



# Clear Creek Technical Team Summary of Activities for Water Year 2023

## Table of Contents

CHAPTER 1. BACKGROUND.....	4
1.1 Clear Creek and the Technical Team.....	4
1.2 Active Members in Water Year 2023 .....	5
1.3 List of Clear Creek Technical Team Discussions.....	7
December 8, 2022 .....	7
March 16, 2023 .....	7
June 16, 2023 .....	7
September 14, 2023 .....	8
CHAPTER 2. CLEAR CREEK STATUS.....	9
2.1 Water Year Characteristics .....	9
2.2 Glory Hole Spill.....	10
CHAPTER 3. CLEAR CREEK MANAGEMENT ACTIONS.....	11
3.1 Minimum Base Flows.....	12
3.2 Water Temperature Management .....	13
3.3 Spring Attraction Flows.....	17
3.4 Channel Maintenance Flows.....	19
3.5 Fish Habitat Restoration and Management (“Gravel Augmentation”).....	20
CHAPTER 4. FISHERIES MONITORING .....	21
4.1 Juvenile Production Monitoring .....	21
4.2 Adult Escapement .....	25
Spring-run Chinook Salmon .....	25
Fall-run Chinook Salmon.....	26
Late-fall run Chinook Salmon .....	27
Steelhead .....	28
4.3 Separation Weir .....	28
4.4 Spawning Habitat Evaluations.....	28

4.5 Spawning Surveys.....	31
CHAPTER 5.References .....	33

# Acronyms and Abbreviations

ACID	Anderson-Cottonwood Irrigation District
BDA	Beaver Dam Analogue
BLM	Bureau of Land Management
BO	Biological Opinion
CCV	California Central Valley
CCRP	Clear Creek Restoration Program
CCTT	Clear Creek Technical Team
CDFW	California Department of Fish and Wildlife
CDWR	California Department of Water Resources
CLTO	Coordinated Long-term Operation
cfs	Cubic feet per second
CV	Central Valley
CVO	Central Valley Operations
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
ESA	Endangered Species Act
GRANDTAB	Grand Table (A CDFW compilation of Chinook Salmon escapement estimates in the Central Valley)
LCCFRP	Lower Clear Creek Floodway Restoration Project
LTO	Long-Term Operations
NMFS	National Marine Fisheries Service
NPS	National Park Service
PA	Proposed Action
PALS	Post Assisted Log Structure
RBFWO	Red Bluff Fish and Wildlife Office
Reclamation	U.S. Bureau of Reclamation
RM	River Mile
RPM	Reasonable and Prudent Measure
RWQCB	Regional Water Quality Control Board
SWP	State Water Project
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Service
WSRCD	Western Shasta Resource Conservation District
WY 2020	Water Year 2020

# BACKGROUND

## Clear Creek and the Technical Team

Since 1995, the Central Valley Project Improvement Act (CVPIA) and the CALFED Bay-Delta Program have undertaken anadromous salmonid habitat and flow restoration actions in Clear Creek. These actions have re-established Central Valley (CV) spring-run Chinook Salmon (*Oncorhynchus tshawytscha*) and California Central Valley (CCV) steelhead (*O. mykiss*) within the Clear Creek watershed (Figure 1). The Clear Creek Technical Team (CCTT) has been working together since 1996 to facilitate implementation of these CVPIA and CALFED restoration actions. Most issues and projects which the CCTT has facilitated involved physical habitat restoration of Lower Clear Creek (i.e., the stream downstream of Whiskeytown Dam to its confluence with the Sacramento River) and proposing flow recommendations. As of February 2020, the CCTT and Bureau of Reclamation (Reclamation)'s Central Valley Operations (CVO) office have performed Clear Creek management under the 2020 Record of Decision (ROD) for the Long-term Operations (LTO) of the CVP and SWP Biological Assessment and corresponding National Marine Fisheries Service (NMFS) Biological Opinion (WCRO-2016-00069; NMFS 2019).

Since being formally established in 1992 by CVPIA, the Clear Creek Restoration Program identified and implemented a variety of actions to improve salmon and steelhead habitat and the ecosystem on which these species depend. Past and continued actions include increased minimum flows, summer, and fall water temperature control through flow management, removal of a low-head dam, large-scale stream and floodplain restoration, gravel augmentation, spring and early summer pulse flows, and erosion control. The effects of these actions have been positive and have resulted in:

- greater than a four-fold increase in escapement of fall-run Chinook Salmon to Clear Creek (population estimate average = 1,749 from 1967 to 1991, and 8,249 from 1998–2022);
- re-established use of Clear Creek by Federal Endangered Species Act (ESA) listed threatened spring-run Chinook Salmon and threatened CCV steelhead;
- re-initiated sediment transport and stream channel movement processes, in some reaches, which help create and maintain fish habitat;
- an increase in the quality and quantity of streamside and floodplain riparian habitat; and
- increases in the amount of salmonid spawning habitat.

## Active Members in Water Year 2023

- Kristin Begun, NMFS
- Tricia Bratcher, USFWS
- Matt Brown, USFWS
- Leslie Bryan, Redding Electric Utility
- Charles Chamberlain, USFWS
- Alicia Herrera, Point Blue
- Amy Lyons, Dept. of Water Resources (DWR)
- Neal McIntosh, NMFS
- Ross Perry, Western Shasta Resource Conservation District (WSRCD)
- Derek Rupert, Reclamation
- Maureen Teubert, WSRCD
- Russ Weatherbee, National Park Service (NPS)
- Tobias Felbeck, Bureau of Land Management (BLM)

Additional people from various agencies and entities participate on a less frequent basis (e.g., Clear Creek Community Service District, Redding Rancheria, Horsetown-Clear Creek Preserve, Sacramento Municipal Utilities District, McBain and Associates, Graham Matthews and Associates, and U.S. Army Corps of Engineers).

CCTT meetings in WY 2023 were facilitated by Kerns & West (Zack Barr and Jackson Gould). They also produced CCTT meeting summaries.

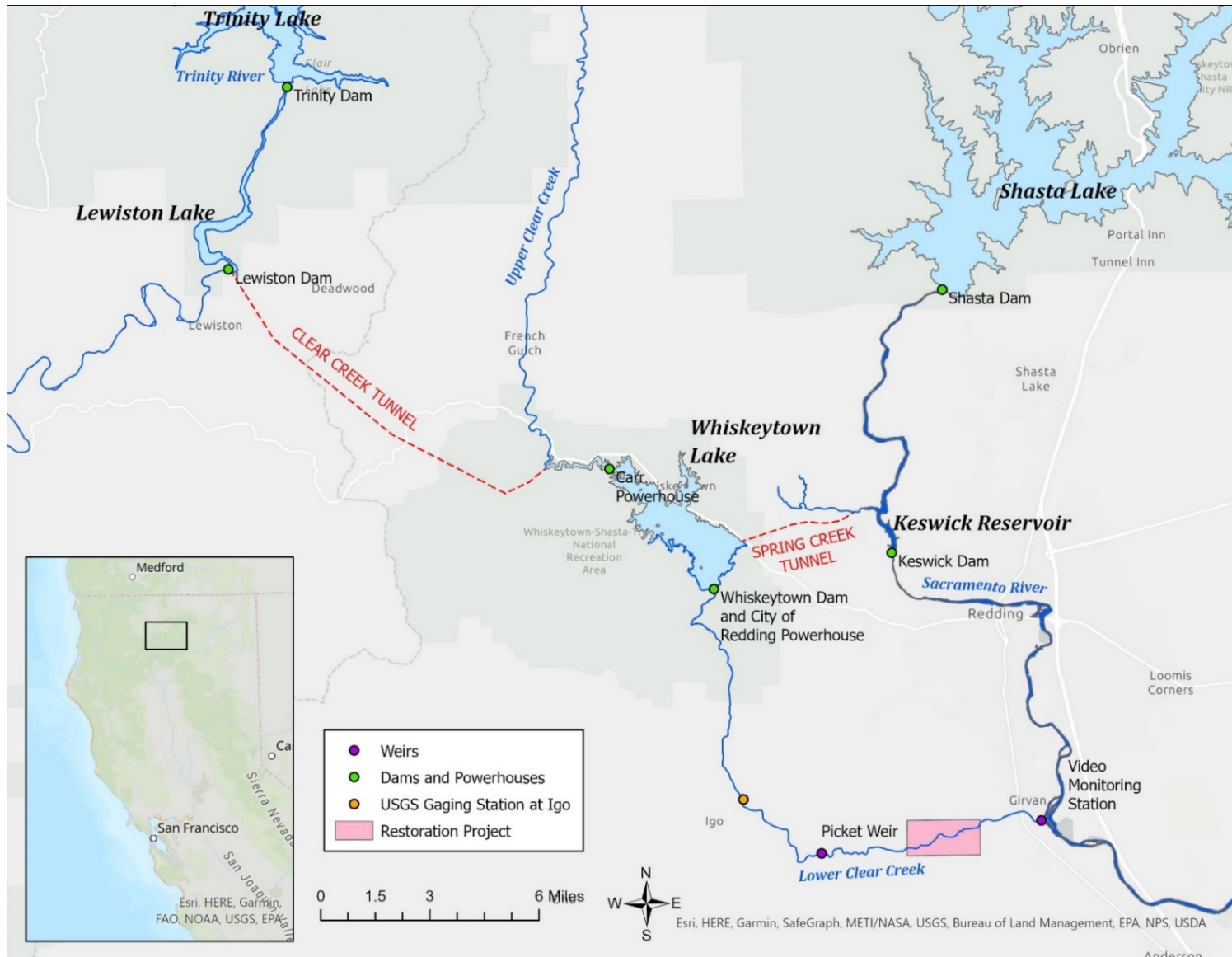


Figure 1. A map showing the location of Lower Clear Creek in Northern California, showing Trinity, Whiskeytown, and Shasta reservoirs and CVP facilities including weirs, dams and powerhouses, and the USGS gaging station at Igo.

## List of Clear Creek Technical Team Discussions

The following CCTT meetings, with an abridged list of discussions, occurred in water year (WY) 2023 (and since the 2022 CCTT Annual Report). The individual CCTT meeting notes provide considerably more detail than the synopsis here.

### December 8, 2022

- Planning for the WY 2023 Clear Creek flow and temperature management plan.
- WSRCD provided a presentation on the ACID syphon fish passage monitoring and potential State funding for drought issues.
- USFWS provided an overview of fish monitoring results, including adult spring run Chinook Salmon snorkel surveys, video station passage, spring run spawning, and fall run spawning.
- Discussion on the priority locations for future gravel augmentations.
- Preparations for a Clear Creek site tour.

### March 16, 2023

- USFWS provided a summary of fish monitoring efforts, including juvenile fish monitoring, spring run escapement estimate, kayak surveys, and rotary screw trap catch.
- Pacific States Marine Fisheries Commission staff gave a presentation on their steelhead/rainbow trout scale analysis project.
- Yurok Tribe and WSRCD staff provided updates on the Phase 3C and Phase 3B Completion projects, respectively.
- Reclamation staff provided a presentation on flow and temperature management, the significant gloryhole spill event, and the channel maintenance pulse allocation.
- Reclamation provided an update on the gravel augmentation sites following the spill event.

### June 16, 2023

- USFWS presented a Google Earth Tour at Sacramento River and Clear Creek Confluence and discussed channel downcutting and its habitat degrading influence in Clear Creek all the way up to the ACID siphon, on Onley Creek, and on the Sacramento River in the Shae Island restoration area.
- Reclamation and USFWS provided an update on the WY 2023 flows and management actions, including the geomorphic pulse, the two spring pulses, coldwater pool, and expected trans-basin deliveries.
- Reclamation's local and Technical Service Center staff provided a presentation on the Clear Creek SRH-2D modeling project, which evaluated the existing conditions and potential designs on the availability of fish habitat, particularly juvenile rearing habitat.
- WSRCD provided updates on their Phase 3B Completion and ACID Syphon projects.

