# CENTRAL VALLEY RECOVERY DOMAIN

## 5-Year Review:
## Summary and Evaluation

***California Central Valley Steelhead Distinct Population Segment***

**National Marine Fisheries Service**
**West Coast Region**

# 5-YEAR REVIEW
## Central Valley Recovery Domain

| Species Reviewed | Evolutionarily Significant Unit or Distinct Population Segment |
|---|---|
| **Steelhead** ***(Oncorhynchus mykiss)*** | **California Central Valley Steelhead Distinct Population Segment** |

## 1.0 GENERAL INFORMATION

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Williams, T.H., B.C. Spence, D.A. Boughton, R.C. Johnson, L. Crozier, N. Mantua, M. O'Farrell, and S.T. Lindley. 2016. Viability assessment for Pacific salmon and steelhead listed under the Endangered Species Act: Southwest. 2 February 2016 Report to National Marine Fisheries Service – West Coast Region from Southwest Fisheries Science Center, Fisheries Ecology Division 110 Shaffer Road, Santa Cruz, California 95060.

### 1.2. Introduction

Many West Coast salmon and steelhead (*Oncorhynchus* sp.) stocks have declined substantially from their historic numbers and now are at a fraction of their historical abundance. There are several factors that contribute to these declines, including: overfishing, loss of freshwater and estuarine habitat, hydropower development, poor ocean conditions, and hatchery practices.

These factors collectively led to NOAA's National Marine Fisheries Service (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©(2), directs the Secretary of Commerce to review the listing classification of threatened and endangered species at least once every five years. After completing this review, the Secretary must determine if any species should be: (1) removed from the list; (2) have its status changed from threatened to endangered; or (3) have its status changed from endangered to threatened. The most recent listing determinations for West Coast salmon and steelhead occurred in 2010, and prior to that 2005 and 2006. This document summarizes NMFS's 5-year review of the ESA-listed California Central Valley (CCV) steelhead Distinct Population Segment (DPS).

### 1.2.1 Background on Listing Determinations

Under the ESA, a species, subspecies, or a DPS may be listed as threatened or endangered. To identify the proper taxonomic unit for consideration in an ESA listing for salmon we draw on our "Policy on Applying the Definition of Species under the ESA to Pacific Salmon" (56 FR 58612). According to this policy guidance, populations of salmon that are substantially reproductively isolated from other con-specific populations and are representing an important component in the evolutionary legacy of the biological species are considered to be an Evolutionarily Significant Unit (ESU). In our listing determinations for Pacific Salmon under the ESA, we treated an ESU as constituting a DPS, and hence a ''species.''

In 2006, we announced that NMFS would apply the joint U.S. Fish and Wildlife Service-National Marine Fisheries Service DPS policy (61 FR 4722) rather than our agency's ESU policy to populations of West Coast steelhead (*O. mykiss*). Under this policy, a DPS of steelhead must be discrete from other con-specific populations, and it must be significant to its taxon. A group of organisms is discrete if it is ''markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, and behavioral factors" (61 FR 4722). According to the DPS policy, if a population group is determined to be discrete, we must then consider whether it is significant to the taxon to which it belongs. Considerations in evaluating the significance of a discrete population include: (1) persistence of the discrete population in an unusual or unique ecological setting for the taxon; (2) evidence that the loss of the discrete population segment would cause a significant gap in the taxon's range; (3) evidence that the discrete population segment represents the only surviving natural occurrence of a taxon that may be more abundant elsewhere outside its historical geographic range; or (4) evidence that the discrete population has marked genetic differences from other populations of the species.

Artificial propagation (fish hatchery) programs are common throughout the range of ESA-listed West Coast salmon and steelhead. On June 28, 2005, we announced a final policy addressing the role of artificially propagated Pacific salmon and steelhead in listing determinations under the ESA (70 FR 37204). Specifically, this policy: (1) establishes criteria for including hatchery stocks in ESUs and DPSs; (2) provides direction for considering hatchery fish in extinction risk assessments of ESUs and DPSs; (3) requires that hatchery fish determined to be part of an ESU or DPS to be included in any listing of those units; (4) affirms our commitment to conserving natural salmon and steelhead populations and the ecosystems upon which they depend; and (5)

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 was part of an ESU or DPS, NMFS convened the Salmon and Steelhead Hatchery Advisory Group (SSHAG), which evaluated all hatchery stocks and programs and divided them into 4 categories (SSHAG 2003):

**Category 1**: The hatchery population was derived from a native, local population; is released within the range of the natural population from which is was derived; and has experienced only relatively minor genetic changes from causes such as founder effects, domestication or non-local introgression.

**Category 2**: The hatchery population was derived from a local natural population, and is released within the range of the natural population from which is was derived, but is known or suspected to have experienced a moderate level of genetic change from causes such as founder effects, domestication, or non-native introgression.

**Category 3**: The hatchery population is derived predominately from other populations that are in the same ESU/DPS, but is substantially diverged from the local, natural population(s) in the watershed in which it is released.

**Category 4**: The hatchery population was predominately derived from populations that are not part of the ESU/DPS in question; or there is substantial uncertainty about the origin and history of the hatchery population.

Based on these categorical delineations, hatchery programs in SSHAG categories 1 and 2 are included as part of an ESU or DPS (70 FR 37204) although hatchery programs in other categories may also be included in an ESU or DPS under certain circumstances.

Because the new hatchery listing policy changed the way NMFS considered hatchery fish in ESA listing determinations, we conducted new status reviews and ESA-listing determinations for West Coast salmon ESUs and steelhead DPSs using this policy. On June 28, 2005, we issued final listing determinations for 16 ESUs of Pacific salmon and on January 5, 2006 we issued final listing determinations for 10 DPSs of steelhead.

The 2006 listing determination concluded that two of the four CCV steelhead artificial propagation programs are considered to be part of the DPS: Coleman National Fish Hatchery (Coleman NFH) and Feather River Hatchery steelhead hatchery programs. NMFS determined that these artificially propagated stocks are no more divergent relative to the local natural population(s) than what would be expected between closely related natural populations within the DPS. The CCV steelhead hatchery programs at Nimbus Fish Hatchery and Mokelumne River Hatchery were not included in the DPS due to the ongoing use of out-of-basin broodstock. In 2010/2011 we conducted a status review of CCV steelhead, and determined that the available information continues to support inclusion of the Coleman NFH and Feather River Hatchery steelhead stocks as part of the CCV steelhead DPS, while continuing to exclude stocks from Nimbus Fish Hatchery and Mokelumne River Hatchery.

## 1.3 Methodology used to complete the review:

A public notice announcing NMFS' intent to conduct 5-year status reviews for the 26 ESUs/DPSs of West Coast anadromous salmonids was published in the Federal Register on February 6th, 2015 (80 FR 6695). This notice initiated a 60-day period for the public to provide comments to NMFS related to the status of the species being reviewed. The West Coast Region of NMFS also coordinated by letter with State and tribal co-managers to ensure those co-managers were informed about the status review and had an opportunity to provide any comments or information. No comments relevant to CCV steelhead were provided during the 60-day period.

Following the comment period, three main steps were taken to complete the 5-year status review for CCV Steelhead: First, the Southwest Fisheries Science Center (SWFSC) reviewed any new and substantial scientific information that has become available since the 2011 status reviews and produced an updated biological status summary report (herein referred to as the "viability report"). The viability report was intended to determine whether or not the biological status of CCV steelhead has changed since the 2011 status reviews were conducted. Next, the California Central Valley Office (CCVO) reviewed the viability report and assessed whether the five ESA listing factors (threats) changed substantially since the 2011 listing determination. To help assess whether the five ESA listing factors have changed substantially since 2011, several key documents were reviewed such as the Federal Register notices identified in Tables 1 and 2 and other relevant publications including:

- The 5-year Status Review Report for Steelhead published in 2011 (NMFS 2011)
- Central Valley Salmon and Steelhead Recovery Plan (NMFS 2014)
- Biological Opinion on the Long-term Operations of the Central Valley Project and State Water Project (OCAP BO) (NMFS 2009)
- Listen to the River: An Independent Review of the CVPIA Fisheries Program (Cummins *et al.* 2008)
- Framework for assessing viability of threatened and endangered Chinook salmon and steelhead in the Sacramento-San Joaquin Basin (Lindley *et al.* 2007)

Finally, the CCVO considered the viability report, the current threats to the species, and relevant conservation measures before making a determination whether CCV steelhead should be uplisted (*i.e.*, threatened to endangered), removed from the list, or remain unchanged.

The lead steelhead biologist for the CCVO gathered and synthesized information from the Area Offices and SWFSC regarding the biology and status of threatened and endangered Pacific salmon and steelhead. In the CCVO a team of four biologists formed the core working group that assimilated information from various sources.

Our information sources included:

- Central Valley Salmon and Steelhead Recovery Plan (NMFS 2014)
- NMFS SWFSC Viability Report (Williams *et al.* 2016)
- Hatchery assessments

- Recent biological opinions pertaining to the protection of CCV steelhead (especially OCAP BO)
- Peer-reviewed scientific publications
- Grey literature (annual reports)
- California Department of Fish and Wildlife (CDFW) Central Valley Project/State Water Project (CVP/SWP) salvage database
- Final rule listing CCV steelhead as threatened (63 FR 13347)
- Final rule designating critical habitat for CCV steelhead (70 FR 52488)

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

### 1.4.1 FR Notice citation announcing initiation of this review:

80 FR 6695; February 6, 2015

### 1.4.2 Listing history

The CCV steelhead DPS was originally listed in 1998 as a threatened species (Table 1). Following the development of NMFS' hatchery listing policy, we re-evaluated the status of this DPS, and issued a final listing determination, that the DPS continued to warrant listing as a threatened species and that the Coleman NFH and Feather River Hatchery stocks of steelhead should be part of the DPS (Table 1).

**Table 1**. Summary of the listing history under the ESA for the CCV steelhead DPS

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

### 1.4.3 Associated rulemakings

Section 4(d) of the ESA directs NMFS to issue regulations to conserve species listed as threatened. This applies particularly to "take," which can include any act that kills, injures, or harms fish, and may include habitat modification. The ESA prohibits any take of species listed as endangered, but some take of threatened species that does not interfere with salmon survival and recovery can be allowed.

The ESA also requires NMFS to designate critical habitat for any 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 of listing, if they contain physical or biological features essential to conservation, and those features may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by the species if the agency determines that the area itself is essential for conservation.

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

| Salmonid Species | ESU/DPS Name | 4(d) Protective Regulations | Critical Habitat Designations |
|---|---|---|---|
| **Steelhead** *(O. mykiss)* | **California Central Valley DPS** | **FR notice:** 65 FR 42422 **Date:** 07/10/2000 | **FR notice:** 70 FR 52488 **Date:** 09/02/2005 |

### 1.4.4 Review History

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

| Salmonid Species | ESU/DPS Name | Document Citation |
|---|---|---|
| **Steelhead** *(O. mykiss)* | **California Central Valley DPS** | **NMFS 2011, Lindley *et al.* 2007; Lindley *et al.* 2006; Good *et al*. 2005; Busby *et al.* 1996** |

### 1.4.5 Species Recovery Priority Number at Start of 5-year Review Process

On June 15, 1990, NMFS issued guidelines (55 FR 24296) for assigning listing and recovery priorities. For recovery plan development, implementation, and resource allocation, we assess three criteria to determine a species' recovery priority number from 1 (high) to 12 (low): (1) magnitude of threat; (2) recovery potential; and (3) conflict with development projects or other economic activity. NMFS re-evaluated the recovery priority numbers for listed species as part of the FY2013-FY2014 ESA Biennial Report to Congress (NMFS 2015). As a result of the re-evaluation, the recovery potential of CCV steelhead increased, causing the species' recovery priority number to change from 7 to 5. Table 4 lists the current recovery priority numbers for the subject species, as reported in NMFS 2015. Regardless of a species' recovery priority number, NMFS remains committed to continued efforts to recover all ESA-listed species under our authority.

### 1.4.6 Recovery Plan or Outline

In 2014, NMFS released a final multi-species recovery plan that addresses all three listed salmonids in the California Central Valley, including the CCV steelhead DPS (Table 4).

