Water Year 2024 Seasonal Report for Old and Middle River Flow Management

Appendix I - Central Valley Steelhead Cohort Report

Cover Photo: Chase Ehlo and Central Valley Steelhead at Stanislaus River

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Background

There remains significant uncertainty regarding California Central Valley (CCV) *Oncorhynchus mykiss* (*O. mykiss*) abundance, distribution, productivity, and life history diversity. This uncertainty is driven from limited data on both the resident (i.e., trout) and anadromous (i.e., steelhead) life-history forms of the species. Although there are CCV salmonid monitoring programs that have collected data on *O. mykiss*, the monitoring is not standardized, often designed for Chinook salmon (*Oncorhynchus tshawytscha*) populations, and inadequate for assessing population viability (Lindley et al. 2007). Data collected on *O. mykiss* are also mainly composed of information on steelhead because this is the only life-history form protected under the Endangered Species Act (ESA). The lack of information on resident trout adds to the underlying uncertainty of CCV *O. mykiss* populations and further complicates management of the species because both forms affect the species' population dynamics, life-history expression, and evolution. Lastly, the factors that drive *O. mykiss* to become anadromous may differ by tributaries but have large implications for the water operations of the Central Valley Project (CVP) and California State Water Project (SWP) the in the Sacramento-San Joaquin Delta (Delta).

Although we lack some key information on *O. mykiss* population status, demographics, and vital rates needed to generate an annual CCV steelhead juvenile production estimate (JPE), this existing data may offer some insight on the relative cohort sizes of *O. mykiss* at the tributaries and what potentially drove the high loss of CCV steelhead at the Delta export facilities in WY 2024.

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Red Bluff Diversion Dam

The United States Fish and Wildlife Service (USFWS) has conducted direct monitoring of juvenile Chinook salmon and *O. mykiss* passage at Red Bluff Diversion Dam (RBDD) on the Sacramento River since 1994 using rotary screw traps (RST; Voss and Poytress 2023). Below are *O. mykiss* catch summary numbers from RBDD monitoring, where brood year (BY) 2022 may be the most relevant. Most studies indicate that most Sacramento River steelhead spent two years rearing in freshwater before entering the ocean (Hallock 1989).