- Reclamation provided an update on the CVP LTO reconsultation process. Discussion included details on changes to base flow regime, temperature management, and pulse flows.
- The USFWS provided a presentation on predicting patterns of spawning use by spring run Chinook Salmon in Clear Creek.
- Reclamation gave an update on the gravel augmentation project and showed CDFW's drone video of Clear Creek.

### **September 14, 2023**

- WSRC and their contractor provided a presentation on the ongoing ACID Syphon fish passage project. They noted the preliminary alternatives they have developed.
- Reclamation provided an overview of the WY 2023 flow and temperature management on Clear Creek.
- WSRC provided an update on the ongoing Phase 3B Completion project, which highlighted their revegetation efforts.
- Yurok Tribe staff discussed the performance of their Phase 3C revegetation efforts.
- USFWS provided a presentation on their Potential Spawning Area Mapping (PSAM), including changes in habitat distribution and abundance.
- USFWS provided an update on their fish monitoring efforts, including video monitoring weir, snorkel surveys, picket weir, and juvenile monitoring.
- A Clear Creek site tour date was selected. This tour is open to anyone interested in learning more about Clear Creek and its fish populations.

# CLEAR CREEK STATUS

## Water Year Characteristics

Water Year 2023 (WY 2023) marked a significant departure from the previous three consecutive years of drought conditions (2020-2022) for the Clear Creek watershed and Sacramento River Basin. The water year classification for Clear Creek is determined through the Sacramento River Water Year Type Index (SVI) and this has important implications for the management of Clear Creek (see CHAPTER 3). The SVI as of May 1, 2023, revealed an Above Normal water year type (registering an 8.89 SVI, at 90% exceedance). Clear Creek flows at the Igo gage (USGS 11372000) saw several larger flow events through the winter and spring months. For example, there were 24 days where the mean daily flows exceeded 800 cfs at the Igo Gage station (Figure 2). A Gloryhole Spillway event in January 2023, led to the highest flows of the water year, peaking at a mean daily flow of 6,463 cfs at the Igo gage. Additionally, 23% of days in this water year (84 of 365 day) exceeded a mean daily flow at Igo gage of 300 cfs or more (which includes the artificial pulse flows).

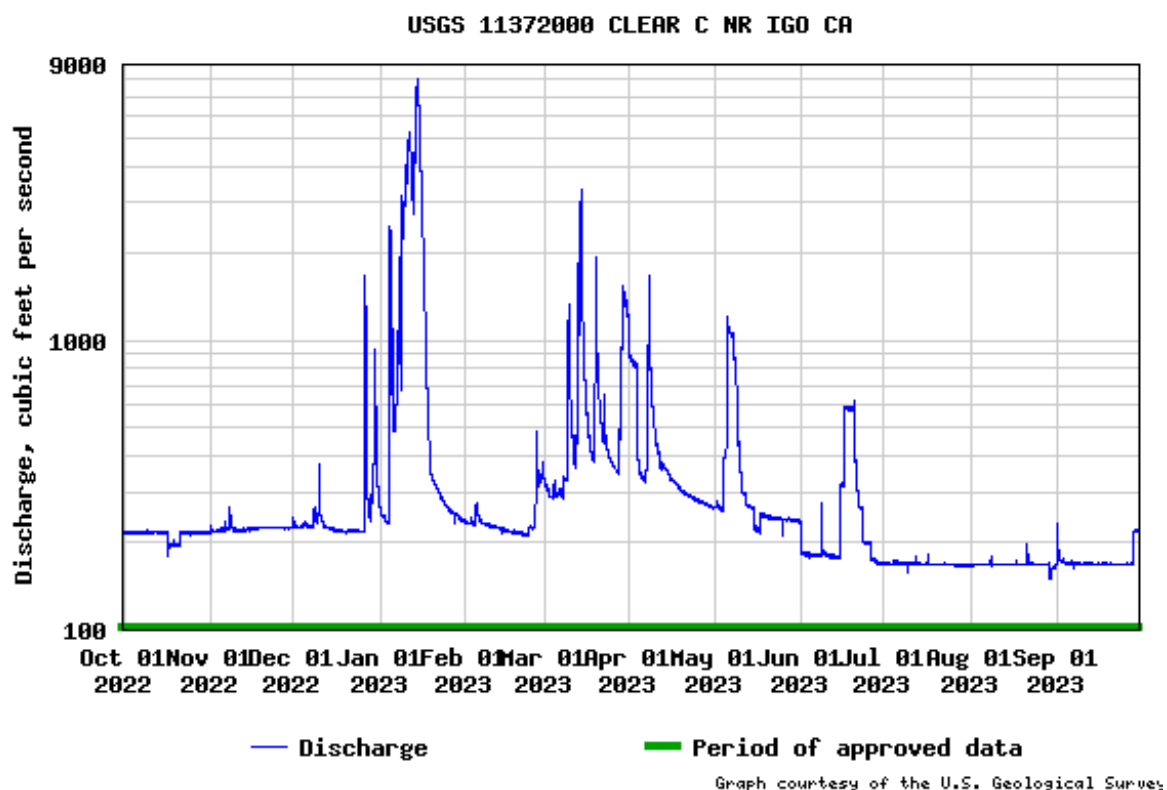


Figure 2. This figure is a line graph showing instantaneous flow on Clear Creek at Igo gage during water year 2023. The graph starts in October 1, 2022 and ends at September 30, 2023, with periods of elevated flows for the month of January, and again from March-July 2023.

## Glory Hole Spill

Uncontrolled releases can occasionally occur through Whiskeytown Dam's gloryhole spillway. These spills can have positive geomorphic impacts on Clear Creek which improve salmonid habitat.

In WY 2023, Whiskeytown Dam saw a 10-day uncontrolled spill event. During this event the instantaneous maximum flow reach 6,100 cfs, and a mean daily maximum of 4,774 cfs (Figure 3). One of the major contributors to this spill event, beyond heavy precipitation in the watershed, was that one of the two Spring Creek Powerplant's generators was down for repairs. This limited the amount of water that could be exported from Whiskeytown Reservoir. With the reduced export capacity, the Whiskeytown Dam spill event had an increased duration and magnitude of spill.

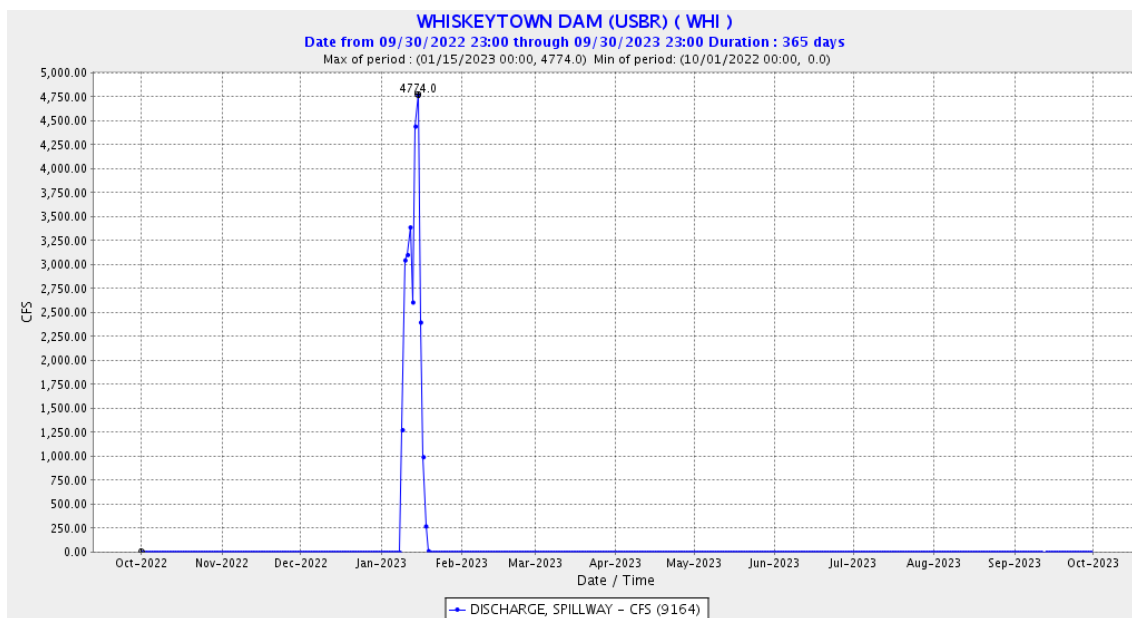


Figure 3. This figure is a line graph showing Whiskeytown Dam mean daily spillway discharge, measured in cubic feet per second (cfs), in water year 2023. The graph shows a spill event on January 15, 2023, with a peak of 4774 cfs.

The WY 2023 spill event made obvious geomorphic changes to Clear Creek. The spill event combined with natural tributary accretions to produce some of the highest flows seen on Clear Creek in recent memory (Figure 4). Nearly all of the gravel augmentation sites were fully evacuated of injected gravel. The location and size of gravel bars throughout the creek were changed, with some long-standing large bars being eroded and new ones formed. Large woody debris was transported and deposited into new locations. The high flows inundated much of the restoration reach, which happened to cause damage to irrigation equipment (Figure 5). Sand was deposited onto floodplains and transported further downstream.



Figure 4. An image showing the Clear Creek Gorge Overlook during the water year 2023 gloryhole spill event. Photo credit: C. Chamberlain (USFWS).



Figure 5. An image showing the Phase 3B restoration area during the WY 2023 gloryhole spill event. Photo credit: John Stafford (Yurok Tribe).

## **CLEAR CREEK MANAGEMENT ACTIONS**

The following sections highlight the management actions that occurred in Clear Creek during WY 2023 (October 1, 2022–September 30, 2023). Occasionally, additional information is included that covers other water years (i.e., WY 2024) for continuity, as some actions cross water years (e.g., water temperature management). With significant precipitation in the winter and spring 2023, the Water Year was designated as Above Normal (see Section 0) allowing for full spring pulse flow volumes to be utilized. Additionally, there was a Gloryhole spill event in

January 2023 (see Section 2.2), of sufficient magnitude and duration to trigger contingencies in the operations plan for reduced Clear Creek channel maintenance pulse flow volumes.

The following Table 1 is a summary of the management actions from WY 2023:

Table 1. Summary of WY 2022 management actions, Clear Creek

Management Action Item	Progress in WY 2023
Minimum Base Flows	Completed
Water Temperature Management	Implemented with some excursions
Spring Attraction Flows	Completed
Channel Maintenance Flows	Completed
Fish Habitat Restoration and Management ("Gravel Augmentation")	Not Completed
Fisheries Monitoring	Completed

## Minimum Base Flows

**Objective:** *Provide flows to allow for sufficient spawning, incubation, rearing, and migration for salmon and steelhead.*

**Action:** *“Reclamation proposes a minimum base flow in Clear Creek of 200 cfs from October through May and 150 cfs from June to September in all year types except Critical year types. In Critical years, Clear Creek base flows may be reduced below 150 cfs based on available water from the Trinity Reservoir.” (Section 4.10.2.4. of the PA).*

**Results:** In WY 2023, Clear Creek’s minimum base flows were met across the entire year with minor exception (Figure 6). Whiskeytown Dam can provide controlled releases of water to Clear Creek via the City of Redding powerhouse and/or the bypass. The bypass’s coarse level of control makes fine-tuning difficult. As such, CVO makes coarse bypass adjustments which are often followed up by several smaller adjustments for fine-tuning of flows. There are also measurement discrepancies between the Whiskeytown Dam flow gage and the USGS Igo gage, with preference placed on the Igo gage’s readings (due to the USGS’s continual gage calibrations). Several times in WY 2023, CVO made flow adjustments to ensure that flows at Igo gage remained consistent when switching between the powerhouse and the bypass releases, and deviances from minimum flow were corrected quickly.

