Clear Creek Technical Team
Summary of Activities for Water Year 2021

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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

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 8,057 from 1998–2020);
- 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 2021

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)
Paul Zedonis, Reclamation

Additional people from various agencies and entities participate on a less frequent basis (e.g., Clear Creek Community Service District, Redding Rancheria, Horse Town-Clear Creek

Preserve, Sacramento Municipal Utilities District, McBain and Associates, Graham Matthews and Associates, and U.S. Army Corps of Engineers). CCTT meetings in 2021 were facilitated by Kerns & West.

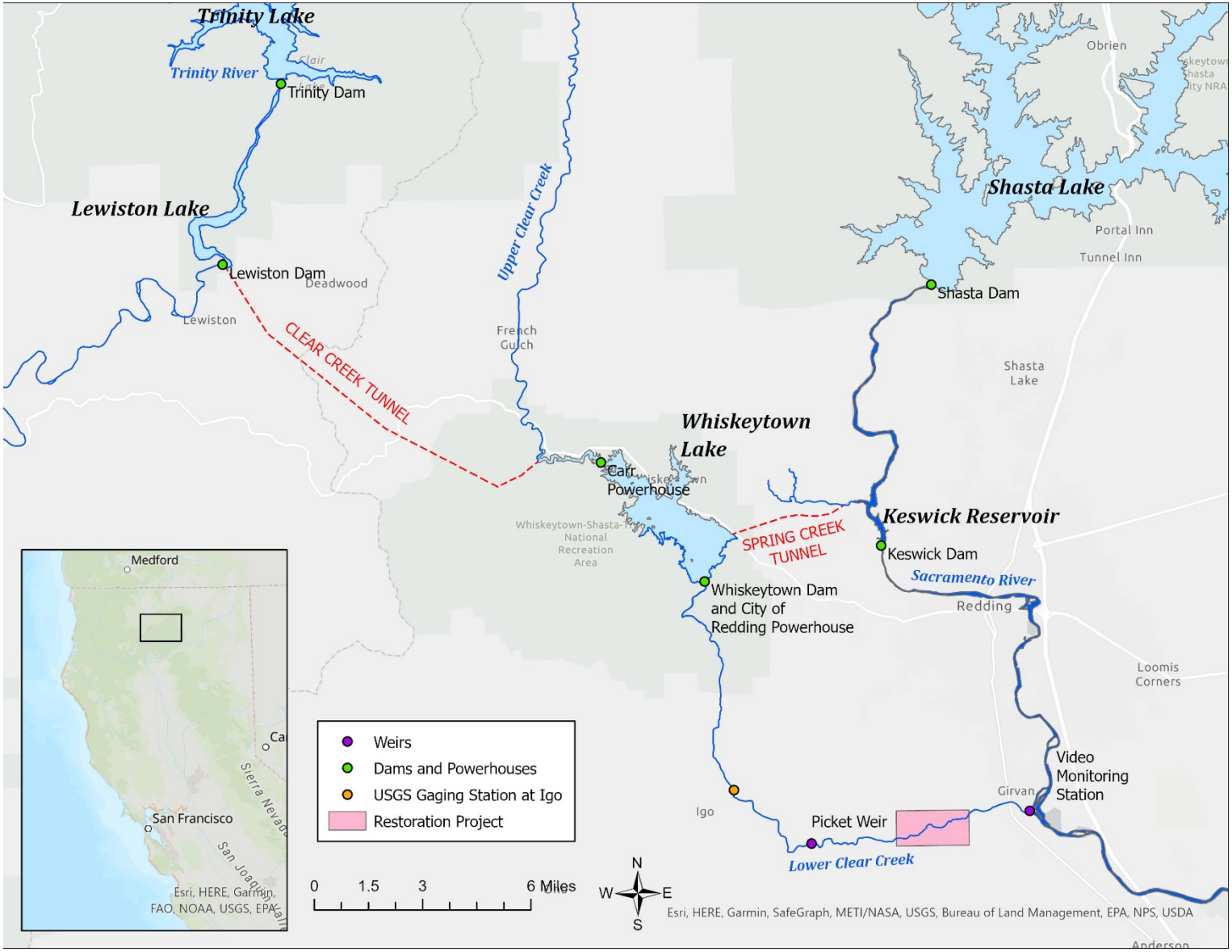

Figure 1. Location of Lower Clear Creek in Northern California, showing Trinity, Whiskeytown, and Shasta reservoirs and related CVP facilities.