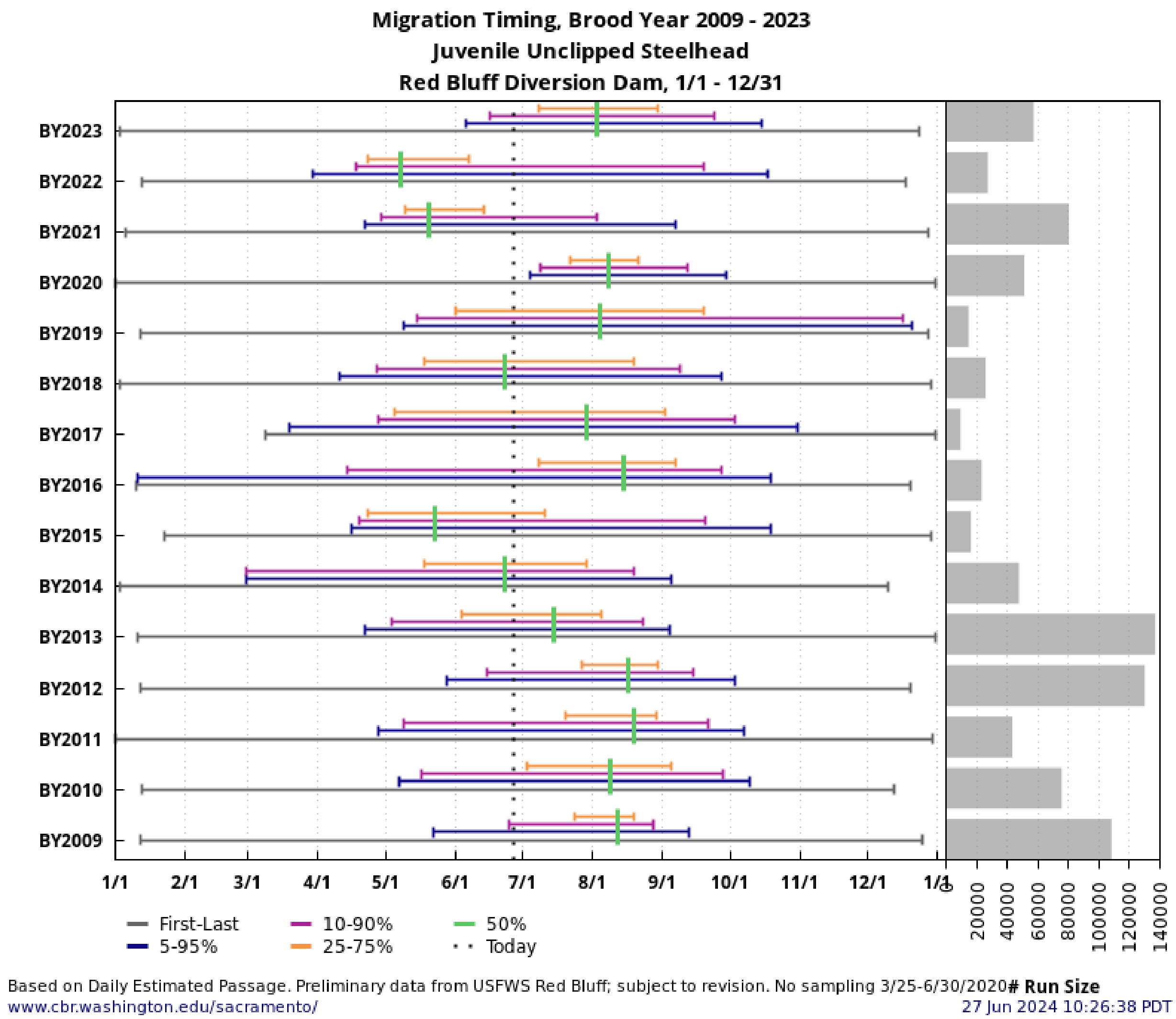

Figure 1. Annual timing (left) and total passage estimates (right) of juvenile O. mykiss at RBDD across years, acquired from SacPAS (see Voss and Poytress 2023 for methods). Previous research reported that up to 70% of outmigrating Sacramento River steelhead spent two years rearing in freshwater before entering the ocean (Hallock 1989). Thus, the majority of CCV steelhead in the Delta in WY2024 arriving from the Sacramento

basin are likely to be from brood year 2022 (age 2+). Note that RBDD samples primarily O. mykiss fry, which do not necessarily mature as steelhead (i.e., can potentially be comprised of mainly resident fish)

Sacramento and San Joaquin Rotary Screw Traps

Several RSTs are operated on the Sacramento (see Red Bluff Diversion Dam above), San Joaquin, and Feather Rivers and their tributaries. For the purposes of this document, the furthest downstream rotary screw trap catch data in the Sacramento River Basin was summarized from 2010-2024 including: Knight's Landing, Tisdale Weir, Lower Sacramento River on the Sacramento River, the Lower Feather River, and the Lower American River as these RSTs are most likely to observe the anadromous form of *O. mykiss* rather than the resident form. RST data from the San Joaquin was not summarized and is explained in further detail below. Because RST operation can be sporadic (i.e. some traps will operate some years and not others) the data was further summarized by dividing the total catch per water year by the number of traps operating that water year (Figure 2). While sample sizes and capture efficiency in rotary screw traps are generally low for steelhead compared to Chinook Salmon, there has been a general increase in capture numbers and WY 2024 had the highest capture of fish/trap since 2014 (Figure 2).