**Table 4**. Recovery Priority Number and ESA Recovery Plans for CCV steelhead DPS

| Salmonid Species | ESU/DPS Name | Recovery Priority Number | Recovery Plans/Outline |
|---|---|---|---|
| **Steelhead** *(O. mykiss)* | **California Central Valley Steelhead** | 5 | **Plan:** Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-run Chinook Salmon and Central Valley Spring-run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead (July 2014)<br>**Plan Status:** Final |

## 2.0 REVIEW ANALYSIS

### 2.1 Delineation of Species under the ESA

#### 2.1.1 Is the species under review a vertebrate?

| ESU/DPS Name | YES* | NO** |
|---|---|---|
| *California Central Valley Steelhead* | **X** | |

** if "Yes," go to section 2.1.2*
*** if "No," go to section 2.2*

#### 2.1.2 Is the species under review listed as a DPS?

| ESU/DPS Name | YES* | NO** |
|---|---|---|
| *California Central Valley Steelhead* | **X** | |

** if "Yes," go to section 2.1.3*
*** if "No," go to section 2.1.4*

#### 2.1.3 Was the DPS listed prior to 1996?

| ESU/DPS Name | YES* | NO** | Date Listed if Prior to 1996 |
|---|---|---|---|
| *California Central Valley Steelhead* | | **X** | ***n/a*** |

** if "Yes," give date go to section 2.1.3.1*
*** if "No," go to section 2.1.4*

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

Yes, the DPS classification was found to be consistent with the 1996 policy standards.

### 2.1.4 Summary of relevant new information regarding the delineation of the ESUs/DPSs under review?

*Mokelumne River Hatchery*

The reason for the exclusion of steelhead produced at Nimbus Fish Hatchery from the CCV steelhead DPS was the known Eel River/Mad River origin of the original broodstock used at the hatchery. Based on the history of egg transfers from the Nimbus Fish Hatchery to the Mokelumne River Hatchery, the Mokelumne River Hatchery was also excluded from the DPS. However, a new analysis of the genetic relationships among the four Central Valley steelhead hatcheries clearly shows that fish from the Mokelumne River Hatchery are nearly genetically identical to fish from the Feather River Hatchery (Pearse and Garza 2015). This is consistent with the fact that in the last few years before the Mokelumne River Hatchery ended the practice of importing eggs from out-of-basin sources, all of its eggs came from the Feather River Hatchery.

Given the new genetic evidence, we are recommending that the Mokelumne River Hatchery be added to the CCV steelhead DPS, as Feather River Hatchery fish are considered to be a native Central Valley stock and are listed as part of the DPS.

## 2.2 Recovery Criteria

### 2.2.1 Do the species have final, approved recovery plans containing objective, measurable criteria?

| ESU/DPS Name | YES | NO |
|---|---|---|
| *California Central Valley Steelhead DPS* | **X** | |

The Final Central Valley Salmon and Steelhead Recovery Plan includes specific, measureable criteria for recovery of the CCV steelhead DPS. The plan calls for a minimum of two viable populations of steelhead within the Basalt and Porous Lava Diversity Group, one within the Northwestern California Diversity Group, four within the Northern Sierra Nevada Diversity Group, and two within the Southern Sierra Nevada Diversity Group.

### 2.2.2 Adequacy of recovery criteria.

#### 2.2.2.1 Do the recovery criteria reflect the best available and most up-to date information on the biology of the species and its habitat?

| ESU/DPS Name | YES | NO |
|---|---|---|
| *California Central Valley Steelhead DPS* | **X** | |

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

Recovery Plan also includes recovery criteria that reflect the current habitat needs of CCV steelhead.

#### 2.2.2.2 Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria?

| ESU/DPS Name | YES | NO |
|---|---|---|
| *California Central Valley Steelhead DPS* | **X** | |

The Final Central Valley Salmon and Steelhead Recovery Plan (2014) includes threats-based recovery criteria that address the five ESA listing factors: (1) present or threatened destruction, modification or curtailment of its habitat or range; (2) overutilization for commercial, recreational, scientific or educational purposes; (3) disease or predation; (4) inadequacy of existing regulatory mechanisms; or (5) other natural or manmade factors affecting its continued existence. The threats-based criteria ensure that the factors that caused the species to become threatened or endangered are adequately addressed before delisting.

### 2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information

The Final 2014 Central Valley Recovery Plan includes the following recovery criteria:

**ESU/DPS level criteria**:

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

**Population level criteria**:

**Low risk of extinction criteria**

- Census population size is >2,500 adults -or- Effective population size is >500
- No productivity decline is apparent
- No catastrophic events occurring or apparent within the past 10 years
- Hatchery influence is low.

**Moderate risk of extinction criteria**

- Census population size is 250 to 2,500 adults -or- Effective population size is 50 to 500 adults
- Productivity: Run size may have dropped below 500, but is stable

- No apparent decline in population growth rate resulting from catastrophic events within the past 10 years
- Hatchery influence is moderate

The current viability of CCV steelhead populations is summarized below in Section 2.3 and described in greater detail in Williams *et al*. (2016).

## 2.3 Updated Information and Current Species Status

### 2.3.1 Analysis of Viable Salmonid Population (VSP) Criteria

***Abundance***

United States Fish and Wildlife Service (USFWS) staff at Coleman National Fish Hatchery (Coleman NFH) operate a weir on Battle Creek, where all upstream fish movement is controlled. Counts of steelhead captured at this weir represent one of the better data sources for the CCV steelhead DPS. In 2005, per NMFS request, Coleman NFH stopped transferring all adipose fin clipped (hatchery-origin) steelhead above the weir.

Steelhead returns to Coleman NFH have increased over the last four years. After hitting a low of only 790 fish in 2010, the last two years have averaged 2,895 fish (Figure 1). Since 2003, adults returning to the hatchery have been classified as wild (unclipped) or hatchery produced (adipose fin clipped). Wild adults counted at the hatchery each year represent a small fraction of overall returns, but their numbers have remained relative steady, typically 200-300 fish each year. Numbers of wild adults have ranged from 185 to 334 in the last five years (Figure 1; USFWS 2016).

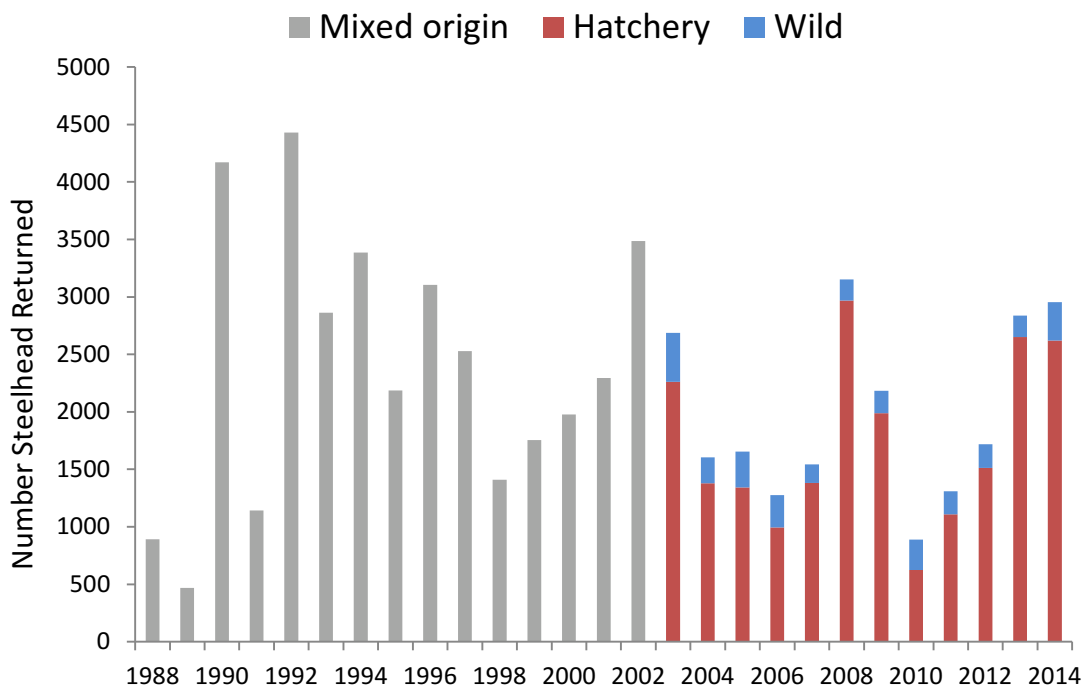


**Figure 1**. Steelhead returns to Coleman NFH from 1988-2014. Starting in 2001, fish were classified as either wild (unclipped) or hatchery produced (clipped).

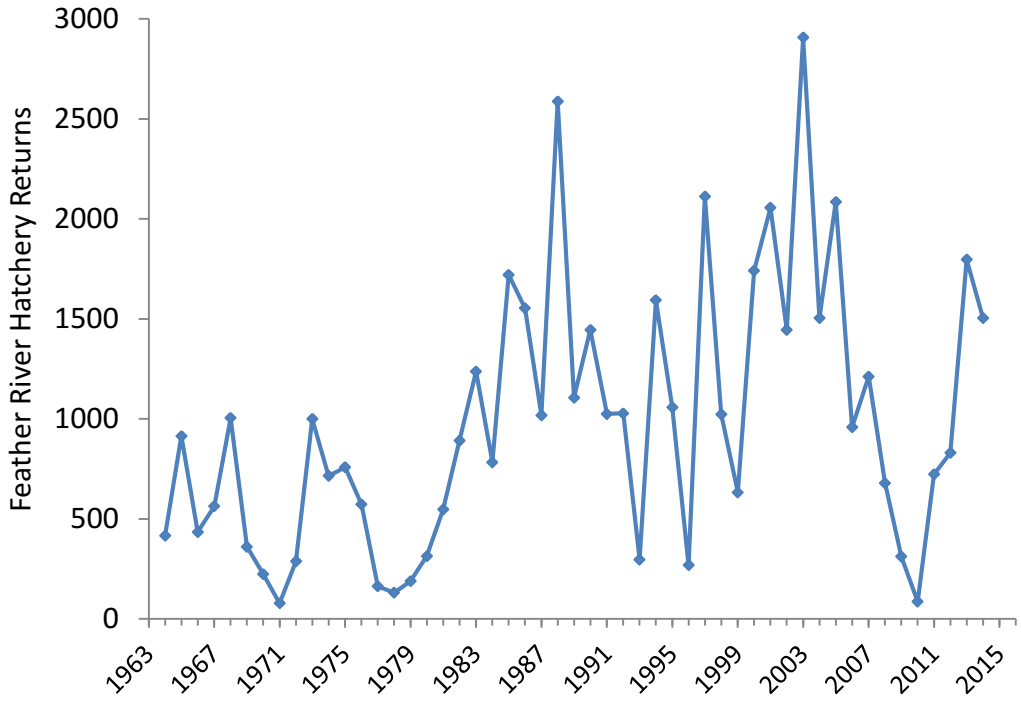


**Figure 2**. Steelhead returns to the Feather River Hatchery from 1964-2015.

The returns of steelhead to the Feather River Hatchery were very low in 2009 and 2010, with only 312 and 86 fish returning in those years (Figure 2; CDWR 2014). Since then the numbers have rebounded, with a high of 1,797 in 2013, and have averaged over 1,100 fish over the last five years. Escapement at this hatchery seems to be quite variable over the years, despite the fact that stocking levels have remained fairly constant and that the vast majority of fish are of hatchery origin.

In the Mokelumne River, East Bay Municipal Utilities District (EBMUD) has included steelhead in their redd surveys on the Lower Mokelumne River since the 1999-2000 spawning season (NMFS 2011). Based on data from these surveys, the overall trend suggests that redd numbers have slightly increased over the years (2000-2010). However, according to Satterthwaite *et al*. (2010), it is likely that a large majority of the *O. mykiss* spawning in the Mokelumne River are non-anadromous (or resident) fish rather than steelhead. The Mokelumne River steelhead population is supplemented by Mokelumne River Hatchery production.

Redd counts are conducted in the American River and in Clear Creek (Shasta County), but there are not yet enough data to compute all risk metrics. An average of 142 redds have been counted on the American River from 2002-2015, with only 58 counted in 2015, a new low for this survey (Figure 3; data from Hannon 2013, Cramer Fish Sciences 2015).