1.3 List of Clear Creek Technical Team Discussions

The following CCTT meetings, with an abridged list of discussions, occurred in water year (WY) 2021 (and since the 2020 CCTT Annual Report). The individual CCTT meeting notes provide considerably more detail than the synopsis here.

December 17, 2020

- Lower Clear Creek Floodway Restoration Project (LCCFRP) Phase 3C (P3C) updates
    - Site visit with CCTT competed.
    - Revegetation is on-going, with over 50,000 container stock planted thus far.
    - Stormwater runoff prevention measures implemented.
- Habitat modeling at 2A/Gold Dredge gravel augmentation site
    - Pre- and post-hydraulic modeling showed increased habitat at all simulated flows.
    - Rearing habitat increased from 2% (spring-run Chinook Salmon fry at 1000 cfs) to 46% (spring-run Chinook Salmon fry at 200 cfs), with an average of 28% for all flows, Chinook Salmon runs, and life stages.
    - Floodplain inundation increased by 17% when instream flows were at 750 cfs.
- Beaver Dam Analogue (BDA) Examples
    - Details of BDA projects shown from across Northern California.
    - The building process was described.
- CCTT Summary of Activities for WY2020
    - The draft was sent to CCTT for review.
    - This document was included as part of the LTO Annual Report.
- Clear Creek water management in WY2021
    - Geomorphic flows unlikely, as precipitation has been low to date.
    - Spring pulse flows are reduced to one pulse in critically dry years.
    - Water temperature management should look to increase, but not exceed, the 60°F mean daily water temperatures at Igo gage to encourage upstream spring-run Chinook Salmon migration and also protect the Whiskeytown cold water pool.
- Gravel Augmentation
    - Early project planning discussed for 2021 project.
    - Top priority sites include the Dog Gulch, Reading Bar, and Above Phase 3A sites.
- Phase 3B Completion Project
    - This project looks to complete some of the unfinished during original construction.
    - Key aspects include revegetation, road decommissioning, and other actions.
    - Sub-group formed to discuss the project; they prioritized the revegetation efforts over the BDA construction.
- CCTT meeting format changes
    - Some format changes could occur to improve the interaction and collaboration within the group, since we have moved to on-line only meetings.
    - Several examples were shown and tested with the Team.
- Fisheries Monitoring
    - The 2020 spring-run Chinook Salmon August index was 59 fish, of which 24 were above the separation weir.
    - The separation weir was removed in November.
    - The pre-QC/preliminary estimate for fall-run Chinook salmon was 6,291 fish (video weir).

March 18, 2021

- CCTT moved to online meeting application due to COVID-19 pandemic
- Fisheries Monitoring
    - The upper rotary screw trap (RST) has captured 7,600 Chinook and 79 steelhead juveniles.
    - The lower RST has captured 112,000 Chinook and 570 steelhead juveniles.
    - There were 48 late-fall run Chinook salmon redds and 352 *O. mykiss* redds.
    - Spawning habitat monitoring data shared (via PSAM).
- Phase 3C
    - Revegetation completed in January, with irrigation to continue in summer/fall.
    - Photos and videos of fish use in the restoration area were displayed, with some discussion on what habitat the fish were utilizing.
- Steelhead Monitoring
    - The steelhead monitoring program (CDFW-lead) is looking to better understand the lifecycle of these fish.
    - 106 *O. mykiss*/steelhead were sampled from Clear Creek.
        - 36 were > 16 inches
        - 83% appeared to be non-anadromous
        - Mill Creek (Tehama County) is also being monitored and had a higher proportion of anadromy
    - Juvenile trapping-tagging in Deer Creek (Tehama County) and Mill Creek's data was also discussed.
- Stream Evolution Model
    - Brian Cluer (NMFS) provided a presentation on the genesis of the Stream Evolution Model and what it means for restoration efforts.
    - Examples of stage-0 restoration projects were shown and discussed.
    - Discussions on how this related to Clear Creek restoration, with two major techniques (1) lower the floodplain or (2) fill in the channel.
    - BDA and Post-assisted log structures (PALS) work by encouraging processes that fill in the channel.
- Wood Structure Supplementation Project
    - This project would seek to implement BDAs and PALSs in Clear Creek.
    - Wood structures would increase wetland area, increase fish rearing habitat, and create wildfire breaks.
- ACID Siphon Hydraulic Modeling
    - Data was shown that revealed possible fish barrier effects on anadromous fish migration.
    - The siphon does not meet CDFW and NMFS criteria for fish passage.
    - Options for remediation of the problem were discussed.
- Gravel Augmentation
    - After a review of the sites, the CCTT produced a plan for the 2021 project.
        - Whiskeytown Dam to receive 1,000 tons of gravel
        - Dog Gulch to receive 2,000 tons and 6 boulders
        - Reading Bar to receive 2,000 tons, boulders, and large wood
        - Above 3A to receive 2,000 tons
    - Augmentations was to occur in July–August of 2021.
    - New Army Corps of Engineers and Water Quality Control Board permits were needed.
- Clear Creek Water Management for WY2021