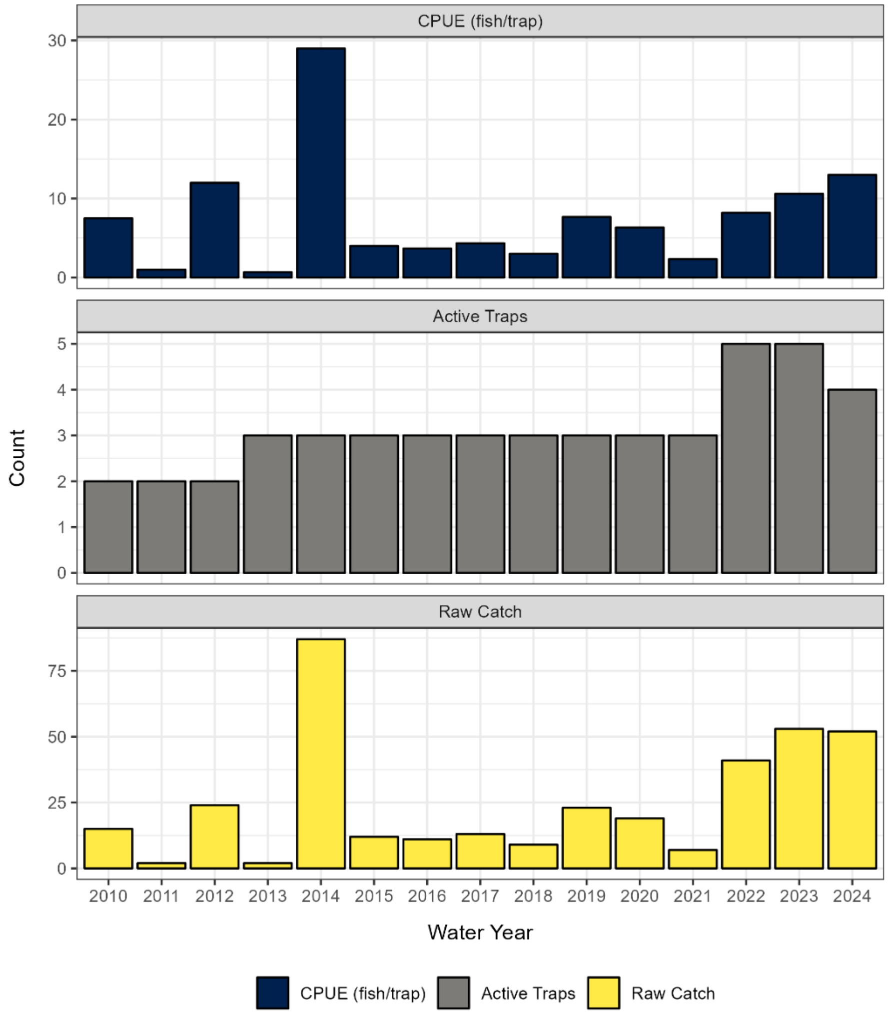

Figure 2. Summary of rotary screw trap (RST) data for Knight's Landing, Tisdale Weir, Lower Sacramento River on the Sacramento River, the Lower Feather River, and the Lower American River from water years (WY) 2010-2024. Raw Catch is the total number of steelhead captured for each WY, active traps is the number of RST locations operating for at least a portion of the WY, and CPUE (fish/trap) is the Raw Catch divided by the number of Active Traps. Datasets used for the construction of graphs do not indicate steelhead lifestage, but it's assumed that count data represents out-migrating steelhead smolts.

Stanislaus River Monitoring

While RSTs are operated in the San Joaquin Basin they are generally inefficient at sampling steelhead. For example, the Caswell RST on the Stanislaus River has only captured four steelhead smolts since 2020 and none in 2024. Another RST on the Stanislaus River located further upstream is more efficient at capturing steelhead, observing 25 steelhead smolts since 2020; however, that trap location was not in operation in WY 2024.

Nonetheless, other monitoring efforts on the Stanislaus River give perspective on steelhead abundance in the river. A juvenile monitoring study being implemented on the Stanislaus River with the intent of estimating abundance, survival, and other demographic information is utilizing close-kin mark-recapture analysis to estimate the number of spawners each year based on genetic analysis. Abundance estimates so far have been 4,496, 4,332, and 14,332 for 2021, 2022, and 2023 respectively (Zeug et al. 2024). This increase in abundance may account for an increase in outmigration and subsequent observed increase in delta salvage and loss estimates over the same time period.

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Sacramento-San Joaquin Delta

Abundance

As previously discussed there are currently no abundance estimates of CCV steelhead entering the Delta. However, regular monitoring, such as trawl data, may provide insight into annual trends of in delta steelhead abundance. Data from the Sacramento River Trawls at Sherwood, San Joaquin River Trawls at Mossdale, and Chipps Island Trawls were summarized from 2010-2024. Sherwood and Mossdale are meant to capture and represent steelhead entering the delta from the Sacramento River and San Joaquin River respectively, and Chipps Island is meant to represent steelhead exiting the delta into the ocean. Based on the summarized data, both raw catch and CPUE (fish/haul) were higher in 2024 than any other individual year since 2010. When broken down by location, both Chipps Island and Mossdale had a higher proportion of the catch in 2024 compared to Sherwood and higher catch than any other year, and Sherwood had the lower catch than the previous year, suggesting that most of the steelhead observed in the delta were of San Joaquin origin.