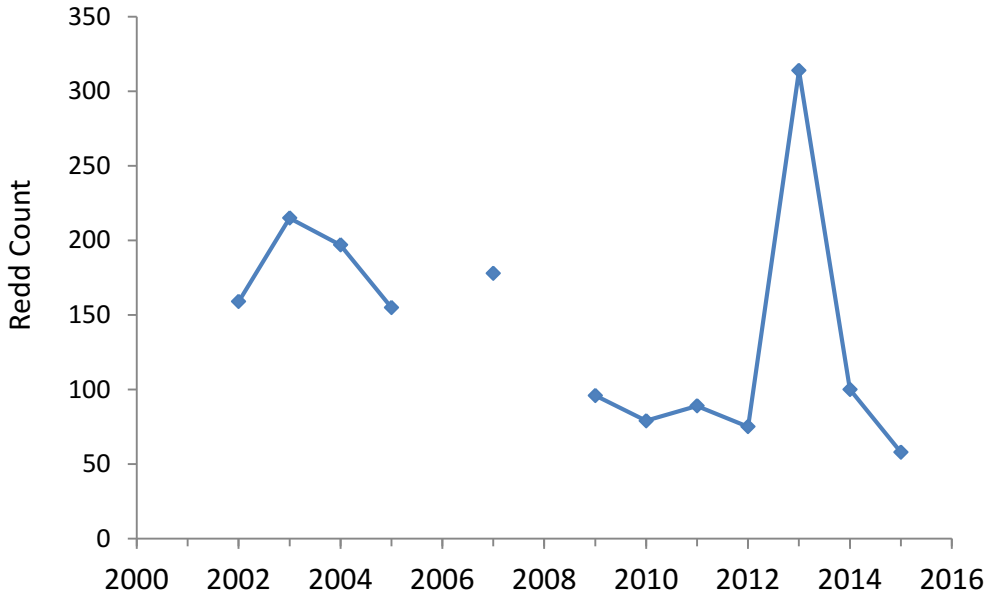


**Figure 3**. Steelhead redd counts from surveys on the American River from 2002-2015. Surveys could not be conducted in some years due to high flows and low visibility.

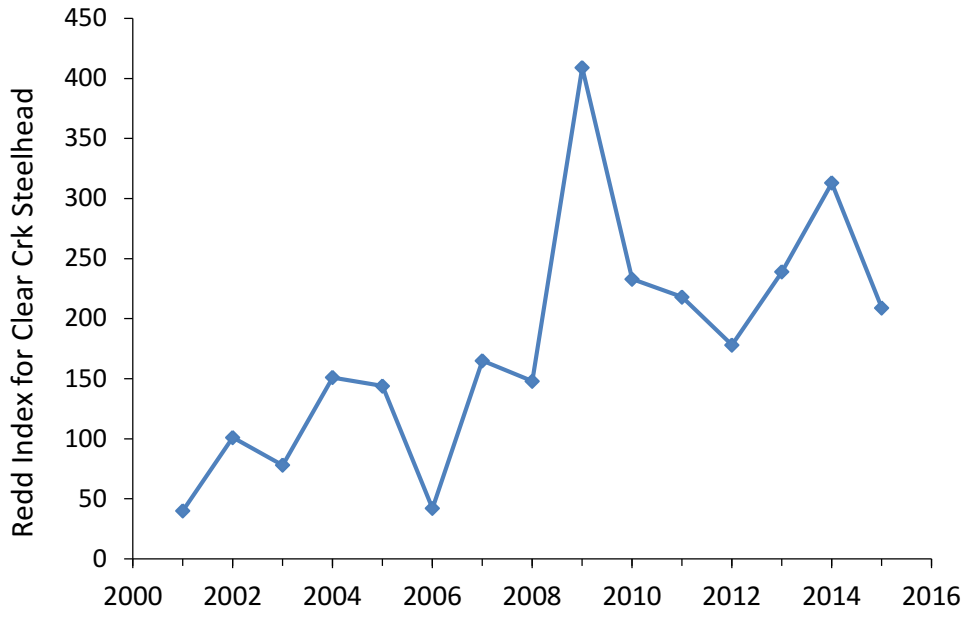


**Figure 4**. Redd counts from USFWS surveys on Clear Creek from 2001-2015.

The Clear Creek population has shown an increasing trend in steelhead redd counts since Saeltzer Dam was removed in 2000 (Figure 4; Giovannetti *et al.* 2013, USFWS 2015). The average redd count over the last 10 years (2006-2015) is 215, representing somewhere between 215 and 431 spawning adult female steelhead. Since 2011, an average of 231 redds has been observed in Clear Creek. The vast majority of these steelhead are wild fish, as no hatchery steelhead are stocked in Clear Creek, and adipose fin clipped steelhead are rarely observed in Clear Creek (M. Brown, USFWS, pers. comm.).

Information on steelhead escapement in Mill Creek is now available from a video monitoring station run by CDFW at Ward Dam. Counts of adult steelhead moving upstream have been made since the 2008-09 season. Adult counts have ranged from 60 to 237, with an average of 142 over the last six years (Figure 5; Killam and Johnson 2008, CDFW 2015a). All of these fish appear to be naturally produced. The recent low flows associated with recent drought years have actually improved the ability to count steelhead at this station. An interesting comparison can be made with counts from Clough Dam on Mill Creek from the 1950's and early 1960's, when steelhead were counted at a fish ladder on the dam. Counts from that time period were almost 10 times greater in magnitude (Figure 6; Harvey 1995), though those fish were likely a mix of hatchery and wild fish, as the state was stocking smolts in the Sacramento River at Princeton at that time, and one year (1956) released 107,000 smolts directly in Mill Creek (Hallock *et al.* 1961).

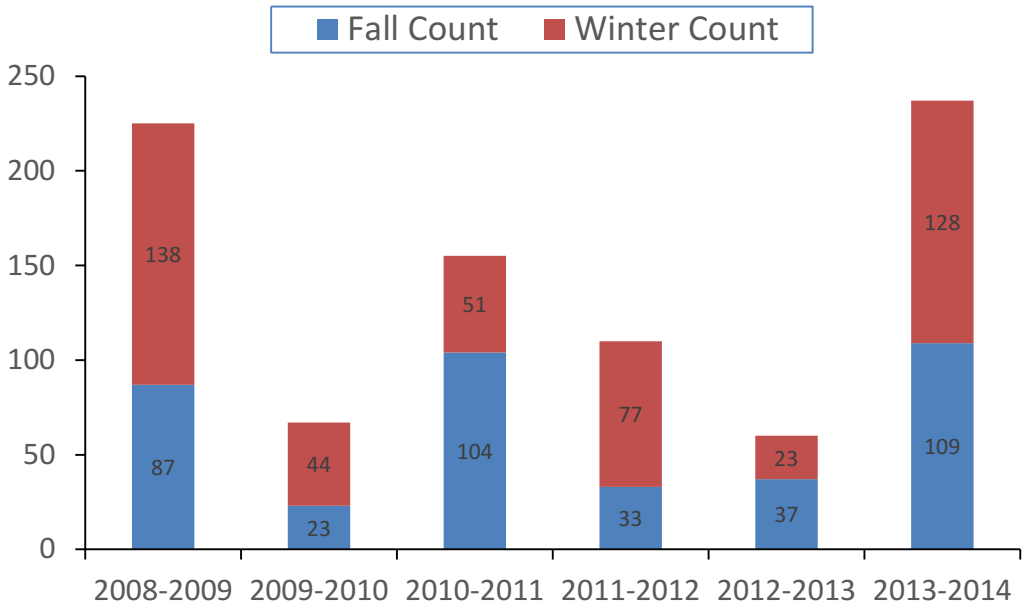


**Figure 5.** Numbers of adult steelhead counted at the video station on Mill Creek, 2009 to 2014.

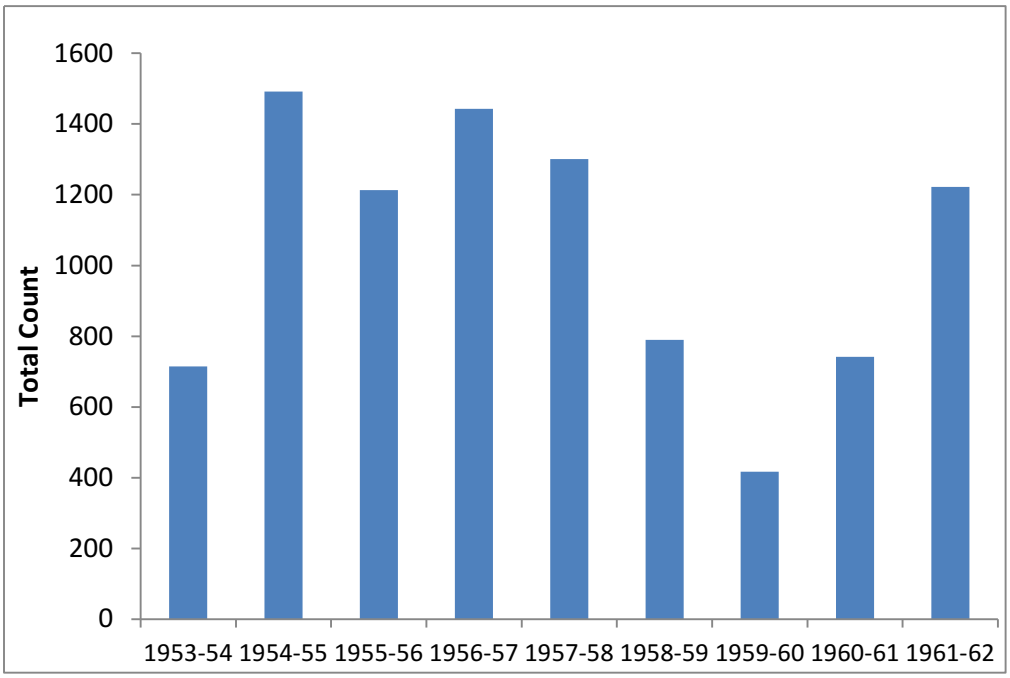


**Figure 6.** Numbers of adult steelhead counted at Clough Dam on Mill Creek, 1954 to 1962.

The Chipps Island midwater trawl dataset maintained by the USFWS provides information on the trend in abundance for the CCV steelhead DPS as a whole. Updated through 2014, the trawl

data indicate that the level of natural production of steelhead has remained very low since the 2011 status review (Figure 7). Catch per unit effort (CPUE) has fluctuated but remained level over the past decade, but the proportion of the catch that is adipose-clipped (100% of hatchery steelhead production have been adipose fin-clipped starting in 1998) has risen, exceeding 90 percent in some years and reaching a high of 95 percent in 2010 (Williams *et al.* 2011). Because hatchery releases have been fairly constant, this implies that natural production of juvenile steelhead has been falling

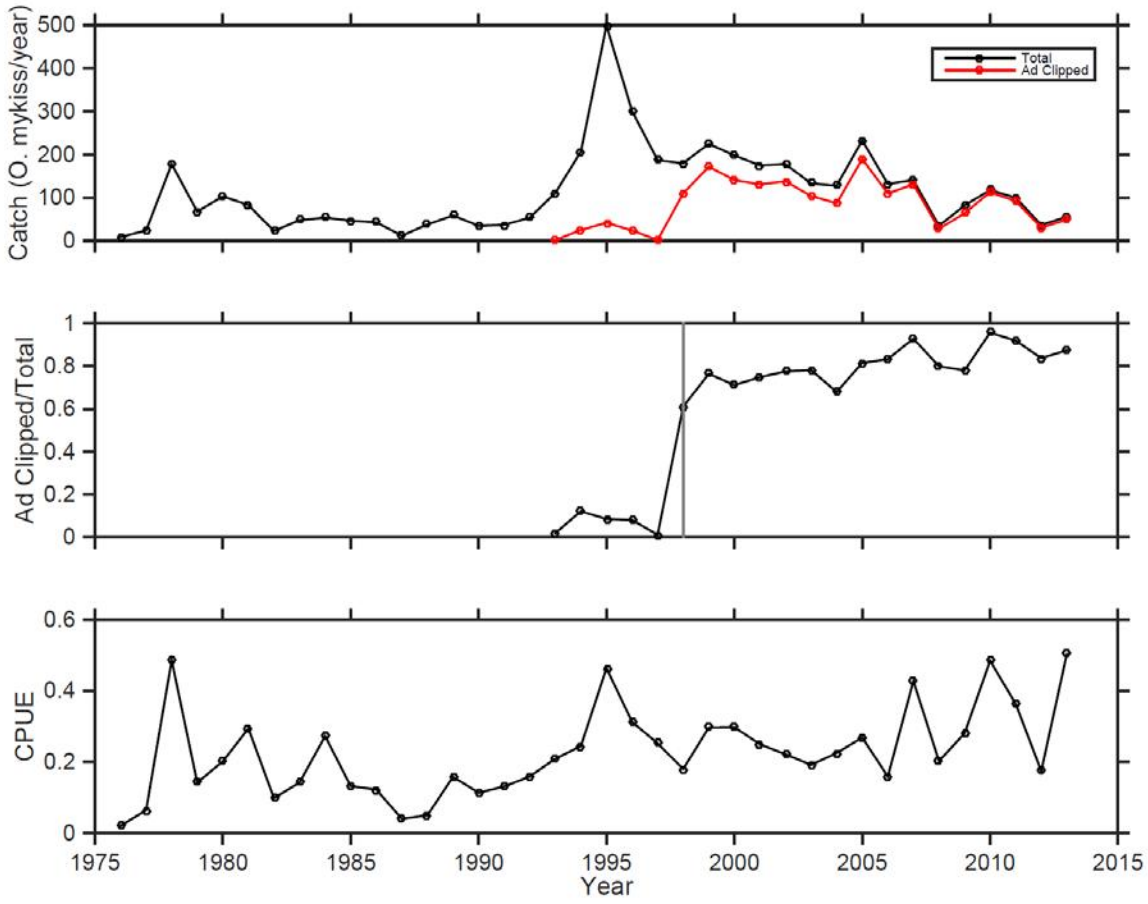


**Figure 7.** Top: Catch of steelhead at Chipps Island by the USFWS midwater trawl survey. Middle: Fraction of the catch bearing an adipose fin clip. 100% of steelhead production has been marked starting in 1998, denoted with the vertical gray line. Bottom: CPUE in fish per million m-3 swept volume. CPUE is not easily comparable across the entire period of record, as over time, sampling has occurred over more of the year and catches of juvenile steelhead are expected to be low outside of the primary migratory season.