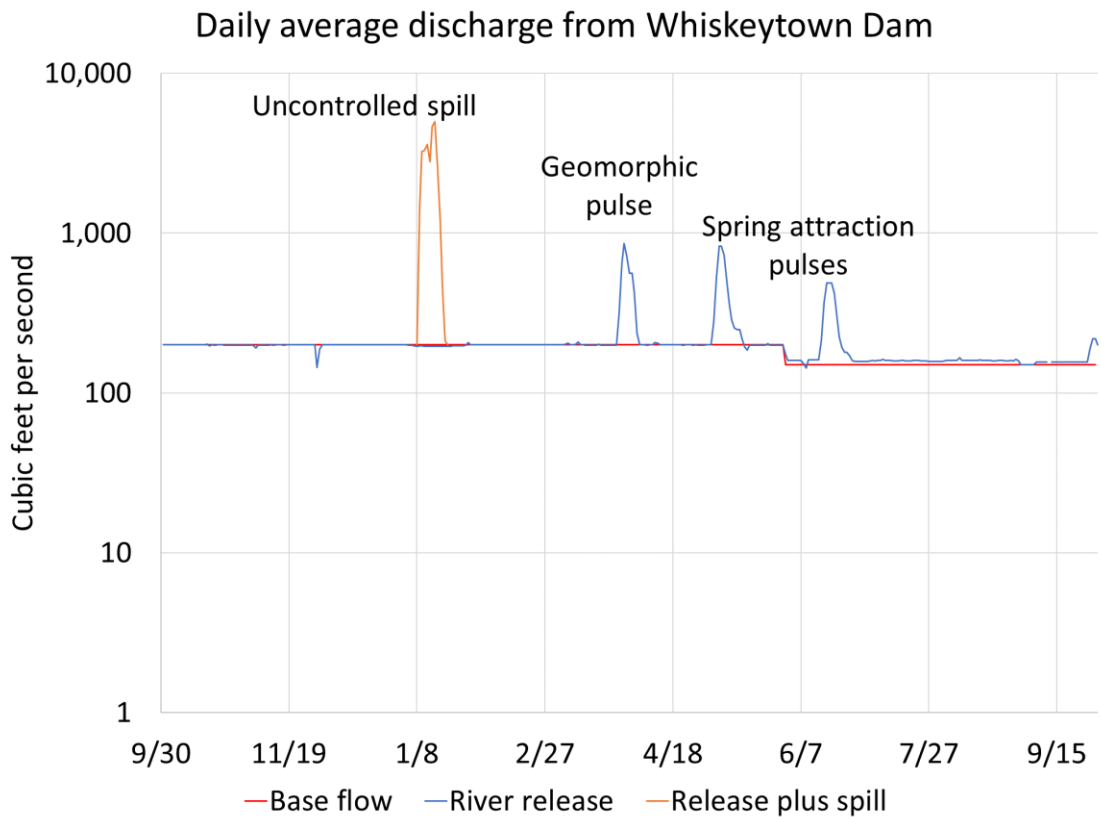


Figure 6. is a line graph showing the mean daily flow on Clear Creek during WY 2023, with base flow, river release, and releases plus spills plotted from 10/01/2022-09/30/2023. An uncontrolled spill event occurred in January 2023, followed by a geomorphic pulse event in March 2023, and multiple Spring attraction pulses in May and June 2023.

## Water Temperature Management

**Objective:** *To reduce thermal stress to over-summering steelhead and spring-run during holding, spawning, and embryo incubation.*

**Action:** *“Reclamation proposes to manage Whiskeytown releases to meet a daily average water temperature of:*

- 1) 60°F at the Igo gauge from June 1 through September 15; and*
- 2) 56°F at the Igo gauge from September 16 to October 31.*

*Reclamation may not be able to meet these temperatures in Critical or Dry water year types. In these years, Reclamation will operate to as close to these temperatures to the extent possible.”*

**Results:** In WY 2023, water temperature criteria were met at Igo gauge with varying levels of compliance. It was not possible to meet the water temperature criteria through all WY 2023, as Whiskeytown Reservoir's cold water pool was depleted, and additional water volume was not

available or would not have improved conditions. Even with the difficulties encountered, the mean daily water temperatures over the management season (June 1–October 31, 2023) remained below or near the criteria (within 1° F).

Water temperature management on Clear Creek is highly dependent of trans-basin deliveries of cold water from the Trinity River. Due to very low storage in Trinity Reservoir at the beginning of WY 2023, CVP prioritized maintaining its storage through the summer months. The Carr water diversions and Spring Creek tunnels were curtailed during much of WY 2023. While curtailed diversions can cause water temperature issues for Clear Creek, temperature criteria were met across the latter half of WY2023 (June 1 to September 30, 2023).

Mean daily water temperatures at Igo gauge remained below 60°F for 100% of the 107-day adult spring-run Chinook Salmon holding period (June 1–September 15, 2023; Table 2 and Figure 4). These temperatures were delivered to Clear Creek via a 50:50 mix of water from the upper and lower guard gates. This configuration was changed to 100% lower guard gates, providing the coldest possible water from Whiskeytown Reservoir, on September 15 in preparation for the 56°F criteria period.

The mean daily water temperature criterion transitions from 60°F to 56°F for the spawning/egg incubation period of September 16 to October 31. It is important to note that the 56°F mean daily water temperature criteria period crosses water years. In October 2022, the 56°F criteria were met for 3 of 31 days (10%). From September 16 through September 30, 2023, the 56°F criteria were met for 15 of 15 days (100%). Overall, in WY 2023, the 56° F criteria were met for 33 of 46 days (39%; Table 2). For Fall of 2023 (Calendar year), which crosses water years, the 56°F criteria were met 45 of 46 days (98%; Table 3, Figure 7).

The Oak Bottom Temperature Control Curtain remained in place and operational during WY 2023. This curtain discourages the mixing of cold water coming from the Carr Tunnels with the warm epilimnion of Whiskeytown Reservoir, helping to extend the cold-water pool resource through the summer months (Figure 8).

Table 2. Proportion of days that water temperatures at Clear Creek IGO gauge met the criteria, during water years. Note: that the September 16 to October 31 temperature criteria crosses water years in a single spawning season.

<b>Water Year</b>	<b>Spawning Temperature ≤56°F October 1 - 31</b>	<b>Holding Temperature ≤60°F June 1 – September 15</b>	<b>Spawning Temperature ≤56°F September 16 - 30</b>
2011	44% (12 of 27 days)*	100% (107 of 107 days)	0% (0 of 15 days)
2012	94% (29 of 31 days)	100% (107 of 107 days)	33% (5 of 15 days)
2013	81% (25 of 31 days)	100% (107 of 107 days)	93% (14 of 15 days)
2014	100% (31 of 31 days)	100% (107 of 107 days)	0% (0 of 15 days)
2015	0% (0 of 31 days)	100% (107 of 107 days)	0% (0 of 15 days)
2016	0% (0 of 31 days)	98% (105 of 107 days)	33% (5 of 15 days)
2017	6% (2 of 31 days)	100% (107 of 107 days)	100% (15 of 15 days)
2018	100% (31 of 31 days)	99% (106 of 107 days)	100% (15 of 15 days)
2019	87% (27 of 31 days)	99% (107 of 107 days)*	13% (2 of 15 days)
2020	94% (29 of 31 days)	99% (103 of 104 days)*	33% (5 of 15 days)
2021	94% (29 of 31 days)	100% (105 of 105 days)*	47% (7 of 15 days)
2022	97% (30 of 31 days)	93% (100 of 107 days)	20% (3 of 15 days)
2023	10% (3 of 31 days)	100% (107 of 107 days)	100% (15 of 15 days)

\* Data missing due to gage malfunctions or vandalism.

Table 3. Proportion of days that water temperatures at Clear Creek IGO gauge met the criteria, during calendar years.

<b>Calendar Year</b>	<b>Holding Temperature ≤60°F June 1 - September 15</b>	<b>Spawning Temperature ≤56°F September 16 – October 31</b>
2011	100% (107 of 107 days)	63% (29 of 46 days)
2012	100% (107 of 107 days)	65% (30 of 46 days)
2013	100% (107 of 107 days)	98% (45 of 46 days)
2014	100% (107 of 107 days)	0% (0 of 46 days)
2015	100% (107 of 107 days)	0% (0 of 46 days)
2016	98% (105 of 107 days)	15% (7 of 46 days)
2017	100% (107 of 107 days)	100% (46 of 46 days)
2018	99% (106 of 107 days)	91% (42 of 46 days)
2019	99% (97 of 98 days)*	67% (31 of 46 days)
2020	99% (103 of 104 days)*	72% (33 of 46 days)
2021	100% (105 of 105 days)*	80% (37 of 46 days)
2022	93% (100 of 107 days)	15% (7 of 46 days)
2023	100% (100 of 107 days)	98% (45 of 46 days)

\* Data missing due to gage malfunctions or vandalism.

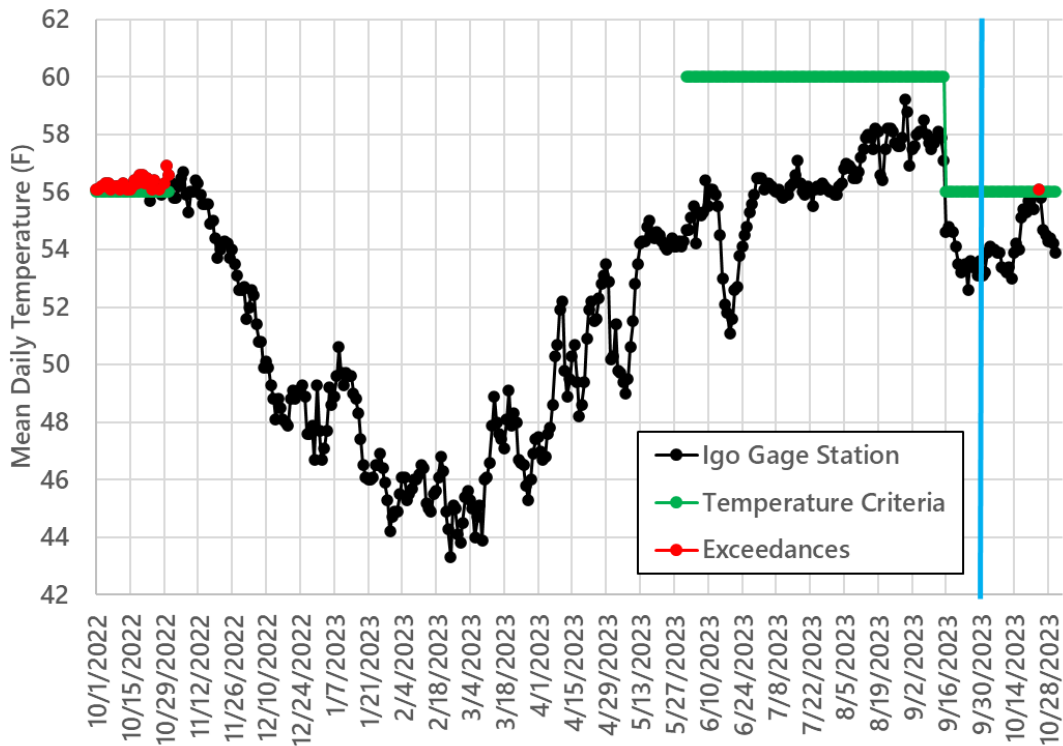


Figure 7. is a multi-line graph showing the mean daily water temperature on Clear Creek at the Igo gaging station in Water Year 2023 compared to the mean daily temperature criteria for spring-run Chinook Salmon holding (60°F from June 1 to September 15) and spawning and incubation (56°F from October 1 to 31 and September 16 to September 30). Red dots highlight days of temperature criteria exceedances, the blue line represents the end of WY 2023 (September 30), and green horizontal bars represent temperature criteria.