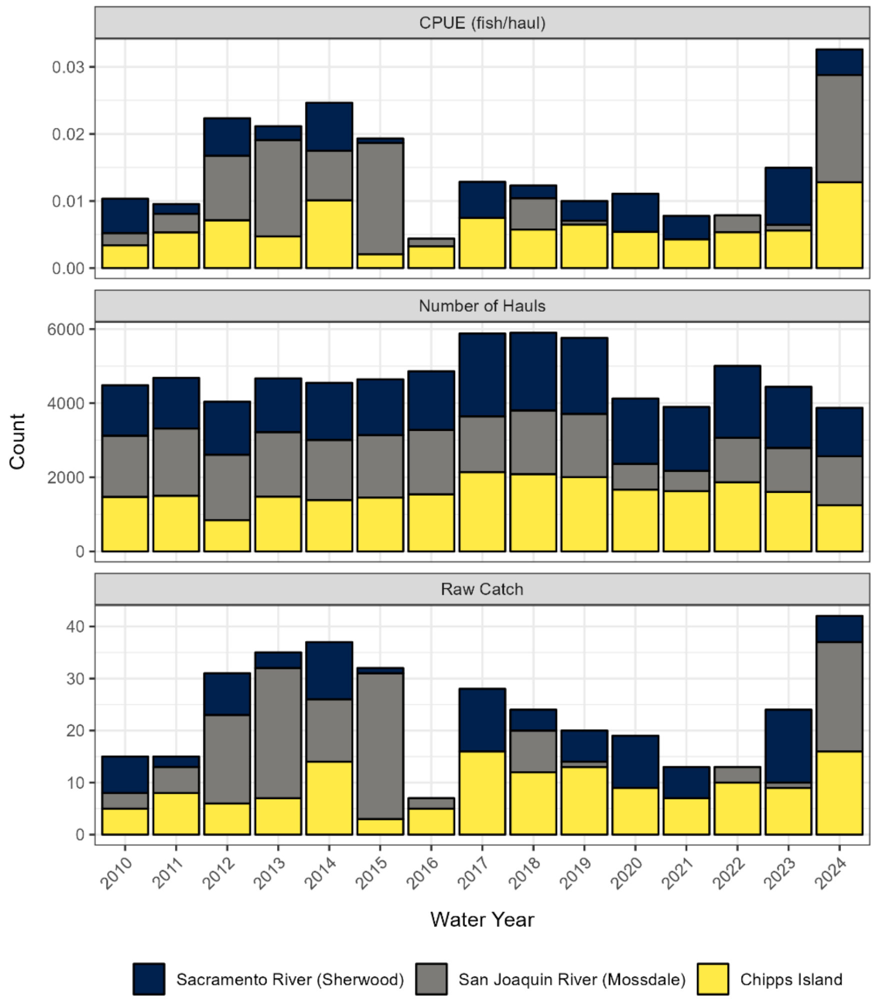

Figure 3. Summary of trawl data for Sacramento River at Sherwood, San Joaquin River at Mossdale, and Chipps Island for (WY) 2010-2024. Raw Catch is the total number of steelhead captured for each WY, number of hauls is the total number of trawl hauls in a given WY, and CPUE (fish/haul) is the Raw Catch divided by the number of hauls. Datasets used for the construction of graphs don't indicate steelhead lifestage, but it’s assumed that count data represents out-migrating steelhead smolts.

Survival

There are currently no real-time routing or survival estimates for CCV steelhead in the Delta. However, the Delta Survival, Travel Time, and Routing Simulation (STARS) model for winter-run Chinook Salmon can be leveraged to evaluate the routing and through-Delta survival of CCV steelhead in WY 2024 that are entering from the Sacramento basin. Methods for the winter-run Chinook Salmon STARS model can be found in Hance et al. (2021). Note that CCV steelhead is generally larger than young-of-year winter-run

Chinook Salmon, and thus are hypothesized to have higher survival than demonstrated in Figure 2. There are no STARS model equivalent for San Joaquin-origin salmon or steelhead. Nevertheless, similar to STARS model findings that Sacramento River flow and temperature largely determine survival, past studies on the San Joaquin basin indicate that survival for San Joaquin-origin steelhead is mainly driven by San Joaquin River flow and temperature (Salmon TWG 2024). Consequently, both San Joaquin and Sacramento River flows were high this year due to a wet winter suggesting that thru-delta survival of CCV steelhead in WY 2024 would be higher than drier years such as 2022.