Catches of steelhead at the fish collection facilities in the southern Delta are another source of information on the relative abundance of the CCV steelhead DPS, as well as the production of wild steelhead relative to hatchery steelhead (CDFW 2014b; ftp.delta.dfg.ca.gov/salvage). The overall catch of steelhead has declined dramatically since the early 2000's, with an overall

average of 2,705 in the last ten years, as measured by expanded salvage (Figure 8). The percentage of wild (unclipped) fish in salvage has fluctuated, but has leveled off to an average of 36 percent since a high of 93 percent in 1999. The number of stocked hatchery steelhead has remained relatively constant overall since 1998, even though the number stocked in any individual hatchery has fluctuated. This relatively constant hatchery production, coupled with the dramatic decline in hatchery-origin steelhead catch at the south Delta fish collection facilities suggests that either stocked hatchery fish from the Sacramento basin are utilizing a more natural outmigration path and not being pulled into the south Delta fish facilities, or the immediate survival of those stocked fish has decreased. With respect to wild steelhead, the data shown in Figure 8 indicate that over the last few years fewer adults are spawning (less eggs deposited), survival of early life stages has decreased, and/or wild steelhead are experiencing reduced exposure to the south Delta fish facilities.

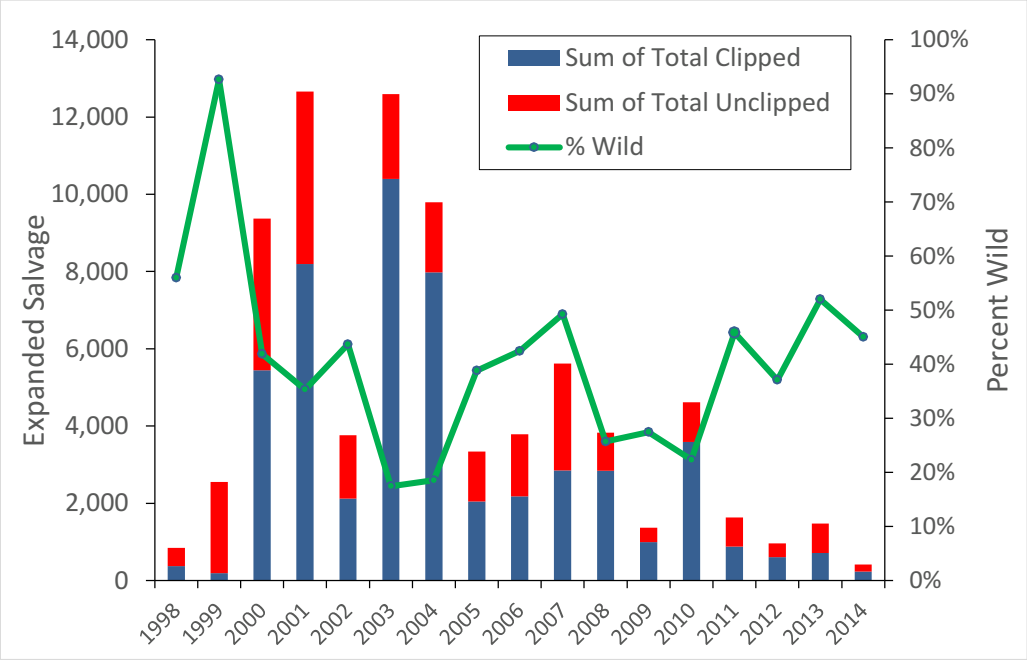


**Figure 8**. Steelhead salvaged in the Delta fish collection facilities from 1993 to 2014. All hatchery steelhead have been adipose fin-clipped since 1998. Data are from CDFW, at: ftp.delta.dfg.ca.gov/salvage.

***Population Growth Rate***

Data are lacking for calculation of population growth rates, although some inferences can be made from redd count trends, as discussed in the previous section.

***Genetic and Life History Diversity***

*O. mykiss* have long been recognized as having one of the most complex and diverse life histories among all the salmonids. Populations may be entirely anadromous, partly anadromous, or entirely resident, and levels of anadromy can vary by age and sex. One of the difficulties in

assessing any steelhead data in the Central Valley is the possibility that some individuals may actually be resident fish, as it is nearly impossible to visually distinguish the two life history forms when they are juveniles.

Satterthwaite *et al*. (2010) modeled lifetime fitness in female *O. mykiss* and showed the importance of smolt survival and asymptotic size on the individual "decision" to be anadromous or resident. They found that the model results agreed fairly well with observations of *O. mykiss* populations in the American and Mokelumne Rivers.

American River steelhead can readily reach a size associated with high probability of surviving emigration as age 1 smolts. Thus they forego maturing in freshwater at a young age and are not well served to wait and expose themselves to additional freshwater mortality risk by smolting at age 2 or older, or to wait and mature in freshwater at an older age.

On the Mokelumne River, it appears that many fish can reach a size large enough to smolt at age 1, but the slower-growing fish are better served to mature as young-of-year (YOY) and spawn at age 1 rather than risk the extra freshwater mortality associated with waiting to smolt at age 2 (since much less time must elapse before the age 1 spawning opportunity compared to age 2 emigration). However, once the first spawning opportunity has passed and even slow growing fish are large enough to have a moderate chance of survival in the ocean, it takes too long and exposes fish to too much risk of freshwater mortality to grow to a large enough size to spawn with much success as a resident female at an even older age.

These results suggests that restoration activities for CCV steelhead should focus on habitat improvements that both increase parr survival and growth in natal rivers, especially in the summer and fall period, and improve smolt survival in the lower river reaches, the Delta, and Bays.

***Spatial Structure***

Steelhead are present throughout most of the watersheds in the Central Valley, but often in low numbers, especially in the San Joaquin River tributaries. Zimmerman *et al.* (2009) used otolith microchemistry to show that *O. mykiss* of anadromous parentage exist in all three major San Joaquin River tributaries, although at low levels, and these tributaries have a higher percentage of resident *O. mykiss* compared to the Sacramento River watershed. The Mossdale trawls conducted by CDFW and USFWS each year catch steelhead smolts annually, although usually in very small numbers.

Most of the steelhead populations in the Central Valley have a high hatchery component, including Battle Creek (adult intercepted at the Coleman NFH weir), the American River, Feather River, and Mokelumne River. This is confounded, of course, by the fact that most of the dedicated monitoring programs in the Central Valley occur on rivers that are annually stocked. Clear Creek and Mill Creek are the exceptions.

Implementation of CDFW's Steelhead Monitoring Program began during the fall of 2015. Important components of the program include a Mainstem Sacramento River Steelhead Mark-

Recapture Program and an Upper Sacramento River Basin Adult Steelhead Video/DIDSON Monitoring Program. The monitoring program will use a temporally stratified mark-recapture survey design in the lower Sacramento River, employing wire fyke traps to capture, mark, and recapture upstream migrating adult steelhead to estimate adult steelhead escapement from the Sacramento-San Joaquin River Delta. Data collected from recaptured adult steelhead will provide additional information on tributary escapement, survival, population structure, population distribution, and spatial and temporal behavior of both hatchery- and natural-origin steelhead.

***Summary***

Overall, the status of CCV steelhead appears to have changed little since the 2011 status review when the Technical Recovery Team concluded that the DPS was in danger of extinction. Further, there is still a general lack of data on the status of wild populations. There are some encouraging signs, as several hatcheries in the Central Valley have experienced increased returns of steelhead over the last few years. There has also been a slight increase in the percentage of wild steelhead in salvage at the south Delta fish facilities, and the percentage of wild fish in those data remains much higher than at Chipps Island. The new video counts at Ward Dam show that Mill Creek likely supports one of the best wild steelhead populations in the Central Valley, though at much reduced levels from the 1950's and 60's. Restoration and dam removal efforts in Clear Creek continue to benefit CCV steelhead. However, the catch of unmarked (wild) steelhead at Chipps Island is still less than 5 percent of the total smolt catch, which indicates that natural production of steelhead throughout the Central Valley remains at very low levels. Despite the positive trend on Clear Creek and encouraging signs from Mill Creek, all other concerns raised in the previous status review remain.

**Table 5.** Viability metrics for CCV steelhead populations. Total population size (*N*) is estimated as the sum of estimated run sizes over the most recent three years for independent populations (bold) and dependent populations. The mean population size ($\hat{S}$) is the average of the estimated run sizes for the most recent three years. Population growth rate (or decline; 10 year trend) is estimated from the slope of log-transformed estimated run sizes. The catastrophic metric (Recent Decline) is the largest year-to-year decline in total population size (N) over the most recent 10 such ratios.

| Steelhead population | *N* | $\hat{S}$ | 10-yr trend (95% CI) | Recent decline (%) |
|---|---|---|---|---|
| American River[a] | 472 | 157.3 | -0.062 (-0.164, 0.039) | 45.8 |
| Clear Creek[a] | 761 | 253.7 | 0.111 (-0.021, 0.244) | 9.5 |
| Coleman National Fish Hatchery | 8461 | 2820.3 | 0.051 (-0.043, 0.146) | 18.4 |
| Feather River Hatchery[b] | 4119 | 1373.0 | 0.061 (-0.171, 0.292) | 38.3 |
| Mokelumne River Hatchery | 398 | 132.7 | -0.051 (-0.169, 0.067) | 30.5 |
| Nimbus Hatchery | 4052 | 1350.7 | -0.155 (-0.378, 0.067) | 4.5 |

a - American River and Clear Creek steelhead data are derived from redd counts. Some redds may be from non-anadromous *O.mykiss* or steelhead.

b - Feather River Hatchery numbers include repeat spawners (fish returning the hatchery multiple times in a single year). These findings based on recent tagging studies suggest hatchery return numbers are likely slightly inflated.

### 2.3.2 Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

#### 2.3.2.1 Present or threatened destruction, modification, or curtailment of its habitat or range:

In classifying the CCV steelhead DPS as threatened in 1998 (63 FR 13347), NMFS highlighted the historical loss and degradation of spawning and rearing habitat as one of the major factors leading to the current low population abundances. This habitat loss and degradation is due to a combination of water development projects and operations that include, but are not limited to: (1) impassable dams, water diversions, and hydroelectric operations on almost every major river in the Central Valley; (2) antiquated fish screens, fish ladders, and diversion dams on streams throughout the Sacramento River Basin; and (3) levee construction and maintenance projects that do not incorporate fish-friendly designs. All of those projects and operations reduce the habitat quality and/or quantity for steelhead.

The massive alterations to river channels from the gold mining era continue to impact aquatic habitats throughout much of the Central Valley. Busby *et al.* (1996) cited other land use practices that have degraded steelhead habitat in the Central Valley including forestry, agriculture, and urbanization of watersheds.

Good *et al.* (2005) described the threats to Central Valley salmon and steelhead as falling into three broad categories: loss of historical spawning habitat, degradation of remaining habitat, and genetic threats from the stocking programs. Cummins *et al.* (2008) attributed the much reduced biological status of Central Valley anadromous salmonid stocks to the construction and operation of the CVP and SWP:

> "*Construction and operation of the CVP and SWP have altered flows, reduced water quality, and degraded environmental conditions and reduced habitat for fish and wildlife in the Central Valley from the headwaters to the Delta. This includes the native anadromous fish of the Central Valley -- winter, spring, fall and late-fall chinook, steelhead and sturgeon. Adult runs that once numbered in the millions have been reduced to thousands or less.*
>
> *The transformation of the natural Sacramento/San Joaquin river systems into a massive water storage and delivery system includes dams and diversions that have blocked access for anadromous salmonids to much of their historical habitat. Development of the CVP and SWP has significantly modified the natural hydrologic, geomorphic, physical and biological systems. The modified river system significantly impacts the native salmon and steelhead production as a result of fragmented habitats, migration barriers, and seasonally altered flow and habitat regimes*."