    - CCTT produced a proposal for water operations based on CVP/SWP Long-Term Operations proposed action (PA).
        - Critically Dry water year is expected (at the time of the meeting)
        - Base flows: 150 cfs June–September, 200 cfs October–May
        - Mean daily temps at Igo gage: 60 °F June 1–September 15; 56°F September 16–October
        - Upper and lower guard gates to be used to alter water temperatures
        - No channel maintenance flows in critically dry years
- Phase 3B Completion
    - Reclamation has opened solicitation for the project.
    - The plan is to have the contract awarded for spring 2022.
    - CCTT collaboration is a requirement of the contract.

June 17, 2021

- Fisheries Monitoring
    - Snorkel surveys (USFWS) show a record number of spring-run Chinook Salmon in Clear Creek, with nearly 1,500 fish (as of June 18).
    - Warmer than normal Sacramento River water temperatures likely encouraged spring-run Chinook Salmon to enter Clear Creek, especially during the May pulse flow.
    - The emergency pulse and low flow period was planned/implemented to encourage migration of spring-run Chinook Salmon upstream. Before emergency actions: 80% of spring-run Chinook Salmon were downstream of the Clear Creek Gorge (river mile (RM) 6.5).
    - Poaching of ESA-listed spring-run Chinook Salmon has been documented on Clear Creek.
    - Estimating juvenile emergence will use a simple model, which uses redd build date, redd location, and water temperatures.
    - RST catch info was as follows.
        - Upper RST caught 7,673 salmon
            - Estimated passage of 60,000 brood year (BY) 2020 (BY20) spring-run Chinook Salmon
        - Lower RST caught 117,999 salmon
            - Estimated passage of 4,000,000 BY20 fall-run Chinook Salmon
        - Traps removed when water temperatures got above 70°F
- Water Management in WY2021
    - Previous two years have been very dry, with few peaks over 1,000 cfs.
    - Spring Attraction flows implemented in May.
    - Images showing floodplain inundation at several locations, including three recent gravel augmentation sites during the 840 cfs pulse flow.
    - The Whiskeytown Powerplant is under repair. There is a reoccurring flow discrepancy in flow measurement between the powerplant and bypass. Adjustments were needed to maintain consistency.
- Restoration Project Updates
    - Gravel augmentation solicitation ended, hoping for award soon.
    - Phase 3B Completion solicitation opened, albeit additional CVPIA funds needed to award based upon submitted bids.
- Clear Creek Hydraulic Modeling

    - Reclamation's Technical Service Center is preparing a 2D hydraulic model of Clear Creek from Clear Creek Road Bride to the confluence with the Sacramento River.
    - Topography and bathometry come from multiple sources.
        - US Geological Survey (USGS) lidar data
        - CDFW topo/bathometry data
        - Phase 3C topo/bathometry data
    - More bathometry data will be collected in fall 2021.
    - Final model calibration is needed.
- Drone footage of Clear Creek Gorge
    - CDFW showed some photos of video and data from recent drone flights.
    - The drone attempted to get flights at various flows.
    - Attempts were made to quantify water surface elevation and velocity, but there were difficulties in doing so.