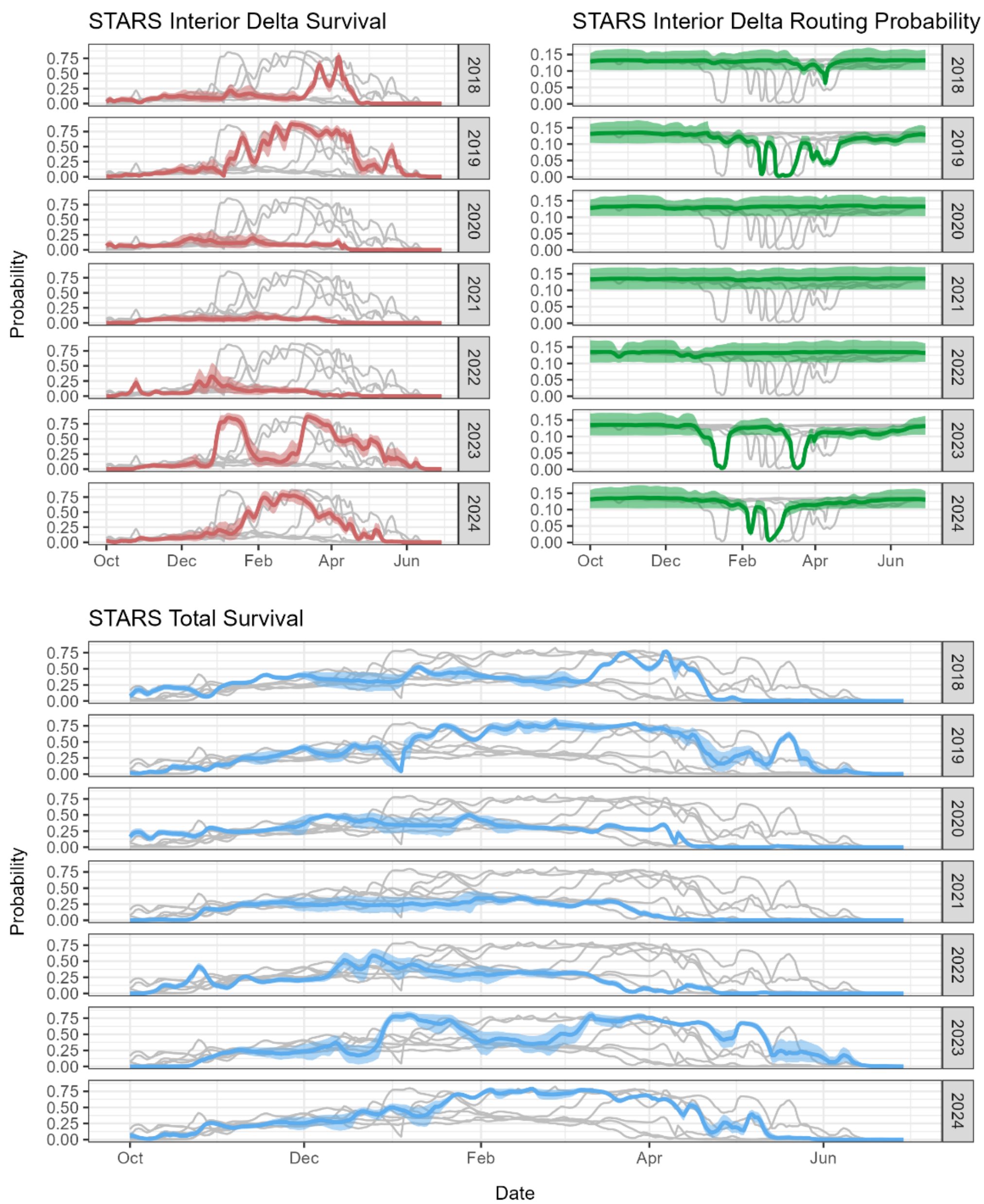

Figure 4. Juvenile winter-run Chinook Salmon STARS survival estimates by year for the interior Delta (top left), probability of routing to the interior Delta (top right), and overall through-Delta survival (bottom).

Size

The majority of wild and hatchery steelhead observed at the Delta salvage facilities in WY 2024 are between 200 and 300 mm fork length (Figure 3). This is the size distribution of age-1 clipped hatchery steelhead. However, wild CCV steelhead in the 200-300 mm size range are likely to be comprised of both age-1 and age-2 individuals. While the size distribution of CCV steelhead at salvage is similar to the sizes of age-1 O. mykiss at the American River where growth is faster, this is the typical size of age-2 steelhead from the Stanislaus River, Mokelumne River, Clear Creek, and Mill Creek (Satterthwaite et al. 2010, Eschenroeder et al. 2022, Lisa Elliott – unpublished scale analysis data). The size distribution of steelhead observed at salvage facilities in WY 2024 is similar to previous years (Figure 4).

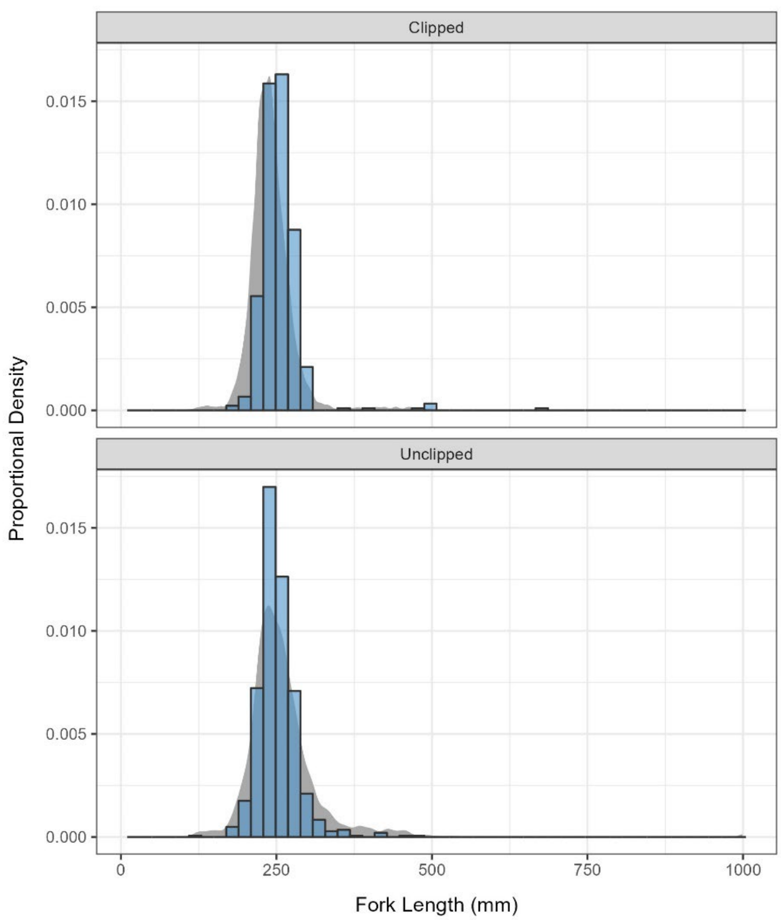

Figure 5. Fork length distribution of wild and hatchery steelhead collected at the CVP and SWP salvage facilities in WY 2024.