However, in the last 5-10 years, some habitat restoration programs and conservation plans have been implemented that, in aggregate, should provide a benefit to the habitat of Central Valley steelhead, or are expected to do so in the future. These are detailed below:

***Clear Creek Restoration Program (ongoing since 2000)***

Seltzer Dam on Lower Clear Creek was removed in in 2000, opening up approximately 10 miles of stream to anadromous salmonids, including steelhead. Since then, extensive gravel augmentation and regulation of instream flows and water temperatures has occurred, both as part of the Clear Creek Restoration Program and as mandated by the NMFS OCAP BO. This program has been successful in restoring Clear Creek to a condition that is supporting a small but increasing population of steelhead. The USFWS has monitored steelhead redds in Clear Creek since 2001, and has documented a steady increase, indicating that the steelhead population has benefited from the new habitat and improved water quality.

***Battle Creek Salmon and Steelhead Restoration Project***

The Restoration Project will eventually remove five dams on Battle Creek, install fish screens and ladders on three dams, and end the diversion of water from the North Fork to the South Fork. When the program is completed, a total of 42 miles of mainstem habitat and six miles of tributary habitat will be open to anadromous salmonids. Phases lA (North Fork Battle Creek actions) and 1B (a tailrace connector project) have been funded. As part of this first phase, Wildcat Diversion Dam on the North Fork of Battle Creek was removed in 2010. In 2011, fish

screens and fish ladders were installed at the Eagle Canyon and North Battle Creek Feeder (NBCF) Diversion Dams. Evaluations of these new facilities found that improvements will be needed to make them work as planned. The modifications are planned for 2016 and 2017. Phase 2 of the restoration project (South Fork Battle Creek actions) has not been completely funded, but design work has begun, and construction is expected to begin in 2017 and finish by 2020.

***California WaterFix and California EcoRestore***

The purpose of the California WaterFix (CWF) is to modernize the state's aging water delivery system and provide additional opportunities to protect sensitive fish species. A proposed CWF water conveyance system would include new points of diversion in the north Delta in concert with improvements to the current through-Delta water export system in the south Delta. Actions under discussion include operation of a dual conveyance system and measures to reduce other stressors to the Delta ecosystem and covered species. CWF is in a developmental stage, its implementation is uncertain, and any new benefits or threats to steelhead resulting from the plan would not occur for many years.

California EcoRestore is an initiative to help coordinate and advance habitat restoration in the Delta in the short term (next four years). The initial goal of California EcoRestore is to advance 30,000 acres of Delta habitat restoration. This restoration is unassociated with any habitat restoration that may be required as part of the construction and operation of any new Delta water conveyance (*e.g*., CWF). California EcoRestore is largely in a developmental stage, so the full benefit to steelhead from the restoration will not be realized for several years.

***Anadromous Fish Restoration Program (AFRP)***

The Central Valley Improvement Act (CVPIA) established the Anadromous Fish Restoration Program (AFRP) in 1992 with the goal of making "all reasonable efforts to at least double natural production of anadromous fish in California's Central Valley streams on a long-term, sustainable basis". Anadromous fish covered under AFRP include all races of Chinook salmon, steelhead, sturgeon, striped bass and American shad. The program is administered jointly by the United States Bureau of Reclamation (Reclamation) and USFWS. Approximately $15 million/year of CVPIA restoration funds will be used for the purpose of protecting, restoring, and enhancing special-status species and their habitats in areas directly or indirectly affected by the CVP. Through the AFRP, Federal funding for beneficial projects include annual spawning gravel augmentation, instream flow management (*i.e.,* use of 800 thousand acre feet of CVPIA b(2) water from the Central Valley Project), and habitat restoration projects (*e.g*., Battle Creek, Clear Creek, and Butte Creek). The AFRP also works to optimize fish screen funds with partnership-based sources such as Wildlife Conservation Board, CDFW, and the Ecosystem Restoration Program (see below) and local sources. These screens are important to protect ESA listed fish such as winter-run Chinook salmon, spring-run Chinook salmon, Delta smelt, and steelhead.

The AFRP has funded restoration projects that improve the habitat, survival, and passage of anadromous fish in Antelope Creek, Cottonwood Creek, and the Calaveras, Cosumnes, Merced, Mokelumne, Stanislaus, and Tuolumne rivers.

Specific river projects listed in the 2011 CVPIA work plan that should benefit steelhead include:

- Antelope Creek, where fish passage improvements at Edwards Diversion Dam were made. In addition, a perched culvert and a low-flow road crossing were replaced with modern structures that will allow for unimpeded passage.
- Butte Creek, where the Anderson-Cottonwood Irrigation District (ACID) Siphon Project will improve passage at a partial low flow barrier. The design and permits were completed in 2010.
- Cow Creek, where modifications to the Millville Diversion Dam (removal of the dam and siphon structure) will open up 10 miles of habitat on Clover Creek, a small tributary to Cow Creek. A preliminary engineering technical report was issued in 2013.
- Yuba River, where the Hammon Bar Habitat Restoration Project has planted cottonwood and willow trees at four sites, covering 129 acres in total. The first phase of implementation was completed in the fall of 2011, with a total of 1,680 cuttings planted. In 2012 an additional 5,000 cuttings were planted. The monitoring of project effectiveness will continue through 2015.
- American River habitat restoration, where several projects have been completed in the last five years. The Nimbus Basin just downstream of Nimbus Dam had extensive gravel augmentation and two side channels constructed in 2014. Riverbend Park had spawning gravel added, flow connectivity to side channels enhanced, and large wood added in 2013. Upper Sunrise had a side channel connectivity improved in 2011. Lower Sailor Bar had gravel augmentation, a side channel created, and large wood added in 2012.
- Mokelumne River gravel augmentation at several sites to improve spawning habitat. The project will result in the placement of 2,500 to 5,000 cubic yards of spawning gravel annually for 3 years at two sites. Additionally, there will be 500 to 1,000 cubic yards supplemented annually, as part of a long term restoration program implemented since 2001.
- Calaveras River, where a series of weirs were installed at Budiselich Flashboard Dam to improve fish passage and improved access to about ten miles of habitat. The Caprini low flow crossing was replaced with a series of box culverts which allow unimpeded fish passage. In addition, designs have finished and the permit process initiated on a project to improve fish passage at the California Traction Railroad crossing.
- Stanislaus River, where in 2011 the Lancaster Road Project created a new side channel, and the Honolulu Bar Project created 485 feet of side-channel habitat. A study of *O. mykiss* movement using acoustic transmitters is planned.
- Merced River, where the Merced River Ranch Floodplain Enhancement Project added 12,000 cubic yards of gravel to the river, creating 1.23 miles of spawning habitat.
- Tuolumne River, where in 2011 the Bobcat Flat Restoration Project and restored about 1.6 miles of spawning and rearing habitat.

***Ecosystem Restoration Program***

The Ecosystem Restoration Program (ERP) has completed several years of an ambitious 30-year plan to restore ecological health and improve water management in the San Francisco Bay and Sacramento-San Joaquin Delta. Starting under the CALFED Record of Decision (ROD) in 2000,

CDFW now fulfills the role of the State's Implementing Agency for ERP, and is currently managing more than 85 ongoing and approximately 10 newly funded projects.

The objectives of the ERP are: (1) to prepare comprehensive ecosystem restoration plans for the Sacramento and San Joaquin rivers; (2) support scientific reviews; and (3) coordinate fish screen and fish passage projects with the AFRP, CVPIA, and other stakeholders to achieve CDFW fish passage goals.

The ERP has protected or restored more than 38,900 acres of habitat, most of which directly or indirectly benefits spring-run Chinook salmon. In 2014 the ERP released its updated Conservation Strategy to help guide the program's future work.

***Butte Creek***

Recent conservation actions have improved habitat conditions for Butte Creek steelhead. Completion of the Willow Slough Weir Project (new culverts and a new fish ladder) in 2010 improved fish passage through the Sutter Bypass. In addition, since 2000, real-time coordinated operations of the DeSabla Centerville Federal Energy Regulatory Commission (FERC) Project No. 803 have been implemented to reduce the water temperature-related effects of the project on spring-run Chinook salmon adults during the summer, which will also benefit steelhead parr. There are also proposals to monitor steelhead as part of the project.

***Feather River***

Through the Oroville FERC License Settlement, the California Department of Water Resources (CDWR) has committed to implementing low-flow channel habitat improvements, which would benefit steelhead spawning and rearing. Currently, nearly all the steelhead that return to the Feather River Hatchery are hatchery-origin fish, indicating that spawning and/or rearing habitat for steelhead in the Feather River is very poor and natural production is limited.

***Lower Yuba River Habitat Restoration***

The U.S. Army Corps of Engineers (Army Corps) initiated a long-term gravel augmentation program in 2010 that is intended to improve spawning habitat in the uppermost reach of the lower Yuba River. However, the gravel is being introduced below Engelbright Dam, and most of it will likely be trapped in the Yuba Narrows pool. Also, the size of the introduced gravel is selected for Chinook salmon, which is larger than optimal for steelhead.

A riparian enhancement project intended to improve rearing habitat in the short- and long-term. This project is largely focused on planting willows on the gravel bars along the river.

The Army Corps is conducting a study of the movement of large wood placed on the gravel bars along the banks of the lower Yuba River. Once a large flow event moves this wood into the water, some of the larger pieces may remain in the river and provide good habitat for rearing juveniles.

***San Joaquin River Restoration Program***

The SJRRP calls for a combination of channel and structural modifications along the San Joaquin River below Friant Dam, releases of water from Friant Dam to the confluence of the Merced River, and the reintroduction of spring-run Chinook salmon. The first flow releases from Friant Dam in support of the SJRRP occurred in October 2009. Key SJRRP milestones included: (1) reintroducing spring-run Chinook salmon by December 2012; (2) completing all high priority channel and structural construction activities by December 2013; and (3) releasing the full restoration flows in 2014. Due to the complexity of the habitat restoration and the ongoing drought in California, the latter two milestones have not been met, but the program is still moving forward. Though this program is focused on spring-run Chinook salmon, it has the potential to improve habitat for steelhead as well. There is currently a small population of resident rainbow trout in the San Joaquin River below Friant Dam, so additional flows and better connectivity to the ocean increase the chances that a wild steelhead population could be reestablished in this river.

***Actions required by the Biological Opinion on the long-term operations of the Central Valley Project and State Water Project***

The OCAP BO contains mandatory actions that are intended to avoid jeopardizing anadromous fish, and avoid the destruction or adverse modification of critical habitat, resulting from the long-term operations of those projects. Actions in the OCAP BO that are intended to improve salmon and steelhead habitat include:

- Implementing multiple actions on Clear Creek to provide more suitable flows and water temperatures, and increase the availability of spawning habitat through gravel additions [underway].
- Modifying gate operations at Red Bluff Diversion Dam so that the gates are raised, allowing fish passage from September 1 through June 14 to improve upstream migration for adults as well as downstream survival of juveniles; by May 2012 the diversion dam must be operated with the gates raised allowing fish passage year-round [completed].
- Providing funding to help complete the Battle Creek Restoration Project (project is briefly described above) [underway].
- Providing funding to support the CVPIA Anadromous Fish Screen Program [underway].
- Implementing multiple actions to improve flow and habitat conditions in the Delta [underway].
- Stanislaus River actions set specific temperature criteria, flow schedules, riparian habitat restoration, and gravel augmentation.
- American River Flow and Temperature Actions set specific temperature criteria, and call for analysis of additional measures to improve temperatures such as a temperature control device, flow schedules, and a Hatchery and Genetic Management Plan.

In addition to the above-listed habitat improvement actions, the OCAP BO includes a phased fish passage program that is intended to reintroduce steelhead above Folsom Dam on the American River. Phases of the fish passage program called for habitat evaluations through January 2012, pilot reintroductions from January 2012 through January 2015, and implementation of the long-

term program by January 31, 2020. None of these phases have yet been implemented, as resolving the issue of replacing the non-native hatchery broodstock in the lower American River (*i.e.*, the Eel/Mad River strain used at the Nimbus Hatchery) has taken priority, and reintroduction efforts in the Central Valley have focused on the re-introduction of winter-run Chinook salmon above Shasta Dam.

