Clear Creek Technical Team
Summary of Activities for Water Year 2022

Table of Contents

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

CHAPTER 1. BACKGROUND

1.1 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 8,468 from 1998–2021);
- 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.

1.2 Active Members in Water Year 2022

Kristin Begun, NMFS
Tricia Bratcher, CA Dept. of Fish and Wildlife (CDFW)
Matt Brown, USFWS
Leslie Bryan, Redding Electric Utility
Charles Chamberlain, USFWS
Alicia Herrera, Point Blue
George Low, RWQCB
Amy Lyons, Dept. of Water Resources (DWR)
Mike Memeo, 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 2022 were facilitated by Kerns & West (Zack Barr and Grace Person). The also produced CCTT meeting notes.

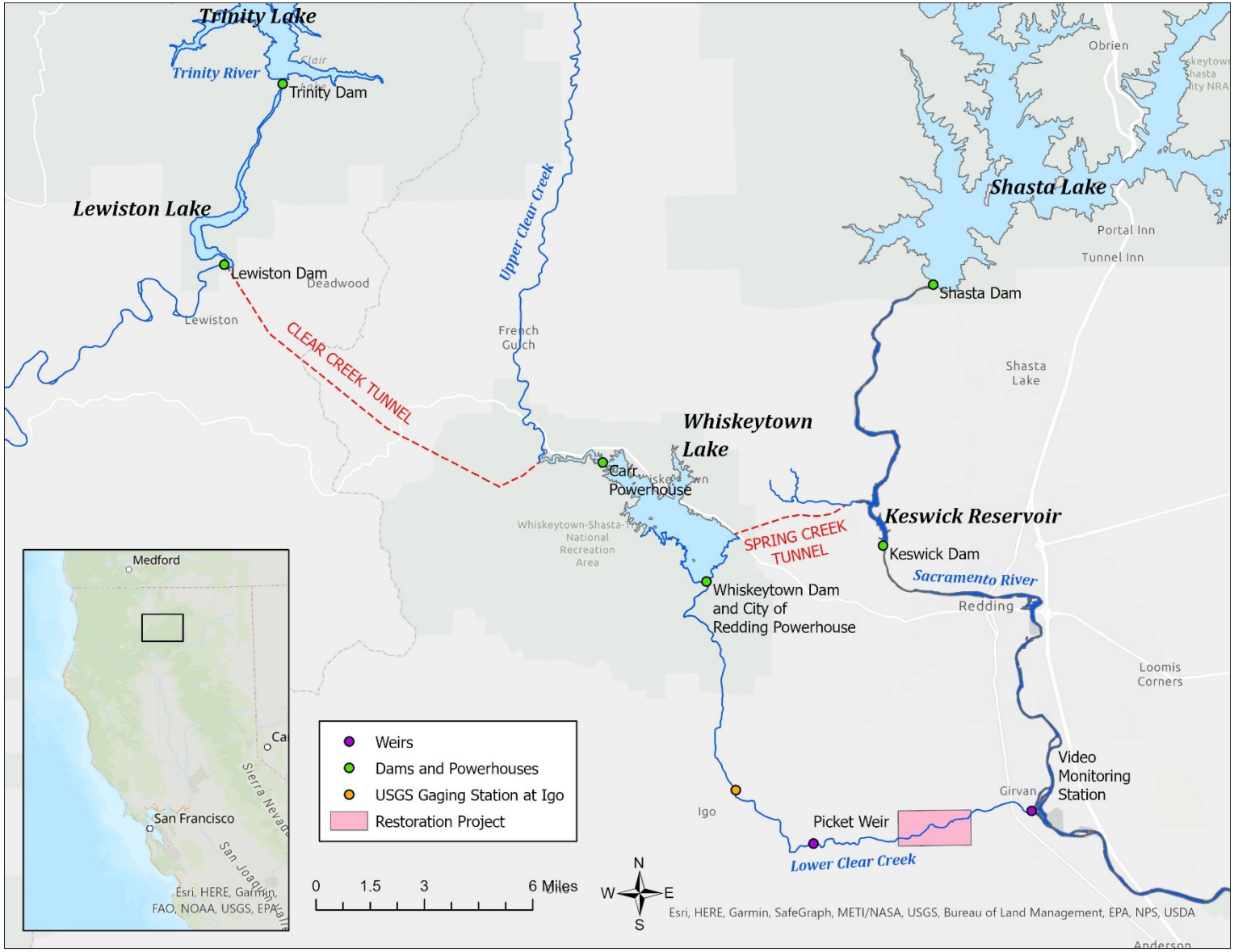

Figure 1. Location of Lower Clear Creek in Northern California, showing Trinity, Whiskeytown, and Shasta reservoirs and related CVP facilities.

1.3 List of Clear Creek Technical Team Discussions

The following CCTT meetings, with an abridged list of discussions, occurred in water year (WY) 2022 (and since the 2021 CCTT Annual Report). The individual CCTT meeting notes provide considerably more detail than the synopsis here.

December 16, 2021

- WSRCD provided an overview of their CVPIA funding proposal. Their plan looked to address the CVPIA's Near-term Restoration Strategy recommendations 6 (Juvenile habitat in Clear Creek) and 9 (Maintain spawning habitat). Projects within the proposal included gravel augmentations, wood structure supplementation, Horsetown restoration project, effectiveness monitoring, and education/outreach.
- BLM provided an overview of beaver monitoring efforts on Clear Creek. Overall, beaver activity was found throughout Clear Creek, with 6 bank dens observed.
- California Geological Survey provided an overview of the post-wildfire debris monitoring. They discussed their debris flow modeling
- Reclamation provided an overview of the infrastructure and operations of Whiskeytown Dam. This includes reservoir operations, schematics, capacity, and temperature management operations.
- WSRCD provided an overview of the Phase 3B Completion project. They discussed the project plan and the selected plant species list.
- USFWS provided and overview of the draft Geomorphic Pulse Flow and Summer Management Proposal. The proposal included, geomorphic pulse flows (for normal or wetter water years), spring pulse flows (for dry or wetter years), spring pulse flow (for critical water years), and temperature management.
- USFWS and CDFW provided an overview of fisheries monitoring efforts on Clear Creek. This included juvenile spring-run Chinook capture at the upper rotary screw trap, and adult escapement.

March 17, 2022

- USFWS provided updates on Clear Creek fisheries monitoring. Their updates included data from late-fall run Chinook Salmon and steelhead redd surveys, juvenile outmigrant monitoring, and juvenile snorkel surveys.
- Reclamation provided an overview of the CVPIA's Notice of Funding Opportunity.
- CDFW provided a review of Clear Creek salmon escapement. The described the historic context of Clear Creek, monitoring procedures, 2021 water temperature issues, and draft 2021 escapement data.
- USFWS provided an analysis of juvenile salmon production on Clear Creek and adult escapement. They discuss how Clear Creek relates to the Sacramento River basin.
- Reclamation provided a review and update on flow management actions on Clear Creek. This included updates on Trinity Reservoir levels, Whiskeytown temperature profiles, Sacramento River water year indicators, and operations plans for WY2022.
- WSRCD provided an update of the Phase 3B Completion project. They discuss the planting schedule and irrigation infrastructure.
- Yurok Design Team provided an update on the Phase 3C project. They are in the final year of irrigation for the restoration project.