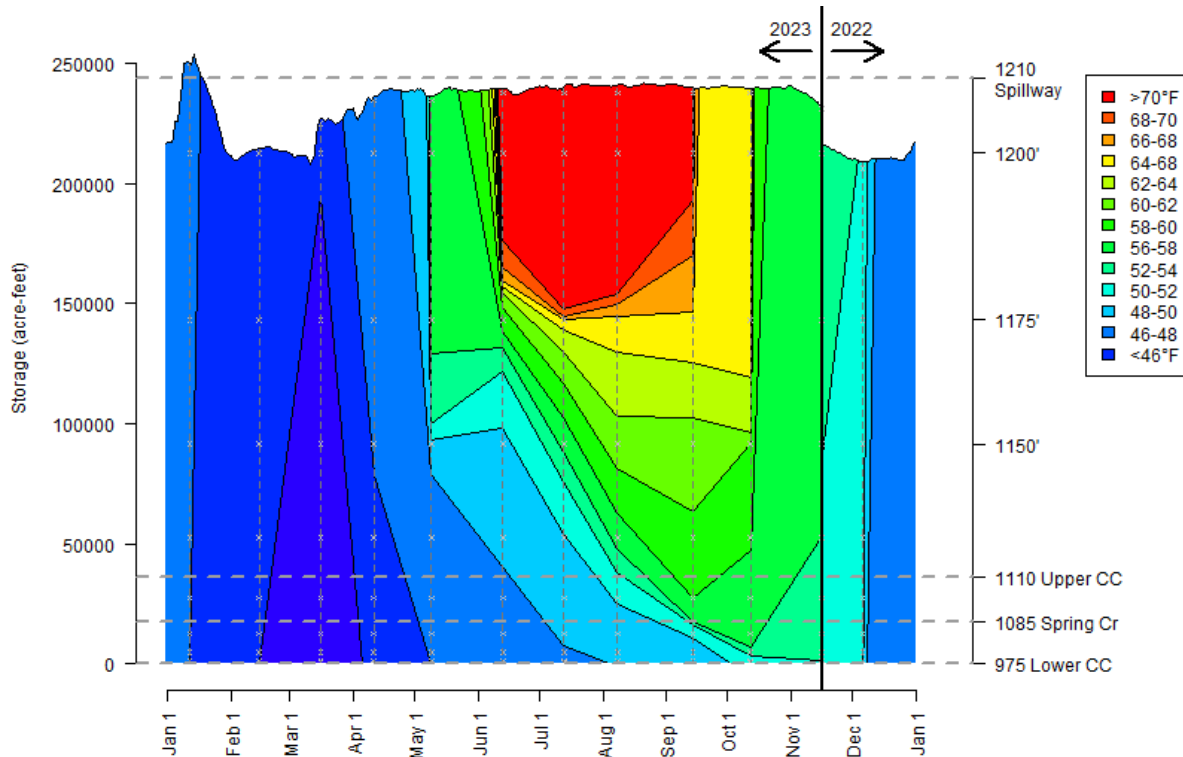


Figure 8. is a chart showing the isothermobaths from Whiskeytown Reservoir in 2023 from <46°F to >70°F as of November 16, 2023.

## Spring Attraction Flows

**Objective:** *Encourage spring-run migrate to upstream Clear Creek habitats for holding and spawning.*

**Action:** *“For spring attraction flows, Reclamation would release 10 TAF (measured at the release), with daily release up to the safe release capacity (approximately 900 cfs, depending on reservoir elevation and downstream capacity), in all year-types except for Critical year-types to be shaped by the Clear Creek Implementation Team in coordination with CVO. In Critical [Dry] years, Reclamation would release one spring attraction flow of up to the safe release capacity (approximately 900 cfs) for up to 3 days.” (Section 4.10.2.4. of the PA).*

**Results:** The CCTT produced an annual proposal for spring pulse flows in the winter of 2023 for implementation of the ROD’s flow requirements on Clear Creek (Figure 9). The CCTT deliberated on the timing and peak(s) of the pulse flow(s) actions and produced a set of pulse flows for different water year designations with their formal proposal to CVO. The intent of the spring pulse flow(s) is to encourage spring-run Chinook Salmon to enter Clear Creek and ascend into the upstream-most reaches of the system.

Adult spring-run Chinook Salmon enter Clear Creek from late April through early July, with peak migration in May and June. In WY 2023, two pulses provided from Whiskeytown Dam were developed to coincide with previously observed peak adult spring-run Chinook Salmon migration into Clear Creek and replicate the spring-run Chinook Salmon attraction success observed during past pulse flows.

While the Sacramento River Index for water year 2023 eventually achieved a “Above Normal” classification, the 90% exceedance forecast for the year had it at a “Dry” designation as of the February 1 forecast, “Below Normal” as of the March 1 forecast, and “Above Normal” as of the April 1 and May 1 forecasts. With the final “Above Normal” water year type determination, 10,000 acre-feet of water volume was available to use towards spring pulse flows in Clear Creek.

Two spring pulse flows were released in WY2023. The first pulse will begin on May 4 and reached a peak of 800 cubic feet per second May 5. Flow rates was reduced to 200 cfs by May 15. The first pulse utilized 5,390 acre-feet of water volume. The second pulse begin on June 15 and reached a peak of 500 cfs of June 16. The second pulse ended on June 26 with Whiskeytown Dam releases dropping to 150 cfs summer base flows. The second pulse utilized 3,050 acre-feet of water volume. Combined the two pulses utilized 8,440 acre-feet of water, considerably less than the 10,000 acre-feet limit.

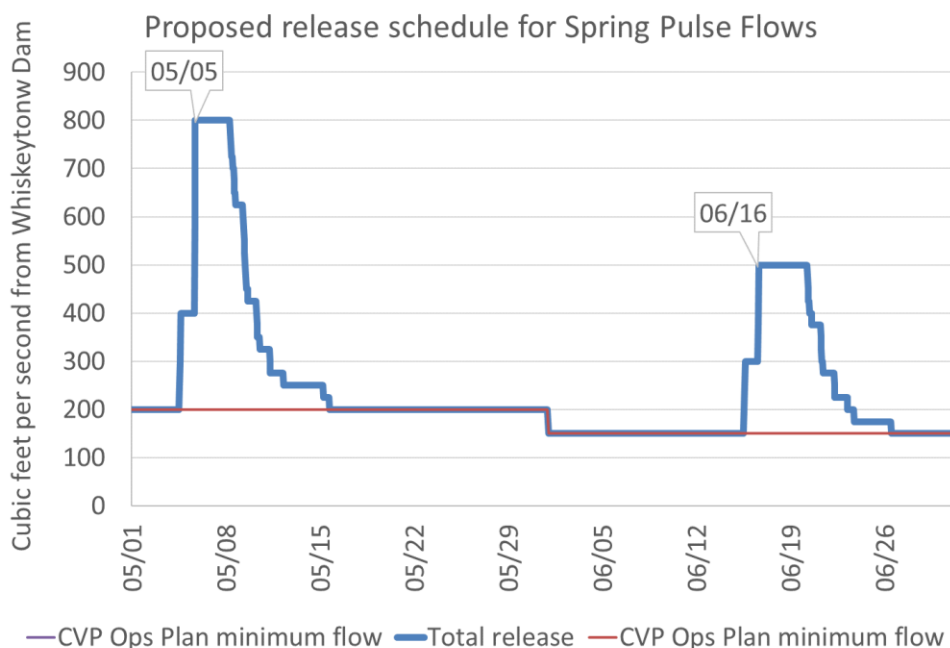


Figure 9. is a multi-line graph of the proposed release schedule for 2023 spring pulse flow from Whiskeytown Dam, including CVP Ops Plan minimum flow, and total release. The pulse flows would start with a larger pulse on May 5th of 800 cfs, and a second pulse on June 16th of 500 cfs.

The rapid increase in flows associated with any pulse flow action on Clear Creek can be disturbing to unknowing public users. The CCTT has previously received criticisms from users that were caught unaware of the flow changes. As such, the CCTT aims to improve communications with the public about all future pulse flows. The CCTT produced posters describing the pulse flow and timing. These posters were then posted at all the popular access points and trailheads on Clear Creek. Also, the CCTT has added a small flow bench (300 or 400 cfs) to the pulse flow to act as a warning that flows are increasing. The cold water and increased turbidity occurring with this flow bench should discourage recreation in the creek.

Snorkel surveys were conducted by the USFWS before and after each pulse flow to help determine the response of spring-run Chinook Salmon to the flow action. These surveys provided

an index of abundance of adult spring-run Chinook Salmon and spatial information on the distribution of adults within Clear Creek (see CHAPTER 1).

## Channel Maintenance Flows

**Objective:** *Provide pulse flows that will induce desirable geomorphic processes, which build and maintain fish habitat.*

**Action:** *“Reclamation would release 10 TAF from Whiskeytown, with a daily release up to the safe release capacity, in all year-types except for Dry and Critical year-types (based on the Sacramento Valley index) to be shaped by the Clear Creek Implementation Team in coordination with CVO. Pulses would be scheduled with CVO. No channel maintenance flows would be scheduled before January 1. For each storm event that results in a Whiskeytown Gloryhole spill of at least 3,000 cfs for 3 days, Reclamation will reduce the channel maintenance flow volume for this year or the following year by 5,000 acre-feet. If two Gloryhole spills occur that meet this criterion in a year, additional channel maintenance flows would not be released in that year. In Critical years, Reclamation would release one spring attraction flow of up to the safe release capacity (approximately 900 cfs) for up to 3 days and would not release any channel maintenance flows. Reclamation could instead, or in addition, use mechanical methods to mobilize gravel or shape the channel if needed to meet biological objectives.” (Section 4.10.2.4. of the PA).*

**Results:** The CCTT developed a plan for implementation of geomorphic flows in WY 2023 (Figure 10). Due to the stipulations within the LTO Proposed Action, and the Gloryhole spill event, the total water volume for the pulse was reduced from 10,000 acre-feet to 5,000 acre-feet. This marked the first time that a channel maintenance pulse was implemented on Clear Creek.

Within the CCTT’s WY 2023 flow proposal, the channel maintenance pulse was not given a specific release schedule. Rather, the plan was to release the pulse with a significant precipitation event in hopes that the pulse and tributary accretions would combine to produce flows capable of causing geomorphic evolution.

In late March 2023, a significant precipitation event was forecasted to occur, and it triggered the channel maintenance pulse. The pulse began on March 28 and ended on April 5. The implementation of the pulse with a precipitation event was successful in increasing the peak flows downstream. The peak instantaneous flow at Igo reached a reported 1,540 cfs on March 29, which was 700 cfs above the peak 840 cfs dam release as measured at the dam.

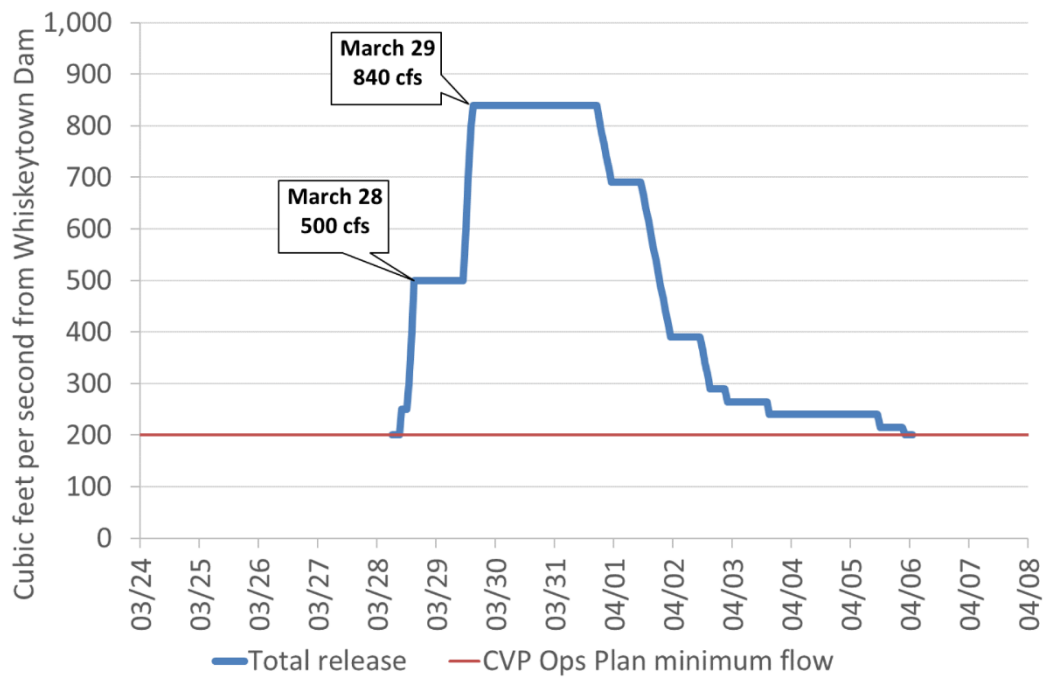


Figure 10. is a multi-line graph of the proposed release schedule for 2023 channel maintenance pulse flow from Whiskeytown Dam and show total release and CVP Ops Plan minimum flow. This pulse flow was scheduled to begin on March 28 and end on April 6 to coincide with a significant precipitation event.