On the Stanislaus River a pilot steelhead passage program is "encouraged" but not required of Reclamation.

***Central Valley Salmon and Steelhead Recovery Plan***

The Final Recovery Plan for Central Valley Salmon and Steelhead was completed by NMFS in 2014. This plan will serve as a road map for recovering Central Valley spring-run Chinook salmon, Sacramento River winter-run Chinook salmon, and CCV steelhead. The plan contains prioritized actions based on a comprehensive threats assessment. The plan calls for the reintroduction of steelhead above Shasta Dam on the Sacramento River, Folsom Dam on the American River, New Melones Reservoir on the Stanislaus River, New Don Pedro Reservoir on the Tuolumne River, and New Exchequer Reservoir on the Merced River. While the plan itself does not include dedicated funding for recovery efforts, it will help guide conservation planning efforts.

***FERC Relicensing on San Joaquin River Tributaries***

Pacific Gas and Electric's (PG&E) license for the Merced Falls Project on the Merced River expired in 2014. Negotiations have included discussion of improved fish passage at Crocker-Huffman Dam, which would allow access up to Merced Falls Dam, opening up about two miles of habitat to CCV steelhead.

The license for the Don Pedro Project on the Tuolumne River, owned by Turlock & Modesto Irrigation Districts, will expire in May 2016. This project has been voluntarily releasing more summer flow than required under their current license, and there has been a small improvement in *O. mykiss* snorkel counts in the Tuolumne River since 1996 (Ford and Kirihara 2009), though these are small improvements from an extremely low baseline. Fewer than 100 fish were observed (river wide) in 65 percent (17 of 26) of years between 1982 and 2009. The highest counts, by some margin, were observed in the high water years of 2006 and 2011, with declining counts in each of the drier years following one of the wet years (Stillwater Sciences 2014).

**2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes:**

***Commercial and Recreational Fisheries***

There is no commercial fishery for steelhead in rivers of the Central Valley, and ocean harvest of steelhead is extremely rare, and is in particular an insignificant source of mortality for the CCV steelhead DPS. Insufficient data are available to estimate CCV steelhead freshwater exploitation rates directly, though exploitation rates are likely relatively low given that retention of natural-origin steelhead is prohibited. Fishing effort estimates based on angler self-report cards,

available from 1993–2005, suggest that effort tripled in the second half of the period in this DPS (Figure 9). Jackson (2007) noted that the increase in Central Valley steelhead fishing effort was accompanied by a decrease in fishing effort observed on many coastal streams, and suspected that this may be the result of regulations allowing retention of hatchery-origin steelhead in the Central Valley.

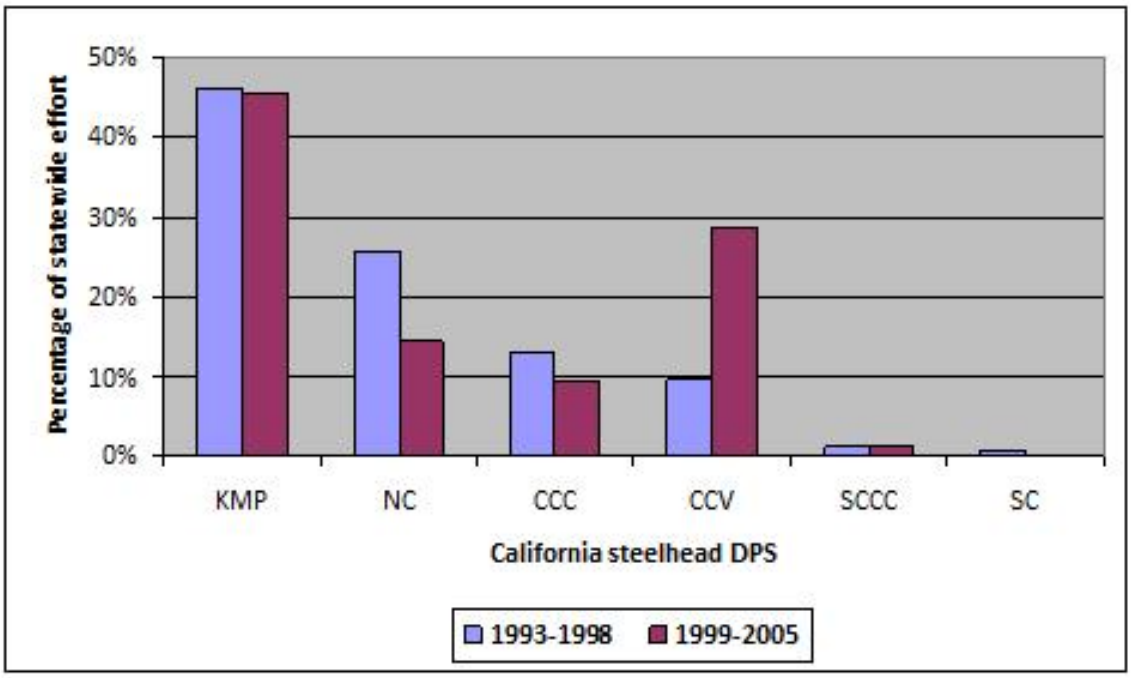


**Figure 9**. Distribution of California statewide fishing effort by DPS for years 1993 – 1998 and 1999 – 2005 (Jackson 2007).

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

***Scientific Research***

For over two decades, research and monitoring activities conducted on anadromous salmonids in California have provided resource managers with a wealth of important and useful information regarding anadromous fish populations. For example, juvenile fish trapping efforts have enabled the production of population inventories, and passive integrated transponder (PIT) tagging efforts have increased the knowledge of anadromous fish abundance by providing information on migration timing and survival. By issuing research authorizations, NMFS has allowed information to be acquired that has enhanced resource managers' abilities to make more effective and responsible decisions to sustain anadromous salmonid populations, mitigate adverse impacts on endangered and threatened salmon and steelhead, and implement recovery efforts. The resulting information continues to improve our knowledge of the respective species' life histories, specific biological requirements, genetic make-up, migration timing, responses to

human activities (positive and negative), and survival in the rivers and ocean. And that information, as a whole, is critical to the species' survival.

Thus, we expect the detrimental effects on the species from scientific research to be minimal and those impacts would only be seen in terms of slight reductions in juvenile and adult abundance and productivity. And because these reductions are so slight, the current ongoing scientific research involving CCV steelhead would have no appreciable effect on the species' diversity or structure. Moreover, we expect the actions to provide lasting benefits for the DPS and that all habitat effects would be negligible.

#### 2.3.2.3 Disease or predation:

***Disease***

There has been documentation of at least one disease in steelhead parr from the American River (lower intestinal bacterial disease also known as rosy anus, documented by Rob Titus, CDFW). It may be linked to high summer and fall water temperatures in that system. Water temperatures on the lower American River often exceed 70 degrees Fahrenheit (°F) for several days to weeks at a time during late summer months. These high water temperatures promote the growth of bacteria, fungi, and parasites, which are common in such environments, and infect cold water fishes such as steelhead at disease levels.

With 2014 being the third consecutive drought year for California, and a subsequent classification as a severe drought, there was concern for the fate of juvenile steelhead on the lower American River. From May of 2014 through the end of October 2014, CDFW monitored the relative abundance, growth, condition, health, and survival of juvenile steelhead on the lower American River in response to drought-induced low-flow conditions. (CDFW 2014a). Despite the higher than average water temperatures, there were no visible signs of stress (or disease) in the captured fish. CDFW anticipates continuing these efforts in subsequent years, with the hopes of tagging and recapturing more fish than 2014, and in a greater variety of rearing habitats, including restored and created side channels.

***Predation***

Predation on steelhead parr and smolts by both native (pikeminnow) and non-native predators (striped bass, largemouth bass, smallmouth bass) is highly likely both in their natal rivers and during their migration though the lower rivers, the Delta, and San Francisco Bay. In Clifton Court Forebay, tagged hatchery smolts were heavily predated on by striped bass (Clark *et al.* 2009). Recent Experiments (San Joaquin River Group Authority 2009) have shown that predation on emigrating Chinook salmon smolts is a major contributing factor to the high mortality in the Lower San Joaquin River and southern Delta. Steelhead smolts, being much larger and faster than Chinook smolts, may be less vulnerable to predation, but predation on steelhead has not been studied at this level. Results from the first two years of the 6-Year acoustic tagging study of steelhead called for in the 2009 OCAP BO will soon be available, and should start to provide valuable information on the movement and survival of steelhead smolts in the Delta.

***Sea lions and harbor seals***

California sea lions and Pacific harbor seals are known predators of salmonids, and their numbers are increasing. Predation by these marine mammals may significantly influence salmonid abundance in some local populations when other prey species are absent and physical conditions lead to the concentration of salmonid adults and juveniles (Cooper and Johnson 1992). Although fishes form the principal food sources of many marine mammals, CCV steelhead are likely a minor component of their diet given the low abundance of wild steelhead in the Central Valley. Although there are likely more seals and sea lions than existed at the time of the last status review, there is no known data that suggests predation is an increased threat to CCV steelhead.

***Hatchery fish predation***

There is little evidence that hatchery steelhead prey on wild steelhead. Most diet studies of steelhead have been on parr in rivers and streams, and typically find the diet dominated by invertebrates, with few if any fish consumed.

**2.3.2.4 Inadequacy of existing regulatory mechanisms:**

***Fisheries Management and Evaluation Plan (FMEP)***

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 of the ESA does not prohibit the take of listed fish in fisheries if a fishery management agency develops a FMEP and NMFS approves it. Some benefits of the FMEP approach are long-term management planning, more public involvement, less government paperwork, and more certainty that there will be fishing opportunities in the future.

In the FMEPs, fisheries will be managed according to the listed fishes' status. This will be determined by using the concepts contained in NMFS' "Viable Salmonid Populations" policy. Fisheries will be scaled to the degree of risk the listed fish face. When a listed population is at a critically low level, harvest impacts will be strictly controlled. Once a population recovers to "viable" levels, fisheries could be less restrictive.

If the FMEP is implemented accordingly, take of listed species in the fisheries addressed in the FMEP will be covered under the ESA. The primary goal of the FMEP is to devise biologically based fishery management strategies that ensure the conservation and recovery of listed ESUs/DPSs. An FMEP would need to be developed by CDFW for CCV steelhead where catch is allowed (see recommendations). This plan should be linked to the new CDFW adult monitoring plan for Sacramento River steelhead, as well as consider additional future monitoring programs.

Currently there are no FMEPs for CCV steelhead, largely because the monitoring of steelhead, both adults and juveniles, is still very limited. The best long term data set for CCV steelhead, counts of adults passing through the fish ladder at Red Bluff Diversion Dam, ended in 1993 due

to changes in the dam operation. Rotary screw traps are used extensively to monitor juvenile salmon, but are usually very inefficient at catching large steelhead smolts, which can range from 150-350 millimeters fork length (mmFL).

***Lack of Monitoring***

In classifying the CCV steelhead DPS as threatened in 1998 (63 FR 13347), NMFS referenced the lack of monitoring data for most populations in the DPS as a cause for concern. In response to these concerns, the CDFW, with funding from the Reclamation and CDWR, has written a detailed monitoring plan for Central Valley steelhead, with a focus on estimating adult escapement in the Sacramento River and its major tributaries (Fortier *et al*. 2014). CDFW began capturing and tagging adult steelhead in the Sacramento River during the fall of 2015. When fully implemented, this monitoring plan will provide steelhead abundance data for several watersheds in the Central Valley, and eventually allow for the long-term tracking of populations in a way that currently exists for the three species of Chinook salmon in the Central Valley. It should also greatly improve our understanding of where and how to concentrate habitat restoration and reintroduction efforts.

**2.3.2.5 Other natural or manmade factors affecting its continued existence:**

***Hatcheries***

There are four hatcheries (Coleman NFH, Feather River Hatchery, Nimbus Fish Hatchery, and Mokelumne River Hatchery) in the Central Valley which combined release approximately 1.73 million yearling steelhead smolts each year. These programs are intended to mitigate for the loss of steelhead habitat caused by dam construction, but hatchery-origin fish from the two hatcheries included in the DPS, now appear to constitute a major proportion of the total abundance in the DPS. Previous status reviews of this DPS have identified hatchery fish influence as a significant threat to its genetic integrity and diversity. Williams *et al.* (2011) identify the increasing dominance of hatchery fish relative to naturally produced fish as a significant concern.