June 16, 2022

- USFWS gave an update on Clear Creek fisheries monitoring. They discussed the adult spring run Chinook translocation from the Keswick fish trap, the juvenile outmigrant trapping, and video weir.
- WSRCD provided an update on the ongoing Phase 3B Completion project. They have ripped the ground, planted 1,500 plants (about half of total), replanting "volunteer" plants, and described the irrigation infrastructure.
- CDFW provided an overview of the adult spring run Chinook Salmon translocations. This included information on the number, locations, and condition of the fish transferred to Clear Creek. They had moved 305 adult salmon up to this point.
- UC Davis and NMFS provided information on their research into juvenile salmon growth in various habitat types on Butte Creek and Sutter Bypass. They described how the different environments produce different invertebrate communities at different densities, and how this translates to fish growth.
- Reclamation provided an update on the CVPIA's Notice of Funding Opportunity process. The 2021 proposals are still under review and the 2022 NOFO will open in the fall.

September 16, 2022

- WSRCD gave an update on the Phase 3B Revegetation Project. The discussed project progress and plant survival so far and provided an overview of their next steps.
- WSRCD gave an update on the ACID Siphon Passage Project. The RCD was successful in pursuing CDFW-funds for analysis and design of a potential fish passage project at the ACID siphon.
- USFWS gave monitoring updates from Potential Spawning Area Mapping and adult salmonid snorkel surveys.
- CVPIA Notice of Funding Opportunity 2021 and 2022. USBR answered questions about the 2021 and 2022 processes.
- USBR provided an overview of water management operations in 2022.
- Reclamation gave a presentation on the history of Clear Creek Restoration. This presentation looked to review important reports, projects, operation changes, and outcomes of the major restoration efforts that took place on Lower Clear Creek. Five future recommendations were provided.
- USFWS and USBR solicited ideas for increasing stakeholder engagement in the Clear Creek Technical Team and activities.
- USFWS discussed some initial ideas for Clear Creek related field trips to discuss at the next meeting in December

CHAPTER 2. CLEAR CREEK STATUS

2.1 Water Year Characteristics

Water Year 2022 (WY 2022) marked the third consecutive year of drought conditions for the Clear Creek watershed and Sacramento River basin. Clear Creek flows at the Igo gage (USGS 11372000) saw only a few natural high flow events in October 2021 through January 2022, but no high flow events from February 2022 through September 2022 (except for the managed pulse spring pulse flow). In WY 2022, there were only four natural instantaneous peak flows that exceeded 800 cfs at the Igo Gage station. In WY 2022, only 7% of days (25 of 365) exceeded a mean daily flow at Igo gage of 300 cfs or more (which includes the artificial pulse flows).

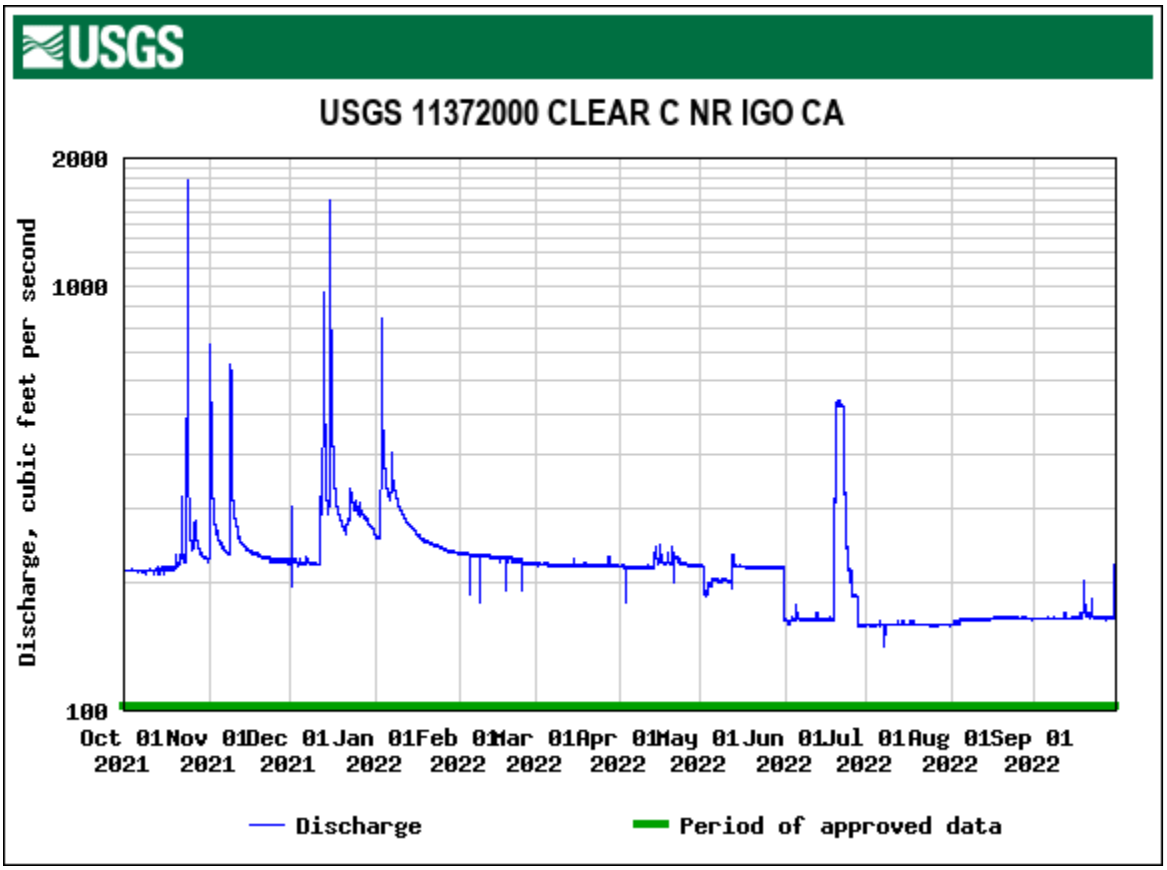

Figure 2. Instantaneous flow on Clear Creek at Igo gage during WY2022. Data courtesy of USGS, https://waterdata.usgs.gov/nwis/uv?site_no=11372000.

The water year classification has important implications for the management of Clear Creek (see CHAPTER 3). The water year classification for Clear Creek is determined through the Sacramento River Water Year Type Index (SVI). Updates to this index occur monthly from December 1 through May 1. In WY 2022, the May 1 update revealed a 4.3 SVI (90% exceedance), the date which defined the WY type for Clear Cr. This put the water year firmly within the Critically Dry water year type (i.e., ≤ 5.4 SVI).

2.2 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. There was no uncontrolled spill in WY 2022.

CHAPTER 3. CLEAR CREEK MANAGEMENT ACTIONS

The following sections highlight the management actions that occurred in Clear Creek during WY 2022 (October 1, 2021–September 30, 2022). Occasionally, additional information is included that covers other water years (i.e., WY 2023) for continuity, as some actions cross water years (e.g., water temperature management). With little precipitation in the winter of 2021 and spring 2022, the water year was designated Critically Dry (see Section 2.1). There are contingencies built into the operations plan for Clear Creek in the event of a Dry or Critically Dry water years, such as decreased base flows and reduce pulse flow volumes.

