recovery scenario includes both independent and dependent populations.

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

The NMFS-appointed North-Central California Coast Domain TRT developed viability criteria metrics based on the McElhaney et al. 2000 VSP concepts (Agrawal et al. 2005; Bjorkstedt

2005; Spence et al. 2008). The 2016 Final Coastal Multispecies Recovery Plan for California Coastal Chinook Salmon, Northern California Steelhead and Central California Coast Steelhead (NMFS 2016b) adopted the North-Central California Coast Domain TRT viability criteria as the biological recovery criteria for the threatened NC steelhead DPS. These criteria metrics describe population extinction risk in 100 years (Figure 1). NMFS color-coded the risk assessment to help readers distinguish the various risk categories.

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

**Figure 1. VSP Criteria Metrics.**

For recovery planning and development of recovery criteria, the North-Central California Coast Domain TRT identified independent populations within the NC steelhead DPS and grouped them into genetically similar diversity strata (Spence et al. 2008). The DPS is composed of five diversity strata: Northern Coastal, North Mountain Interior, Lower Interior, North-Central Coastal, and Central Coastal (Figure 2).

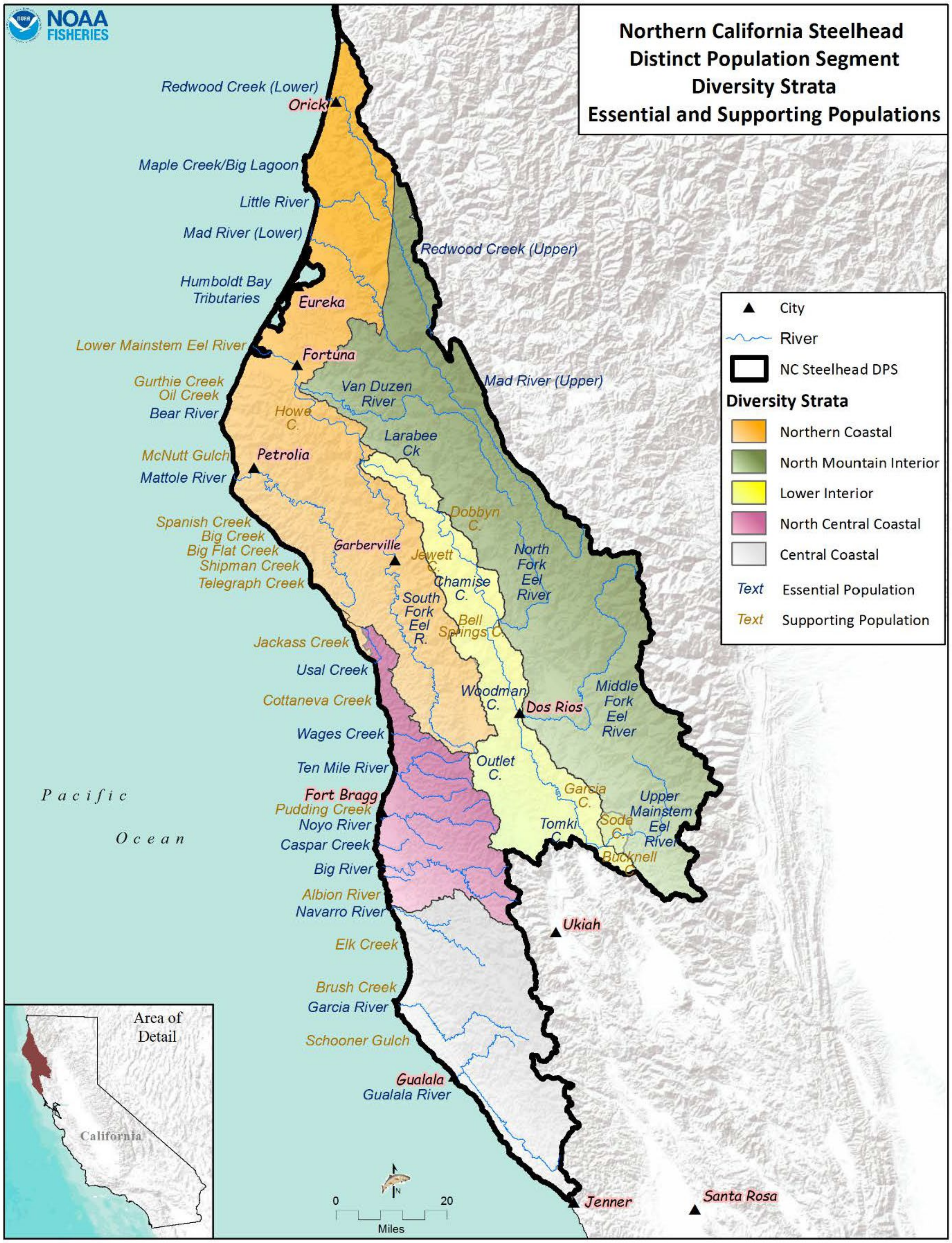


Figure 2. Diversity strata map for the NC Steelhead DPS.

Recovery strategies outlined in the 2016 Final Coastal Multispecies Recovery Plan aim to achieve, at a minimum, the biological viability criteria for each major diversity stratum in the DPS in order to have all five diversity strata at viable (low extinction risk) status with representation of all the major life history strategies historically present, and with the abundance, productivity, spatial structure, and diversity attributes required for long-term persistence. The plan recognizes that, at the diversity stratum level, there may be several specific combinations of populations that could satisfy the recovery criteria. It identifies particular combinations of various populations that are the most likely to result in achieving diversity strata viability, and hence DPS viability.

The TRT recovery criteria are hierarchical in nature, with ESU/DPS-level criteria being based on the status of natural-origin steelhead assessed at the population level. A detailed description of the TRT viability criteria and how they were developed (Spence et al. 2008 and Spence et al. 2012) can be found in Volume III of the Final Coastal Multispecies Recovery Plan (NMFS 2016b).

The four DPS viability criteria are:

(1) Representation Criteria;

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

- AND

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

(2) Redundancy and Connectivity;

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

- AND

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

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

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

strata.

The 2016 Final Coastal Multispecies Recovery Plan identifies a set of most likely scenarios to meet the TRT's recommendations for low risk populations at the diversity stratum level. The following describes the combination of population status most likely to achieve viability for each diversity stratum for NC steelhead (NMFS 2016b). The Redwood Creek, Mad River, South Fork Eel River, and Mattole River populations of summer-run steelhead must reach established effective population size criteria listed in Table 3 of the 2016 Final Coastal Multispecies Recovery Plan (NMFS 2016b).

**Northern Coastal Diversity Stratum**

1. Essential independent populations in the Bear River, Humboldt Bay Tributaries, Little River (Humboldt Co.), Mad River (Lower), Maple Creek/ Big Lagoon, Mattole River, Redwood Creek (Lower) (Humboldt Co.), and South Fork Eel River must reach at least *Viable* (low risk) status;
2. Supporting dependent populations in Big Creek, Big Flat Creek, Guthrie Creek, Howe Creek, Jackass Creek, Lower Mainstem Eel River Tributaries, McNutt Gulch, Oil Creek, Shipman Creek, Spanish Creek, and Telegraph Creek, must reach established redundancy and occupancy criteria (Table 2 in Volume III of the Final Multispecies Recovery Plan (NMFS 2016b));

**North Mountain Interior Diversity Stratum**

1. Essential independent populations in Larabee Creek, Mad River (Upper), Middle Fork Eel River, North Fork Eel River, Redwood Creek (Upper) (Humboldt Co.), Upper Mainstem Eel River, Van Duzen River populations must reach at least *Viable* (low risk) status;
2. A supporting independent population in Dobbyn Creek must reach at least moderate risk status; and
3. The Redwood Creek, Mad River, Van Duzen River, Larabee Creek, North Fork Eel River, Upper Middle Mainstem Eel River, Middle Fork Eel River, and Upper Mainstem Eel River populations of summer-run steelhead must reach established effective population size criteria (Spence et al. (2008) (Table 2; Vol III)).

**Lower Interior Diversity Stratum**

1. Essential independent populations in Chamise Creek, Outlet Creek, Tomki Creek, and Woodman Creek must reach at least *Viable* (low risk) status;
2. Supporting independent populations in Bell Springs Creek, Bucknell Creek and Jewett Creek must reach at least at least moderate risk status; and
3. Supporting dependent populations in Garcia Creek and Soda Creek must reach the established redundancy and occupancy criteria (Table 2 in Volume III of the Final Multispecies Recovery Plan (NMFS 2016b)).

**North-Central Coastal Diversity Stratum**

1. Essential independent populations in the Big River, Noyo River, Ten Mile River, Usal Creek, and Wages Creek must reach at least *Viable* (low risk) status;
2. Supporting independent populations in Albion River, Cottaneva Creek and Pudding Creek populations must reach at least moderate risk status; and
3. Supporting dependent populations in Caspar Creek population should reach the established redundancy and occupancy criteria (Table 2 in Volume III of the Final Multispecies Recovery Plan (NMFS 2016b)).

**Central Coastal Diversity Stratum**

1. Essential independent populations in the Garcia River, Gualala River, and Navarro River must reach at least *Viable* (low risk) status;
2. Supporting independent populations in Brush Creek and Elk Creek must reach at least moderate risk status; and
3. A supporting dependent population in Schooner Gulch must reach the established redundancy and occupancy criteria (Table 2 in Volume III of the Final Multispecies Recovery Plan (NMFS 2016b)).

## 2.3 Updated Information and Current Species' Status

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

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

Information provided in this section is summarized from SWFSC 2022 - Viability assessment for Pacific salmon and steelhead listed under the Endangered Species Act: Southwest. Please see SWFSC 2022 for a more detailed discussion of each species' VSP status.

**Updated Biological Risk Summary**

Overall, the availability of information on steelhead populations in the NC Steelhead DPS has improved considerably in the past 5 years with continued implementation of the CDFW/NMFS Coastal Monitoring Program (CMP) across a significant portion of the DPS. However, significant gaps in information still remain, particularly in the Lower Interior and North Mountain Interior diversity strata, where there is very little information from which to assess viability. Overall, the available data for winter-run populations—predominately in the North Coastal, North-Central Coastal, and Central Coastal strata—indicate that all essential populations remain well below recovery targets. In the North Coastal stratum, direct comparison with recovery targets is confounded by (1) the fact that survey efforts target Chinook salmon and thus do not encompass the entire spawning season or space for steelhead, and (2) the lack of methods for converting redd estimates to population abundance. Nevertheless, even if population sizes are several times greater than current redd estimates suggest, these populations would likely still be less than 10–15 percent of recovery targets. For the North-Central Coastal stratum, essential populations are currently at 8–12 percent of their recovery targets, and in the Central Coastal stratum, they are at 5–10 percent of these targets. Trends for essential independent populations have been mixed, with the majority showing slight (non-significant) increases. Most supporting independent populations and both essential and supporting dependent populations currently number in the tens of fish, and have shown downward (but non-significant) trends. Time series of partial or aggregate populations show essentially no trends in abundance. On the positive side, strata-wide estimates for winter-run steelhead have trended slightly upwards over the last 10 years. Overall, the data suggest that the status of winter-run populations has not changed appreciably since the previous viability assessment (Spence 2016).

Summer-run populations remain a significant concern. The Middle Fork Eel River population has remained remarkably stable for nearly five decades and is closer to its recovery target (~80 percent) than any other population in the DPS. Populations in the Mad and Van Duzen rivers have averaged in the low hundreds of fish and are at 18 percent and 26 percent of their recovery targets, respectively. However, both the Redwood Creek and Mattole River populations appear very small, and little is known about other populations including the various tributaries of the Eel River. We know of no evidence of recent occurrence of summer-run steelhead in either Larabee Creek or the South Fork Eel River. There are recent reports of summer-run steelhead being observed in the North Fork Eel River, apparently the first observations in many years (Z. Ruddy, BLM, personal communication, 2022). With recent climatic trends indicating warming of air temperatures and high variability in stream discharge (see Section 2.2), summer-run steelhead populations are likely to experience increased risk in the near future due to both decreased thermal suitability of over-summering habitats for adults and reduced access to historical spawning areas in years of low precipitation.

In summary, the new information for NC-Steelhead available since the previous viability assessment (Spence 2016) indicates that overall extinction risk is moderate and has not changed appreciably since the prior assessment.

### 2.3.2 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 listing determinations after conducting a review of the status of the species and considering efforts to protect such species. Below we discuss new information relating to each of the five factors as well as efforts being made to protect the species.

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

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

#### Current Status and Trends in Habitat

Below, we summarize information on the current status and trends in habitat conditions by diversity stratum since our last 2016 5-year review. We specifically address: (1) the key emergent or ongoing habitat concerns (threats or limiting factors) focusing on the top concerns that potentially have the biggest impact on independent population viability; (2) the population-specific geographic areas (e.g., independent population major/minor spawning areas) where key emergent or ongoing concerns about this habitat condition remain; (3) population-specific key protective measures and major restoration actions taken since the 2016 5-year review toward achieving the recovery plan viability criteria adopted by NMFS in the 2016 Final Coastal Multispecies Recovery Plan (NMFS 2016b) 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; (5) recommended future recovery actions over the next five 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.

NMFS (2016a) stated that "poor ocean conditions, water withdrawals, marijuana cultivation and drought, in particular, have had significant negative impacts on NC steelhead since the last review." These four threats continue to have significant negative impacts to the NC steelhead DPS throughout their range. Since the last review in 2016, the negative impact on steelhead habitat from ongoing drought (higher water temperatures, lack of physical habitat availability, and poor riverine ecological function) continues to limit the effectiveness of other restoration actions, such as habitat improvement projects.

#### Northern Coastal Diversity Stratum

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

For the eight essential independent populations comprising the Northern Coastal Diversity Stratum (Bear River, Humboldt Bay Tributaries, Little River, Lower Mad River, Maple Creek/Big Lagoon, Mattole River, Lower Redwood Creek, and South Fork Eel River), and the eleven supporting populations, the primary habitat concerns, as reported in 2016 5-year review (NMFS 2016a), continue to be:

- Decreased water quantity due to climate change, agricultural use (including cannabis; e.g. Bauer et al. 2015), and residential use, causing low flows, insufficient stream velocities and depths for adults, lack of access to spawning habitat for adults, and poor conditions for juvenile rearing (all populations)
- Degraded water quality due to climate change, agricultural use (including cannabis), urban runoff (e.g. and residential use causing high water temperatures, low dissolved oxygen levels, and lack of food supply for rearing juveniles (all populations).
- Lack of instream habitat complexity (e.g., large woody canopy cover, riffle/run/pool diversity off-channel habitat, and access to the floodplain) due largely to timber harvest, agriculture, and grazing practices (all populations).