## Fish Habitat Restoration and Management (“Gravel Augmentation”)

**Objective:** *Enhance and maintain previously degraded habitat for anadromous salmonids, through the placement of desirable materials such as coarse sediment (“gravel”) and large wood.*

**Action:** *“Reclamation and DWR propose to continue channel maintenance under the Clear Creek Restoration Program.”*

**Results:** In WY2023, the Fish Habitat Restoration and Management Project (a.k.a., “gravel augmentations”) was not completed. This project should be a priority for implementation in WY 2024, as the Gloryhole spill event fully evacuated all the gravel augmentation sites on Clear Creek.

WY 2023 did mark the final stages of both the Lower Clear Creek Floodway Rehabilitation Project Phase 3C and Phase 3B-Completion projects. Both projects finished their final year of re-vegetation irrigation. The Phase 3C project is now considered fully completed, and no further work is anticipated. The Phase 3B-Completion project will reach its end in WY 2024, with site clean-up and invasive plant removal.

# FISHERIES MONITORING

**Objective:** *Monitor and evaluate the response of fisheries to the restoration actions occurring in Lower Clear Creek.*

**Action:** *The USFWS monitors salmonid habitat and adult and juvenile life history of salmonid populations in Clear Creek. The CDFW monitors the escapement of fall-run in Clear Creek.*

## Juvenile Production Monitoring

The USFWS operates rotary screw traps at two locations on Clear Creek, at RM 8.4 (Upper Clear Creek [UCC]) and RM 1.7 (Lower Clear Creek [LCC]). The UCC trap produces a juvenile spring run Chinook Salmon passage index (JPI), while the UCC trap captures all anadromous salmonid species of Clear Creek. The juvenile passage indices for fall run Chinook Salmon, late-fall run Chinook Salmon, and *O. mykiss* (Rainbow Trout/steelhead) are calculated from catch at the LCC trap. In WY 2023, the two traps were on the water and operating from November 15, 2022, to June 30, 2023. The preliminary brood year 2022 juvenile passage estimates at LCC were: fall run Chinook Salmon was 790,793 fish (Figure 11), *O. mykiss* was 28,471 fish (Figure 12). The adjusted passage index for redds below LCC was 32,430. The brood year 2022 juvenile spring run Chinook Salmon passage index at UCC was 51,020 fish (Figure 13). There were no redds observed above the separation weir and below the UCC trap. The UCC trap did not operate for part of the spring run Chinook Salmon out-migration period, so the JPI is most certainly lower than the actual passage (Figure 14). Similarly, the LCC trap did not operate for parts of the fall run Chinook Salmon out-migration (Figure 15). The USFWS's Clear Creek Brood Year 2022 Juvenile Report is in progress.

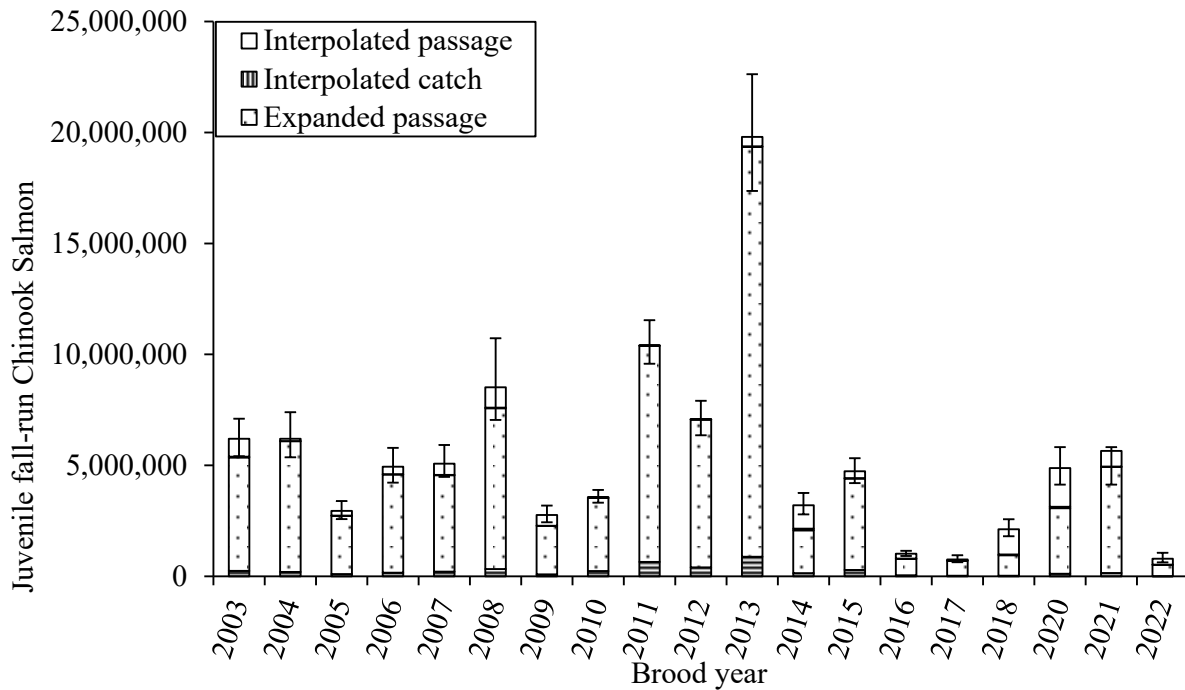


Figure 11. is a box and whisker graph showing the annual passage indices of juvenile fall run Chinook Salmon by brood year at the lower Clear Creek rotary screw trap from 2003 to 2022 including interpolated passage, interpolated catch, and expanded passage with 2013 showing the highest passage numbers, and no discernible trends.

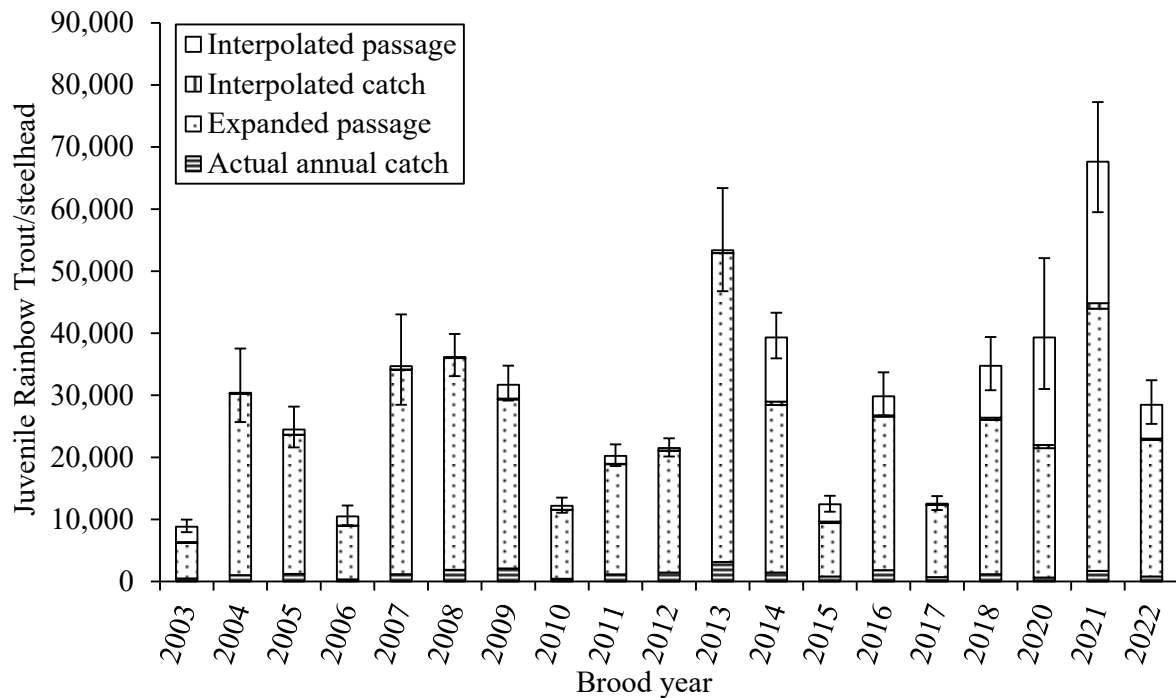


Figure 12. is a box and whisker graph showing the annual passage of juvenile Rainbow Trout/steelhead by brood year at the lower Clear Creek rotary screw trap from 2003 to 2022

2022 including interpolated passage, interpolated catch, expanded passage, and actual annual catch. Brood year 2021 shows the highest level of passage, with no discernible trends.

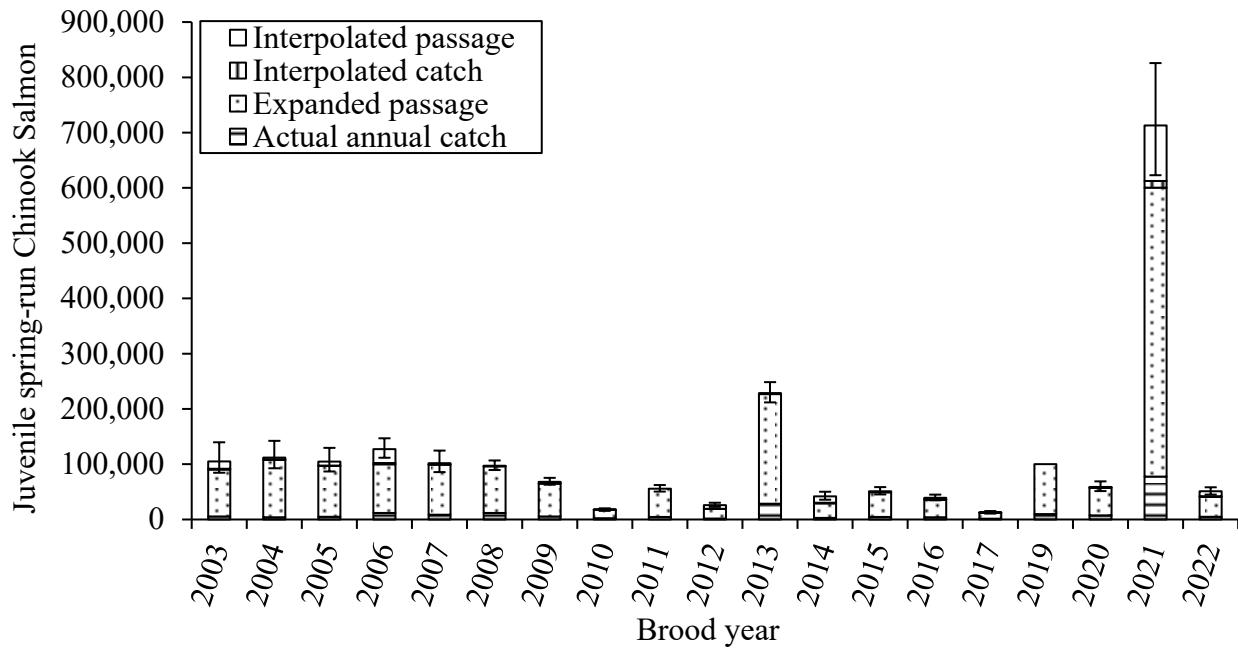


Figure 13. is a box and whisker graph showing the annual passage of juvenile spring run Chinook Salmon by brood year at the upper Clear Creek rotary screw trap from 2003 to 2022 including interpolated passage, interpolated catch, expanded passage, and actual annual catch. Brood year 2021 shows the highest total fish passage, all other years show comparatively low fish passage.