The following is a summary of the management actions from WY 2022:

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

Management Action Item		Progress in WY 2022
1.	Minimum Base Flows	Completed
2.	Water Temperature Management	Implemented with some excursions
3.	Spring Attraction Flows	Completed
4.	Channel Maintenance Flows	Not Implemented
5.	Fish Habitat Restoration and Management ("Gravel Augmentation")	Not Completed
6.	Fisheries Monitoring	Completed

3.1 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 2022, Clear Creek's minimum base flows were met across the entire year. The operations plan for Clear Creek has provisions for deviating from base flow minimums during critically dry water years, such as WY 2022, but such reductions were not implemented.

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 2022,

CVO made flow adjustments to ensure that flows at Igo gage remained consistent when switching between the powerhouse and the bypass releases.

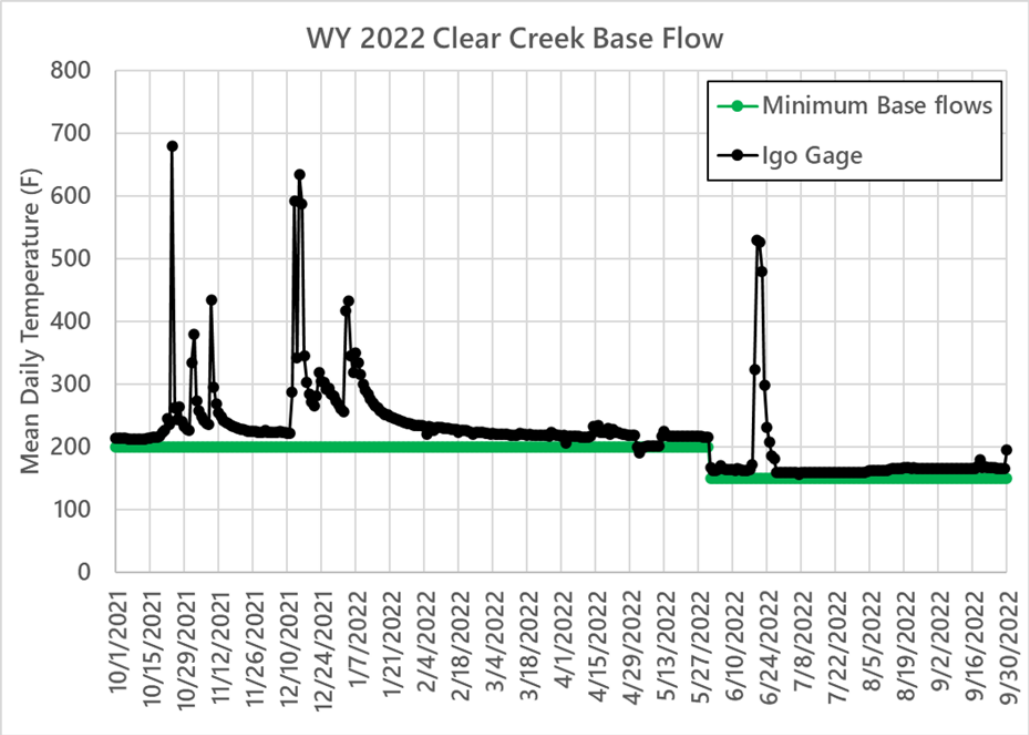

Figure 3. Mean daily flow on Clear Creek during WY 2022, measured at Igo gauge (USGS 11372000; black line). The Proposed Action's base flow minimums are shown as a green line.

3.2 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 2022, water temperature criteria were met at Igo gauge with varying levels of compliance. The operations plan for Clear Creek has provisions for deviating from temperature management criteria during dry and critically dry water years, such as WY 2022 (a "critically dry" year). It was not possible to meet the water temperature criteria through all WY 2022, as cold water was depleted and additional water volume was not available. Even with the difficulties encountered, the mean daily water temperatures over the management season (June 1–October 31, 2022) remained below or near the criteria (within 1° F).

The Oak Bottom Temperature Control Curtain remained in place and operational during WY 2022. 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.

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 and excessive water temperatures in the Lower Klamath and Trinity Rivers, the Carr diversions and Spring Creek tunnels were curtailed and occasionally reduced to near zero flow during some portions of summer-fall 2022. Under this emergency action, Clear Creek was the only significant withdraw from Whiskeytown Reservoir, which was allowed to slowly drain towards the normal winter pool elevation. Trinity River flows were increased to protect salmon from diseases, as those fish migrated from the ocean into the poor environmental conditions of the Klamath and Trinity Rivers.

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 2021, the 56°F criteria were met for 30 of 31 days (97%). From September 16 through September 30, 2022, the 56°F criteria were met for 3 of 15 days (20%). Overall, in WY 2022, the 56° F criteria were met for 33 of 46 days (72%; Table 2). For Fall of 2021, which crosses water years, the 56°F criteria were met 7 of 46 days (15%; Table 3). It's useful to note that the criteria periods were established long ago with the assumption that the shorter days of November and lower ambient air temperatures would relieve temperature concerns beyond October 31 while spring run Chinook Salmon eggs are still developing in redds constructed in September and October. However, cold water resources of Whiskeytown Dam are depleted at the time of this report, and it is likely that both spring and fall run Chinook Salmon eggs will experience temperatures more than 56°F into November 2022 as they did in November 2021.

Mean daily water temperatures at Igo gauge remained below 60°F for 93% of the 107-day adult spring-run Chinook Salmon holding period (June 1–September 15, 2022; 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.

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.

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

Calendar Year	Holding Temperature ≤60°F June 1 - September 15	Spawning Temperature ≤56°F September 16 - October 31
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)

* Data missing due to gage malfunctions or vandalism

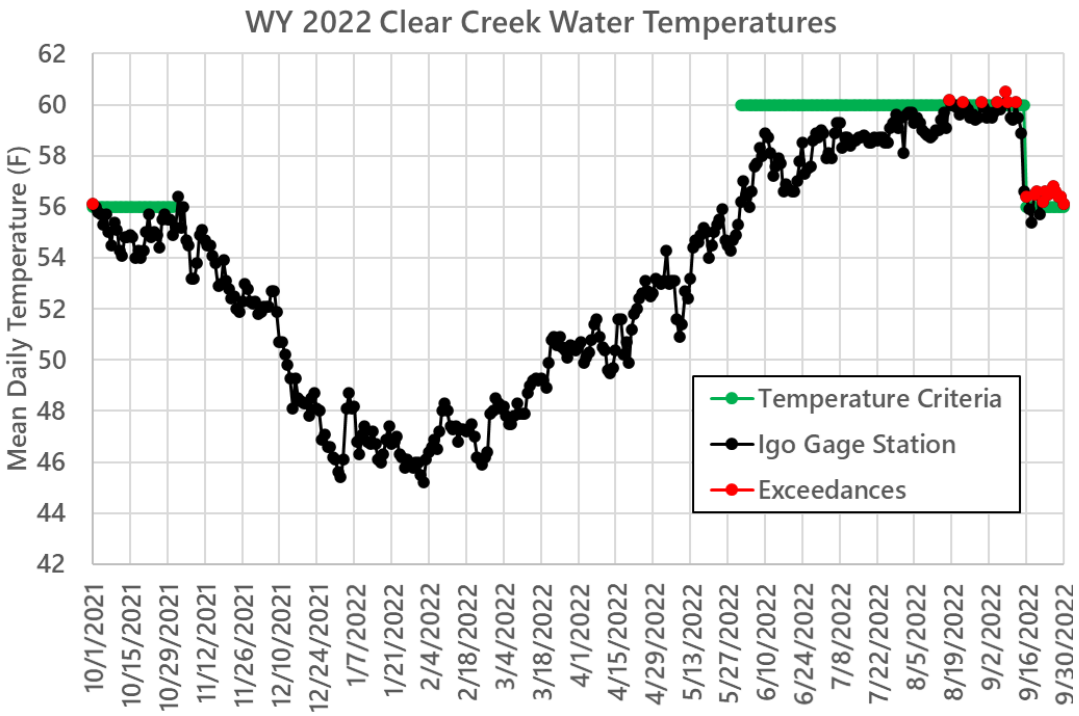

Figure 4. Mean daily water temperature on Clear Creek at the Igo gaging station in Water Year 2022 compared to the mean daily temperature criteria for spring-run Chinook Salmon holding (60°F from June 1 to September 15) and spawning and incubation (56°F from October 1 to 31 and September 16 to September 30). Red dots highlight days of temperature criteria exceedances.