Major emergent habitat concerns since the 2016 5-year review are:

- Diminished pool depths and unpassable riffles for returning adults as a result of diminished water quantity to levels in the lower Eel River that were unprecedented (Power et al. 2015). Pool depths and area have been diminished and early arriving adult steelhead are commonly observed in the Lower Eel during early fall dives. Shallow pools and unpassable riffles have led to stranding events where adults are unable to safely pass and have stranded (all adults returning to the Eel River, but in particular those entering the river early).
- Estuary degradation and simplification as a result of channelization from coastal development and reduced streamflow continue to limit juvenile steelhead production. Prolonged estuary closures exacerbated by reduced flows associated with climate change have contributed to poor water quality conditions further reducing essential habitat for rearing juvenile steelhead prior to ocean entry (Redwood Creek and Mad River populations).
- Degraded water quality due pesticides and urban stormwater runoff (e.g. Challis et al 2021) (Humboldt Bay Tributaries, Lower Mainstem Eel, and Lower Mad River)

**2) Population-Specific Geographic Areas of Habitat Concern Since the 2016 5-year review**

- Mad River (Summer steelhead)
- South Fork Eel River (Summer and Winter Steelhead)
- Lower Redwood Creek and Mad River Estuaries
- Lower Eel River
- Mattole River

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

The key protective measures and major restoration actions addressing population-specific habitat concerns in the Northern Coastal Diversity Stratum implemented since adoption of the Recovery Plan in 2016 and the previous 2016 5-year review are:

- Increased habitat complexity from installation of dozens of habitat structures (Little River; Salmon Creek; Humboldt Bay Tributaries Ryan Creek; Salmon Creek; South Fork Eel River watershed; Eel River watershed; CDFW 2020; GDRC 2020).
- Decreased sediment supply from road decommissioning projects (Redwood Creek watershed; Humboldt Bay tributaries, Morrison Creek and Ryan Creek; GDRC 2020; RNSP 2020)
- Opening up of 1.8 miles of fish habitat by barrier removal and channel restoration in Powers Creek, a tributary to the lower Mad River (Lower Mad River population; BLR 2020).
- Improved riparian habitat with two acres of riparian habitat planted, and 0.04 acres of invasive plant species were treated along 1.13 miles of streambank. Tributaries streams were enhanced with instream structures including Hollow Tree Creek, Anderson Creek, and Redwood Creek (Redwood Creek population; S.F. Eel Population; CDFW 2020).
- Opening up previously inaccessible habitat for steelhead with the fish passage projects on Dinner Creek, Kenny Creek, Jack of Hearts Creek (South Fork Eel population; CDFW 2020)
- Improved habitat complexity and floodplain connection from the Salt River Ecosystem Restoration Project, located within the Eel River estuary (Eel River populations)

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

The NMFS 2016 Coastal Multispecies Recovery Plan (NMFS 2016b) and the 2016 5-year review identified inadequate regulatory mechanisms as a priority issue affecting Northern California steelhead recovery in the Northern Coastal Diversity Stratum. Various federal, state, county and tribal regulatory mechanisms are in place to minimize or avoid habitat degradation caused by human use and development. Many of these mechanisms have been improved and updated in the past five years. However, the implementation and effectiveness of regulatory mechanisms has not been adequately documented. ***See Listing Factor D: Inadequacy of Existing Regulatory Mechanisms in this document for details.***

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

The greatest opportunity to advance recovery of NC steelhead in the North Coastal Diversity Stratum is to:

- Increase water forbearance (e.g. use of water stored in the winter for use in the low flow summer and fall periods), streamflow enhancement, water conservation and groundwater sustainability projects (all populations). Prioritize water conservation projects for funding.

- Continue LWD supplementation throughout the diversity strata (all populations).
- Continue road decommissioning, fine sediment control, and habitat restoration projects (all populations).
- Advance the decommissioning of the Potter Valley Project, while restoring access to hundreds of miles of high-quality habitat upstream in the upper Eel River (Eel River populations).
- Improve habitat complexity (all populations).
- Complete estuary restoration and levee setbacks in lower Redwood Creek.
- Address the shallow and simplified holding and staging habitat in the Lower Eel River through a combination of short-term actions to improve complexity and promote pool scour and to address the lack of tidal prism and geomorphic dysfunction in the lower river to improve sediment routing and increase depths and complexity.

### North Mountain Interior Diversity Stratum

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

For the seven essential independent populations comprising the North Mountain Interior Diversity Stratum (Larabee Creek, Upper Mad River, Middle Fork Eel River, North Fork Eel River, Upper Redwood Creek, Upper Mainstem Eel River, Van Duzen River) and the supporting independent population (Dobbyn Creek), the primary habitat concerns, as reported in 2016 5-year review (NMFS 2016a), continue to be:

- Decreased water quantity exacerbated by climate change and land use resulting in diminished pool depths and habitat complexity necessary for steelhead holding and staging in the Lower Van Duzen River Lower Mainstem Eel River tributaries and Van Duzen River populations).
- Increased water temperatures (e.g. Power et al. 2015) (all populations).
- Potter Valley Project passage conditions at the Van Arsdale Fisheries Station located at Cape Horn Dam have been compromised multiple times during high flow events during the winter, completely eliminating passage for weeks at a time for upstream and downstream passage of all life stages (Upper Mainstem Eel River population.
- Inadequate reservoir storage to ensure timely releases during the fall and spring continues to be a concern for the Eel River during extensive and more frequent drought years. Since 2012, water quantity issues and water storage in Lake Pillsbury have been exacerbated by climate change. The Potter Valley Project has required several extensive variances to existing Federal Energy Regulatory Commission (FERC) license operations to prevent complete depletion (deadpool) of reservoir water storage and avoid catastrophic failure. (Upper Mainstem Eel River population)

#### 2) Population-Specific Geographic Areas of Habitat Concern Since the 2016 5-year review

- Upper and Lower Eel River populations
- North Fork and Middle Fork Eel Rivers (summer-run steelhead)

- Lower Van Duzen River
- Upper Redwood Creek

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

The key protective measures and major restoration actions addressing population-specific habitat concerns in the North Mountain Interior Diversity Stratum implemented since adoption of the Recovery Plan in 2016 and the previous 2016 5-year review are:

1. Resolution of Clean Water Act and Endangered Species Act Section 9 take violations on the Van Duzen River with implementation of remediation plans in 2018.
2. Improved infrastructure and modifications to the fish passage facility at Cape Horn Dam:

    - Reduced prolonged fish ladder closures during intense high sediment load storm events.

    - Monitoring and performance metrics to determine the effectiveness of these improvements for fish passage over Cape Horn Dam (2020).

3. Completion of the Salt River Ecosystem Restoration Project, located within the Eel River estuary, supporting the recovery of all NC steelhead populations within the Eel River watershed.

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

The NMFS 2016 Coastal Multispecies Recovery Plan (NMFS 2016b) and the 2016 5-year review identified inadequate regulatory mechanisms as a priority issue affecting Northern California steelhead recovery in the North Mountain Interior Diversity Stratum. Various federal, state, county and tribal regulatory mechanisms are in place to minimize or avoid habitat degradation caused by human use and development. Many of these mechanisms have been improved and updated in the past five years. However, the implementation and effectiveness of regulatory mechanisms has not been adequately documented. ***See Listing Factor D: Inadequacy of Existing Regulatory Mechanisms in this document for details.***

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

The greatest opportunity to advance recovery of NC steelhead in the North Mountain Interior Diversity Stratum is to:

- Increase water forbearance, streamflow enhancement, water conservation and groundwater sustainability projects (all populations). Prioritize water conservation projects for funding.

- Advance the decommissioning of the Potter Valley Project, while restoring access to hundreds of miles of high-quality habitat upstream in the upper Eel River (Eel River populations).
- Improve habitat complexity and reduce water use (ground and surface water) (all populations).
- Complete all phases of the lower Salt River Ecosystem Restoration Project and other proposed habitat expansion sites to improve the Eel River estuary.

### Lower Interior Diversity Stratum

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

For the four essential independent populations comprising the Lower Interior Diversity Stratum (Chamise Creek, Outlet Creek, Tomki Creek, Woodman Creek) and the three supporting independent populations (Bell Springs Creek, Bucknell Creek, Jewett Creek), the primary habitat concerns, as reported in 2016 5-year review (NMFS 2016), continue to be:

- Worsening water quantity issues exacerbated by climate change and land use. Drought during the fall and winter of 2019-2020 have required variances to Potter Valley Project (PVP) releases resulting in the lowest PVP releases in decades despite the first observations of summer run steelhead entering the project area. (all populations)
- Increasing water temperatures throughout the diversity stratum despite the continued growth of riparian vegetation. (all populations)
- Continued high demand by cannabis cultivation on limited water resources. Despite new regulations, many illicit operations continue to operate out of compliance with local ordinances and regulations. (all populations)

Major emergent habitat concerns since the 2016 5-year review are:

- Increasing groundwater use throughout the diversity stratum as cannabis growers discontinue summer water diversions and revert to groundwater well use. In the Franciscan geology of most of the diversity stratum, groundwater is not only connected to surface water flowing in streams but groundwater is thought to be the mechanism that provides for all summer flow (Hahm et al. 2019). Legal groundwater pumping and other diversions continue to cause dry and intermittent stream reaches throughout the stratum (all populations).
- Diminished water quantity caused by groundwater pumping and other diversions resulting in dry and intermittent stream reaches throughout the stratum, diminished groundwater elevations, and lower fall flows. In the Franciscan geology of most of the diversity stratum, groundwater is not only connected to surface water flowing in streams but groundwater is thought to be the mechanism that provides for all summer and early fall flow (Hahm et al. 2019). Diminished groundwater basins and lower fall flows impede or preclude the passage of adult NC steelhead and also may reduce water quality and the extent of holding and staging habitat available during the early fall months (Upper and Lower Eel River populations).

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

- Passage conditions at the Van Arsdale Fisheries Station located at Cape Horn Dam have been compromised multiple times during high flow events during the winter months, completely eliminating passage for weeks at a time.

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

The key protective measures and major restoration actions addressing population-specific habitat concerns in the Lower Interior Diversity Stratum implemented since adoption of the Recovery Plan in 2016 and the previous 2016 5-year review are:

- Fish passage to Woodman Creek, a tributary to Eel River, re-connected over 10 miles of steelhead habitat.

#### 4) Key Regulatory Measures Since the 2016 5-year review

The NMFS 2016 Coastal Multispecies Recovery Plan (NMFS 2016b) and the 2016 5-year review identified inadequate regulatory mechanisms as a priority issue affecting Northern California steelhead recovery in the Lower Interior Diversity Stratum. Various federal, state, county and tribal regulatory mechanisms are in place to minimize or avoid habitat degradation caused by human use and development. Many of these mechanisms have been improved and updated in the past five years. However, the implementation and effectiveness of regulatory mechanisms has not been adequately documented. ***See Listing Factor D: Inadequacy of Existing Regulatory Mechanisms in this document for details.***

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

The greatest opportunity to advance recovery of NC steelhead in the Lower Interior Diversity Stratum is to:

- Prioritize funding for water conservation projects that increase water forbearance, streamflow enhancement, water conservation and groundwater sustainability (all populations).
- Advance the decommissioning of the Potter Valley Project, while restoring access to hundreds of miles of high-quality habitat upstream in the upper Eel River (Eel River populations).
- Improve habitat complexity and reduce water use (ground and surface water) (all populations).
- Address low flow conditions and warm water temperatures in the summer months by better managing reservoir storage and cold-water pool volume in Lake Pillsbury, and by reducing diversions to the Russian River.
- Address the unlimited use of groundwater wells and groundwater pumping on surface flows. (all populations)

## North Central Coastal Diversity Stratum

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

For the five essential independent populations comprising the North Central Coastal Diversity Stratum (Big River, Noyo River, Ten Mile River, Usal Creek, Wages Creek) and the three supporting independent populations (Albion River, Cottaneva Creek, Pudding Creek), the primary habitat concerns, as reported in 2016 5-year review (NMFS 2016a), continue to be:

- Lack of instream habitat complexity (e.g., large woody canopy cover, riffle/run/pool diversity, and access to the floodplain) due largely to impacts associated with legacy timber operations and ranching grazing practices in all populations in this diversity stratum.
- Low dry season stream flows and elevated water temperatures (all populations)
- Lack of estuarine complexity due to urbanization, recreation, California State Highway 1, and timber operations in the Noyo River, Big River, Albion River, Usal Creek, and Wages Creek (Big River, Noyo River Ten Mile River populations).
- Stream embeddedness related to mass wasting from past timber harvest and fine sediment delivery from industrial forest road systems in the Big River, Noyo River, Albion River, and Ten Mile River has resulted in reduced spawning gravel quality and juvenile rearing habitat quality for steelhead.

Major emergent habitat concerns since the 2016 5-year review include:

- Sedimentation, reduced stream flows, and increased stream water temperatures due to increasing wildfire scope and intensity; wildfire risk in larger watersheds such as Big River, and the Noyo River could increase with predicted warmer temperatures and more frequent, severe droughts which create extremely dry forest conditions that are more conducive to ignition and spread (Big River and Noyo River populations)

### 2) Population-Specific Geographic Areas of Habitat Concern Since the 2016 5-year review

- Noyo River
- Big River
- Ten Mile River

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

The key protective measures and major restoration actions addressing population-specific habitat concerns in the North Central Coastal Diversity Stratum implemented since adoption of the Recovery Plan in 2016 and the previous 2016 5-year review are:

- Installation of large wood debris to improve steelhead and salmon habitat quality in many tributaries of Ten Mile River, Noyo River, Big River, and Albion River.
- Restoration of Ten Mile River estuary by the Nature Conservancy and the protection of

the 23,000 acres of the South Fork Ten Mile River. The Nature Conservancy (TNC) acquired a conservation easement in the Ten Mile River watershed from the Lyme Redwood Company in September of 2017 (Coastal Conservancy 2017). Increased riparian buffers, management for late seral stage forest conditions, and stream restoration of 25 miles of anadromous streams have been implemented since acquiring this easement.

- Installation of dozens of habitat structures (Noyo River; Pudding Creek (CDFW 2020). Completion of two fish passage projects in the Big River (personal communication, J. Pecherich, NMFS, personal communication, 2022)
- Completion of the James Creek Fish Passage Project in 2018 that opened up seven miles of high-quality habitat.

#### 4) Key Regulatory Mechanisms Since the 2016 5-year review

The NMFS 2016 Coastal Multispecies Recovery Plan (NMFS 2016b) and the 2016 5-year review identified inadequate regulatory mechanisms as a priority issue affecting Northern California steelhead recovery in the North Central Coastal Diversity Stratum. Various federal, state, county and tribal regulatory mechanisms are in place to minimize or avoid habitat degradation caused by human use and development. Many of these mechanisms have been improved and updated in the past five years. However, the implementation and effectiveness of regulatory mechanisms has not been adequately documented. ***See Listing Factor D: Inadequacy of Regulatory Mechanisms in this document for details.***

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

The greatest opportunity to advance recovery of NC steelhead North Central Coastal Diversity Stratum is to:

- Acquire additional conservation easements or land from industrial timber companies. Improvement and protection of riparian areas will improve riparian shade and wood delivery to stream channels under conservation easements (all populations).
- Continue upgrading and decommissioning forest roads. Reducing slide and road related sediment delivery is expected to improve instream gravel quality (all populations).
- Continue improving wood frequency in streams across the diversity strata. The Multi-Species recovery plan (NMFS 2016b) identifies habitat complexity as limiting for streams across this DS.
- Eliminate depletion of summer flows (Albion River Population, Big River Population) and promote passive diversion devices designed to allow diversions of water only when minimum streamflow is met (Noyo River Population).