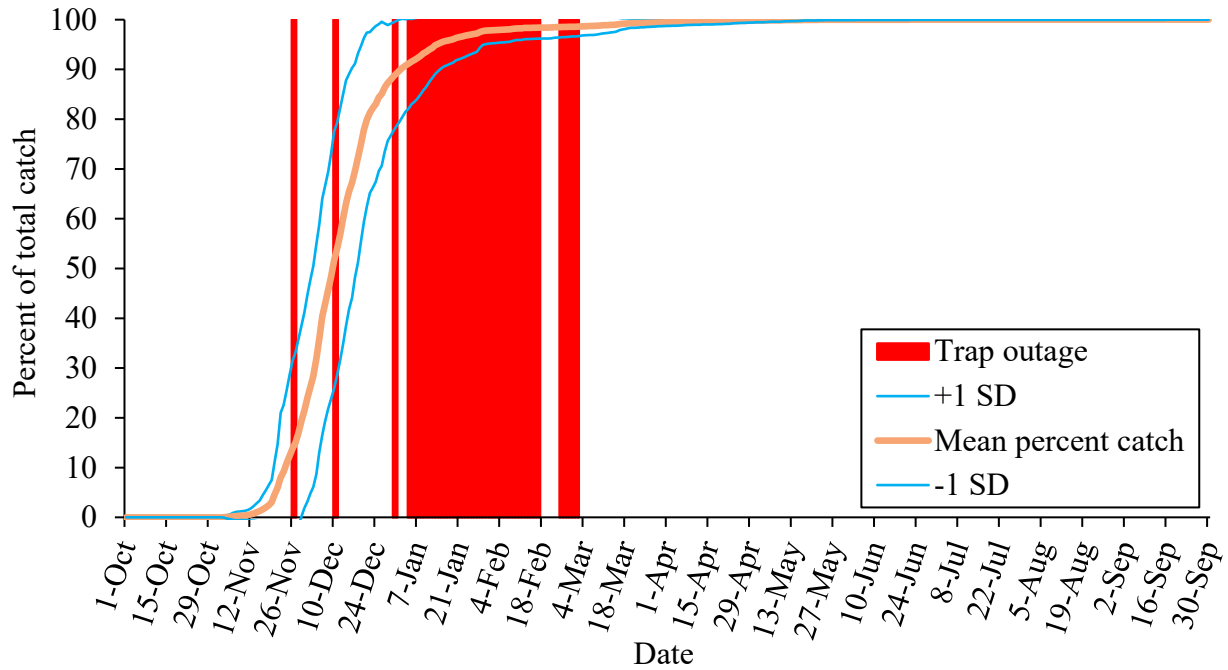


Figure 14. is a multi-line and bar graph showing the mean percent cumulative of the annual catch for brood years 2003–2022, one standard deviation above and below, and the rotary screw trap outage during the brood year 2022 spring-run Chinook Salmon out-migration period. Long trap outages occurred from January 7 to February 18, 2022.

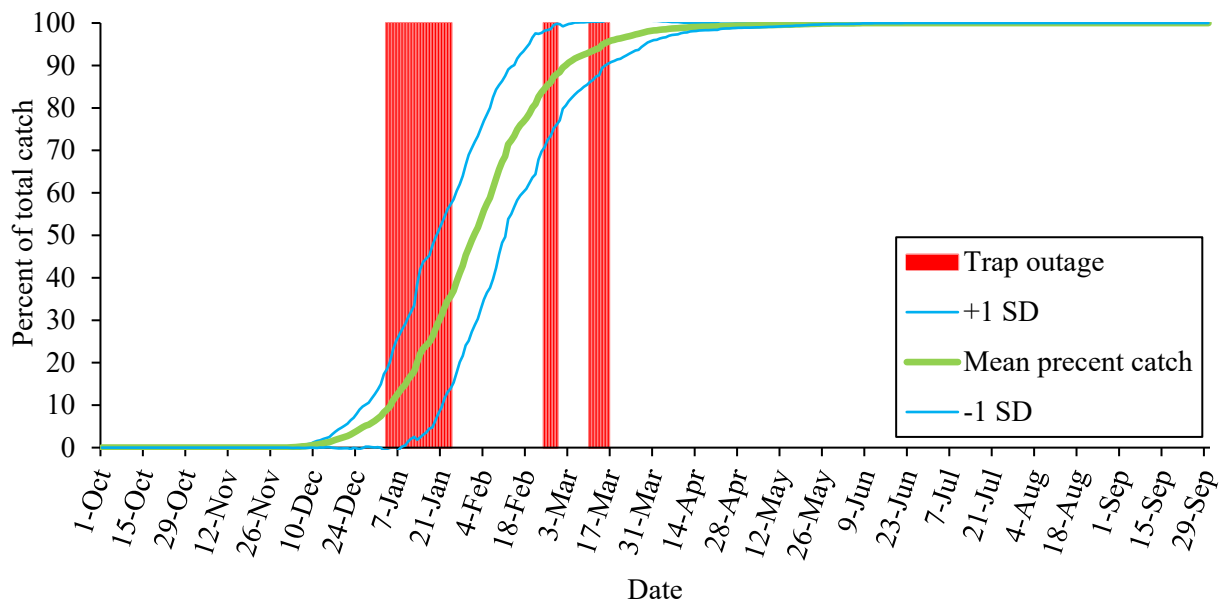


Figure 15. is a multi-line and bar graph showing the mean percent cumulative of the annual catch for brood years 2003–2022, one standard deviation above and below, and

the rotary screw trap outage during the brood year 2022 fall-run Chinook Salmon out-migration period.

## **Adult Escapement**

The USFWS and CDFW jointly operate a video weir at the mouth of Clear Creek (RM 0.1). In WY 2023, CDFW operated the weir from the start of the water year (October 1, 2022) to December 19, 2022. The USFWS operated the weir from December 17, 2022, to August 14, 2023. The CDFW operated the weir again from August 15, 2023, through the end of the water year (September 30, 2023).

### **Spring-run Chinook Salmon**

Adult spring run Chinook Salmon upstream passage into Clear Creek is monitored at a video station near the confluence with the Sacramento River and sometimes estimated via snorkel survey when weir data are insufficient. Figure 16 shows the adult population estimates from 200 through 2022. Video data are being evaluated by the Red Bluff USFWS office to characterize spring run Chinook Salmon passage through the entire emigration period and to look for a detectable response to the spring pulse flows. Final estimates for BY 2022, 195 spring run Chinook Salmon entered the Creek on their own in addition to the 378 translocated from the Sacramento River. Of adults translocated, 51 tagged fish were observed leaving the system for a potential spawning population of 327. The low number of adults observed in August Snorkel Index surveys and low number of redds observed in the fall suggest that many of the translocated spring run died over the summer. BY 2023 spring run Chinook Salmon adult monitoring was directly impacted by the historic and protracted high flow event in January of 2023. The video station was inoperable and not fish tight for much of the critical passage period. No spring run Chinook Salmon were observed during the August Index survey which has served as an alternative population estimated in the past. While a few spring run Chinook Salmon were observed passing into Clear Creek and two carcasses were recovered in their spawning territory, to comparable spring run Chinook Salmon adult population estimate is possible for BY 2023.

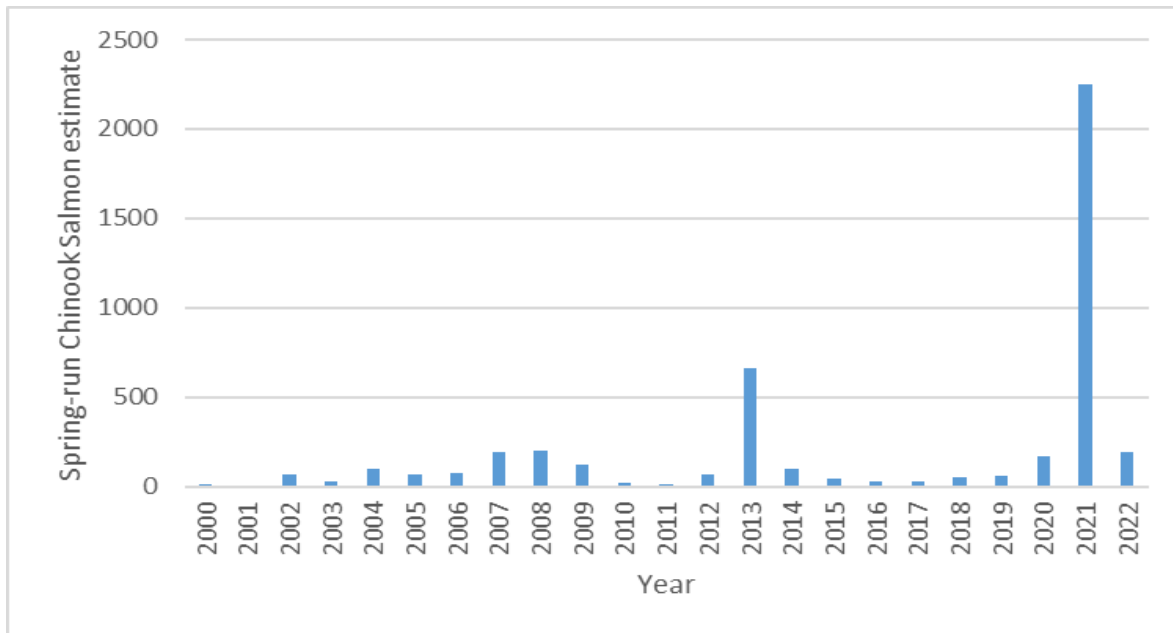


Figure 16. is a bar graph showing the Clear Creek spring run Chinook Salmon escapement reported to GrandTab for the years 2000 through 2022, with 2021 showing the highest escapement.

**Fall-run Chinook Salmon**

The adult fall run Chinook Salmon estimate is produced by CDFW based on the Clear Creek video weir passage. CDFW reported 2,997 fall-run Chinook Salmon entered Clear Creek in 2022 (Azat 2023, Figure 17). Fall-run 2023 estimates are still underway, but preliminarily 2023 looks like a below average year for fall run Chinook Salmon in the Sacramento Basin, Clear Creek included.

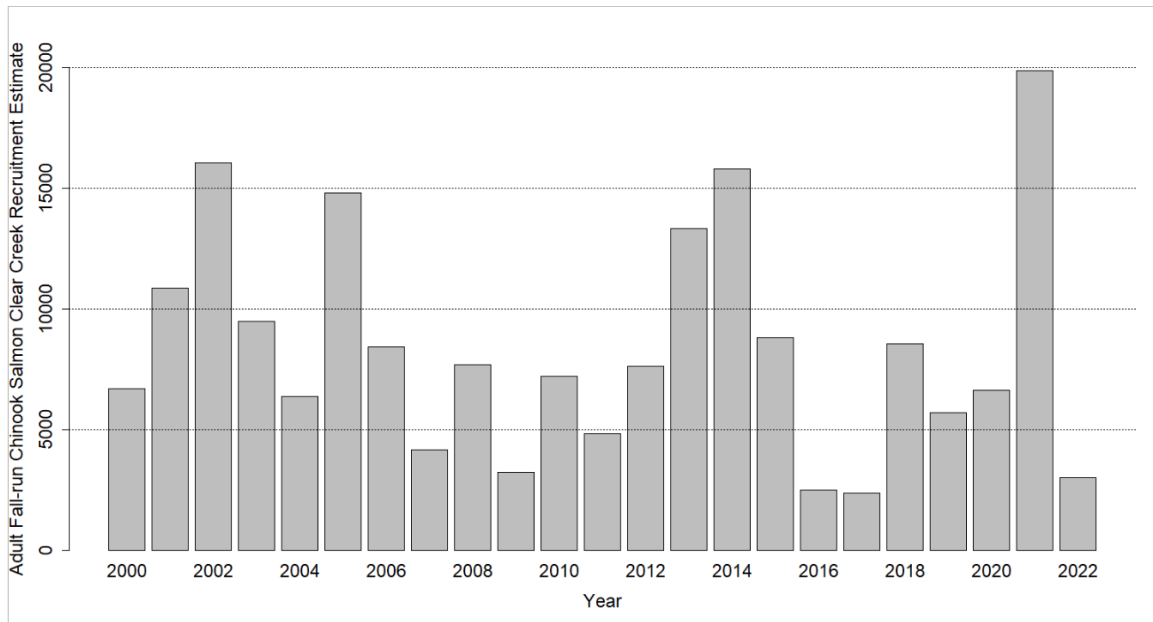


Figure 17. is a bar graph showing the Clear Creek Fall-run Chinook Salmon escapement reported to GrandTab for the years 2000 through 2022, with 2021 showing the highest escapement.