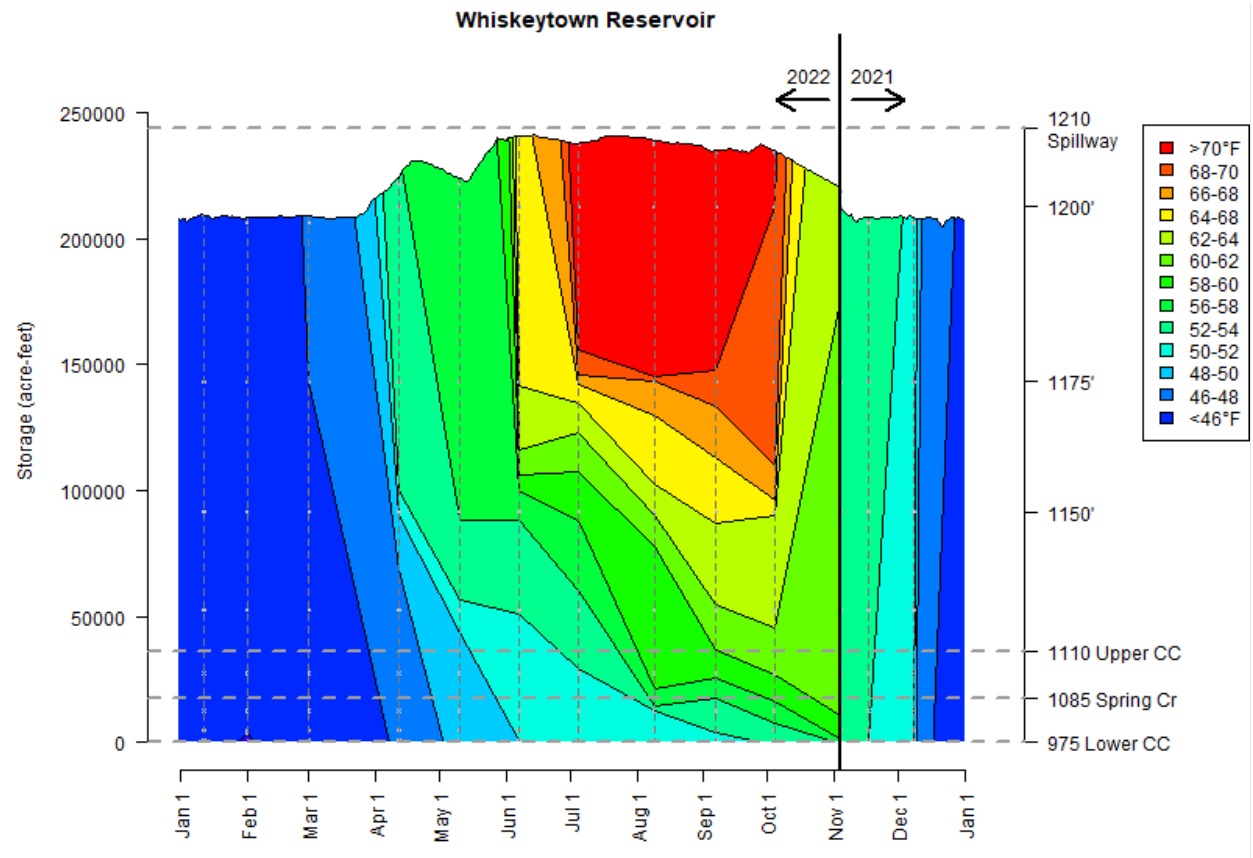

Figure 5. The isothermobath from Whiskeytown Reservoir in 2022 as of November 4.

3.3 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 2022 for implementation of the ROD's flow requirements on Clear Creek. 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 2022, the single flow pulse provided from Whiskeytown Dam was 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.

Due to WY2022 critically dry water designation, a single spring pulse flow occurring June 17 through June 27, 2022, which had a 500 cfs peak. While this pulse is consistent with the Proposed Action and corresponding Biological Opinion, the pulse volume was reduced from the CCTT proposal due to the on-going drought conditions. The originally proposed single pulse flow would have utilized approximately 6,200 acre-feet, while the implemented pulse used 3,000 acre-feet.

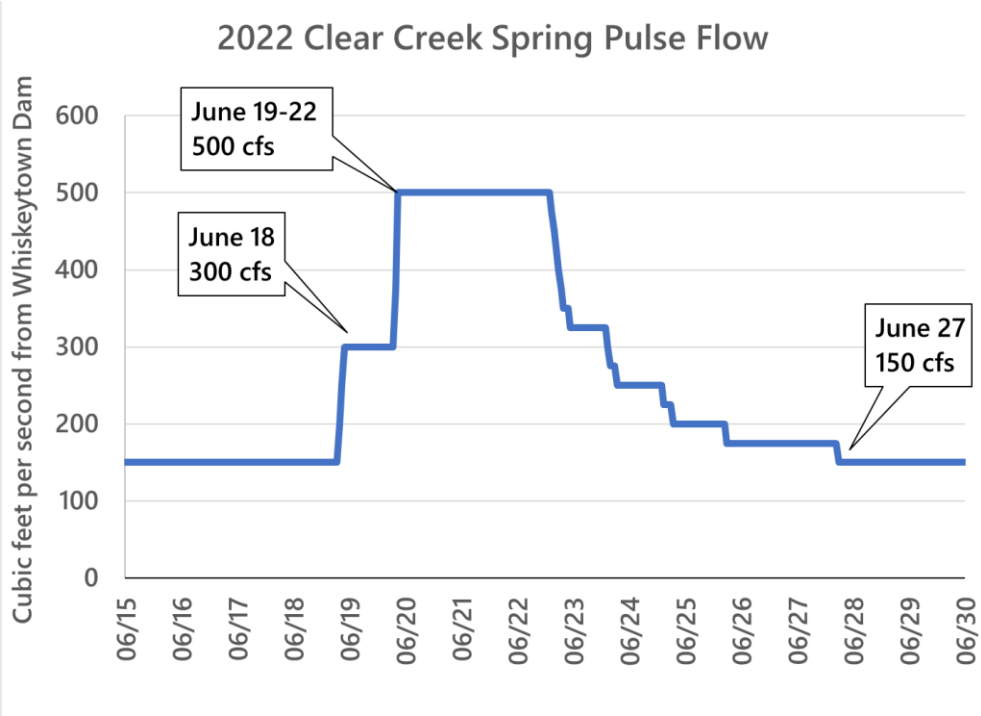

Figure 6. Proposed release schedule for 2022 spring pulse flow from Whiskeytown Dam.