### Central Coastal Diversity Stratum

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

For the three essential independent populations comprising the Central Coastal Diversity Stratum

(Garcia River, Gualala River, Navarro River) and the two supporting independent populations (Brush Creek, Elk Creek), the primary habitat concerns, as reported in 2016 5-year review (NMFS 2016a), continue to be:

- High water temperatures and low water flows due to a lack of riparian vegetation and rural residential and agricultural water withdrawals. (all populations)
- Extensive and prolonged hydrologic drought conditions that exacerbate high water temperatures and low water flows. (all populations)
- Lack of estuarine habitat complexity (including floodplain and off-channel habitat) due to grazing practices, California State Highway 1, and timber operations throughout the diversity stratum, leading to an increased risk of predation, reduced stream carrying capacity, and reduced opportunity for full life history expression. (all populations).
- Lack of instream habitat complexity (e.g., large woody canopy cover, riffle/run/pool diversity, and access to the floodplain or off-channel habitat) due largely to impacts associated with legacy timber operations, forest-to-vineyard land conversions, and ranching grazing practices. Future timber harvest plans may prolong or contribute to legacy timber harvest impacts. (all populations)
- Stream embeddedness related to mass wasting and fine sediment delivery from legacy timber harvest impacts, and recently catastrophic wildfires and extreme weather events, which reduce spawning and egg survival in all the populations within the diversity stratum. (all populations)

Major emergent habitat concerns since the 2016 5-year review include:

- Loss of riparian/canopy cover leading to elevated water temperatures and intense sedimentation due to catastrophic wildfires (Gualala River, Garcia River, and Navarro River)
- Intense sedimentation from flooding and mass wasting due to extreme weather patterns (Gualala River, Garcia River, and Navarro River)

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

There are no additional population-specific geographic areas of concern beyond the areas specifically identified above.

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

Since adoption of the Recovery Plan in 2016, and the previous 2016 5-year review, the following key measures and restoration actions have addressed habitat concerns in the Central Coastal Diversity Stratum:

1. Off-stream storage implementation in the Navarro River to improve and protect dry season summer flows that support rearing juvenile steelhead.

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

The NMFS 2016 Coastal Multispecies Recovery Plan (NMFS 2016b) and the 2016 5-year review identified inadequate regulatory mechanisms as a priority issue affecting Northern California steelhead recovery in the Central Coastal Diversity Stratum. Various federal, state, county and tribal regulatory mechanisms are in place to minimize or avoid habitat degradation caused by human use and development. Many of these mechanisms have been improved and updated in the past five years. However, the implementation and effectiveness of regulatory mechanisms has not been adequately documented. ***See Listing Factor D: Inadequacy of Regulatory Mechanisms in this document for details.***

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

The greatest opportunity to advance recovery of NC steelhead in the Central Coastal Diversity Stratum is to:

1. Increase water forbearance, streamflow enhancement, water conservation and groundwater sustainability projects (all populations). Prioritize water conservation projects for funding.
2. Implement the Garcia River Estuary Habitat Enhancement Plan (Garcia River estuary; Garcia River population)

### DPS Summary

Major habitat concerns remain in this DPS particularly with regard to (1) water quality (2) water quantity, and (3) estuary function, and (4) habitat simplification. When combined with land use, the current climate change trajectory threatens the ability of many streams throughout the NC steelhead DPS to support steelhead in the future (e.g., Power et al. 2015).

### Listing Factor A Conclusion

The NC steelhead DPS, and northern California as a whole have experienced unprecedented drought in the last ten years. Worsening climate change effects from severe droughts and catastrophic wildfires exacerbate threats to the NC steelhead DPS. The original listing of the NC steelhead DPS (65 FR 36074) found that habitat simplification from wetland loss, habitat simplification in streams, and reduction in pool depths from sedimentation were among factors responsible for the decline of steelhead on the west coast, including the NC steelhead DPS. New information available since the last 5-year review indicates there has been substantial investment in freshwater and estuary habitat restoration projects, which are expected to benefit the NC steelhead DPS.

However, continued water use, high summer water temperatures, and low flow conditions exacerbated by drought and climate change have reduced the efficacy of these restoration actions. In particular, low flow conditions throughout the NC steelhead DPS have limited the productivity of the habitat and reduced the potential for the habitat to support the conditions that steelhead need to prosper. Moreover, NMFS (2016a; 2016b) highlighted the need for water conservation projects, such as forbearance and reduction in diversions. In Volume III of NMFS Final Multispecies Recovery Plan (NMFS 2016b; pg 68-69), 23 separate water related recovery actions were listed, several being the highest priority, and yet virtually none of these were completed or implemented in the last five years. While a notable quantity of physical habitat restoration and upslope projects were completed in the last five years, projects that focused on increasing stream flows were virtually absent from project lists obtained from restoration partners. These physical habitat restoration projects are unlikely to be effective without sufficient streamflow to support basic water quality needs of NC steelhead. The original listing of the NC steelhead DPS (65 FR 36074) stated that "water diversions for agriculture, flood control, domestic, and hydropower purposes have greatly reduced or eliminated historically accessible habitat. NMFS assesses that these threats remain and few investments in this area have been made that have resulted in measureable benefits to streamflow in the NC steelhead DPS.

We therefore conclude that the risk to the species' persistence because of habitat destruction or modification has increased since the last 2016 5-year review. Future 5-year reviews would benefit from a systematic review and quantitative analysis of the amount of habitat addressed (NMFS 2016b) in order to track progress against plan objectives. Habitat concerns remain in several subbasins of this DPS, particularly with regard to stream flow, and water temperature in areas that exceed water quality standards due to anthropogenic causes. There remain numerous opportunities for habitat restoration or protection throughout the range of this DPS, the most significant of which is removal of Scott Dam on the Eel River. Estuary Restoration in the Ten Mile and Garcia rivers are expected to benefit the NC steelhead DPS. Estuary restoration in Noyo and Big rivers should be pursued in the future to increase the productivity of these areas for NC steelhead. Planned estuary restoration in Redwood Creek and ongoing channel restoration in lower Prairie Creek should also benefit the Redwood Creek population. Additional habitat protection or restoration actions focused on water quantity are necessary to bring this DPS to viable status, specifically restoration actions that preserve cold water resources in the warm season and limit water use during low flow periods.

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

#### Harvest

##### Overfishing

Ocean harvest in California and Oregon is an insignificant source of mortality for the NC steelhead DPS because steelhead are rarely encountered, and retention is not permitted in commercial salmon fisheries. They are rarely encountered in commercial or recreational salmon fisheries in California, Oregon, and Washington because the high seas distribution of the majority of steelhead is in the Gulf of Alaska (Light et al. 1989). Steelhead rarely show up in analyses of Gulf of Alaska bycatch or other fisheries monitored by the United States. (D. Stram, NMFS, personal communication, 2022). Since 2015 improved low flow fishing closures have reduced sport fishing for steelhead during times that adult fish are most vulnerable (J. Fuller, NMFS, personal communication, 2022).

The impact of freshwater recreational angling is thought to be low for steelhead in this DPS; however, the actual level of impact cannot be estimated with existing data. Recreational steelhead fishing is popular within this DPS and on the Mad River there is a bag limit of two hatchery steelhead. In streams where only catch and release fishing is allowed, all wild steelhead must be released without further harm. Bait is still permitted for use by CDFW in many streams throughout the DPS. Importantly, retention of coastal cutthroat trout in freshwater sport fisheries is also permitted in many streams in the DPS (e.g. Big Lagoon, Maple Creek, and Redwood Creek), where they are easily confused with NC Steelhead half pounders after capture by anglers. In addition to the risk of anglers inadvertently retaining NC steelhead half pounders, hooking mortality from the permitted use of bait is likely greater than it would be if regulation only permitted artificial lures. For example, Pauley and Thomas (2011) found that mortality of cutthroat trout was greater ($P < 0.05$) from the four sizes of worm-baited hooks (39.5–58.1 percent) than from the three different spinner treatments (10.5–23.8 percent). The extent to which retention fisheries increase the mortality of wild NC steelhead is not known.

In periods of decreased habitat availability (drought or low flow conditions), recreational fisheries have a greater impact on wild steelhead, and since the last 5-year review, there have been several years of drought that may have resulted in higher impacts in some areas. However, in 2015 the California Fish and Game Commission adopted regulations that prohibit fishing for NC steelhead during low flow conditions. Several streams already had low flow closures in place, such as the Mad River in Humboldt County. The regulations are intended to provide fishing opportunities when conditions allow for ample upstream and downstream movement by adult steelhead. These regulations will likely reduce the threat of recreational angling to NC steelhead during low flow periods. Little is known about fisheries on the Round Valley Indian Reservation.

#### Illegal Harvest

Illegal harvest of NC steelhead by sport or commercial fisherman is likely low, given the existing state ban on possessing wild steelhead in both the ocean and freshwater rivers – state and federal law includes significant fines for those caught possessing wild steelhead in California. However, the extent of poaching in the DPS in not well known. Since the previous 5-year review of this DPS, NMFS has worked with local stakeholders on outreach initiatives to reduce poaching incidents within the DPS. Specifically, NMFS, with assistance from CDFW, North Coast Regional Water Quality Control Board (NCRWQCB), Mendocino County Sheriff’s Department, The Nature Conservancy, and the Manchester-Point Arena Band of Pomo Indians worked collaboratively to finalize a tribal resolution that eliminates harvesting NC steelhead from the Garcia River. As part of this effort, new fishing information signs outlining the State’s fishing regulations for the Garcia River are posted throughout the watershed and these signs are expected to be posted in other watersheds. NMFS expects that a small amount of freshwater poaching may still occur within the Garcia River and elsewhere, and losing several adult fish may continue to significantly impact population productivity and genetic diversity in specific watersheds where current abundance is below the “high risk” threshold and poaching occurs frequently.

### Scientific Research and Monitoring

The quantity of take authorized under ESA sections 10(a)(1)(A) and 4(d) for scientific research and monitoring for NC steelhead remains low in comparison to their abundance, and much of the work being conducted is done for the purpose of fulfilling state and federal agency obligations under the ESA to ascertain the species' status. Authorized mortality rates associated with scientific research and monitoring are generally capped at 0.5 percent across the West Coast Region for all listed salmonid ESUs and DPSs. As a result, the mortality levels that research causes are very low throughout the region. In addition, and as with all other listed salmonids, the effects research has on NC steelhead are spread out over various reaches, tributaries, and areas across population 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 NC steelhead.

Any time we seek to issue a permit for scientific research, we consult on the effects that the proposed work would have on each listed species' natural- and hatchery-origin components. However, because research has never been identified as a threat or a limiting factor for any listed species, and because most hatchery fish are considered excess to their species' recovery needs, examining the quantity of hatchery fish taken for scientific research would not inform our analysis of the threats to a species' recovery. Therefore, we only discuss the research-associated take of naturally-produced fish in these sections.

Database records (NMFS APPS database; https://apps.nmfs.noaa.gov/) show that from 2015 through 2019 researchers were approved to take a yearly average of fewer than 3,400 adult (<16 lethally) and fewer than 335,000 juvenile (<4,900 lethally) NC steelhead per year, and for the vast majority of scientific research actions, history has shown that researchers generally take far fewer salmonids than are authorized every year. Reporting from 2015 through 2019 indicates that over those five years, the actual (reported) take for naturally-produced juveniles was 24 percent of the total amount authorized, and 6 percent of the total number of adults authorized to be taken. The reported lethal take was also low over the same five-year period: total lethal take of juveniles was only 4 percent of the mortalities authorized, and no adult mortalities were reported.

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, fyke nets, minnow traps, weirs, and hand or dip netting, with smaller numbers collected as a result of other seines, trawling, hook and line sampling, and those intentionally sacrificed. Adult take has primarily been (and is expected to continue to be) capture via weirs or fish ladders, hook and line angling, with smaller numbers captured via trawls or hand or dip nets, and getting unintentionally captured by screw traps, seining, and other methods that target juveniles (NMFS APPS database; https://apps.nmfs.noaa.gov/). Our records indicate that mortality rates for screw traps are typically less than 1 percent and backpack electrofishing are typically less than 3 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 3 percent. Also, a small number of adult fish may die as an unintended result of research because of interactions with trawl sampling equipment.

The quantity of total take authorized over the past five years has increased by 15 percent and authorized lethal take has increased by 36 percent. While authorized take has increased, the total amount of take reported from 2015 through 2019 has actually decreased compared to the total take reported from 2010 through 2014 (by 17 percent for total take and 39 percent for lethal take).

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

### Listing Factor B Conclusion

New information available since the last 5-year review indicates that harvest impacts for NC steelhead have remained similar since the last 5-year review in 2016. NMFS concluded in the original listing of the NC steelhead DPS (65 FR 36074) that overutilization for commercial, recreational, scientific, or education purposes was unlikely to have significantly contributed to the observed declines in steelhead populations throughout the Pacific coast, including the NC steelhead DPS. Scientific research impacts authorized through the West Coast Region have decreased NC steelhead compared to the past five years (NMFS APPS database; https://apps.nmfs.noaa.gov/). Due to the small number of individuals affected relative to the species' abundances and the dispersed nature of research activities, the impacts from these sources of mortality are not considered to be major limiting factors for this DPS. Furthermore, a Fisheries Management and Evaluation Plan (FMEP) for NC steelhead in the Mad River, when approved, is also expected to reduce impacts associated with NC steelhead produced at the Mad River Hatchery, through biologically based fishery management strategies that ensure the conservation and recovery of listed ESUs. Although data and information is limited, we do not have evidence that the persistence of the species because of overutilization due to harvest or research has changed since the 2016 5-year review. Therefore, we conclude that the risk to the persistence of the species because of overutilization due to harvest or research since the 2016 5-year review is low.

## Listing Factor C: Disease and Predation

### Predation

#### Marine Mammals

The four main marine mammal predators of salmonids in the eastern Pacific Ocean are harbor seals (*Phoca vitulina richardii*), fish-eating killer whales (*Orcinus orca*), California sea lions (*Zalophus californianus*), and Steller sea lions (*Eumetopias jubatus*).

Recent research over the past five years suggests that predation pressure on ESA-listed salmon and steelhead from seals, sea lions, and killer whales has been increasing in the northeastern Pacific Ocean over the past few decades (Chasco et al. 2017a, Chasco et al. 2017b). 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 fish-eating (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 period (Marshal et al 2016; Chasco et al 2017a; Ohlberger et al. 2018). This same modeling suggests that these increasing trends have continued across all regions of the northeastern Pacific over the past five years. Using a juvenile-to-adult conversion for pinnipeds, Chasco et al. (2017a) estimates that the biomass of Chinook salmon consumed in central California by these marine mammals may have increased by almost tenfold from 1975 to 2015 (Figure 3). The potential predation impacts from the four main marine mammal predator species of ESA-listed salmonids on the West Coast are discussed individually below.