### Late-fall run Chinook Salmon

The estimated late fall-run Chinook Salmon population was 30 adults (Figure 18). This number was calculated by applying an expansion factor of 2.75 on the 11 late-fall run Chinook Salmon redds that were observed during the survey season (December 14, 2022–April 1, 2023). However, due to hydrologic conditions during the survey period only ~25% of surveys were completed. The USFWS report detailing this analysis is in progress.

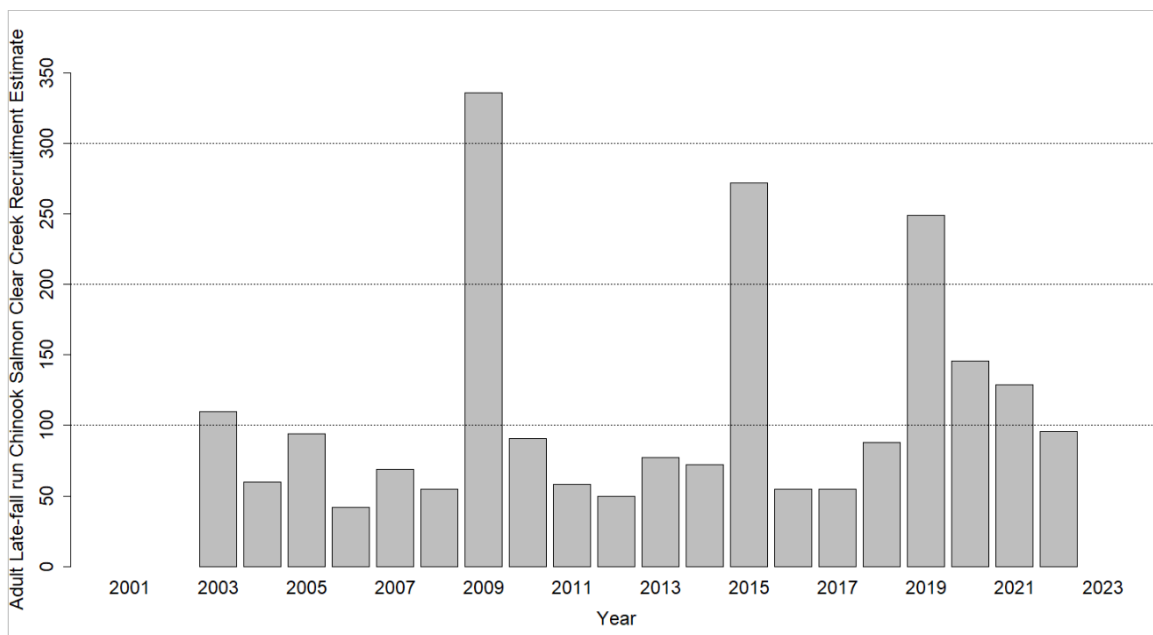


Figure 18. is a bar graph showing the Clear Creek Late-fall run Chinook Salmon escapement reported to GrandTab for the years 2001 through 2023. The missing values

denote years when no comparable estimate was submitted to Grandtab. Late-fall run Chinook Salmon escapement falls year on year between 2019-2022, with 2009 showing the highest escapement.

### **Steelhead**

The resolution for adult “steelhead” numbers in Clear Creek is poor due to complicated O. mykiss life histories. CDFW estimates a net gain of >16-inch fish into Clear Creek during their operation period (August to December). During the USFWS monitoring period (December to August) more >16-inch fish leave the system than enter (post-spawn runbacks). CDFW has been monitoring life history dynamics of Clear Creek via acoustic tag and radio antennae equipment since 2020 and has shared some preliminary results during CCTT meetings. A final report is pending.

### **Separation Weir**

The USFWS operated a separation weir at RM 8.2 to prevent fall-run Chinook Salmon from negatively impacting spring run Chinook Salmon upstream of the weir. The weir is typically operated from the end of August through the beginning of November. In 2023, the weir was installed on August 10 and closed to upstream fish passage on September 12. The weir was removed on November 2 after completion of spring run Chinook Salmon spawning surveys. Two spring run Chinook Salmon carcasses were retrieved from the weir during its operation. Both were small males, known as “jacks,” and were unmarked.

### **Spawning Habitat Evaluations**

The USFWS completes an annual survey of Clear Creek’s potential spawning habitat available to salmon and steelhead. Data collected in July 2023 indicate significant changes in the spawning habitat in Clear Creek. Much of the change is attributable to the historic and protracted discharge event in January 2023. Some areas of the creek still retained sand, perhaps indicating a continued “recovery” of spawning habitat area following the fine sediment inundation from the 2018 Carr Fire. In general, gravel injection sites in the upstream reaches of Clear Creek were depleted of gravel and much of the suitable spawning attributable to the gravel was found further downstream. Sand continues to accumulate in the lower reaches of Clear Creek, though there is some evidence it is transporting out of the key spawning areas in “Renshaw Riffle” (RM 5–5.5). From 2021 to 2022 a decrease in total spawning area was mapped in Clear Creek. (2022- 837,560 ft<sup>2</sup>, 2021- 907,569 ft<sup>2</sup> (Figure 19) In 2023 this trend continued, and we measured only 710,840 ft<sup>2</sup>. The habitat is greater than was mapped in 2019 following the Carr fire (573,051 ft<sup>2</sup>), but it is the second lowest measurement since 2011. In Reach 1 there was a measured reduction in spawning habitat in most 1000 ft breaks. The spawning gravel that was previously in these areas was pushed to downstream locations. At the top end of Reach 2 and downstream of the Guardian Rock gravel augmentation site a noted reduction in habitat was found, similar to what was seen upstream in Reach 1. Lower in Reach 2 and into the canyon reach, mapped spawning habitat appeared in a new location (RM 14.6-RM14). It is likely this is the resting place for the injection gravel transported from upstream. Little habitat was mapped in Reach 3, the downstream extent of this reach (above old Placer Bridge) had been an area with growing spawning area over the last few years (RM 11.2). Spawning gravel was transported out of this area and no sizeable spawning area was mapped here in 2023. In Reach 4 there was a sizeable

reduction in spawning area in the upstream areas and below the Placer Bridge gravel augmentation site. Near the downstream most area of Reach 4, just upstream of the Clear Creek Road Bridge, there was a dramatic increase in spawning habitat, again likely the resting spot of the transported gravel from upstream. A few changes were noted in the downstream reaches of Clear Creek which area primarily used by fall run Chinook Salmon for spawning. “Renshaw Riffle” (RM 5–5.5) continues an increasing trend of spawning habitat following the Carr Fire, though still far shy of the historical spawning habitat that used to persist there. From the Restoration Reach and downstream, there was much less spawning habitat area than in recent years. It appears much of the decomposed granite that was released from the Clear Creek tributaries following the Carr fire has transported to these reaches where there is less stream power to move it out.

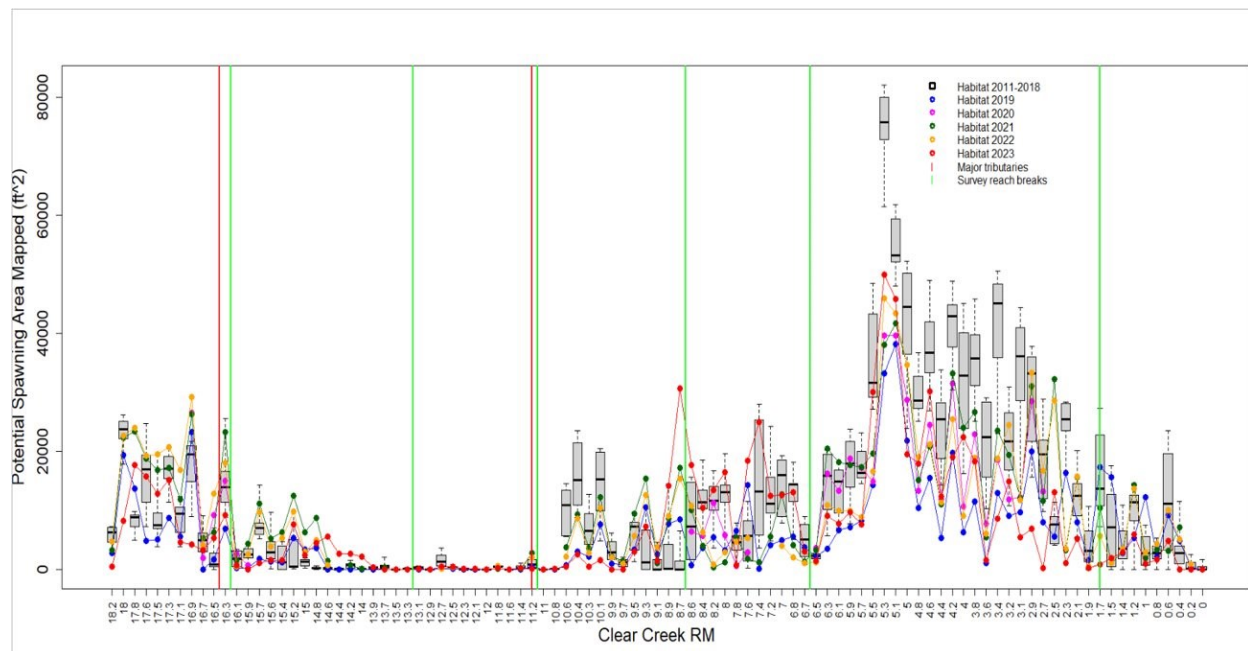


Figure 19. is a (type of chart) showing anadromous fish spawning habitat mapped on Clear Creek 2011–2023. The X-axis indicates Clear Creek river mile breaks of roughly 1,000 ft. The Y-axis indicates the magnitude of habitat within each break. Years 2011–2018 are displayed by boxplot, 2019–2023 are presented as points showing habitat in the given year. In 2020 only a subset of reaches was completed. Suitable habitat is located between river mile 18.2–14.6 and 10.4–0.4 with little suitable habitat between river mile 14.4–10.8.

The USFWS conducts annual Spawning Area Mapping (SAM) surveys to detect and map fall run Chinook Salmon redds on Clear Creek. Surveys are carried out in October and December to capture early and late spawning of fall run Chinook Salmon along the downstream reaches, where spawning primarily occurs. In comparison to 2008–2020 SAM data from the Clear Creek Gorge to the USFWS lower rotary screw trap (RM 6.5 – 1.7), the 2022 SAM surveys began above the Gorge starting at the Clear Creek Road Bridge and finished at the confluence with the Sacramento River (RM 8.6 – 0). Spawning activity was defined as the area where substrate had been moved by salmon in the process of constructing a redd.