September 16, 2021

- Fisheries Monitoring
    - Preliminary 2020 RST data/estimates were provided.
        - 58,314 juvenile Chinook salmon estimated to pass the upper RST site
        - 5,580,117 juvenile Chinook Salmon estimated to pass the lower RST site
    - Preliminary estimate of 2,015 adult spring-run Chinook salmon entered Clear Creek this year!
    - Potential Spawning Area Mapping (PSAM) results were shared.
    - August index snorkel survey was truncated due to wildfire.
- Flow management review
    - Pulse flows results were discussed.
    - Emergency pulse results were discussed; CCTT agreed that this would be a good tool to use in the future if needed.
    - Drone footage was discussed from Gorge Cascade during pulse flow
- Overview presentation of BLM managed lands in Clear Creek
- Presentation on the Phase 3B Vegetation Completion Project.
    - Revegetate 7.5 acres, decommission spur roads, clean up
- Gravel augmentation 2021 before and after presented
    - Sites: Above 3A, Whiskeytown Dam, Below Dog Gulch
- Presentation of the CVPIA Near-Term restoration Strategy
- Fish Passage at ACID siphon crossing/discussion of field trip results
- CCTT Planning for future restoration actions

CHAPTER 2. CLEAR CREEK STATUS

2.1 Water Year Characteristics

Lower Clear Creek has a relatively small watershed with few significant tributaries and is highly reliant on water releases from Whiskeytown Dam. In WY2021, Clear Creek flows at Igo gauge saw very little natural flow variability. There were no natural instantaneous peak flows that exceeded 800 cfs. There were only three storm events that produced instantaneous peak flows over 300 cfs. In WY2021, only 3% of days exceeded a mean daily flow at Igo gage of 300 cfs or more (which includes the artificial pulse flows). If the managed flow releases are removed, only 1 day (0.02%; January 4 at 307 cfs) saw a mean daily flow of 300 cfs or more at Igo gage.

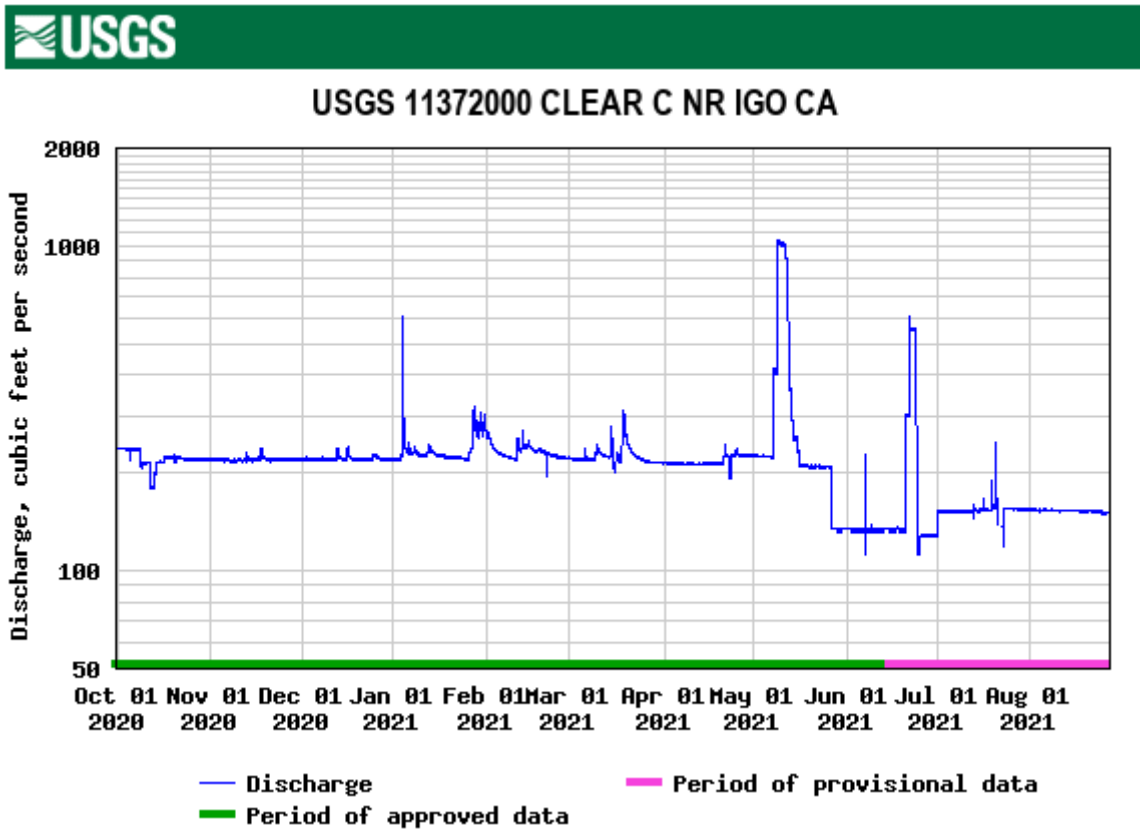

Figure 2. Instantiations flow on Clear Creek at Igo gage during WY2021. Data courtesy of USGS, https://waterdata.usgs.gov/nwis/uv?site_no=11372000.