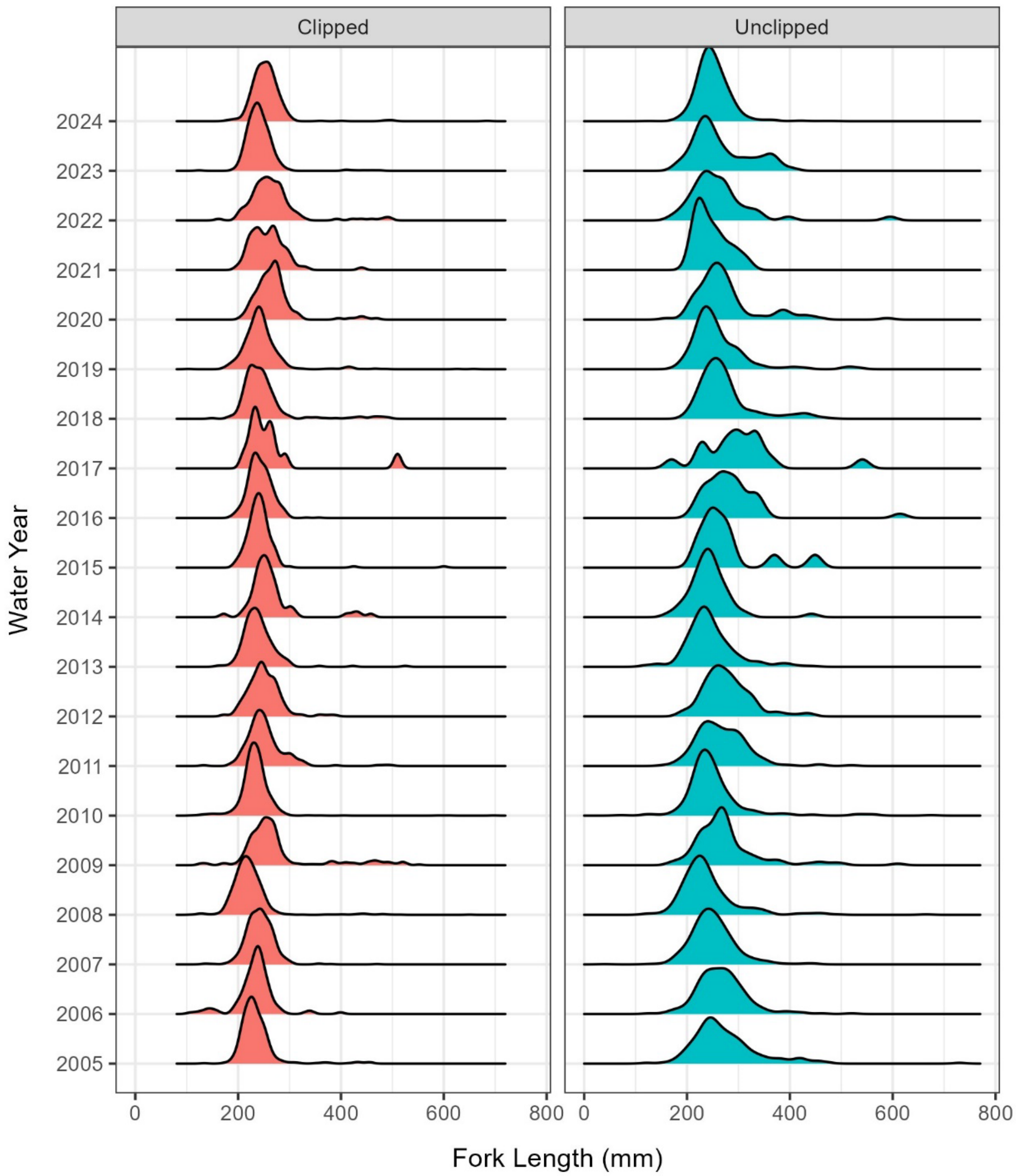

Figure 6. Smoothed fork length distribution of wild and hatchery steelhead collected at the CVP and SWP salvage facilities for WY 2005 to 2024.

Loss

Loss data at the Delta salvage facilities extends back to WY 1994, which allows for comparison of annual losses of unclipped (presumably wild) steelhead. In WY 2024, total annual loss of unclipped CCV steelhead was the highest since the 2008-2009 Biological Opinion (NMFS 2009) (Figure 6). Total annual loss of clipped steelhead in WY 2024 was also relatively high, but were comparable to a few years since 2009 (Figure 6).