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 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 4).

3.4 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 2022. Unfortunately, the appropriate water year type did not materialize. As such, no Channel Maintenance Flows were released in WY 2022.

The CCTT has a conceptual plan for a project that would "use mechanical methods to mobilize gravel or shape the channel if needed to meet biological objectives." This project would remove, clean, and sort coarse sediment from near-bank tailing piles. The materials would then be used in gravel augmentations. This project would reshape the channel, where natural and managed flows are unable to mobilize coarse sediment and naturally build wildlife habitat. More planning is anticipated to occur in 2023.

3.5 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 WY2022, the Fish Habitat Restoration and Management Project was not completed. No funding was made available from the CVPIA for the project.

CHAPTER 4. 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.*

4.1 Juvenile Production Monitoring

The USFWS operates rotary screw traps at two locations on Clear Creek, at RM 8.2 (UCC) and RM 1.7 (LCC). The upper trap produces a spring-run juvenile Chinook salmon passage index, while the lower trap captures all anadromous species of Clear Creek salmonids. The juvenile passage indices for fall-run Chinook Salmon, late-fall run Chinook Salmon, and *O. mykiss* are calculated from catch at the lower site. In WY 2022, two traps were on the water from October 25, 2021, to June 30, 2022. Both traps were not fished on the weekends starting April 2, 2022, because of reduced staffing levels.

The juvenile fall-run Chinook Salmon passage index at LCC RST near China Garden was 5,655,780 fish (Figure 7). The *O. mykiss*/steelhead passage index at LCC RST was 39,316 fish the highest passage in the history of the trap (Figure 8). This passage is not adjusted for redds below LCC. Spring-run Chinook Salmon passage index at UCC near Clear Creek Road Bridge was 712,692 fish (Figure 9). This passage is not adjusted for redds between the separation weir and UCC. Spring-run Chinook Salmon passage estimate at LCC was 178,702. Note that the official reported index is from UCC, and the LCC passage index is calculated for comparison purposes. The Brood Year 2021 Juvenile Report is in progress.

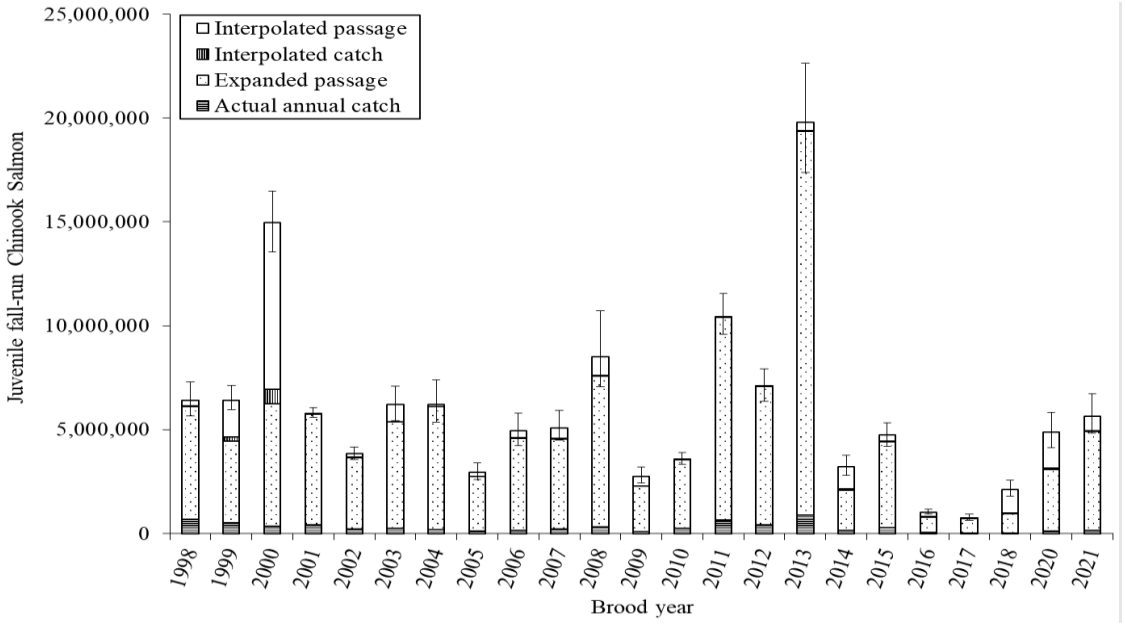

Figure 7. Annual passage indices of fall-run Chinook Salmon by brood year at the lower Clear Creek rotary screw trap from 1998 to 2021. Passage data from brood year 2019 are being summarized at the time of this report; delays in report development were due to COVID-19 related issues. USFWS-Red Bluff unpublished data.

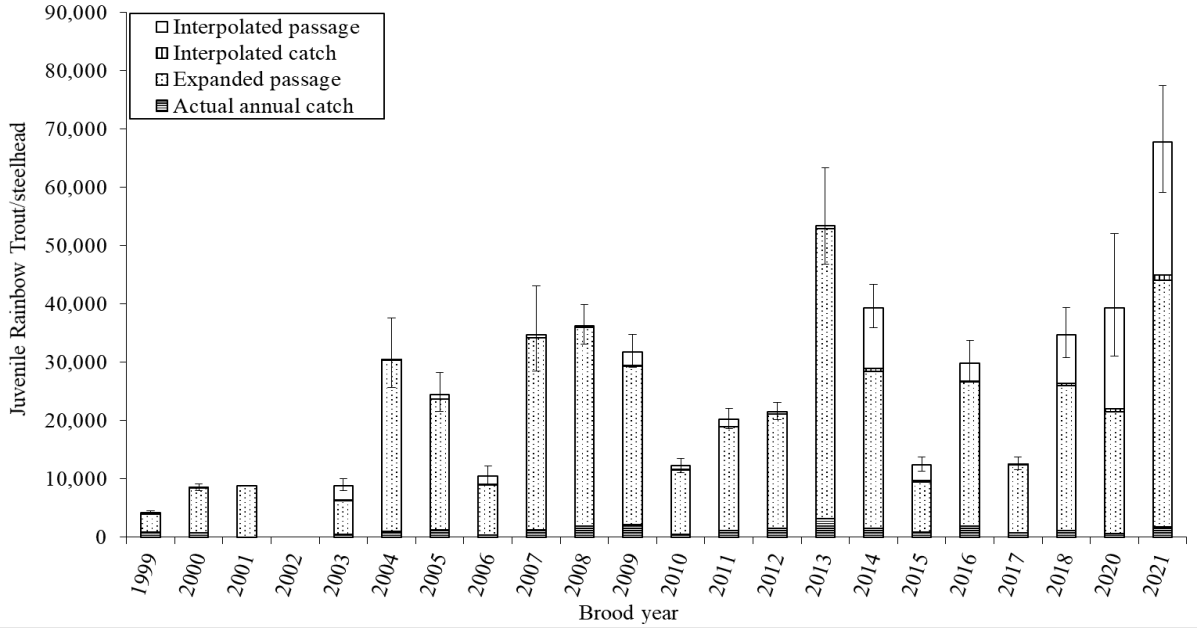

Figure 8. Annual passage of Rainbow Trout/steelhead by brood year at the Lower Clear Creek rotary screw trap from 1999 to 2021. There is no passage index for brood year 2019 because the trap was not fished during peak out-migration due to COVID-19 stay at home orders. USFWS-Red Bluff unpublished data.