As noted in the previous status review (NMFS 2011), two of these hatchery stocks (Nimbus and Mokelumne River hatcheries) originated from outside the DPS (mainly from the Eel River and Mad River) and are not presently considered part of the DPS. At the Mokelumne River Fish Hatchery, egg transfers that occurred in the past using the out-of-basin Eel River strain were discontinued after 2001. Following program failure, the hatchery obtained eggs from the Feather River Hatchery steelhead program, a stock that is considered to be part of the listed DPS. Recent genetic work (Pearse and Garza 2015) now shows that steelhead from the Mokelumne River Hatchery are nearly identical genetically to steelhead from the Feather River Fish Hatchery, and are descended from steelhead that are currently part of the DPS.

Based on recommendations from the Hatchery Scientific Review Group and a reasonable and prudent alternative (RPA) required by the 2009 OCAP BO, planning has begun for the eventual replacement of the out-of-basin broodstock currently used at the Nimbus Hatchery with a more suitable broodstock native to the DPS. A genetic analysis of upper American River *O. mykiss* populations was conducted in 2014, which found that the historic American River steelhead

genetics are likely still intact in the American River above Folsom Dam. A study has been proposed to investigate the potential of creating a steelhead broodstock from resident rainbow trout collected above Folsom Dam, but is still in the planning stage. On a separate track, steelhead eggs from Coleman NFH were imported into Nimbus Hatchery in 2015, in part to help the hatchery meet its egg production goal in a year when very few adult steelhead returned to the American River. Efforts are also underway to determine how best to study the growth and survival of these fish relative to that of the Nimbus Hatchery stock.

Potential threats to natural steelhead from hatchery programs include: (1) mortality of natural steelhead in fisheries targeting hatchery-origin fish; (2) competition for prey and habitat; (3) predation by hatchery-origin fish on younger natural fish; (4) disease transmission; and (5) genetic introgression by hatchery-origin fish that spawn naturally and interbreed with local natural populations.

High densities of hatchery fish in some rivers may cause competition with wild parr and smolts. This problem will be greatest when hatchery smolts residualize. How often this occurs in Central Valley Rivers is unknown. What is known is that some hatchery smolts do stray into other rivers. For example, hatchery smolts have been documented in the Vaki Riverwatcher camera at Daguerre Dam on the Yuba River and most likely originated from the Feather River. It appears that they do not remain upstream of the dam for long based on anecdotal information from angling and snorkel surveys, but their behavior below the dam is unknown. In the lower American River, some hatchery smolts appear to become "half-pounders", but it is unknown how much time they spend in the river versus in the Delta or Bays.

Introgression of the Nimbus Hatchery broodstock (originating from Eel/Mad rivers) with native *O. mykiss* populations may be occurring in some cases such as in the lower Calaveras and lower Tuolumne Rivers, based on recent genetic analyses (Pearse and Garza 2015). In at least one river, domestic rainbow trout appear to be escaping from their hatchery and/or introgressing with in-river spawning steelhead, as genetic analysis has documented their presence in the lower Merced River (Pearse and Garza 2015).

It is unclear whether the impacts of hatchery programs have changed in severity since the last review, but new information clearly suggests a loss of genetic diversity and population structure over time. Overall, impacts from hatcheries continue to be an ongoing threat to this DPS.

***Harvest Regulation Changes***

Over the last five years, in an attempt to minimize potential negative behavioral and genetic interactions with natural-origin steelhead, CDFW has increased the bag limit for hatchery steelhead on several popular rivers in the Central Valley. Following is a chronological rundown of changes in daily bag and possession limits that have occurred since March 1, 2010, which was the effective date of the 2010-2011 regulations cycle:

- Prior to March 1, 2010, the daily bag and possession limit in the Sacramento River system, including the lower Mokelumne River, was one steelhead in the bag and one in possession.

- Effective March 1, 2010, the steelhead daily bag and possession limit on the mainstem Sacramento and American rivers increased to a daily bag of two hatchery steelhead and a possession limit of four hatchery steelhead. On the Feather and Mokelumne rivers, the daily bag and possession limit remained at one hatchery steelhead in the bag, and one hatchery steelhead in possession.
- On March 1, 2013, the steelhead daily bag and possession limit on the Feather River increased to two and four hatchery steelhead, respectively.
- In the current regulations cycle with an effective date of March 1, 2016, the steelhead daily bag and possession limit remains at two and four, respectively, on the Sacramento, American, and Feather rivers; and at one and one, respectively, on the Mokelumne River.

Recent drought conditions have affected some steelhead fishing opportunities for this DPS. For example, the California Fish and Game Commission imposed an emergency fishery closure on the American River during February of 2014. The closure ended in April of that year.

The regulation changes reviewed above for steelhead fishing in the Central Valley suggest that there is the potential for a change in harvest dynamic over the past several years. The overall trend has been to incrementally increase the opportunity for harvest of hatchery-origin steelhead by increasing the daily bag and possession limits. The rationale behind encouraging more harvest of hatchery-origin steelhead is to minimize potential negative behavioral and genetic interactions with natural-origin steelhead. In addition, retention of hatchery-origin steelhead in the Central Valley is typically very low. Yet, the purpose of the hatchery programs is to provide a harvestable fishery resource. Thus, CDFW would like to see more of that resource utilized for its intended consumptive purpose.

CDFW performs angler surveys on Central Valley streams, and data from these surveys are used to estimate steelhead harvest and fishing effort, however these estimates do not appear to be regularly reported. Available data on angler retention of hatchery-origin steelhead suggest an increase in retention since the 2010-2011 regulatory cycle (Figure 10; CDFW 2015b). Mean retention from 2007-2008 through 2009-2010 was 13.1 percent, while mean retention from 2010-2011 through 2015-2016 was 20.4 percent. These means do not differ significantly, however (2-tailed $t$-test: $t = -1.82$, $p = 0.11$; no significant departure from normality in sample data; variances not significantly different). This analysis may possibly be improved by using expanded catch and retention data for each regulatory year.

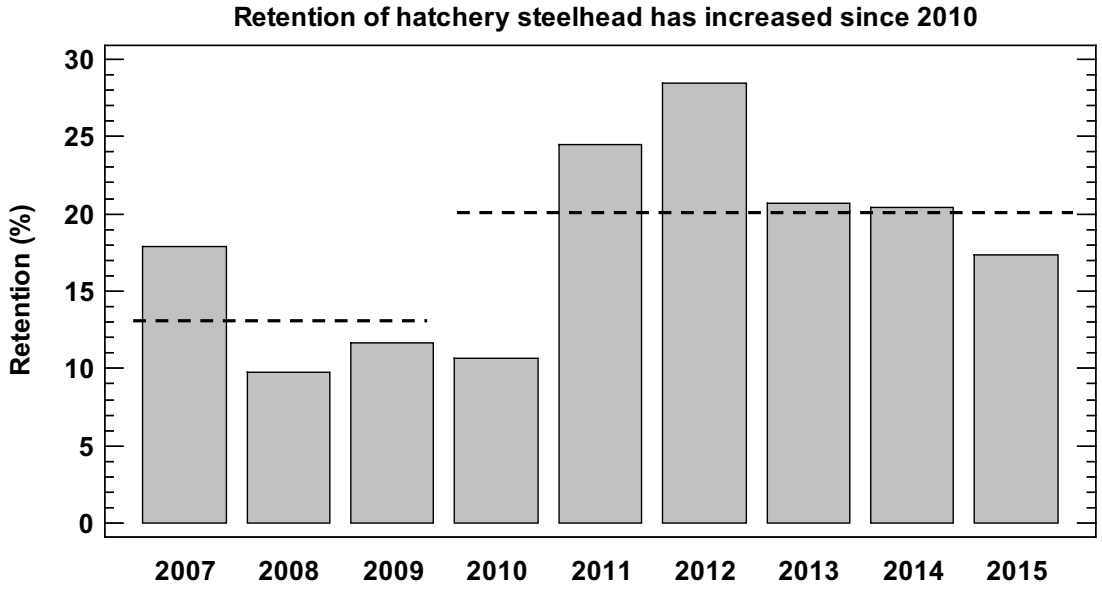


**Figure 10.** Trend in angler retention of hatchery-origin steelhead in the Central Valley steelhead sport fishery. Percent retention is based on unexpanded angler interview data. The dashed lines indicate mean retention prior to liberalization of the daily bag and possession limit (2007 - 2009 regulation years), and afterwards (2010 - 2015 regulation years). Each year shown is a regulations year that covers the period March 1 of the year shown through February 28 of the following year; *e.g.*, 2007 represents March 1, 2007 - February 28, 2008.

***Inconsistent Terminology***

The reporting of Chinook salmon escapement in the Central Valley is compiled in Grandtab, a databased published by CDFW that is widely used by management agencies. Because there is no centralized compilation of escapement data for steelhead in the Central Valley, and also due to the diversity of life-history types present in steelhead populations, the use of terminology to describe the different life-history forms of steelhead is inconsistent among Central Valley hatcheries. The half-pounder form is sometimes listed in escapement summaries, as are "shorts", "jacks", and sometimes even "immature males". This inconsistency and the use of slang terminology makes interpretation of escapement summaries and comparisons among the hatcheries difficult. Clearly defined, consistent nomenclature for all forms is needed, as well as standardized reporting among all four Central Valley steelhead hatcheries.

***Double-counting of hatchery fish***

Estimates of adult steelhead returns to the Feather River Hatchery are known to be biased high in some years due to individual fish returning to the hatchery shortly after their release and being counted a second time. Hatchery staff conducted a three year tagging study, which confirmed that this was occurring. Other hatcheries use some type of mark, such as a caudal clip, to mark all steelhead that have been counted as part of the escapement, which prevents double counting of adults in the same year. Marking of any fish that might be released in to the river should be a standard practice at every hatchery.

***Non-lethal method needed to determine the life-history of individual fish***

The management of steelhead in the Central Valley is currently hampered by the inability to conclusively determine if individual fish have made an ocean migration and can be considered to be steelhead under the ESA. Traditional scale analysis is a useful tool, and can provide information on life-history traits such as stream age, ocean age, age at first maturity, and repeat spawning, and can offer clues about potential anadromy or residency, but as this analysis simply examines relative changes in growth rates as a fish ages, even a large increase in growth does not always mean a marine life phase occurred.

The analysis of strontium to calcium (Sr/Ca) ratios in fish otoliths has become widely accepted as a reliable method to determine the migratory history of salmon, but due to the iteroparous life-history of *O. mykiss*, is limited to either specially permitted collections of juveniles or the opportunistic collection of carcasses, which are not nearly as common in *O. mykiss* populations as in Chinook populations.

There are a few studies that have examined the use of Sr/Ca ratios in scales of bull trout (Campbell *et al.* 2010, AFS Conference Paper) and in brook trout (Courtemanche *et al.* 2006). These studies found that Sr appears to be absorbed by the entire scale, not just the ocean growth increment, but that the elevated levels of Sr in the scales of known anadromous fish could be distinguished from that in scales of fish that had not been to the ocean.

That this method should be investigated to determine its effectiveness in Central Valley *O. mykiss*, and whether it can reliably distinguish between scales from known anadromous fish (such as hatchery adults or adults caught during CDFW adult steelhead monitoring program) and scales from known resident fish (such as fish from reaches above barrier dams). Ideally, otoliths and scales from the same fish, of both life-history types, would be compared to check on the level of agreement between the two sources. The Sr/Ca ratio in the otoliths (and potentially the scales) could then be used to assess the results of an anadromy/residency determination made using an analysis of growth patterns in the scales of those fish.

***Climate***

*2012-2015 Drought impacts on West Coast salmon and salmon habitat:* California has experienced well below average precipitation in each of the past 4 water years (2012, 2013, 2014 and 2015), record high surface air temperatures the past 2 water years (2014 and 2015), and record low snowpack in 2015. Some paleoclimate reconstructions suggest that the current 4-year drought is the most extreme in the past 500 or perhaps more than 1000 years. Anomalously high surface temperatures have made this a “hot drought”, in which high surface temperatures substantially amplified annual water deficits during the period of below average precipitation.

California's 2014 Water Year, which ended September 30, 2014, was the third driest in 119 years of record. It also was the warmest year on record. On April 1, 2015, CDWR measured the statewide water content of Sierra snowpack at five percent of average for April 1st. These levels are lower than any year in records going back to 1950. Annual runoff, which is calculated from

streamflow data, supplies many of our needs for water. Recent runoff estimates for California show measurements on par with 1930's and late 1970's droughts. Additionally, excessive groundwater pumping and aquifer depletion has resulted in land subsidence (sinking), which can cause permanent loss of groundwater storage in the aquifer system and infrastructure damage. Finally, dry, hot and windy weather, combined with dry vegetation and a spark - either through human intent, accident or lightning - can start a wildfire. Drier-than-normal conditions can increase the intensity and severity of wildfires. According to CalFire (www.calfire.ca.gov), in 2014, fire crews responded to 4,266 fires which burned over 191,000 acres (which was similar to the year-to-date average of 4,508 wildfires on 109,888 acres burned), and in 2015, there have been 6,284 fires and over 307,595 acres burned.