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 WY2021, the May 1 update revealed a 3.7 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 WY2021.

2.3 Undesirable Physical Conditions

Some reaches of Clear Creek continue to be negatively impacted from excessive fine sediments from the 2018 Carr Wildfire, which burned most of the Lower Clear Creek watershed. Large amounts of decomposed granite (a coarse sand-like material) are entering Clear Creek from the tributaries (e.g., South Fork Clear Creek) that burned during the 2018 Carr Wildfire. These materials are small and light enough to move during low flows, coating the stream bottom as they move downstream. Excessive fine sediments in the stream channel have several major negative impacts, such as filling in holding pools, degrading spawning habitat, and a potentially lowered emergence percentage of Chinook salmon and steelhead fry. The lack of natural and managed geomorphic flows in WY2021 limited the creek's ability to force these sediments out of the creek channel and onto the floodplains.

Figure 3. Decomposed granite (a sand-like sediment) coats the stream channel upstream of Clear Creek Road Bridge. Large inputs of fine sediments occurred following the Carr Wildfire in 2018. Photo credit: Derek Rupert, Bureau of Reclamation.

Clear Creek continues to suffer from a lack of frequent and long-duration floodplain inundation. Both morphology and hydrology limit the potential for floodplain inundation. The reaches with wide alluvial valleys and low slopes (i.e., areas downstream of Clear Creek Road Bridge) generally have overly large channels, with thick riparian berms. Some areas with overly large channels are confined by tall tailings piles that completely block lateral migration. Other areas, such as the Restoration Reach (between RM2 and RM5), have accessible floodplains, but inundation only occurs with rare, short duration high flow events (Figure 4). Complete inundation of the valley floor is very rare. During the spring pulse flow (840 cfs peak) in WY 2021, some localized floodplain areas located in direct proximity to gravel augmentation sites

were inundated. These gravel augmentation sites can reduce the channel capacity and allow elevated water levels to engage the floodplains more easily. However, with only two days of elevated flows in WY2021 (stemming from the managed spring pulse flows), little seasonally inundated habitat was provided to rearing fish, and for too short a period to provide much benefit. More in-channel restoration actions are required to effectively increase seasonally inundated habitats. The CCTT has discussed the use of Beaver Dam Analogues (BDAs), Post-Assisted Log Structures (PALSs), gravel augmentations, floodplain lowering, and a change to the annual hydrograph to address the oversized morphology of the Clear Creek channel.

Figure 4. The restoration reach experienced little inundation during the spring attraction pulse flows (May 11), which was Clear Creek's highest flow in water year 2021. Photo credit: Derek Rupert, Bureau of Reclamation.

2.4 Central Valley Improvement Act Near Term Restoration Strategy

The CVPIA has funded many of the past restoration actions (monitoring and implementation) on Clear Creek and continues to be the main source of funding for current restoration efforts. Clear Creek is the only basin to be called out specifically for restoration, in CVPIA section 3406(b)(12). The CVPIA process for selecting and funding future restoration actions has recently changed significantly, with an emphasis on Structured Decision Making (SDM; Reclamation and USFWS 2020). The SDM looks to "…identify solutions that achieve the desired objectives, in a manner that is explicit and transparent" (Reclamation and USFWS 2020). The SDM process culminated in the 2020 Near Term Restoration Strategy (NTRS).

The NTRS highlights Clear Creek as a top priority system for restoration. The NTRS states, "Clear Creek has consistently produced fall-run [Chinook Salmon] and spring-run [Chinook Salmon] and the [Science Integration Team] recognizes that it has the potential to increase the natural production of both runs. The DSM results indicated that Clear Creek was included in the candidate strategies with the greatest increases in natural production and was frequently chosen for juvenile habitat restoration during the optimal spring-run and fall-run strategies. Based on the strategy simulations, juvenile habitat restoration in Clear Creek has the greatest potential to increase productivity in the Northwestern California diversity group. The [Science Integration

Team] also assumed that the juvenile habitat restoration would consist of a mixture of both in-channel and floodplain habitats based on the opportunities available at the restoration areas" (Reclamation and USFWS, 2020).