##### Pinnipeds

The three main seal and sea lion (pinniped) predators of ESA-listed salmonids in the eastern Pacific Ocean are harbor seals, California sea lions, and Steller sea lions. With the passing of the Marine Mammal Protection Act (MMPA) in 1972, these pinniped stocks along the West Coast of the United States have significantly increased in abundance (Carretta et al. 2022). With their increasing numbers and expanded geographical range, marine mammals are consuming more Pacific salmon and steelhead, and some are having an adverse impact on some ESA-listed species (Chasco et al. 2017a; Thomas et al. 2017; Marshall et al. 2016).

By converting juvenile Chinook salmon into adult equivalents, Chasco et al. (2017a) estimated on a Pacific coast-wide scale that by 2015, pinniped consumption of Chinook salmon was double that of Resident killer whales and six times greater than the combined volume of commercial and recreational catches (Figure 3). In California, pinnipeds occur seasonally in the American River and the Sacramento River. However, there are no qualitative or quantitative assessments of pinnipeds (i.e., number of seasonal animals) in these systems. In the Columbia Basin recent research found that survival of adult spring-summer Chinook salmon through the estuary and lower Columbia River is negatively impacted by higher sea lion abundance for populations with run timing that overlaps with seasonal increases in Steller and California sea lions (Wargo Rub et al. 2019, Sorel et al. 2021).

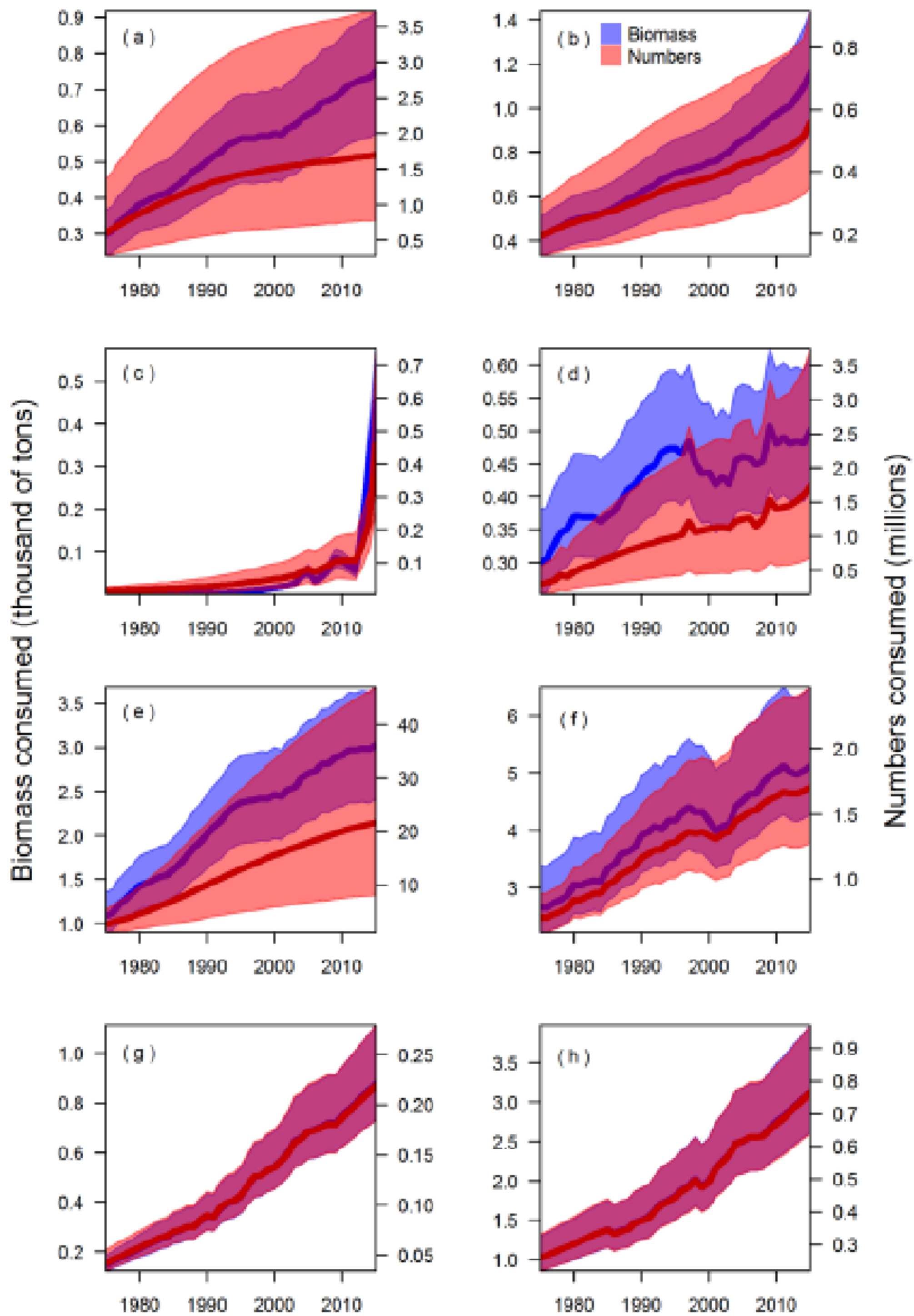


**Figure 3. [Reproduced from Chasco et al. 2017a] Estimates of consumption of Chinook salmon by the combined marine mammal predators, with uncertainty, in terms of the biomass (primary axis) and number (secondary axis) of Chinook salmon consumed per region: Central California (a), Northern California/coastal Oregon (b), Columbia River (c), Washington coast (d), Salish Sea (e), West Coast Vancouver West Coast Vancouver Island and coastal British Columbia (f), Southeast Alaska (g), and Gulf of Alaska (h).**

Most authors have focused research on Chinook salmon because they have the highest energy value for predators (O'Neill et al. 2014). However, some study authors have found that pinnipeds like harbor seals can have a significant impact on other species of salmon (Thomas et al. 2017), and steelhead (Moore et al. 2021) through the consumption of outmigrating juveniles. Though harbor seal predation data specific to California is not currently available, we expect that impacts of all pinnipeds in California estuaries and rivers has increased significantly since the 1970s, similar to the modeling results of the studies discussed above.

Information available since the last 5-year review clearly indicates that predation by pinnipeds on Pacific salmon and steelhead continues to pose an adverse impact on the recovery of some ESA-listed salmon and steelhead. Pinniped populations on the West Coast have increased significantly since the MMPA was enacted in 1972, and recent modeling efforts indicate predation by pinniped species has been on the rise, particularly Chinook salmon, over the last few decades in Washington, Oregon, and California. Therefore, while there are management efforts underway to reduce pinniped predation on Pacific salmon and steelhead in select areas of the Columbia River Basin, these management efforts alone may be insufficient to reduce the severity of impacts pinniped predation poses to the recovery of Pacific salmon and steelhead in the Columbia River Basin, Puget Sound and California. Given the lack of information currently available in California, further study of pinniped predation interactions is warranted to determine whether these impacts are limiting the recovery of ESA-listed salmon and steelhead in the state.

#### Avian and Other Mammal Predation

The effect of avian predation on NC steelhead from birds like terns, cormorants and gulls is not well understood. However, NMFS believes that in some specific areas in the NC steelhead DPS and nearshore environments, avian predation could have a substantial effect on out migrating juvenile NC steelhead. An indirect effect of urbanization is the resultant increase in opportunistic, generalist predators (e.g., western gulls or raccoons) that utilize anthropogenic resources (e.g., landfills, garbage), to increase their local carrying capacity. For example, Osterback et al. (2013) determined that juvenile salmonid mortality from western gull predation in Central California populations was greater than previously estimated.

#### Invasive Species

Aquatic invasive species (AIS) are organisms (plants, animals, or pathogens) that impact the diversity or abundance of native species, the ecological stability of infested waters, and/or the commercial, agricultural, aquaculture or recreational activities dependent on such waters. In coastal marine and freshwater environments, AIS have been shown to have major negative effects on the receiving communities where they often outcompete native species, reduce species diversity, change community structure, reduce productivity and disrupt food web function by altering energy flow among trophic levels (Cohen and Carlton 1995, Cohen and Carlton 1998, Ruiz et al. 2000, Stachowicz and Byrnes 2006). There are multiple mechanisms of impact that directly affect salmonids, such as predation and infection (disease and parasitism), discussed here, and indirect impacts such as competition, hybridization, and habitat alterations (Mack et al.

2000, Simberloff et al. 2005), as discussed under Listing Factor E.

In California, approximately half of the freshwater species, which include aquatic invasive plants, animals, and pathogens, are introduced; and as many as 40 introduced species may be present in individual watersheds. Despite the abundance of AIS (plants and invertebrates taxa), there is limited information to assess their impacts on aquatic ecosystems, thus the associated implications for habitats occupied by threatened and endangered salmonids are difficult to determine (Sanderson et al. 2009). For NC steelhead, no attempts at quantifying predation by Sacramento pikeminnow (*Ptychocheilus grandis*) in the Eel River system have been made. More studies are needed to specifically investigate the impacts of AIS on ESA-listed salmonid populations, their designated critical habitat, and species recovery.

The non-native Sacramento pikeminnow is a large piscivorous fish that was introduced into Lake Pillsbury (upper mainstem Eel River) around 1979 and has since expanded its distribution throughout most of the Eel River basin (Harvey et al. 2002, Kinziger et al. 2014). Pikeminnow occur at very high densities in many parts of the watershed (White and Harvey 2001) and have the potential to fundamentally alter the aquatic ecosystem and negatively impact many native species (Stillwater Sciences and Wiyot Tribal Natural Resources Department 2020). Various studies indicate that pikeminnow compete with, prey on, or alter behavior of juvenile salmonids, lampreys, and other native fishes in the Eel River basin (White and Harvey 2001, Nakamoto and Harvey 2003, Stillwater Sciences and WTNRD 2020). The efficacy of eradication efforts is unknown, though plans for additional pikeminnow monitoring and eradication efforts are being undertaken by the Wiyot Tribe (Stillwater Sciences and WTNRD 2020). Data collected in the upper Eel River by Pacific Gas and Electric Company (PG&E; 2010) indicate that pikeminnow populations have decreased from peak numbers in the 1980s and 1990s, but monitoring efforts since 2005 show their abundance has been variable. In addition, interactions between multiple stressors such as Sacramento pikeminnow and smallmouth bass (*Micropterus dolomieu*) predation at small diversion dams and other altered habitat can also dramatically impact listed species (Sabal 2014). Overall, the predation threat to NC steelhead from invasive species is thought to be unchanged since the last 5-year review in 2016.

#### Recommended Future Actions

- Expand, develop, fund, and implement monitoring efforts in California to identify pinniped predation interactions in select areas, e.g., river mouths/migratory pinch points, and quantitatively assess predation impacts by pinnipeds on Pacific salmon and steelhead stocks.
- Evaluate the effects of marine mammal salmon predators protected under the MMPA on ESA recovery goals for listed salmonids, including the NC Steelhead DPS.
- Continue to support and complete the study on Sacramento pikeminnow in the South Fork Eel River being conducted by Stillwater Sciences and the Wiyot Tribe.
- Continue to refine PG&E's monitoring and suppression program for Sacramento pikeminnow in Lake Pillsbury and in between Scott and Cape Horn Dams.

### Disease

The potential for disease outbreaks, due to introductions and straying of out-of-basin and other non-native fishes, is less likely than at the time of listing due to implementation of CDFW policies prohibiting interbasin transfers. Therefore, wild populations of NC steelhead are at less risk of disease outbreaks from a hatchery fish than they were previously. The threat of disease has been reduced at the Mad River hatchery by the use of well water, ultraviolet treatment of recirculated water and mandatory disease check of juveniles before release. NMFS finalized ESA Section 4(d) consultation on the Mad River Hatchery and Genetic Management Plan (HGMP) in 2017 (NMFS 2017).

Habitat conditions, such as low water flows and high temperatures, continue to exacerbate susceptibility to both disease and predation through increased physiological stress and physical injury. These conditions may be exacerbated by releases from reservoirs (primarily Lake Pillsbury and Lake Mendocino) when water storage is low due to drought conditions. There is no information regarding how low storage in these reservoirs influences disease outbreaks within either population; nevertheless, the potential exists as noted in other watersheds (i.e., Klamath basin) and therefore poses a threat to these populations as drought conditions continue. No quantitative information has emerged since the last 5-year review that would suggest disease impacts have elevated in the time since, or that disease impacts are a more prominent factor in the present depressed state of the NC steelhead DPS.

### Listing Factor C Conclusion

In the original listing of the NC steelhead DPS (65 FR 36074) NMFS determined there was insufficient data to conclude that pinnipeds were having a significant impact on steelhead populations on the west coast, and recommended additional studies. There is new and substantial evidence, much of which was published since the last 5-year review in 2016, that marine mammal predation on salmonids has been increasing significantly in recent decades throughout the U.S. west coast and Canada. Therefore, it is likely that NC steelhead have experienced an increase in marine mammal predation commensurate with other salmonid populations in the western U.S. Pikeminnow suppression by the Wiyot Tribe in the Eel River Basin has targeted areas for the removal of Sacramento pikeminnow. However, no estimates of the effect of the removals on NC steelhead are available. There is no new information available since listing or the last 5-year review to indicate whether there is an increase in the level of avian or fish predation on NC steelhead, or that disease impacts are more than a minor factor in the present depressed state of the DPS.

## Listing Factor D: Inadequacy of Regulatory Mechanisms

Various federal, state, county and tribal regulatory mechanisms are in place to reduce habitat loss and degradation caused by human use and development and harvest impacts. For this 5-year review, we focus our analysis on regulatory mechanisms for Habitat and for Harvest that have either improved for NC steelhead, or are still causing the most concern in terms of providing adequate protection for NC 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 strata that comprise the species. The habitat conditions across all habitat components (tributaries, mainstems, estuary, and marine) necessary to recover the listed NC 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 largely reflects the underlying ownership of the land and water resources as federal, state, or private holdings.

One factor affecting habitat conditions across all land or water ownerships is climate change, the effects of which are discussed under Listing Factor E: Other natural or manmade factors affecting its continued existence. We reviewed summaries of national and international regulations and agreements governing greenhouse gas emissions. These documents indicate that, while the number and efficacy of such mechanisms have increased in recent years, there has not yet been a substantial deviation in global emissions from the past trend, and upscaling and acceleration of far-reaching, multilevel, and cross-sectoral climate mitigation will be needed to reduce future climate-related risks (IPCC 2022). These findings suggest that current regulatory mechanisms, both in U.S. and internationally, are not adequate to address the rate at which climate change is negatively impacting habitat conditions for many ESA-listed salmon and steelhead.

Inadequate regulatory mechanisms have contributed substantially to the decline of the NC steelhead DPS. In developing the 4(d) rule for this DPS (67 FR 1116), NMFS noted several federal, state, and local regulatory programs that have been implemented to reduce threats to these and other species. Although many regulatory mechanisms and conservation efforts were in place at the time this DPS was listed, NMFS concluded they collectively still do not provide for the attainment of properly functioning habitat conditions that would protect and conserve the species. Below is our current assessment of these mechanisms and efforts.