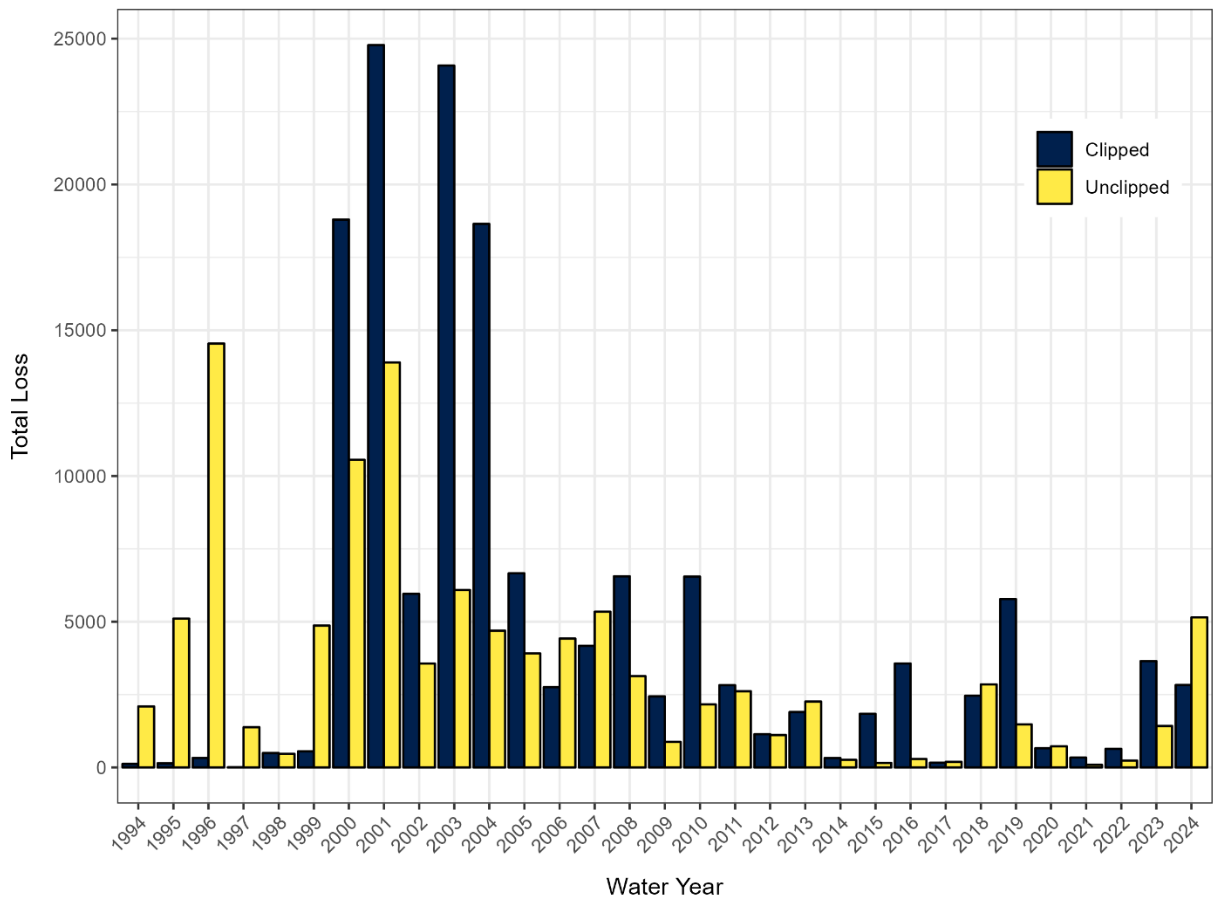

Figure 7. Total annual loss of unclipped and clipped CCV steelhead at the Delta salvage facilities (CVP and SWP combined) between WY 1994 to 2024.

The rate of cumulative loss in WY 2024 for unclipped steelhead was also more similar to years prior to 2009 than post-2009 Biological Opinion (Figure 7). Unlike other post-2009 years, loss of unclipped steelhead at the salvage facilities began to increase rapidly in February. This high rate of loss continued into March and mid-April despite OMR restrictions implemented in these months.