The CCTT plans to pursue habitat restoration projects that will fulfill the NTRS's recommended actions for Clear Creek. These include juvenile salmonid habitat restoration and maintaining salmonid spawning habitat. The CCTT understands that all future Clear Creek restoration actions must increase the quantity and quality of both perennial and seasonally inundated juvenile salmonid habitats to address the goals of the NTRS. The CCTT has several restoration project plans for future projects and will be seeking funding to implement them. The CCTT will also look to continue ongoing habitat management projects which are showing positive habitat improvements (Figure 5).

Figure 5. Off-channel floodplains inundated during the May 2021 spring pulse flows (840 cfs release) at the Gold Dredge/Phase 2A site. The 2020 gravel augmentations at this site improved conditions for localized floodplain inundation. This area only experienced 2 days of inundation in WY2021. Photo credit: Derek Rupert, Bureau of Reclamation.

CHAPTER 3. CLEAR CREEK MANAGEMENT ACTIONS

The following sections highlight the management actions that occurred in Clear Creek during WY2021 (WY2021: October 1, 2020–September 30, 2021). Occasionally, additional information is included that covers other water years (i.e., WY2020) for continuity, as some actions cross water years (e.g., water temperature management). With little precipitation in the winter of 2020 and spring 2021, the water year was designated Critically Dry. 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 WY2021:

Table 1. Summary of WY2021 management actions, Clear Creek

	Management Action Item	Progress in WY2021
1.	Minimum Base Flows	Completed with some purposeful/approved deviations
2.	Water Temperature Management	Implemented with some excursions
3.	Spring Attraction Flows	Completed
4.	Channel Maintenance Flows	Not Implemented
5.	Emergency Pulse Flow and Low Flow Periods (A Water Neutral Action)	Completed
6.	Fish Habitat Restoration and Management ("Gravel Augmentation")	Completed
7.	Phase 3C Habitat Restoration Project	Completed
8.	Fisheries Monitoring	Completed see CHAPTER 4

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 WY2021, Clear Creek's minimum base flows were met for most of the year, except for a purposeful reduction during an emergency action (see below). The operations plan for Clear Creek has provisions for deviating from base flow minimums during critically dry water years, such as WY2021.

Additional flows were required to meet temperature criteria in the fall of 2020. From the beginning of WY2021 through October 8, 2021, Whiskeytown Dam releases to Clear Creek were elevated, running at approximately 225 cfs (Figure 6). These flows were a continuation from the adjustments required to attempt to meet water temperature criteria in WY2020 that started on September 28, 2020. The flows returned to the normal base flow of 200 cfs on October 9. As water temperatures again exceeded the temperature criteria, flows were increased to 215 cfs on October 15. These elevated flows were maintained through February 27, 2021. Flows were finally reduced to 200 cfs on February 28, 2021.

The single spring attraction flow occurred May 8–11, 2021, with an 840 cfs peak. The USFWS's data showed a record number of spring-run Chinook Salmon in the creek and a significant proportion of the fish were downstream of the Clear Creek Gorge. The CCTT developed emergency actions that would reduce base flows below normal base flows to 'bank' water for an emergency pulse flow. The CCTT hoped to encourage the spring-run Chinook Salmon to migrate further upstream. The emergency actions were initiated on May 27, 2021, with a base flow reduction (from 200 cfs to 125 cfs). These reduced flows (125 cfs) occurred both before and after the emergency pulse (from May 27–June 20, and June 25–July 1). The emergency pulse occurred from June 21–24, with a 500 cfs peak. For additional details, please see section 3.3 Spring Attraction Flows.

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 WY2021, CVO made flow adjustments to ensure that flows at Igo gage remained consistent when switching between the powerhouse and the bypass.

Additionally, small flow discrepancies occurred in WY2021 when the USGS performed several gage calibrations. The USGS struggled to find repeatable and precise readings at the Igo gage during low flow periods. Some of these issues may stem from the heavy loads of decomposed granite that continually change the cross-sectional area at the gaging location (see Section 2.3 for more information on decomposed granite).