### Regulatory Mechanisms Resulting in Adequate or Improved Protection

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

#### 1. State Water Management

#### California Water Action Plan

Issued by Governor Brown in January 2014, the California Water Action Plan sets forth 10 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 (SWRCB) and the Department of Fish and Wildlife will implement a suite of individual and coordinated administrative efforts to enhance flows statewide in at least five stream systems that support critical habitat for anadromous fish." As part of implementing Action 4, CDFW's Instream Flow Program has supported flow enhancement activities and is developing flow criteria in five priority streams throughout the state that support critical habitat for threatened and endangered anadromous salmonids: Mark West Creek (Sonoma County), Mill Creek (Tehama County), SF Eel River (Humboldt/Mendocino counties), Shasta River (Siskiyou County), and the Ventura River (Ventura/Santa Barbara counties). To set instream flow prescriptions, CDFW is using the California Environmental Flows Framework (CEFF) to identifying ecological flow needs for rivers and streams in California. The CEFF uses flow records and site-specific instream habitat analysis to quantify ecologically-relevant flow characteristics (flow magnitude, frequency, duration, timing, and rate of change) at the individual stream reach. The identified flow characteristics then inform flow patterns supportive of five identified "functional flow components" (fall pulse flow, wet-season baseflow, wet-season peak flow, spring recession flows, and dry-season baseflow) that inform habitat suitability for various life-stages of anadromous salmonids. The resulting ecological flow recommendations will be used in water management, planning, and decision-making processes, which may include submitting to the SWRCB pursuant to Public Resources Code §10000-10005. Preliminary instream flow recommendations have been developed for the Ventura River as of November 2020; flow recommendations remain in development for the other four priority streams identified in the Water Action Plan.

Other critical Water Action Plan components identified under Action 4 that specifically address salmon and steelhead habitat include managing headwaters for multiple benefits, re-introducing spring Chinook salmon to the San Joaquin River, restoring coastal watersheds, dam removal and restoration on the Klamath River, 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.

#### 2. Federal Power Act and Energy Policy Act

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 hydroelectric projects. In estuary and marine environments, BOEM has jurisdiction over wind, gas, and oil energy projects; and FERC has jurisdiction over tide or current related energy (hydrokinetic) projects. These energy projects affect NOAA trust resources in the Pacific Ocean, offshore of Washington, Oregon, and California. FERC and BOEM have several types of licensing/re-licensing processes that are used to guide the collection of data, development of a license application, and the issuance of a license. 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.

##### Potter Valley Block Water Releases

In 2002, NMFS issued a jeopardy biological opinion that addresses the impacts to Southern Oregon-Northern California (SONCC) coho salmon, CC Chinook salmon and NC steelhead from hydropower generation at the Potter Valley powerhouse and the Lake Mendocino powerhouse under current and future (2020) sediment conditions and water diversions from the Eel River Basin to the Russian River Basin. The jeopardy biological opinion contained a reasonable and prudent alternative (RPA) that called for implementing changes in river flow that would more closely resemble the natural hydrograph (NMFS 2002). NMFS expects the actions required by the RPA to substantially improve habitat conditions and survival rates for NC steelhead and SONCC coho salmon. In 2012, and twice during 2014, NMFS and CDFW jointly requested the project proponent (PG&E) to make spring (2016-2020) block water releases pursuant to RPA B.3 and D.1. Spring blockwater releases are primarily designed to encourage the timely emigration of juvenile Chinook salmon. Each of these spring blockwater releases presented different water supply constraints requiring different release strategies. These strategies range from temperature dependent cues, to sequential pulse releases, to mimicking a spring freshet. The purpose of the summer 2014 block water release was to enhance water quality (*i.e.*, temperature) conditions between Scott and Cape Horn dams and increase habitat availability and quality below Cape Horn Dam to Tomki Creek for rearing juvenile NC steelhead. Based on preliminary data from ongoing monitoring at the time of this 5-year review, these releases appear to have been successful in meeting their intended objective. Since NMFS issued the biological opinion, these releases were the first time that RPA B.3 and D.1 have been used. Continued implementation of these elements of the RPA in the biological opinion will further reduce the threat from altered hydrologic function from the Potter Valley Project

#### Marine Hydrokinetic/Marine Wind Energy Projects

Since the last 5-year review, NMFS has participated in efforts to license several existing and proposed Marine Hydrokinetic/Marine Wind Energy (MHK/MWE) projects in California. For projects that are proposed or relatively recent, their impact to NMFS trust resources are not fully known. Given this uncertainty and the duration of such energy licenses, it is essential that NMFS remain meaningfully engaged in review and approval processes with FERC and BOEM.

### 3. Medicinal and Adult-Use Cannabis Regulation and Safety Act

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

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

The regulatory and permitting program outlines a comprehensive approach to minimize cannabis cultivation impacts on surface water quality and quantity, including those affecting salmon and steelhead. However, most cannabis cultivators seeking permitting from CDFW and the SWRCB propose using groundwater pumping as their water source, thus avoiding the season and bypass flow requirements stipulated for surface water diversions. An unknown, but likely large number of these wells are located near streams and rivers since shallow groundwater depths decrease well drilling costs, and groundwater depths typically increase proportionally with distance from a stream. These wells may be depleting hydraulically connected streamflow and significantly impairing salmon and steelhead instream habitat, especially during summer months when flows are lowest and irrigation demand highest. This groundwater-surface water relationship largely goes unrecognized and unanalyzed during local and state permitting processes. Another factor that limits the State's environmental protection efforts is the number of illegal/unregulated cultivation operations that remain on the landscape. Many growers object to the cost associated with permitting a "legal" grow operation, which may incentivize growers to avoid state regulation. Eradicating unregulated cannabis operations and increasing overall industry oversight through MAUCRSA will be required to realize appreciable improvements in instream habitat quality for salmon and steelhead and other native aquatic resources.

#### 4. California Forest Practices and Anadromous Salmon Protection

At the time of NC steelhead listing (65 FR 36074), the State Forest Practice Rules were found by NMFS to inadequately protect salmonids. Many of the identified inadequacies have been ameliorated through regulation changes by the State Board of Forestry. The most notable rule changes with input from NMFS, CDFW, and other State agencies are the 2010 Anadromous Salmonid Protection Rules and the 2012 Road Rules. These rules expanded stream-buffer widths, reduced the use of damaging road and harvest techniques, and limited riparian harvesting to collectively improve instream and riparian habitat and function over the long-term. Additionally, some private timber companies are actively restoring damaged aquatic and upslope habitat by increasing instream large wood volume or abating upslope erosion sources. The State Forest Practice Rules have also made additional changes to the cumulative watershed effects analysis of proposed timber harvest practices. These Board of Forestry rules (which apply to the northern/central portion of the DPS) provide additional no-cut buffer protections to certain Class II-Standard watercourses.

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

### Regulatory Mechanisms Resulting in Inadequate or Decreased Protection

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

#### 1. Clean Water Act

The Federal Clean Water Act addresses the development and implementation of water quality standards, the development of Total Maximum Daily Loads (TMDLs),[2] point source permitting, the regulation of stormwater, and other provisions related to the protection of U.S. waters. The State of California administers the Clean Water Act with oversight by the U.S. Environmental Protection Agency (EPA). State water quality standards are set to protect beneficial uses, which include several categories of salmonid use. Together the State and Federal clean water acts regulate the level of pollution within streams and rivers in California.

Each state has a water quality section 401 certification program that reviews projects that will discharge into waters of the United States, and issues certifications that the proposed action meets State water quality standards and other aquatic protection regulations, if appropriate. Each state also issues National Pollution Discharge Elimination System (NPDES) permits under section 402 for discharges from industrial point sources, waste-water treatment plants, construction sites, and municipal stormwater conveyances, with established parameters for the allowance of mixing zones if the discharged constituent(s) do(es) not meet existing water quality standards at the 'end of the pipe.' TMDLs are prepared to develop actions to reduce concentrations of specific contaminants or natural constituents recognized within a waterbody

[2] 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.

that fail to meet water quality standards in repeated testing.[3] These constituents may be pesticides, such as dieldrin, which are regulated under the Federal Insecticide, Fungicide and Rodenticide Act; industrial chemicals, such as polychlorinated biphenyls (PCBs) regulated under the Toxic Substances Control Act;[4] 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.

The United States Army Corps of Engineers (USACE) regulates dredging and filling in the waters of the United States through the Federal Clean Water Act Section 404 Program. The USACE program is implemented through the issuance of a variety of individual, nationwide, and emergency permits. Permitted activities should not "cause or contribute to significant degradation of the waters of the United States." A variety of factors, including inadequate staffing, training, and in some cases regulatory limitations on land uses (e.g., agricultural activities) and policy direction, resulted in ineffective protection of aquatic habitats important to migrating, spawning, or rearing steelhead. The deficiencies of the current program are particularly acute during large-scale flooding events, such as those associated with El Niño conditions, which can put additional strain on the administration of the Clean Water Act Section 404 and 401 programs. The Clean Water Act is not effectively protecting fish resources, particularly regarding non-point sources of pollution. The USACE continues to lack a comprehensive and consistent process to address the cumulative effects of the continued development of waterfront, riverine, coastal, and wetland properties.

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

Urbanized areas contribute general-use pesticides sold in stores and legacy contaminants from their current and former land uses such as dioxins and PCBs, nutrients from lawn and garden care, and elevated levels of suspended sediment and turbidity from land-disturbing activities. Stormwater runoff can also carry geologic signatures from their source areas, for example, elevated levels of aluminum throughout the NC steelhead ESU. Roads and streets contribute additional stormwater contaminants such as Polycyclic Aromatic Hydrocarbons (PAHs) like oils

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

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

and greases, various heavy metals such as copper and zinc, and other toxic substances such as tire particles (6PPD-quinone).

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

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

The tire particle associated 6PPD-quinone has only recently been identified although it has been in use for many decades and may be responsible for observations of toxicity whose cause was previously listed as unknown. Tire-derived products used by agencies and municipalities, such as asphalt rubber paving, fill for overpass construction or surface area covers for porous walkways, paths and bike trails, may also contribute harmful chemicals to waterways (CA DTSC 2022). Potential impact levels in a waterbody depend on roadway utilization (traffic density and average speeds) and road density (Feist et al. 2018, Peter et al. 2022) as well as the specific drainage patterns from the roadways. Symptoms of morbidity to *O. mykiss* exposed to 6PPD-quinone or untreated urban stormwater runoff were noticeable within hours, and they did not recover when transferred to clean water (Brinkmann et al. 2022, French et al. 2022). Mortality of 50% of the juvenile rainbow trout occurred at low levels of 6PPD-quinone (1 part per billion (ug/L)) that are realistic and documented in the environment (Challis et al. 2021, Johannessen et al. 2022).

The highest concentration of chemicals harmful to instream habitats are expected to be associated with the point of discharge during and shortly after rainfall, particularly “first-flush” rain events after long antecedent dry periods. However, when road densities are high enough many contaminants exhibit transport-limited, rather than mass-limited, characteristics. This means the source of contaminants within the system is large enough that additional precipitation continues to mobilize the pollutants either by transporting that which was newly deposited on the roadway or that which was less mobile or more distant from the discharge point (Peter et al. 2022, Johannessen et al. 2022, Feist et al. 2018). In these cases, designated critical habitat has the potential to experience a temporary or permanent reduction in function and value as a result of exposure to untreated stormwater runoff, particularly near urban areas. Therefore, the effects of pollution from roads and urban runoff remain a concern for NC steelhead.

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

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

NMFS has performed a series of consultations on the effects of EPA registration under FIFRA of commonly applied chemical insecticides, herbicides, and fungicides, which are authorized for use per EPA label criteria. Such chemicals enter waterways through a variety of mechanisms, including runoff, agricultural return flows, and spray drift. Table 5 contains a list of the agricultural pesticides and herbicides for which NMFS has provided an ESA consultation that either jeopardize NC steelhead and/or adversely modify their critical habitat. Several other chemicals are known to jeopardize other species of salmonids and may do so for steelhead but those listed in Table 5 have specifically been categorized by NMFS as jeopardizing NC steelhead or their habitat. Agricultural areas often contribute current and legacy agricultural pesticides and herbicides from farmed land to water bodies. Therefore, the effects of pollution from herbicides, insecticides, and fungicides remain a concern for NC steelhead.

**Table 5. Commonly applied chemical insecticide and herbicide that NMFS has determined either jeopardize NC steelhead and/or adversely modify their critical habitat.**

| Chemical Insecticides, Herbicides, Fungicides | Does it Jeopardize NC steelhead Species? | Does it Adversely Modify NC steelhead Habitat? | Citation |
|---|---|---|---|
| 2,4-D | Yes | No | NMFS 2011 |
| Diflubenzuron | Yes | Yes | NMFS 2015 |

#### 3. National Flood Insurance Program and Federal Emergency Management Agency

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

Nearly all West Coast salmonid species, including 27 of the 28 species listed under the ESA, are negatively affected by an overall loss of floodplain habitat connectivity and complex channel habitat. The reduction and degradation of habitat has progressed over decades as flood control and wetland filling occurred to support agriculture, silviculture, or conversion of natural floodplains to urbanizing uses (e.g., residential and commercial development). Loss of habitat through conversion was identified among the factors for decline for most ESA-listed salmonids. "NMFS believes altering and hardening stream banks, removing riparian vegetation, constricting channels and floodplains, and regulating flows are primary causes of anadromous fish declines" (65 FR 42422; July 10, 2000); "Activities affecting this habitat include…wetland and floodplain alteration" (64 FR 50394; Sept. 16, 1999).

Development proceeding in compliance with NFIP minimum standards ultimately impacts floodplain connectivity, flood storage/inundation, hydrology, and habitat-forming processes. Development consequences of levees, stream bank armoring, stream channel alteration projects, and floodplain fill, combine to prevent streams from functioning properly and result in degraded habitat. Most communities (counties, towns, cities) in California are NFIP participating communities, applying the NFIP minimum criteria. For this reason, it is important to note that, where it has been analyzed for effects on salmonids, floodplain development that occurs consistent with the NFIP's minimum standards has been found to jeopardize 18 listed species of salmon and steelhead (Chinook salmon, steelhead, chum salmon, coho salmon, sockeye salmon) (NMFS 2008, 2016b).

#### 3. California's Sustainable Groundwater Management Act

California's Sustainable Groundwater Management Act (SGMA) was signed into law in January, 2015, during the height of the state's historic drought. SGMA required medium and high priority groundwater basins to form local Groundwater Sustainability Agencies (GSAs) by 2017, and develop and begin implementing a Groundwater Sustainability Plan (GSP) by 2022 that achieves sustainable groundwater conditions no later than 2042. Sustainability under the act is defined as avoiding six "undesirable results" caused by unsustainable groundwater management, one of which is "significant and unreasonable impacts to beneficial uses of surface water". Since many waterways overlying SGMA basins contain Federally designated critical habitat for ESA-listed salmonids, NMFS has actively participated as a stakeholder in many GSP development processes throughout the state by advising GSAs to consider and avoid streamflow depletion impacts to salmon and steelhead habitat. However, a provision in SGMA legislation allows each GSA to choose whether they wish to address any undesirable results occurring prior to January 1, 2015.