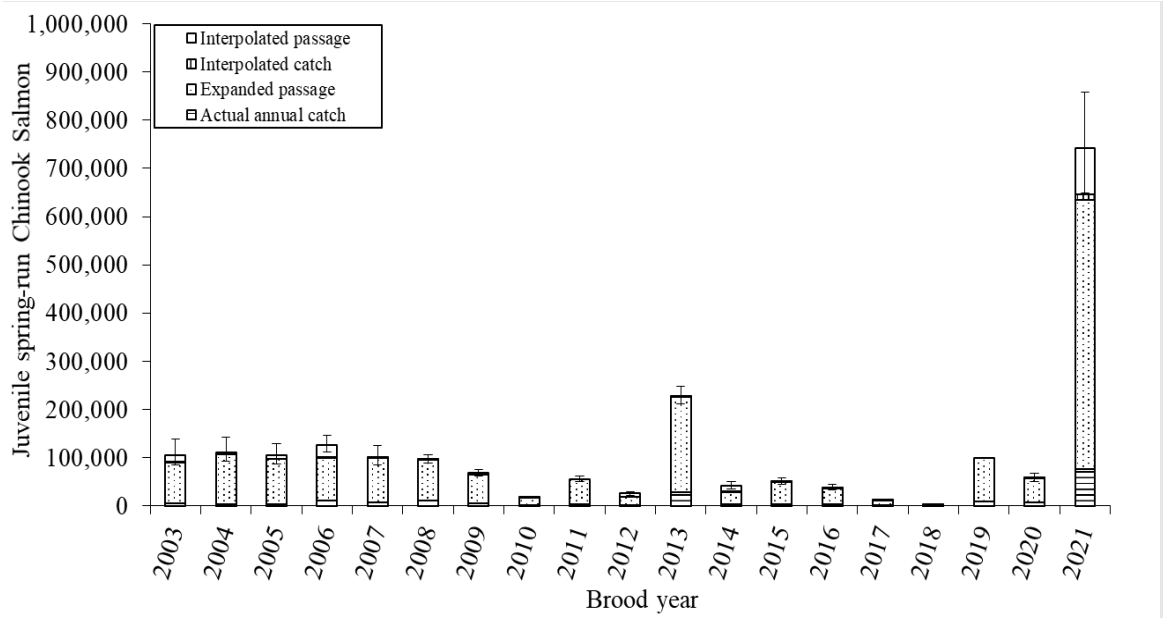

Figure 9. Annual passage of juvenile spring-run Chinook Salmon by brood year at the upper Clear Creek rotary screw trap from 2003 to 2021. Passage data from brood year 2019 are being summarized at the time of this report; delays in report development were due to COVID-19 related issues. USFWS-Red Bluff unpublished data.

4.2 Adult Escapement

The USFWS and CDFW jointly operate a video weir at the mouth of Clear Creek (RM 0.1). In WY 2021, CDFW operated the weir from the start of the water year (October 1, 2020) to December 16, 2020. The USFWS operated the weir from December 17, 2020, to August 16, 2021. The CDFW operated the weir again from August 17, 2021, through the end of the water year (September 30, 2021).

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. 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 2021, revealed 2,252 adult spring-run Chinook Salmon passed upstream at the video weir near the mouth 90% CI = [1,791 to 3,206]. The video analyses for 2022 are still underway and will be completed in the future. Final estimates will be communicated and published to GrandTab (Figure 10).

Sacramento River Drought Actions

Emergency drought actions were taken in the Sacramento River Basin in 2022. In the spring of 2022, modeling of the Sacramento River and Shasta Lake indicated that cold water pool volumes in the reservoir might be depleted in late summer/early fall. Spring-run Chinook Salmon that stayed in the Sacramento River were potentially going to be exposed to high mortality in the anticipated warm conditions of the Sacramento River. To alleviate this situation, spring-run encountered at the fish trap on Keswick Dam were processed and trucked to Clear Creek for release. A total of 373 spring run were trucked to Clear Creek and released at NEED Camp near Whiskeytown Dam. At least 41 of these fish were observed leaving Clear Creek at the video station near the Sacramento River confluence, though the number may be much higher. With low

water at the weir, the Floy tags and caudal fin punches that these transported fish were marked with were barely detectable at times, and presumably many could have been missed. A total of 14 spring run Chinook Salmon carcasses were recovered during spawning surveys and of those, only 4 were Floy tagged.

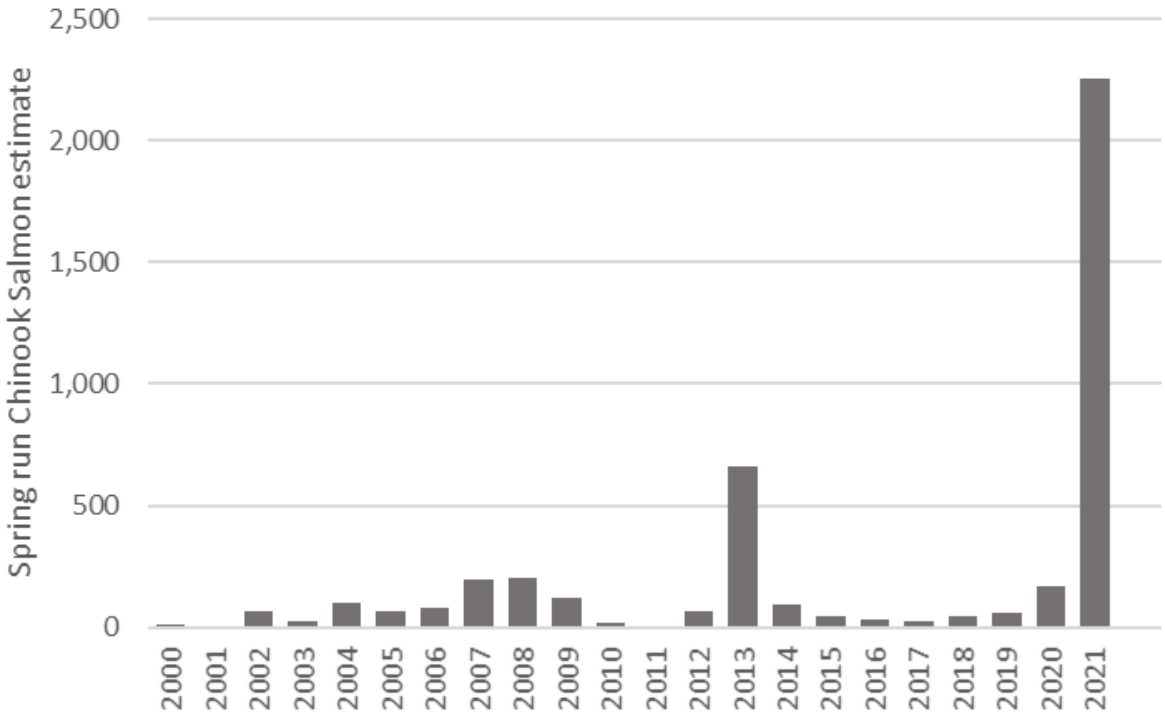

Figure 10. Clear Creek spring-run Chinook Salmon escapement reported to GrandTab (Azat 2022).