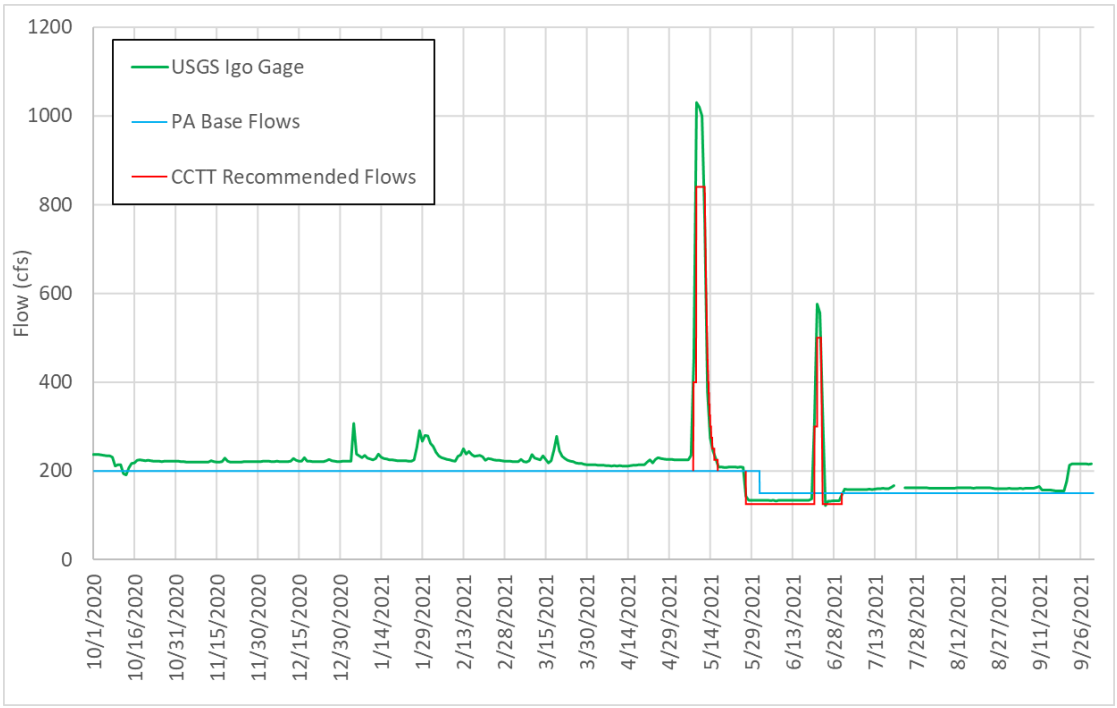

Figure 6. Mean daily flow on Clear Creek during WY2021, measured at Igo gauge (USGS 11372000; green line). The Proposed Action's base flow minimums are shown as a blue line. CCTT recommended flow actions shown as a red line.

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 WY2021, water temperature criteria were met at Igo gauge with varying levels of compliance. WY2021 was a "critically dry" year. Water temperatures over the management season (June 1–October 31) remained below or near the criteria.

The Oak Bottom Temperature Control Curtain remained in place and operational during WY2021. 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. The relatively large amount of water diverted from Trinity Reservoir from the Carr Tunnels helped maintain the cold-water pool in Whiskeytown Reservoir in WY2021.

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; Table and Figure 7). The mean daily 60°F criterion is hypothesized to work in conjunction with spring pulse flows to exert

thermal gradients in stream temperatures and encourage the migration of spring-run Chinook Salmon.

The temperature criterion transitioned from 60°F to 56°F for the spawning/egg incubation period of September 16 to October 31. A Whiskeytown Dam gate adjustment was attempted on September 15 to withdraw more water from the lower guard gate, providing the coldest possible water from Whiskeytown Reservoir. However, it's unclear if 100% of the flow came from the lower gate, and the gate adjustment was insufficient to meet the 56°F temperature criterion at Igo gage. Water releases from Whiskeytown Dam were subsequently increased from 150 to 200 cfs on September 21, several days before the base flow would normally return to 200 cfs. During the spawning/incubation criteria period, mean daily water temperatures were met for 37 of 46 days (80%; Table 2 and Figure 3). All the daily water temperature exceedances were relatively minor, with all but one day remaining within 1 F° of the 56°F mean daily temperature criterion. The first day of the 56°F period (September 16), exceeded the mean daily temperature criterion by 1.3 F°.