To date, every GSA has interpreted that language as allowing streamflow depletion rates consistent with summer 2014 as an appropriate and legal management objective. This means that the threshold to take action on streamflow depletion only applies when streamflow depletion is *worse* than that seen during the depths of our recent historic drought, as 2014 was the third year in the driest 4-year stretch in California's recorded history (Hanak et al. 2016), with many detrimental consequences for salmon and steelhead individuals and habitat. To counter this approach, NMFS has commented consistently within every basin during the past five years of GSP development that proposed streamflow depletion thresholds consistent with historic drought conditions are likely to degrade salmonid migration, spawning, and rearing habitat and harm ESA-listed species.

Streamflow depletion is difficult to measure, and often requires a groundwater/surface water model for analysis, which the GSPs will develop within the first five years of plan implementation. One basin (Sonoma Creek) developed a "preliminary" model during GSP development that estimated groundwater pumping caused a streamflow depletion rate of 90 percent (as compared to a "no pumping" scenario) during summer-fall 2014, providing support for NMFS' concern about detrimental impacts to salmon and steelhead habitat. California's Department of Water Resources (DWR) is currently evaluating the submitted GSPs for consistency with the Act/regulations, with final determinations expected in early 2024. Given the lack of response by DWR to any of NMFS' attempts to directly raise this issue to date, NMFS is not confident that any GSA will be required to amend their GSP to thresholds that do not use the 2014 drought conditions as an acceptable objective.

## Harvest

### 1. California Freshwater Fishing Regulations

The 2022-23 California State Sport Fishing Regulations allow catch and release or retention of wild and hatchery salmon and/or steelhead in nearly all anadromous streams in California. Partial protection measures have been established by the California Fish and Game Commission to provide fishing opportunities while reducing threats to federally listed salmonids. These partial protection measures include low-flow closures, catch and release, reduced bag limits, limited fishing days, geographic limits, gear restrictions, and fishing prohibitions. Recreational angling is popular across all ESUs and DPSs, yet its impact remains uncertain despite restrictions through modifications of the angling regulations.

Recreational, commercial, and tribal fisheries can be managed in a way that protects listed salmon and steelhead and allows them to recover. The 4(d) rule does not prohibit the take of listed fish in fisheries if a fishery management agency develops an FMEP and NMFS approves it. If an FMEP is implemented accordingly, take of listed species in the fisheries will be covered under the ESA. The primary goal of an FMEP is to devise biologically based fishery management strategies that ensure the conservation of listed ESUs/DPSs. Development and finalization of FMEPs for California are recommended and necessary to authorize these fisheries under the ESA. These plans ensure proper fisheries management of sensitive stocks by establishing a more formal program to minimize the take of federally-listed salmonids. Currently, there are no FMEPs for NC steelhead. An FMEP is currently being developed for the Mad River, but is not yet in place. An FMEP is needed to meet the 4(d) rule criteria for the freshwater fishing of NC steelhead on the Mad River and throughout the NC steelhead DPS where catch and release is allowed.

Finally, species identification and proper handling and release techniques, when incidental capture of listed salmonids occurs, are critical to reduce the likelihood of injury and/or death. Improving angling outreach remains a priority to educate anglers on handling techniques, the reporting of poaching and other illegal activities, and their contributions to species population monitoring. Other efforts to improve angler conservation awareness and handling and release skills can be found in NMFS' Scaling Back Your Impact: Best Practices for Inland Fishing[5].

### Listing Factor D Conclusion

The NMFS 2016 Coastal Multispecies Recovery Plan (NMFS 2016a) and the 2016 5-year review identified inadequate regulatory mechanisms as contributing substantially to the decline of the NC Steelhead DPS. Despite a significant amount of text devoted to describing regulatory mechanisms in the NC steelhead DPS, the original listing determination (65 FR 36074) did not conclusively state that inadequate of regulatory mechanisms was a significant factor in the decline in abundance of this DPS. Although many regulatory mechanisms and conservation efforts were in place at the time this DPS was listed, NMFS concluded that they were insufficient to provide for the attainment of properly functioning habitat conditions and sustainable harvest conditions that would protect and conserve the species. The primary regulatory mechanisms that protect NC steelhead are not comprehensive, and are vastly different across the landscape and land use type (NMFS 2016b). Based on the improvements noted above, we conclude that the risk to the species' persistence because of the adequacy of existing regulatory mechanisms has decreased slightly. However, despite improvement in the adequacy of regulatory mechanisms within the DPS, a number of concerns remain regarding existing regulatory mechanisms, including:

- Lack of implementation and enforcement of existing regulations, including the Clean Water Act's "no net wetland loss" policy. Improving wetland protection within the NC steelhead DPS will likely be critical in future recovery efforts as wetlands contribute to overall watershed health.
- USACE continues to lack a comprehensive and consistent process to address the cumulative effects of the continued development of waterfront, riverine, coastal, and wetland properties.
- NFIP implementation in California may also be incrementally and permanently diminishing floodplain habitat form and function to the detriment of NC steelhead.
- Surface and groundwater use and failure to regulate surface and groundwater withdrawals throughout the DPS, but particularly in areas with shallow interconnected groundwater such as the lower Eel River.
- No FMEPs have been completed in the NC steelhead DPS to adequately address the impacts of harvest.
- Inadequate cumulative watershed effects analysis in CA Forest Practices.

[5] https://media.fisheries.noaa.gov/2021-01/scaling-back-your-impact-catch-and-release.pdf

### Recommended Future Actions

#### Habitat

- Improve salvage logging practices to better address the emerging threat of increased frequency and intensity of wildfires
- Work with the SWRCB to eliminate depletion of summer base flows from unauthorized water uses and withdrawals in over-appropriated streams. Coordinate efforts by federal, state, and county law enforcement agencies to remove illegal diversions from streams.
- Work with the SWRCB establish permanent minimum instream flows for each stream or river to ensure viable NC steelhead populations in the DPS range.
- Implement and enforce AB 2121, which codified (in sections 1259.2 and 1259.4 of the California Water Code) CDFW and NMFS' Water Diversion Guidelines, and expand similar regulations throughout the DPS range to ensure protective flows for all life stages of salmonids.
- Develop water conservation measures at local and State levels to include a drought management plan for each watershed that is triggered by identified minimum flow requirements.
- Evaluate and implement off-channel storage facilities to reduce impacts of water diversion (storage tanks for rural residential users).
- Continue to pursue and implement the Sustainable Ground Water Management Act (SGMA).

#### Harvest

- Develop FMEPs for rivers and streams in which angling is permitted.

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

### Climate Change

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

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

#### Salmon and Steelhead Habitat Changes

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

##### Forests and Wildfires

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

A major emergent habitat concern since the 2016 5-year review is the increased frequency and severity of large unprecedented wildfires throughout the NC steelhead DPS. Forest fires affect salmon streams by altering sediment load, channel structure, and stream temperature through the removal of the tree canopy.

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

Holden et al. (2018) examined environmental factors contributing to observed increases in the extent of forest fires throughout the western United States. 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).

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

#### Freshwater Environments

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

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

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

As cited in Siegel and Crozier (2019), Isaak et al. (2018) examined recent trends in stream temperature across the western U.S. using a large regional dataset. Stream warming trends paralleled changes in air temperature and were pervasive during the low-water warm seasons of

1996-2015 (0.18-0.35°C/decade) and 1976-2015 (0.14-0.27°C/decade). Isaak et al. (2018) concluded that most stream habitats will likely remain suitable for salmonids in the near future, with some becoming too warm. However, in cases where dams and other barriers restrict habitat access, salmon and steelhead will be confined to downstream reaches that are typically most at risk of rising temperatures unless passage is restored (FitzGerald et al. 2020; Myers et al. 2018).

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

#### Drought

At the time of the 2016 5-year review, California had experienced well below average precipitation from 2012-2015 and record-high surface air temperatures during 2014 and 2015. For water years 2020, 2021, and 2022, California experienced a historically severe drought. In the spring of 2022, the National Integrated Drought Information System and NOAA categorized all habitat in the NC steelhead DPS as a severe or extreme drought (Figure 4). Many NC steelhead DPS streams that are usually flowing with water were already dry or almost dry, making them uninhabitable to salmonids for much of the year. The decrease in streamflow shows that the drought had cumulative impacts on alluvial aquifer and groundwater conditions (Dolman et al. 2019). The drought conditions contribute to higher than normal water temperatures in the summer and fall and lower amounts of wetted habitat available to returning adults and rearing juveniles. Those conditions also create a suite of other problems, such as environmental conditions that favor predators of steelhead, like low water turbidity. The impacts on the affected steelhead populations will not be fully apparent until monitoring occurs and more cohorts return as adults. However, early information suggests that low adult run sizes can be expected in 2023, likely in part due to the drought conditions.

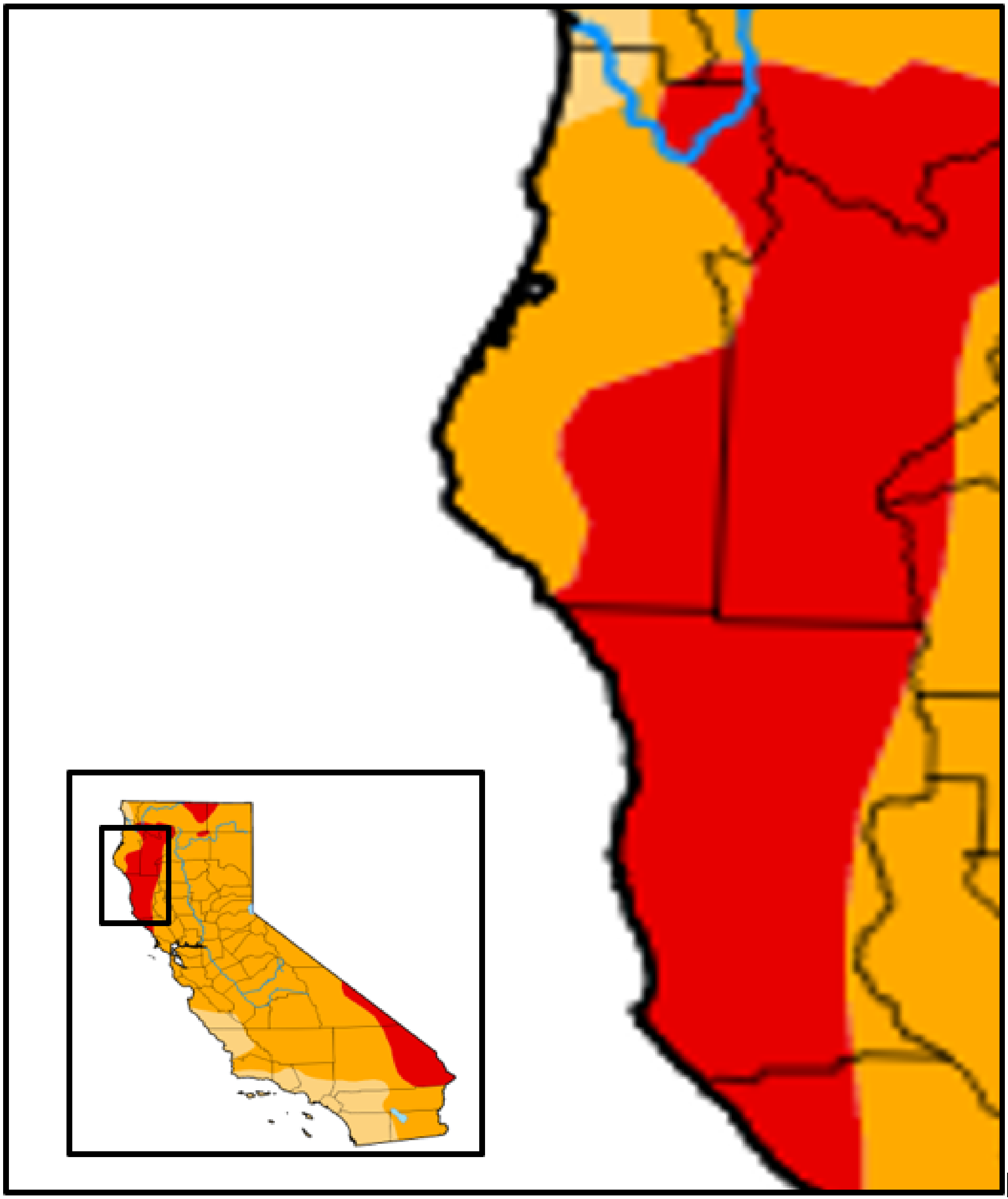

**Figure 4. Map of NC steelhead DPS showing areas of severe drought (orange) and extreme drought (red) from NOAA's U.S. Drought Monitor, March, 2022.**

**Marine and Estuarine Environments**

Along with warming stream temperatures and concerns about sufficient groundwater to recharge streams, a recent study projects a nearly complete loss of existing tidal wetlands along the U.S. West Coast due to sea-level rise (Thorne et al. 2018). California and Oregon showed the greatest threat to tidal wetlands (100 percent), while 68 percent of Washington tidal wetlands are expected to be submerged. Coastal development and steep topography prevent horizontal migration of most wetlands, causing the net contraction of this crucial habitat.

Rising ocean temperatures, stratification, ocean acidity, hypoxia, algal toxins, and other oceanographic processes will alter the composition and abundance of a vast array of oceanic species. In particular, there will be dramatic changes in both predators and prey of Pacific salmon, affecting both salmon life history traits and relative abundance. One example of this is a recent shift in food webs in the northeastern Pacific Ocean, which has led to increased abundance of anchovies in certain coastal regions. Anchovies produce an enzyme called thiaminase that breaks down thiamine, which typically supports nerve, muscle, and heart function. When adult salmonids consume large quantities of anchovies prior to their return to river entry, their offspring suffer from thiamine deficiency complex, substantially reducing their survival (discussed below).

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

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

### Thiamine Deficiency

Ocean conditions remain a critical component to salmon survival and reproductive success since they spend the majority of their lives in the ocean. Thiamine deficiency can occur in adult salmonids and influence their reproductive success and the health of their progeny (Harder et al. 2018). In fall and winter of 2019, Chinook salmon populations in the Central Valley of California (fall-, spring-, and late fall-run) were diagnosed with thiamine deficiency complex (TDC) resulting from parental diets high in anchovies (SWFSC 2022). More recently, steelhead sampled at Mad River Hatchery and Warm Springs Hatchery (Russian River) had low thiamine levels in 2022 (SWFSC unpublished data). Further research is needed to determine the effect of thiamine deficiency on populations of NC steelhead.