The combination of low precipitation and high temperatures favored elevated stream temperatures, and these have been documented to be extreme in some watersheds. The lack of cold water stored behind Shasta Dam, in combination with water release decisions, led to a loss of stream temperature control below Shasta Dam in September 2014. Stream temperatures that exceeded the 56 °F target in Sacramento River Chinook salmon spawning areas are thought to have contributed to 95 percent mortality rates for eggs and fry produced by spawning winter-run and fall-run Chinook salmon in in 2014.

*2014-15 exceptionally warm ocean conditions in the Northeast Pacific:* Much of the northeast Pacific Ocean, including parts typically used by California salmon and steelhead, experienced exceptionally high upper ocean temperatures beginning early in 2014 and areas of extremely high ocean temperatures continue to cover most of the northeast Pacific Ocean. A "warm blob" formed offshore of the Pacific Northwest region in fall 2013 (Bond *et al*. 2015). Off the coast of Southern and Baja California, upper ocean temperatures became anomalously warm in spring 2014, and this warming spread to the Central California coast in July 2014. In fall 2014, a shift in wind and ocean current patterns caused the entire northeast Pacific domain to experience unusually warm upper ocean temperatures from the West Coast offshore for several hundred kilometers. During spring of 2015, nearshore waters from Vancouver Island south to San Francisco mostly experienced strong and at time above average coastal upwelling that created a relatively narrow band (approximately 50 to 100 kilometers wide) of near normal upper ocean temperatures, while the exceptionally high temperature waters remained offshore and in coastal regions to the south and north.

*Expectations for future climate risks and impacts already in the pipeline for West Coast salmonids:* Adult Chinook salmon and steelhead returns for this fall (next winter) and for the next 2 to 3 years (depending on ocean residence times, maturing in 2015, 2016, 2017 and 2018) have likely been negatively impacted by poor stream and ocean conditions.

The expected effects of the 2015/16 tropical El Niño are likely to favor a more coastally-oriented warming of the Northeast Pacific this fall and winter that will persist into spring 2016. Next spring's ocean migrants will likely encounter an ocean strongly influenced by (if not dominated by) a subtropical food-web that favors poor early marine survival for both coho and Chinook salmon, though there is some evidence suggesting that Central Valley Chinook are more sensitive to these kind of changes than Klamath Basin Chinook salmon (O'Farrell and Mantua, unpublished analysis in prep).

NOAA's Climate Prediction Center (CPC) forecasts a 95 percent likelihood that the tropical El Niño event will persist through the winter of 2016, and they also predict a high likelihood for this event to alter North Pacific and Western US climate for the next few seasons. Seasonal climate forecasts issued by CPC in mid-September showed increased odds for typical El Niño fall/winter climate conditions that included above average fall and winter temperatures in West Coast states, and increased odds for a wet fall in Southern California, and a wet winter in all of California. Because El Niño events favor fall/winter periods with an especially strong Aleutian Low pressure anomaly centered in the Gulf of Alaska, the "warm blob" of exceptionally warm upper ocean temperatures off the Pacific Northwest coast is expected to weaken considerably. In contrast exceptionally warm ocean temperatures between Central, Southern, and Baja California and Hawaii are expected to remain elevated for the next few seasons. El Niño-related changes in wind and related ocean current patterns are expected to cause a coast-wide warming of upper ocean temperatures from Alaska south to Mexico, but confined to a relatively narrow band within 100 miles off the coast.

The strong El Niño event is predicted to substantially reduce the odds for a repeat of the extreme warmth of the past two winters, extreme precipitation deficit experienced in California the past 4 winters, and the extreme warmth of the offshore waters of the Northeast Pacific Ocean that have persisted for most of the past two years. The past two years have also seen persistence in the warm phase pacific decadal oscillation (PDO) pattern of North Pacific Ocean temperatures, and the warm phase of the PDO is likely to continue for another year because of its strong tendency for persistence and the expected El Niño influences on the Aleutian Low and related ocean currents in the next near future.

***Summary***

The Central Valley has experienced a severe drought during 2012 through 2015, which has likely reduced the already limited habitat quality and range for CCV steelhead during this period. The very low numbers of adults seen at the Nimbus Fish Hatchery during the last two years may be related to the drought, as water temperatures in the lower American River at Hazel Avenue reached the low 70's (°F), well above the 65°F limit set in the 2009 OCAP BO, likely impacting survival of wild steelhead parr. Steelhead populations in the Central Valley historically dealt with periodic drought. The concern is that at current low levels of abundance and productivity, some populations may go extinct during long dry spells, and the re-establishment of these populations may be difficult due to the degraded habitat conditions.

**Table 6.** Summary of how each listing factor for CCV Steelhead has changed since the 2011 status review.

| Listing Factor | Change since 2011 |
|---|---|
| Present or threatened destruction, modification, or curtailment of its habitat or range | Several fish passage and habitat restoration projects have been completed: American River AFRP projects, Antelope and Cow Creek passage improvements, *etc*. Battle Creek Restoration still in progress. |
| Overutilization for commercial, recreational, scientific, or educational purposes | Recent increases in the bag limit for hatchery-origin steelhead on several popular rivers in the Central Valley. Suggesting development of a FMEP, and limited angling closures to protect high density spawning areas. |
| Disease or predation | Unknown, but possibly worsened by drought. |
| Inadequacy of existing regulatory mechanisms | Reporting of hatchery returns still using inconsistent terminology. Other existing issues raised in this review include Nimbus Fish Hatchery broodstock replacement and need for a tool to determine individual life-history (residency versus anadromy). |
| Other natural or manmade factors affecting its continued existence | Ongoing drought and climate change likely resulting in adverse impacts. |

## 2.4 Synthesis

Information on the status of CCV steelhead consist of three types of data sources: direct adult counts, redd counts, and smolt counts. Adult data are the best source, but are complicated by inconsistent counting methods and reporting formats among the hatcheries and weirs. Redd counts represent valuable information from rivers where there are no dams or weirs to block adult migration, but the actual number of adults represented by each redd are unknown. Sampling of smolts in trawls and at the salvage facilities gives us an idea of relative productivity for a region and between hatchery and wild sources, but the survival of these smolts is unknown, and the counts cannot give us estimates of adult abundance. Implementation of CDFW's Central Valley Steelhead Monitoring Program should result in greater consistency in reporting of adult escapement and estimates of abundance that are currently lacking.

Hatchery production and returns are dominant over natural fish. Continued decline in the ratio between naturally produced juvenile steelhead to hatchery juvenile steelhead in fish monitoring efforts indicates that the wild population abundance is declining. Hatchery releases (100% adipose fin-clipped fish since 1998) have remained relatively constant over the past decade, yet the proportion of adipose fin-clipped hatchery smolts to unclipped naturally produced smolts has steadily increased over the past several years.

One continuing strength of the CCV steelhead DPS is the widespread distribution of this species throughout the rivers of the Central Valley. While most of the measured populations are small, steelhead can be found in most of the major rivers and streams of the Sacramento River, San Joaquin River, and eastside tributaries including the Mokelumne River and Calaveras River. Although there have been recent restoration efforts in the San Joaquin River tributaries, CCV steelhead populations in the San Joaquin Basin continue to show an overall very low abundance, and fluctuating return rates.

The widespread distribution of wild steelhead in the Central Valley provides the spatial structure necessary for the DPS to survive and avoid localized catastrophes. However, most wild CCV populations are not monitored, and may lack the resiliency to persist for protracted periods if subjected to additional stressors, particularly widespread stressors such as climate change and drought (NMFS 2011). The genetic diversity of CCV steelhead has likely been impacted by low population sizes and high numbers of hatchery fish relative to wild fish. The life-history diversity of the DPS is mostly unknown, as very few studies have been published on traits such as age structure, size at age, or growth rates in CCV steelhead.

The best chance for eventual delisting of this species is expansion of their range, as it was the creation of dams that has removed them from over 80 percent of their original spawning and rearing habitat in the Central Valley. This species has clearly benefited from the removal of Saeltzer Dam on Clear Creek, resulting in one of the strongest steelhead populations in the Central Valley. The Battle Creek Restoration Project, which will eventually open up 42 miles of high quality habitat to steelhead, is possibly the single greatest hope for creating a large, independent steelhead population in the Central Valley.

## 3.0 RESULTS

### 3.1 Recommended Classification:

Many watersheds in the Central Valley are experiencing decreased abundance of CCV steelhead. Dam removal and habitat restoration efforts in Clear Creek appear to be benefiting CCV steelhead as recent increases in non-clipped (wild) abundance have been observed. Despite the positive trend in Clear Creek, all other concerns raised in the previous status review remain, including low adult abundances, loss and degradation of a large percentage of the historic spawning and rearing habitat, and domination of smolt production by hatchery fish. Many other planned restoration and reintroduction efforts have yet to be implemented or completed, or are focused on Chinook salmon, and have yet to yield demonstrable improvements in habitat, let alone documented increases in naturally produced steelhead. There are indications that natural production of steelhead continues to decline and is now at a very low levels. Their continued low numbers in most hatcheries, domination by hatchery fish, and relatively sparse monitoring makes the continued existence of naturally reproduced steelhead a concern. We therefore conclude that CCV steelhead remain listed as threatened, as the DPS is likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

### 3.2 DPS Boundary and Hatchery Stocks

***Mokelumne River Hatchery***

Based on the history of egg transfers from out-of-basin sources (Nimbus Fish Hatchery and Feather River Hatchery) to the Mokelumne River Hatchery, the Mokelumne River Hatchery is currently excluded from the CCV steelhead DPS. However, this practice was discontinued for the Nimbus Fish Hatchery stock after 1991, and discontinued for Feather River Hatchery stock after 2008. Recent genetic studies (Pearse and Garza 2015) show that Mokelumne River Hatchery steelhead are now closely related to Feather River Hatchery fish, suggesting that there has been little carry-over of genes from the Nimbus stock.

## 4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

- Given the new genetic evidence described by Pearse and Garza (2015), we are recommending that steelhead originating from the Mokelumne River Hatchery be added to the CCV steelhead DPS, as Feather River Hatchery fish are considered to be a native Central Valley stock and are listed as part of the DPS.
- Continue implementation of CDFW's Adult Steelhead Monitoring Program. Conduct steelhead smolt monitoring in representative watersheds. This monitoring should include trapping, sampling, and tagging smolts at these locations to determine run timing, size and age at smolting, and smolt to maiden spawner survival rates.
- Hatchery and Genetic Management Plans should mandate that all Central Valley steelhead hatcheries collect a full set of biological data, including scale samples, length, weight, sex, origin, and state of maturity, from a subset of all returning fish. Hatcheries should be required to conduct studies of smolt survival using modern tagging methods such as PIT tags and/or acoustic tags. Terminology used to report different life-history forms should be standardized among all hatcheries.
- Develop FMEPs that:
    - Incorporate delisting criteria
    - Determine impacts of the fishery in terms of VSP parameters
    - Do not limit attainment of population-specific criteria
    - Annually estimate the commercial and recreational fisheries bycatch and mortality rate
    - Are specifically designed to monitor and track catch and mortality of wild and hatchery salmon and steelhead stemming from recreational fishing in freshwater and the marine habitats
    - Provide for adaptive management options as needed to ensure actual fisheries impacts do not exceed those consistent with recovery goals
- Implement the 2014 Central Valley Salmon and Steelhead Recovery Plan.
- Complete the Battle Creek Restoration Program.
- Improve passage for both juveniles and adults in all streams.
- Implement the RPAs pursuant to the 2009 OCAP BO which includes provisions for:
    - Replacement of the non-native Eel/Mad River broodstock at Nimbus Hatchery with a native strain
    - Provide fish passage above Nimbus and Folsom dams
    - Improve survival through the Delta

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**NATIONAL MARINE FISHERIES SERVICE**
**5-YEAR STATUS REVIEW**
CALIFORNIA CENTRAL VALLEY RECOVERY DOMAIN
*California Central Valley Steelhead DPS*

**Current Classification**: Threatened

**Recommendation resulting from the 5-Year Status Review:** Retain current ESA classification as threatened and retain current DPS boundary.

**REGIONAL OFFICE APPROVAL**:

Approve: Maria Rea Date: May 5, 2016

Maria Rea
Assistant Regional Administrator
California Central Valley Office
West Coast Region