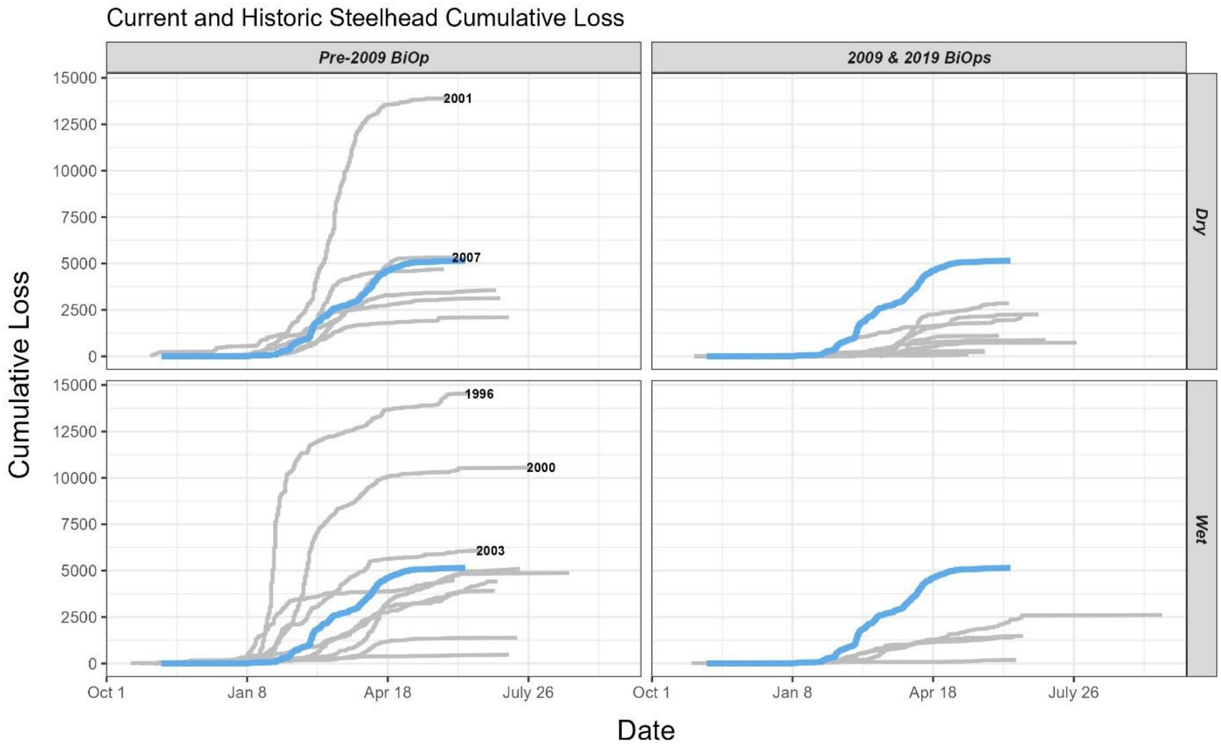

Figure 8. Cumulative unclipped steelhead loss plots for WY 2024 in blue relative to other water years. Labeled years are those years in which total salvage exceeded WY 2024.

Since a JPE for CCV steelhead has not been finalized, it is unclear what proportional of CCV steelhead that entered the Delta in WY 2024 was lost at the export facilities. In instances where the exact numbers of Chinook salmon or steelhead cannot be easily estimated, uniquely marked hatchery-origin fish can be released at a similar time, location, and size as the natural-origin fish. These hatchery fish can then be used as surrogates to represent take of the ESA-listed natural-origin fish. For example, under the NMFS 2019 BiOp for the CVP and SWP, coded-wire-tags are placed in late-fall run juvenile Chinook salmon to evaluate take of yearling spring-run Chinook salmon, an ESA-listed run, at the water project export facilities in the Delta (NMFS 2019).

Hatchery CCV steelhead loss relative to release numbers can offer some insight as to the proportion of fish lost at the export facilities (Table 1). Note, however, that this relies on the assumption that hatchery-origin fish survive at similar rates and exhibit similar behavior to natural-origin fish. There are also no hatchery releases in the San Joaquin River. As such, % loss numbers shown below may not be indicative of whatever may be occurring with San-Joaquin origin steelhead. In WY 2024, it is estimated that roughly 0.18% of hatchery steelhead was lost to the export facilities, which appears to be comparable to previous years. Acoustic tagged steelhead releases occurred in Mill and Deer Creeks which are tributaries to the Sacramento River, the Mokelumne River, and in the San Joaquin and Stanislaus Rivers. San Joaquin basin releases had higher proportions of the release groups salvaged than either Sacramento Basin or Mokelumne River releases, although overall survival was lower for the San Joaquin basin release groups (Table 2). While the proximity of the San Joaquin River releases to the CVP and SWP export facilities likely was a factor in the higher proportion salvaged, the proximity of the Mokelumne release did not result in a similar proportion of the release reaching, or being entrained at, the facilities.

Table 1. Annual loss of clipped juvenile steelhead at the salvage facilities and total hatchery juvenile steelhead release numbers for brood years 2016 to 2022. Note that release locations and dates, which vary by year, were not considered for this calculation. Hatchery release numbers were acquired from: CDFW hatchery releases- Calfish.org and USFWS hatchery releases data provided by Kevin Offill, 3/13/2024. Water facility loss data acquired from: SacPAS and reflects Water Year 2017 – 2024. *Brood Year 2023 only includes all fish released prior to 3/14/2024

Brood Year	Total Hatchery Steelhead Release Number (Brood Year)	Loss of clipped steelhead at the facilities (Water Year)	% Total Hatchery Number Lost to the Facilities	Water Year
2016	1,019,501	164.29	0.016	2017
2017	811,379	2,462.90	0.304	2018
2018	1,264,939	5,777.70	0.457	2019
2019	1,084,899	659.44	0.061	2020
2020	1,853,751	341.69	0.018	2021
2021	1,676,701	639.79	0.038	2022
2022	1,623,483	3,650.30	0.225	2023
2023	1,592,998	2,828.56	0.178	2024

Table 2. Acoustic tagged steelhead releases that occurred in Water Year 2024. Percent survival, percent of release group observed in salvage and percent observed entering the salvage facilities in Water Year 2024. Data available at CalFishTrack (noaa.gov).

Release Location	**% Survival**	**% observed at salvage1**	**% observed at Projects2**
Mill and Deer Creek Steelhead	39.6	0.0	0.0
Mokelumne Steelhead Exports Effects Study	42.2	0.4	0.8
SJR Steelhead March	12.8	8.7	36.7
SJR Steelhead April	11.4	6.3	26.0
SJR Steelhead May	9.3	5.5	15.7
Stanislaus Steelhead Fall Release	9.3	6.6	8.1
Stanislaus Steelhead Spring Release	1.1	1.1	3.9

1: % of Release observed in the CVP tank and Clifton Court Intake Canal 2: % of Release observed at CVP trash rack and Clifton Court Radial Gates (fish may or may not enter)

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