### Impacts on Salmon

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

In freshwater, year-round increases in stream temperature and changes in flow will affect physiological, behavioral, and demographic processes in salmon, and change the species with which they interact. For example, as stream temperatures increase, many native salmonids face increased competition with more warm-water tolerant invasive species. Changing freshwater temperatures are likely to affect incubation and emergence timing for eggs, and egg survival in locations where the greatest warming occurs, although several factors impact intergravel temperature and oxygen (e.g., groundwater influence) as well as sensitivity of eggs to thermal stress (Martin et al 2017). Changes in temperature and flow regimes may alter the amount of habitat and food available for juvenile rearing. This, in turn, could lead to a restriction in the distribution of juveniles, further decreasing productivity through density dependence. Rising river temperatures increase the energetic cost of migration and the risk of *en route* or pre-spawning mortality of adults with long freshwater migrations, although populations of some ESA-listed salmon and steelhead may be able to make use of cool-water refuges and run-timing plasticity to reduce thermal exposure (Keefer et al. 2018; Barnett et al. 2020).

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

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

At the population level, the ability of organisms to genetically adapt to climate change depends on how much genetic variation currently exists within salmon populations, as well as how selection on multiple traits interact, and whether those traits are linked genetically. While genetic diversity may help populations respond to climate change, the remaining genetic diversity of many populations is highly reduced compared to historical levels. 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). Salmon historically maintained relatively consistent returns across variation in annual weather through the portfolio effect (Schindler et al. 2015), in which different populations are sensitive to different climate drivers.

#### Species-Specific Climate Effects

Northern California steelhead adults exhibit both summer- and winter-run migration timing. Low flow conditions during spring can hinder migration of adult summer steelhead, causing them to over-summer in suboptimal (i.e., warmer) habitats lower in the watershed, and therefore summer-run steelhead were considered to have higher vulnerability to climate change because of additional exposure to high summer stream temperatures. Steelhead make extensive use of the estuarine lagoons, and the estuary life stage is affected by sea level rise, increasing temperature, and flooding due to the importance of estuary breaching dynamics for this life stage. Estuary and lagoon habitats were considered in poor condition compared to other habitat components.

Juveniles are also highly vulnerable to climate change due to exposure to increasing sea surface temperature and ocean acidification. Juveniles are expected to have long periods of exposure to climate change effects in the freshwater and marine environments, although the offset of timing of winter-run individuals from the worst of the flow and temperature effects gives the DPS an overall vulnerability ranking of moderate (Figure 5). In addition, the DPS is moderately sensitive to hatchery influence, as well as population viability and other extrinsic stressors including water diversions, land use practices, dams, and invasive species.

Northern California steelhead was ranked high in adaptive capacity because of its substantial life-history diversity, which includes both winter- and summer-run types, as well as a wide age range at smolt migration and maturation.

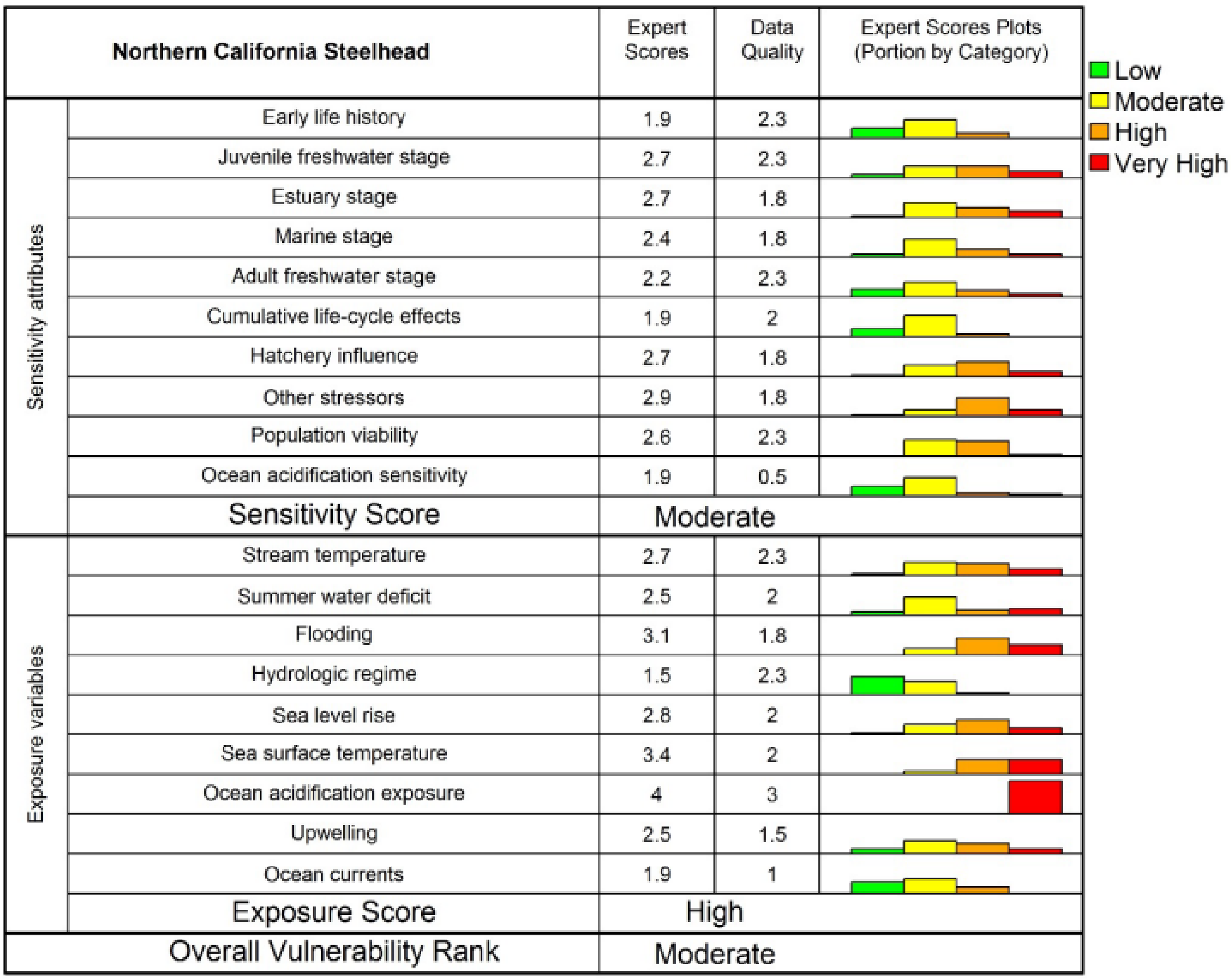


**Figure 5. NC steelhead Climate Effects Exposure and Vulnerability (Crozier et al. 2019).**

### Small Population Size

Many populations of NC steelhead have declined in abundance to levels that are well below low-risk abundance targets, and several are, if not already extirpated, likely below the high-risk depensation thresholds specified by Spence et al. (2008). These small populations are at risk from natural stochastic processes, in addition to deterministic threats, that may make recovery of this DPS/ESU difficult to achieve. As natural populations get smaller, stochastic processes may cause alterations in genetics, breeding structure, and population dynamics that may interfere with the success of recovery efforts and need to be considered when evaluating how populations may respond to recovery actions.

### Invasive Species

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

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

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

#### New Zealand Mudsnail (*Potamopyrgus antipodarum*)

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

#### Hatchery Effects

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

The USACE and CDFW have submitted an HGMP as part of a permit application for authorization of the hatchery and monitoring activities associated with the Russian River Steelhead Program (RRSP) over the next ten years, NMFS approved the section 10(a)(1)(A) permit on March 7, 2024 (NMFS 2024). The HGMP for the Mad River Hatchery was prepared by CDFW and submitted to NMFS for approval in 2016 (CDFW 2016). NMFS issued its biological opinion in late 2016, and completed the ESA section 4(d) approval and final National Environmental Policy Act (NEPA) documents in early 2017 (NMFS 2017). The Mad River HGMP (CDFW 2016) outlines the winter-run NC steelhead supportive breeding and associated monitoring and evaluation actions that would occur in the lower Mad River watershed. The purpose of the Mad River Hatchery steelhead program is to provide a robust fishery for hatchery-origin steelhead in the Mad River. The program is operated as an integrated hatchery program. Actions outlined in the HGMP are intended to promote the integration of wild steelhead into the hatchery broodstock to preserve genotypes, as well as to minimize inbreeding and outbreeding. Natural-origin steelhead are incorporated into the broodstock at the rate they are collected, such that 50-100 percent (with a target of 67 percent) of the hatchery broodstock would be of natural origin (NMFS 2016). The conservation actions required by the recently implemented HGMP are expected to improve the viability and abundance of natural steelhead populations in the Mad River and reduce the risk of hatchery production to NC steelhead.

Problems with initial implementation of the HGMP occurred. For example, significant mismarking of hatchery steelhead smolts contributed to a lower true value of the proportionate natural influence (PNI) than the apparent value (CDFW 2018). Because CDFW (2016) proposed a PNI goal of 67 percent and minimum PNI of 50 percent, the proposed action was assumed to increase PNI to those levels. PNI in 2018 and 2019 was 58 percent and 43 percent, respectively

(Sparkman 2021). More recently, CDFW has broadened the methods used to identify hatchery fish during spawning operations to decrease error associated with identifying natural origin broodstock and hatchery origin broodstock. Quality control measures have also decreased the mismark rate for clipping steelhead smolts. Improvements in the collection of natural origin adults through the use of volunteer anglers has also led to an increase in the proportion of natural origin broodstock in 2020. Mad River Hatchery is not currently being proposed for inclusion in the DPS until the PNI objectives outlined in the HGMP (CDFW 2016) can be met. We expect that prior to the next 5-year review, proportion of natural origin broodstock (pNOB) will increase over current levels, and the PNI and/or genetic data will be appropriately tracked. At that time, the Mad River Hatchery program should be recommended for inclusion into the DPS.

### Listing Factor E Conclusion

#### Climate Change

NC steelhead has a high risk of overall climate vulnerability based on its high risk for biological sensitivity and high risk for climate exposure. The risk to this DPS from further populations declines resulting from climate change has increased since the 2016 5-year review. The original listing determination (65 FR 36074) stated that "persistent drought conditions have reduced already limited spawning, rearing and migration habitat." However it stopped short of determining this was among the top factors contributing to population declines in this DPS. Life-stage sensitivity attributes for NC steelhead scored high for both juvenile and adult freshwater stages. NC steelhead DPS are at the southern distributional range of the species and thus already face numerous limiting factors stemming from climate effects. The likely four most important threats to the species from climate change are estuary breaching dynamics, hydrologic changes, fog dynamics, and shifts in smolt and adult migration timing (Crozier et al. 2019).

#### Invasive Species

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

#### Hatchery Effects

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

The recent completion and implementation of the HGMP for NC steelhead produced at the Mad River Hatchery has likely reduced the adverse effects of the hatchery program on ESA-listed species within Mad River since the 2016 5-year review. The conservation actions required by the HGMP are expected to substantially improve the viability and abundance of natural steelhead populations in the Mad River and reduce the risk of hatchery production. The Mad River Hatchery is currently working towards meeting the PNI objectives outlined in CDFW (2016) and NMFS (2017). Inclusion of the hatchery in the DPS should be reconsidered in the next 5-year review after the objectives can be met, and genetic analyses determine appropriate use of natural origin broodstock.

#### Recommended Future Actions

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

- Implement outreach and education efforts to prevent the spread of AIS species, such as New Zealand mudsnail, and increase the eradication of invasive plants.

## Other Recommendations

### Research, Monitoring and Evaluation

#### California Coastal Monitoring Program

The CDFW/NMFS Coastal Monitoring Program (CMP), described in Adams et al. 2011 (e.g., CDFW Fish Bulletin 180), draws on the viable salmonid populations framework of McElhaney et al. (2000) to assess salmonid viability in terms of the four population metrics: abundance, productivity, spatial structure, and diversity. CMP divides the coastal zone of California into northern and southern areas based on differences in species composition, levels of abundance, distribution patterns, and habitat differences that require distinct monitoring approaches. CMP data that can include adult estimates that include redd count surveys of stream reaches using a statistically-valid sampling design expanded to adult estimates based on spawner:redd ratios, redd surveys and estimates that are not expanded to adult estimates (e.g., no spawner:redd ratio estimates available), and weir counts (e.g. Shasta and Scott rivers). More recently, SWFSC and CDFW have been working on more specific application of monitoring approaches for southern California steelhead, an addendum type document to better address specifics related to the environment and *O. mykiss* ecology in south-central and southern California. The viability assessment conducted by SWFSC informs this 2022 5-yr review and assesses progress to meeting viability targets at the population and ESU/DPS level in terms of extinction risk.

The longer time series available in the northern monitoring area, since CMP has been implemented, have improved our ability to assess status and trends for a number of salmon and steelhead populations. These data are either approaching or exceeding the 4 generations needed to evaluate recovery plan downlisting and delisting criteria (e.g., Mendocino coast, Scott Creek LCM station in Santa Cruz Co., Lagunitas/Olema Creek in Marin Co.). These data have also improved our ability to assess the status of smaller populations, which were poorly understood prior to implementation of CMP (e.g., Caspar Creek, Little River, Redwood Creek [Marin Co.]. Information on selected populations (Redwood Creek [Humboldt Co.], Mad River, Eel River) has improved with installation of sonar cameras.

Unfortunately, lapses in funding have resulted in some programs being interrupted (e.g., Navarro and Garcia rivers) or discontinued with no resumption in sight (e.g., Santa Cruz Mountain Diversity Stratum; some populations on the Mendocino Coast with long time series [Caspar Creek, Little River]). Furthermore, spatial coverage has been lacking in the southern monitoring area and remains highly patchy in other geographies (e.g., Trinity River). Some sampling efforts generally target primarily coho salmon and so do not encompass the entire spatial or temporal extent of spawning for other listed species, and several populations identified as essential to recovery are not currently monitored; this is especially true for steelhead in Eel River subbasins and the San Francisco Bay Area.

Intermittent implementation issues continue to hinder assessment of a number of populations. CMP nonetheless provides a substantially better basis for informing NMFS' recovery and viability criteria compared with previous assessments and 5-year reviews and will increase greatly in value as these time series become longer. Additionally, funding to monitor and evaluate the sustainability and fitness of populations or runs enhanced by the conservation hatchery program stockings is needed to inform progress towards performance targets for these programs. We therefore recommend the following actions related to the CMP:

- Allocate long-term dedicated resources to support California's monitoring program.
- Expand the spatial extent of CMP monitoring programs with the use of sonar cameras and other methods to improve adult return information for selected populations that are not currently monitored

#### Other Research Priorities

- Estimate impacts to all California salmonids from marine mammal predation, and if appropriate develop management measures to reduce these impacts.
- Develop and implement plans to increase stream flows and reduce water temperatures in key streams with the greatest potential to support salmon and steelhead during ongoing drought and climate change.

## 2.4 Synthesis

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

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

### 2.4.1 Updated Biological Risk Summary

Overall, the available data for winter-run populations—predominately in the North Coastal, North-Central Coastal, and Central Coastal strata—indicate that all essential populations remain well below recovery targets. In the North Coastal stratum, direct comparison with recovery targets is confounded by (1) the fact that survey efforts target coho salmon and thus do not encompass the entire spawning season or space for steelhead, and (2) the lack of methods for converting redd estimates to population abundance. Nevertheless, even if population sizes are several times greater than current redd estimates suggest, these populations would likely still be less than 10–15 percent of recovery targets (SFWSC 2022). For the North-Central Coastal stratum, essential population are currently at 8–12 percent of their recovery targets, and in the Central Coastal stratum, they are at 5–10 percent of these targets (SFWSC 2022). Overall, the data suggest that the viability of winter-run populations has not changed appreciably since the previous viability assessment (Williams et al. 2016).