Spawning area for each dataset was calculated for 1,000-foot analysis reaches within the study area. For 2022, the total October-survey SAM area was 82,043 sq ft, the total December-survey SAM area was 9,563 sq ft (Figure 20) While the spawning area mapped in 2022 was far less than in many other years, fall run Chinook Salmon recruitment into Clear Creek this year was very low. Other factors that could explain differences in the spawning area per adult include: geomorphological changes due to increased storm severity and frequency, drought, and lasting effects from the 2018 Carr fire.

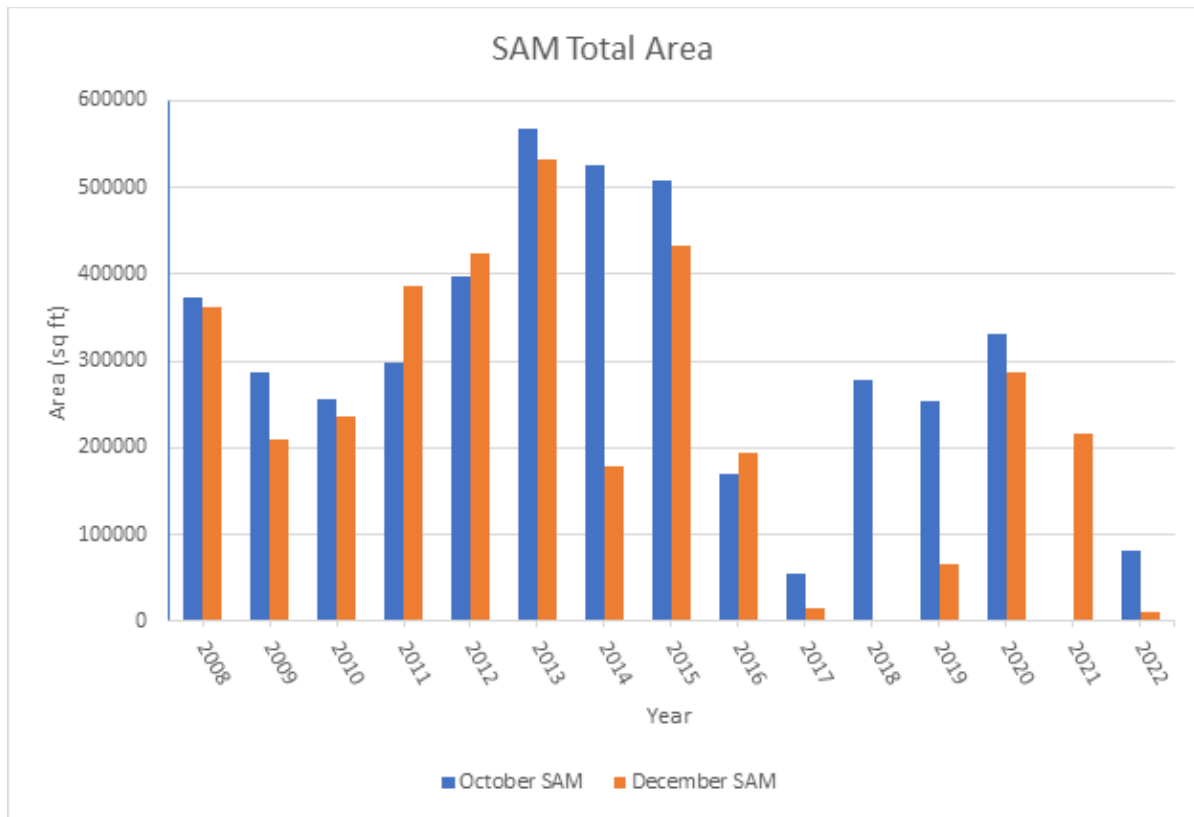


Figure 20. is a clustered column graph showing the area of fall run Chinook Salmon spawning by calendar year from 2008-2022. The spawning area mapped in October is represented by blue bars. The spawning area mapped in December is represented by orange bars. The graph shows generally increased spawning activity between 2009-2013, followed by declining spawning activity from 2014-2021.

The gravel augmentation program’s influence on spawning habitats in Clear Creek is assessed empirically by (1) identifying the habitat used by spring run Chinook Salmon and CCV steelhead for spawning, and (2) by annually surveying the amount of habitat available for spawning by these runs/species. Data from 2013 through 2023 show the proportional use of injected gravels vs. native gravels has increased for both spring-run Chinook Salmon and CCV steelhead (Figure 21).

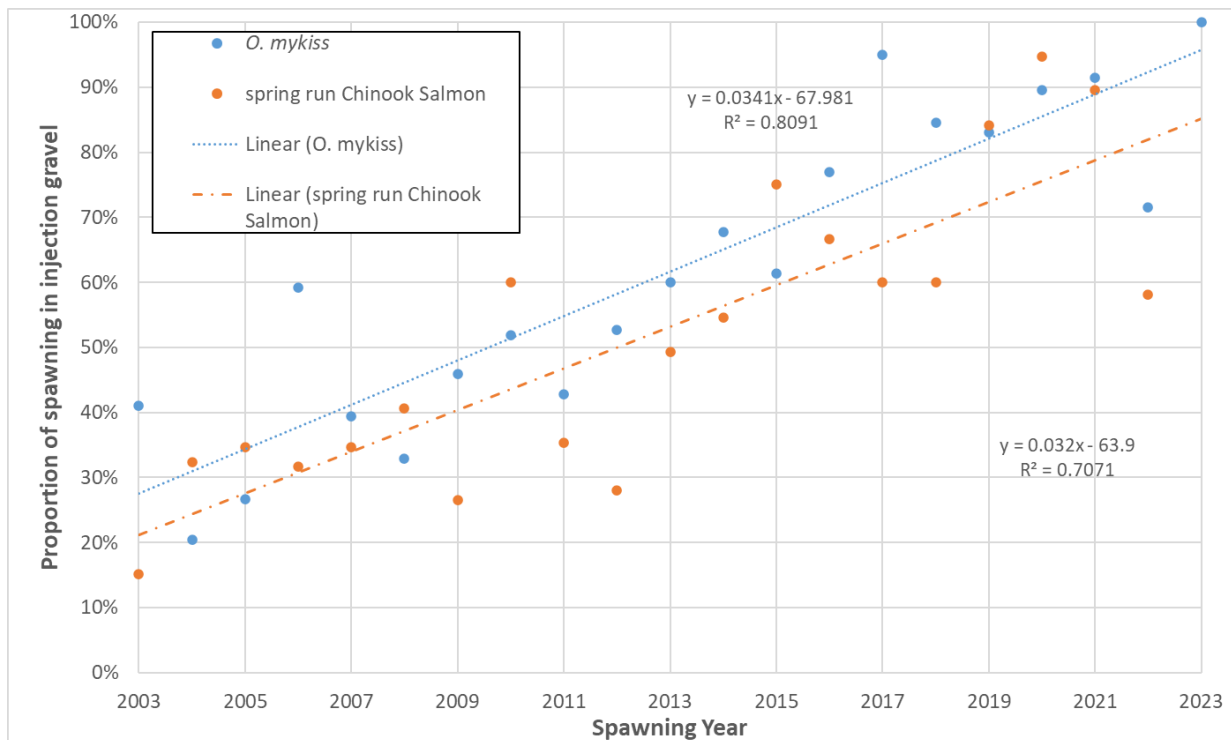


Figure 21. is a scatter plot with trend lines with a trend upwards towards the upper right corner, showing the annual proportion of spring run Chinook Salmon and steelhead (*O. Mykiss*) spawning in injection gravels from 2003–2023. Results limited to Clear Creek upstream of the spring and fall run Chinook Salmon segregation weir.

## Spawning Surveys

The USFWS completes two spawning surveys on Clear Creek annually. The “kayak” spawning survey with the intent of quantifying late-fall run Chinook Salmon and *O. mykiss* spawning and the “snorkel” spawning survey with the intent of quantifying spring run Chinook Salmon spawning. In the 2022-2023 kayak season, one full creek survey and two partial creek surveys were completed between mid-December 2021 and the last week of March 2022. The surveys observed 11 late-fall and 117 *O. mykiss* redds. Additionally, two late-fall run Chinook Salmon carcasses were retrieved, one of which was identified to be marked (adipose fin absent). The head from adipose absent carcasses will be processed to extract the coded wire tag and determination of hatchery of origin.

During the 2023 snorkel season, surveyors conducted three creek-length spawning ground surveys between September 19th and October 26th. Surveyors did not record any redds where successful spawning was thought to have occurred with high confidence (Figure 22). However, one questionable redd was identified and mapped upstream of the separation weir where spawning activity is attributed to spring run Chinook Salmon. Additionally, no spring run Chinook Salmon carcasses were retrieved during the survey period.

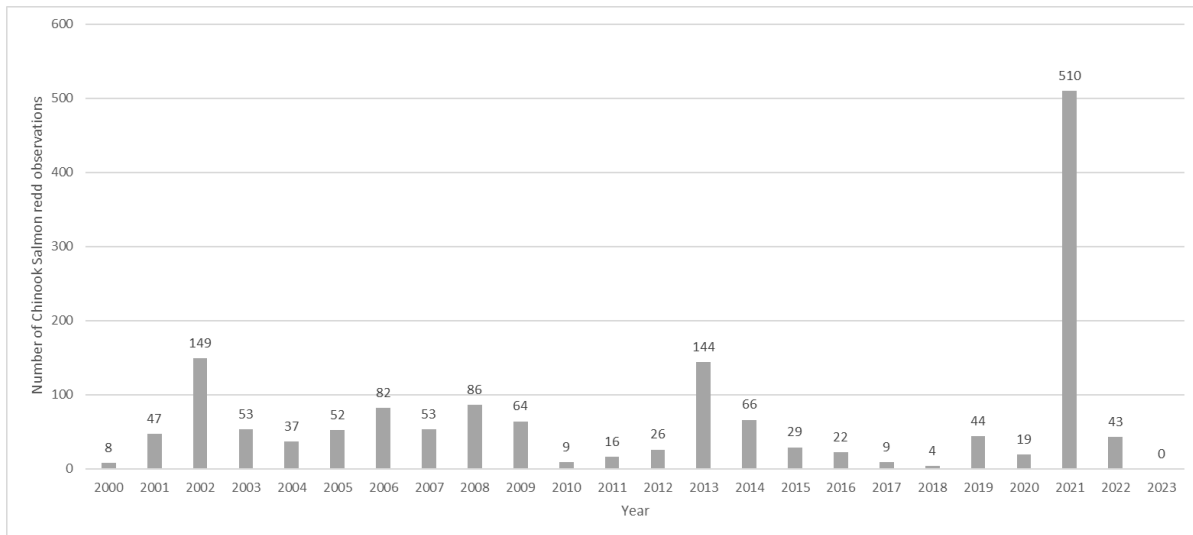


Figure 22. is a bar graph showing the number of spring run Chinook Salmon redds observed above the segregation weir on USFWS spawning surveys from 2000- 2023. There is no discernable trend to the data other than a decline in observations from 2015-2023, with 2021 being an outlier with the most observations in the period of record.

# References

- Azat, J. 2022. California Central Valley Chinook Population Database Report. California Department of Fish and Wildlife. Updated on July 20, 2022 by Jason Azat, Fisheries Branch, Anadromous Resources Assessment. 27 pp. Available at: <https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=84381&inline>
- Bureau of Reclamation (Reclamation). 2019. Reinitiation of Consultation on the Long-term Operations of the Central Valley Project and State Water Project. Final Biological Assessment. U.S. Department of Interior.
- Bureau of Reclamation (Reclamation). 2020. Record of Decision (ROD) for the Reinitiation of Consultation on the Long-term Operations of the Central Valley Project and State Water Project. Final Biological Assessment. U.S. Department of Interior.
- Bureau of Reclamation and U.S. Fish and Wildlife Service (Reclamation and USFWS). 2020. 2020 Near Term Restoration Strategy for the Central Valley Project Improvement Act Fish Program. U.S. Department of Interior.
- National Marine Fisheries Service (NMFS). 2019. Biological Opinion on Long Term Operation of the Central Valley Project and State Water Project. WCRO-2016-00069.