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 19,867 fall-run Chinook Salmon entered Clear Creek in 2021 (Azat 2022). Fall-run 2022 estimates are still underway, but preliminarily 2022 looks like a below average year for fall-run in the Sacramento Basin, Clear Creek included.

Late-fall run Chinook Salmon

The estimated late fall-run Chinook Salmon population was 96 adults. This number was calculated by applying an expansion factor of 2.75 on the 35 late-fall run Chinook Salmon redds that were observed during the survey season (December 14, 2021–April 1, 2022). The USFWS report detailing this analysis is in progress.

Steelhead

The resolution for adult "steelhead" numbers in Clear Creek is fuzzy 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.

4.3 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 2022, the weir was installed on August 10 and closed to upstream fish passage on September 6. The USFWS preliminarily plans to remove the weir in early November.

4.4 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 2022 indicates a continuing "recovery" of spawning habitat area following the fine sediment inundation from the 2018 Carr Fire. While less spawning habitat was mapped in 2022 (837,560 ft^2) than in 2021 (907,569 ft^2). The 2022 habitat area mapped is still greater than the area mapped in the two years following the fire. Total suitable spawning area mapped in 2022 is still less than the average habitat mapped 2011–2018, primarily from the reduction in habitat in "Renshaw Riffle" (RM 5–5.5), which is a key area for fall-run Chinook Salmon spawning. In the 2022 data, we see some evidence that the upstream-most reaches have "recovered" fully from the Carr Fire in terms of potential spawning area magnitude. The injection below Placer Road Bridge is showing an interesting pattern of habitat shifting downstream towards Clear Creek Road Bridge – it may be due to an increase of sand, depletion of gravel from the upstream end, or both. The downstream increase in this localized area is certainly due to the arrival of the Placer gravel slug. Very low magnitudes of spawning habitat were mapped near the gorge cascade (both upstream and down). The areas upstream of the cascade, from shooting gallery downstream, are the lowest areas in the 10-year record. This may be from high deposition of decomposed granite from the Carr Fire currently in this reach.

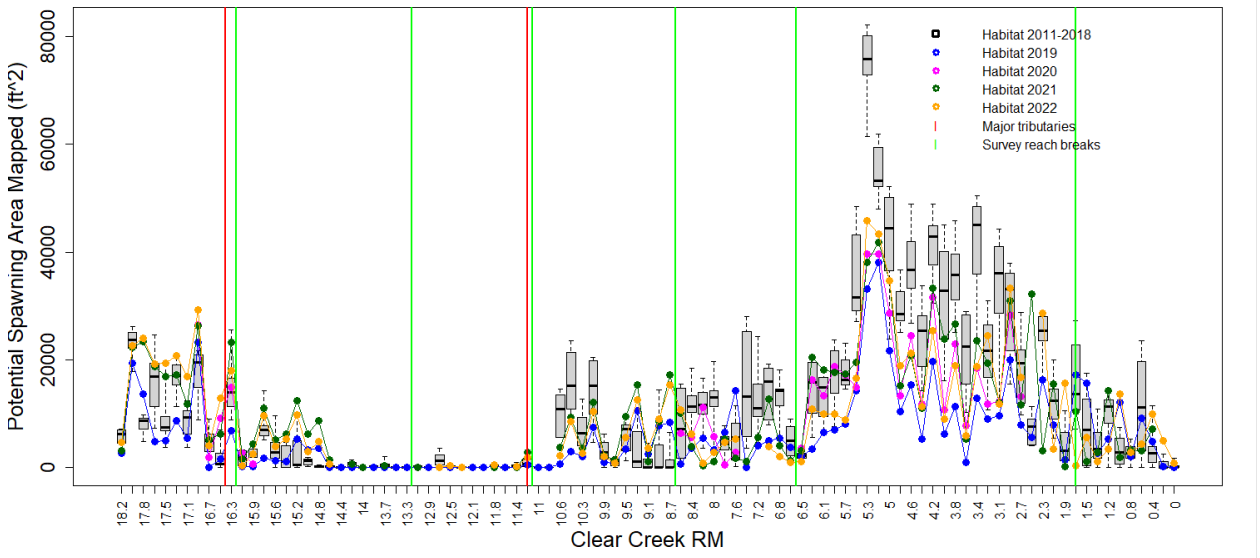

Figure 11. Anadromous fish spawning habitat mapped on Clear Creek 2011–2021. The X-axis indicates river mile breaks of roughly 1,000 ft. The Y-axis indicates the magnitude of habitat within each break. Years 2011–2018 are displayed by boxplot, 2019, 2020 and 2021 are presented as points. In 2020 only a subset of reaches was completed. USFWS-Red Bluff unpublished data.

The USFWS annually completes two surveys specific to monitoring fall-run Chinook Salmon. The Spawning Area Mapping (SAM) survey is completed each October and December and

spatially delineates the area disturbed by fall-run Chinook Salmon spawning in Lower Clear Creek (opposed to the available habitat, which is discussed in the previous paragraph). The October survey in 2021 was canceled due to a large rain event which obscured early fall-run Chinook Salmon spawning. The December survey was completed but this spawning area mapping only represents spawning that occurred after the rain event. In 2020, there were 389,174 ft^2 of spawning area mapped for BY 2020 fall-run Chinook Salmon (Figure 12).

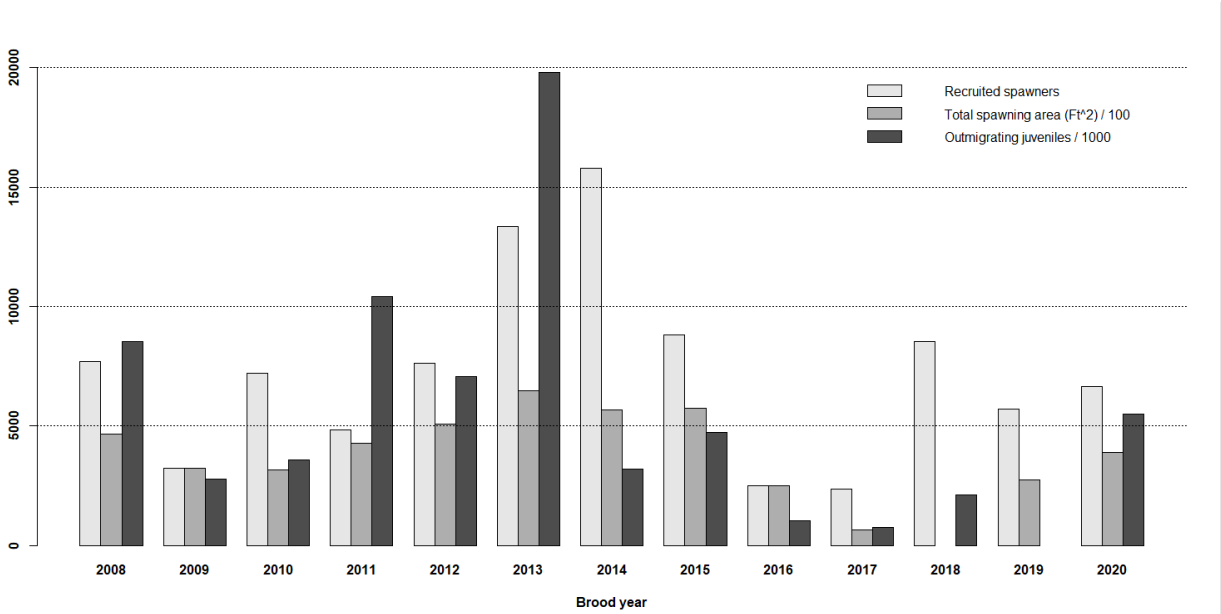

Figure 12. Area of spawning, adult escapement, and juvenile escapement fall-run Chinook Salmon 2008 to 2020. Total recruited spawners (light grey bar, Azat 2022). The combined total area of spawning disturbance, or spatial union of the October and December survey (ft^2) divided by 100 (dark grey bar). Out-migrating juveniles divided by 1,000 (Schraml et al. 2020). USFWS-Red Bluff unpublished data.