Summer-run populations remain a significant concern. The Middle Fork Eel River population has remained remarkably stable for nearly five decades and is closer to its recovery target (~80 percent) than any other population in the DPS (SFWSC 2022). Populations in the Mad and Van Duzen rivers have averaged in the low hundreds of fish and are at 18 percent and 26 percent of their recovery targets, respectively (SFWSC 2022). Both the Redwood Creek and Mattole River populations appear very small, and little is known about other populations including the various tributaries of the Eel River (SFWSC 2022). In summary, the available information for winter-run and summer-run populations of NC Steelhead do not suggest an appreciable increase or decrease in extinction risk since publication of the last viability assessment (Williams et al. 2016).

### 2.4.2 ESA Listing Factor Analysis

**Listing Factor A (habitat):** We conclude that since the last 5-year review, the risk to NC steelhead persistence because of degraded habitat conditions has increased relative to this factor at the time of listing and the last 5-year review, and is high. Physical habitat improvement remains a priority objective throughout this DPS. However relatively few projects have resulted in measurable improvements with regard to streamflow and water temperature in areas that exceed water quality standards due to anthropogenic causes.

**Listing Factor B (overutilization):** We conclude that since the last 5-year review, the risk to NC steelhead persistence because of overutilization and scientific study remains low. No direct take of natural origin NC steelhead is allowed in any commercial or recreational fishery, and although the amount of bycatch or illegal harvest is difficult to estimate, recently developed fishery management plans are expected to reduce these impacts when they are completed and approved. The amount of take for scientific study is limited, and has decreased since the last 5-year review.

**Listing Factor C (disease and predation):** We conclude that since the last 5-year review, the risk to NC steelhead persistence because of disease or predation has increased and is at least moderate due to the significant increases in modeled pinniped predation highlighted in recent model studies. Given the lack of information currently available in California, further study of pinniped predation interactions is warranted to determine whether these impacts are limiting the recovery of ESA-listed salmon and steelhead in the state.

**Listing Factor D (inadequacy of existing regulatory mechanisms):** New information available since the last 5-year review indicates that the adequacy of a number of regulatory mechanisms has improved slightly, with more mechanisms showing the potential for some improvement, and fewer mechanisms making the protection and recovery of NC steelhead challenging. The risk to the species' persistence because of the adequacy of existing regulatory mechanisms has therefore decreased slightly, but remains high.

**Listing Factor E (other manmade or natural factors):** We conclude that since the last 5-year review, the overall risk to NC steelhead persistence because of other manmade and natural factors remains high because of the major threats of climate change, droughts, wildfires and ocean conditions. Thiamine deficiency is a concern and studies should continue to assess the population wide effects. Since 2017, NMFS has approved the Mad River HGMP (82 FR 13801) and the RRSP HGMP (NMFS 2024). The conservation actions required by the recently implemented HGMPs are expected to improve the viability and abundance of natural steelhead populations in the Mad River and Russian rivers and reduce the risk of hatchery production to NC steelhead. These captive broodstock programs are a low threat to the NC steelhead DPS, and the Mad River program may be considered for inclusion in the DPS in the future when HGMP goals are being met.

Although conservation efforts have reduced some threats facing this DPS, the threats highlighted in the five listing factor discussion in section 2.3.2 have with few exceptions remained unchanged since the last review (71 FR 834), and some have gotten worse. Poor ocean conditions, water withdrawals, marijuana cultivation, and drought, in particular, have had significant negative impacts on NC steelhead since the last review. After considering the biological viability of the NC steelhead DPS, which showed no significant trends in population levels, and the current status of the ESA section 4(a)(1) factors, we conclude that the status of the DPS remains unchanged from that reported in the 2016 5-year review.

### 2.4.3 ESU/DPS Delineation and Hatchery Membership

- The SWFSC's assessment (SWFSC 2022) found that no action has been taken to modify existing DPS delineations, and there is no new information available since the prior viability assessment to suggest a change in delineation for NC steelhead is warranted.
- Our review of new information since the 2016 5-year review regarding the DPS membership status of various hatchery programs indicates that no changes in the NC steelhead DPS membership are warranted.

### 2.4.4 ESU/DPS Viability and Statutory Listing Factors

- The SWFSC's assessment of updated information (SWFSC 2022) does not indicate a change in the biological risk category of NC steelhead since the time of the last 5-year review.
- Our analysis of ESA section 4(a)(1) factors indicates that the collective risk to NC steelhead persistence has not changed significantly since our last 5-year review in 2016 (NMFS 2016a). The overall level of concern remains the same.

# 3 ·Results

## 3.1 Classification

**Listing Status:**
Based on the information identified above, we recommend that the NC Steelhead DPS remain classified as a threatened species.

**DPS Delineation:**
Given the lack of new information to support adjusting the composition of this DPS (SWFSC 2022), we conclude that delineation of the NC Steelhead DPS remains unchanged.

**Hatchery Membership:**
The NC steelhead DPS membership does not include any hatchery programs. We do not recommend any changes.

## 3.2 New Recovery Priority Number

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

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

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# 4 ·Recommendations for Future Actions

In our review of the listing factors, we identified several actions critical to improving the status of the NC Steelhead DPS. NMFS provided a number of recommended actions in the 2016 5-year review that are still relevant at this time. In this review, we focus on the most important actions to pursue over the next 5 years. Improving conditions for steelhead will require improved flow volume in streams, improved water quality (temperature and dissolved oxygen) and access to quality habitat. Projects that demonstrably improve the quantity of streamflow should be prioritized for funding of restoration of NC steelhead habitat. Additional habitat alterations (e.g. LWD additions and stream passage) will not be effective without sufficient stream flows that support the basic water quality requirements of steelhead. Larger scale projects focused on buying land, establishing conservation easements, retiring irrigated land, and/or otherwise substantively reducing water use and increasing stream flows in the summer and fall months will be necessary to ensure this DPS can achieve recovery.

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

The following identifies the most important actions to pursue over the next five years.

### General Actions

- Support and fund projects intended to increase stream flows during the summer and fall months.
- Dedicate long-term funding resources to support California's Coastal Monitoring Program (CMP) and critical science questions.
- Expand the spatial extent of CMP monitoring programs with the use of sonar cameras and other methods to improve adult return information for selected populations that are not currently monitored.
- Allocate funding to implement recovery actions and prioritize those actions identified in this 5-year review. Similarly, allocate funding to implement the monitoring recommended in the Coastal Multispecies Public Draft Recovery Plan (NMFS 2016b). Funding priority should be given to projects that have a primary goal to increase stream flows (forbearance, storage, land buy backs).

### Listing Factor A: Habitat

The following actions, outlined previously under Listing Factor A, are repeated here for ease of reference.

#### Northern Coastal Diversity Stratum

A1: Increase water forbearance, streamflow enhancement, water conservation and groundwater sustainability projects (all populations). Prioritize water conservation projects for funding.

A2: Continue LWD supplementation throughout the diversity strata (all populations)

A3: Continue road decommissioning, fine sediment control, and habitat restoration projects (all populations)

A4: Advance the decommissioning of the Potter Valley Project, while restoring access to hundreds of miles of high quality habitat upstream in the upper Eel River (Eel River populations).

A5: Improve habitat complexity and reduce water use (ground and surface water) (all populations)

A6: Complete estuary restoration and levee setbacks in lower Redwood Creek

A7: Address the shallow and simplified holding and staging habitat in the Lower Eel River through a combination of short-term actions to improve complexity and promote pool scour and to address the lack of tidal prism and geomorphic dysfunction in the lower river to improve sediment routing and increase depths and complexity.

#### North Mountain Interior Diversity Stratum

A8: Increase water forbearance, streamflow enhancement, water conservation and groundwater sustainability projects (all populations). Prioritize water conservation projects for funding.

A9: Continue to advance the relicensing of the Potter Valley Project to achieve the decommissioning of Scott Dam, while restoring access to hundreds of miles of high quality habitat upstream in the upper Eel River. (Eel River populations).

A10: Improve the fish passage facilities at Cape Horn Dam and Van Arsdale Fisheries Station; and improve the magnitude and timing of the diversion to Russian River by identifying specific windows of operations that minimize impacts to juvenile and adult NC steelhead in the Upper Eel River. Improve habitat complexity and reduce water use (ground and surface water) (all populations).

A11: Complete all phases of the lower Salt River Ecosystem Restoration Project and other proposed habitat expansion sites to improve the Eel River estuary.

#### Lower Interior Diversity Stratum

A12: Increase water forbearance, streamflow enhancement, water conservation and groundwater sustainability projects (all populations). Prioritize water conservation projects for funding.

A13: Continue to advance the relicensing of the Potter Valley Project to achieve the decommissioning of Scott Dam, while restoring access to hundreds of miles of high-quality habitat upstream in the upper Eel River.

A14: Improve the fish passage facilities at Cape Horn Dam and Van Arsdale Fisheries Station; and improve the magnitude and timing of the diversion to Russian River by identifying specific windows of operations that minimize impacts to juvenile and adult NC steelhead in the Upper Eel River.

A15: Low flow conditions and warm water temperatures in the summer months should be addressed by better managing reservoir storage and cold-water pool volume in Lake Pillsbury. Dry season flow conditions should be potentially ameliorated by reducing diversions to the Russian River following analysis and modeling results.

A16: Address the unlimited use of groundwater wells and groundwater pumping on surface flows (all populations).

#### North-Central Coastal Diversity Stratum

A17: Increase water forbearance, streamflow enhancement, water conservation and groundwater sustainability projects (all populations). Prioritize water conservation projects for funding.

A18: Acquire additional conservation easements from industrial timber companies. Improvement and protection of riparian areas will improve riparian shade and wood delivery to stream channels under conservation easements.

A19: Continue upgrading and decommissioning forest roads. Reducing slide and road related sediment delivery is expected to improve instream gravel quality.

A20: Continue improving wood frequency in streams across the diversity strata. The Multi-Species recovery plan (NMFS 2016) identifies habitat complexity as limiting for streams across this diversity stratum.

A21: Increase water forbearance, streamflow enhancement, water conservation and groundwater sustainability projects (all populations)

A22: Eliminate depletion of summer flows (Albion, Big) and promote passive diversion devices designed to allow diversions of water only when minimum streamflow is met (Noyo River).

#### Central Coastal Diversity Stratum

A23: Increase water forbearance, streamflow enhancement, water conservation and groundwater sustainability projects (all populations). Prioritize water conservation projects for funding.

A24: Implement the Garcia River Estuary Habitat Enhancement Plan

#### All Diversity Strata

A25: Implement and enforce AB 2121, which codified (in sections 1259.2 and 1259.4 of the California Water Code) CDFW and NMFS' Water Diversion Guidelines, and expand similar protections to the rest of the DPS to ensure protective flows for all life stages of salmonids

A26: Work with EPA, SWRCB, and local stakeholders to implement actions under section 303(d)(1)(C) and (D) of the Clean Water Act. This would require the State to prepare Total Maximum Daily Loads (TMDLs) for all water bodies that do not meet State water quality standards.

A27: Develop water conservation measures at local and State levels to include a drought management plan for each watershed that is triggered by minimum flow requirements.

A 28: Work with State and County agencies to minimize impacts from cannabis operations on listed salmonids, and appropriately quantify cumulative impacts from cannabis permitting programs.

A29: Restart and finalize the Mendocino Redwood Company HCP. The Mendocino Redwood Company owns portions of six high priority recovery watersheds in Mendocino and Sonoma counties; watersheds currently supporting extant steelhead populations. HCP implementation is expected to facilitate the survival and recovery of NC steelhead.

### Listing Factor B: Overutilization

B1: Develop and implement FMEPs where fishing occurs in the NC steelhead DPS.

B2: Continue to develop protective regulations to minimize impacts from fishing during migratory periods (*e.g.*, until sandbars open naturally) within one mile of the river mouths of the focus watersheds, and to improve freshwater sport fishing regulations to minimize take and incidental mortality of listed salmonids.

B3: Complete FMEPs for streams within the NC Steelhead DPS where CDFW permits angling. Until FMEPs are completed, regulation changes throughout the DPS should include eliminating the use of bait on streams with no hatchery and eliminating allowable harvest of cutthroat trout, which anglers can readily confuse with steelhead half-pounders.

B4: Work with CDFW to address illegal fisheries activities in the Eel and Russian rivers.

### Listing Factor C: Disease and Predation

C1: Continue to support and complete the study on Sacramento pikeminnow in the South Fork Eel River being conducted by Stillwater Sciences and the Wiyot Tribe.

C2: Continue to refine PG&E's monitoring and suppression program for Sacramento pikeminnow in Lake Pillsbury and in between Scott and Cape Horn Dams.

C3: Ensure that the new FERC license for the Potter Valley Project has an adequate Sacramento pikeminnow removal component planned for Lake Pillsbury prior to, during, and after the removal of Scott Dam.

C4: Pacific salmon and steelhead recovery partners are encouraged to expand, develop, and implement monitoring efforts in the Columbia River Basin, Puget Sound, and California to identify pinniped predation interactions in select areas (e.g., river mouths/migratory pinch points) and quantitatively assess predation impacts by pinnipeds on Pacific salmon and steelhead stocks.

C5: Evaluate the effects of marine mammal salmon predators on ESA recovery goals for listed salmonids, including the NC Steelhead DPS

### Listing Factor D: Inadequacy of Existing Regulatory Mechanisms

D1: Work with the SWRCB to eliminate depletion of summer base flows from authorized water users due to a lack of cumulative effects analysis in current water laws.

D2: Work with the SWRCB to eliminate depletion of summer base flows by unauthorized water uses. Coordinate efforts by federal and state, and county law enforcement agencies to remove illegal diversions from streams.

D3: Evaluate and implement off-channel storage facilities to reduce impacts of water diversion (storage tanks for rural residential users).

D4: Implement more effective measures to protect ground and surface water by updating or amending the Sustainable Ground Water Management Act (SGMA).

D5: Appropriately quantify cumulative impacts from California Forest Practices throughout all watersheds, modify timber harvest methods and practices as needed.

### Listing Factor E: Other Factors

E1: Work with the Mad River Hatchery to implement Hatchery and Genetic Management Plan (HGMP) to preserve genotypes, minimize inbreeding and outbreeding, and to ensure a viable steelhead population.

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

Northern California 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 Northern California Steelhead Evaluation Team

**REGIONAL OFFICE APPROVAL:**

**Lead Regional Administrator, NOAA Fisheries**

Approve QUAN.JENNIFER.LEIGH.1536293139 Digitally signed by QUAN.JENNIFER.LEIGH.1536293139 Date: 2024.06.13 16:55:53 -07'00' 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: 2024.06.24 09:20:10 -04'00' Date: _______