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 2021 show the proportional use of injected gravels vs. native gravels has increased for both spring-run Chinook Salmon and CCV steelhead (Figure 13).

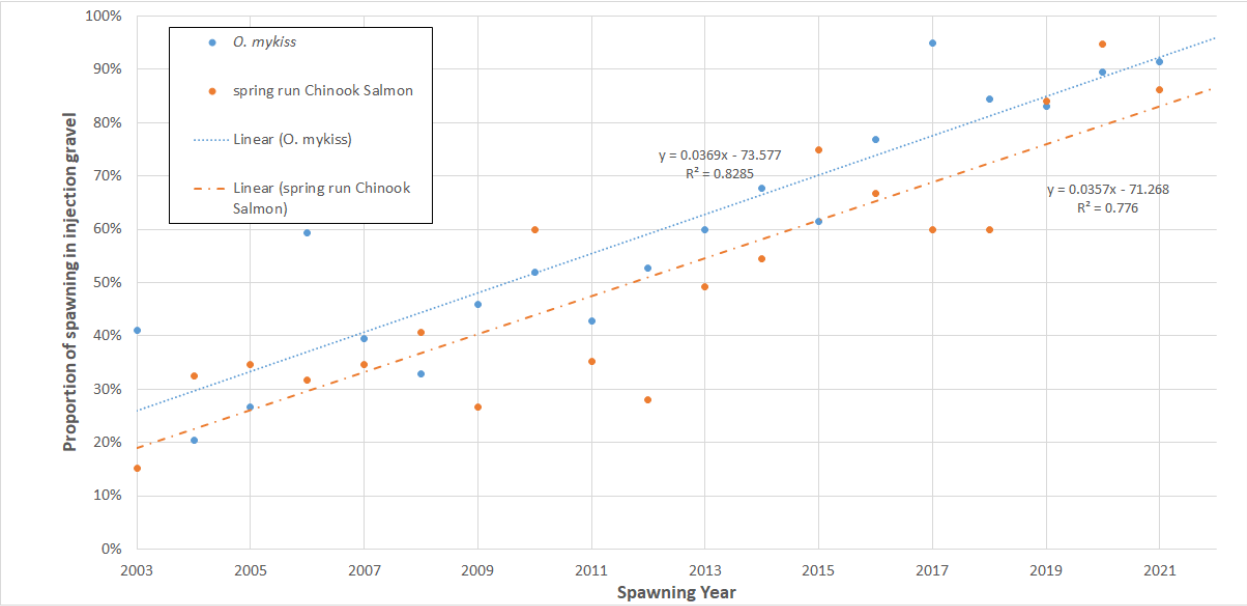

Figure 13. Annual proportion of spring-run Chinook Salmon and steelhead spawning in injection gravels, 2003–2021. Results limited to Clear Creek upstream of the spring- and fall-run Chinook Salmon separation weir. USFWS-Red Bluff unpublished data.

4.5 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 steelhead spawning and the "snorkel" spawning survey with the intent of quantifying spring-run Chinook Salmon spawning. In the 2021-2022 kayak season, seven surveys were completed between mid-December 2021 and the last week of March 2022. The surveys observed 35 late-fall and 217 *O. mykiss* redds. Additionally, 13 late-fall Chinook Salmon carcasses were retrieved, five of which were marked (adipose absent). The heads from adipose absent carcasses will be processed in the coming weeks to search for coded wire tags and determination of hatchery of origin.

As of the writing of this report, three snorkel-based spawning ground surveys have been completed during the 2022 spring-run Chinook Salmon spawning season (in areas upstream of the separation weir. Surveyors have observed and mapped 44 redds upstream of the separation weir (Figure 14) where they are attributed to spring-run Chinook Salmon. Additionally, survey crews have sampled 7 Chinook Salmon carcasses, four of which had Floy tags, and three are of unknown mark status. Additional information regarding final redd counts, carcass retrievals, and analysis of coded wire tags will be forthcoming after the survey season ends in mid-November.

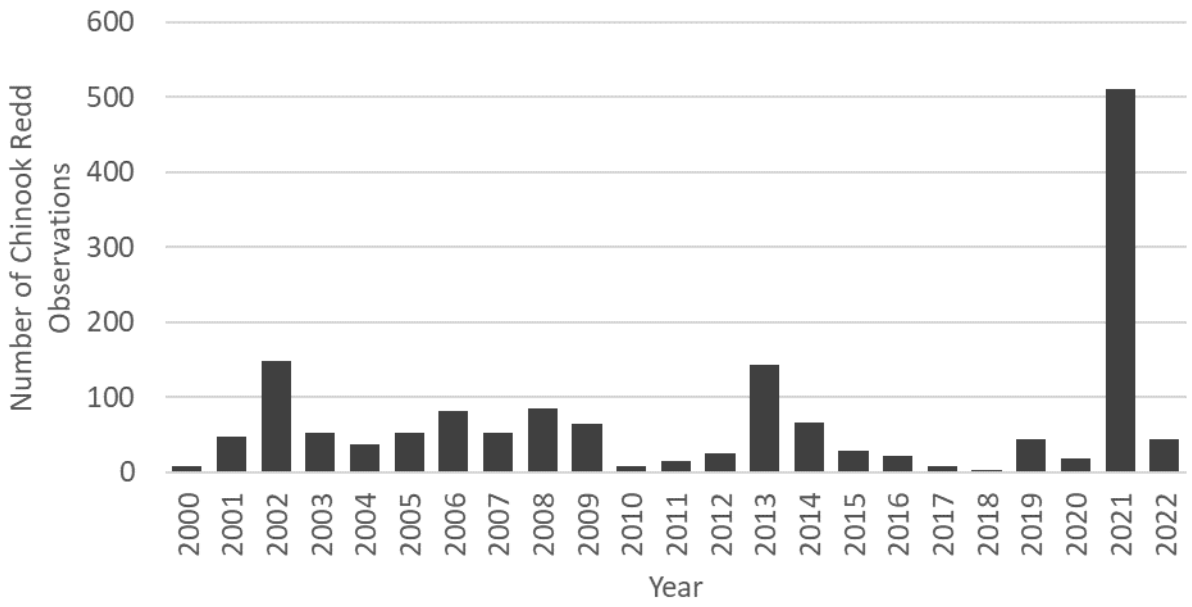

Figure 14. Number of spring-run Chinook Salmon redds observed above the segregation weir on USFWS spawning surveys from 2000- 2022. Note the 2022 redd count will be finalized after completion of the survey season in mid-November. USFWS-Red Bluff unpublished data.

Additional details on USFWS monitoring of Clear Creek can be found at https://www.fws.gov/office/red-bluff-fish-and-wildlife or by contacting Charlie Chamberlain, RBFWO.

CHAPTER 5. 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.