Table 2. Proportion of days that water temperatures at Clear Creek IGO gauge met the criteria. Note: that these data refer to the 2021 calendar year, as opposed to water year. The September 16 to October 31 temperature criteria span water years.

Year	Holding temperature ≤60°F June 1 to September 15	Spawning temperature ≤56°F September 16 to October 31
Pre-2009 (average)	99%	93%
2009	100%	26%
2010	100%	26%
2011	100%	62%
2012	100%	64%
2013	100%	96%
2014	100%	0%
2015	100%	0%
2016	98%	15%
2017	100%	100%
2018	99%	87%
2019	98%	67%
2020	100%	74%
2021	100%	80% (37 of 46 days)

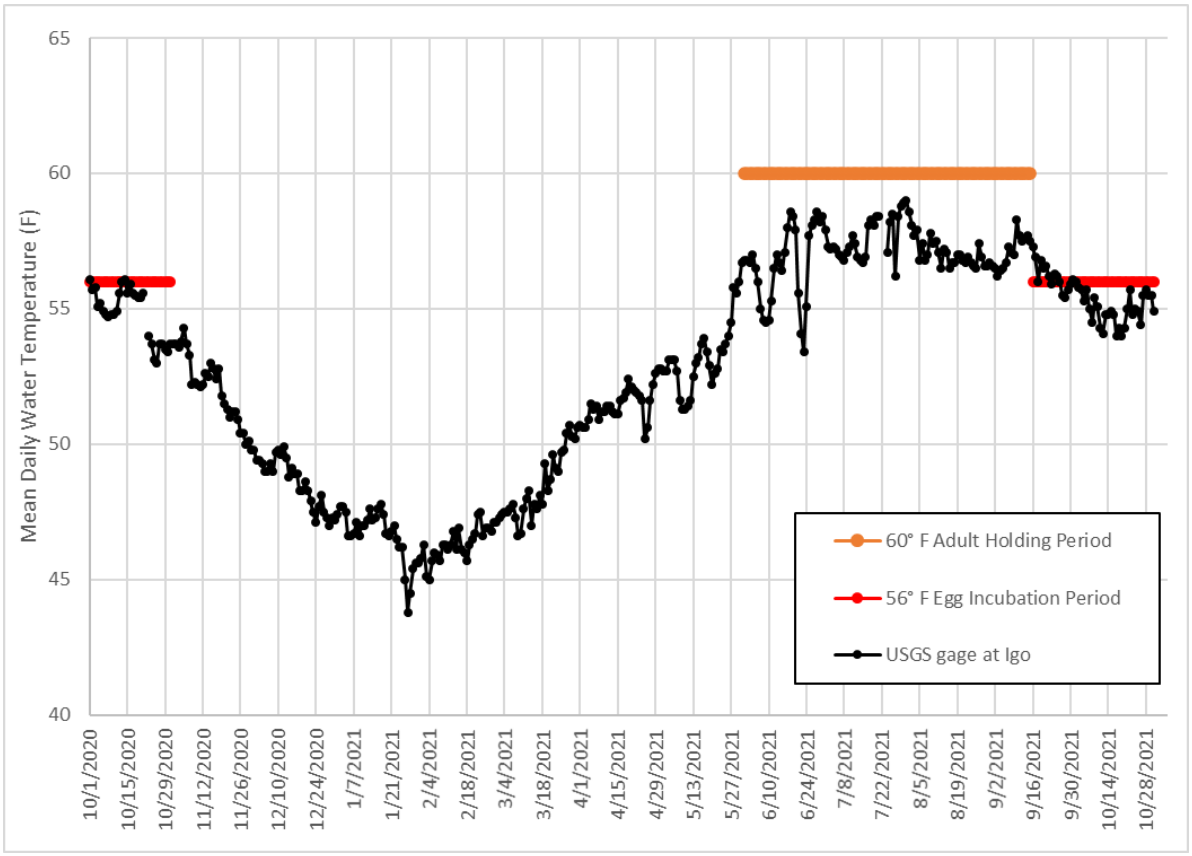

Figure 7. Mean daily water temperature on Clear Creek at the Igo gaging station in 2021 compared to the mean daily temperature criteria for spring-run Chinook Salmon holding (60°F June 1 to September 15) and spawning and incubation (56°F September 16 to October 31). Data from October 2021 (WY2022) shown for reference.

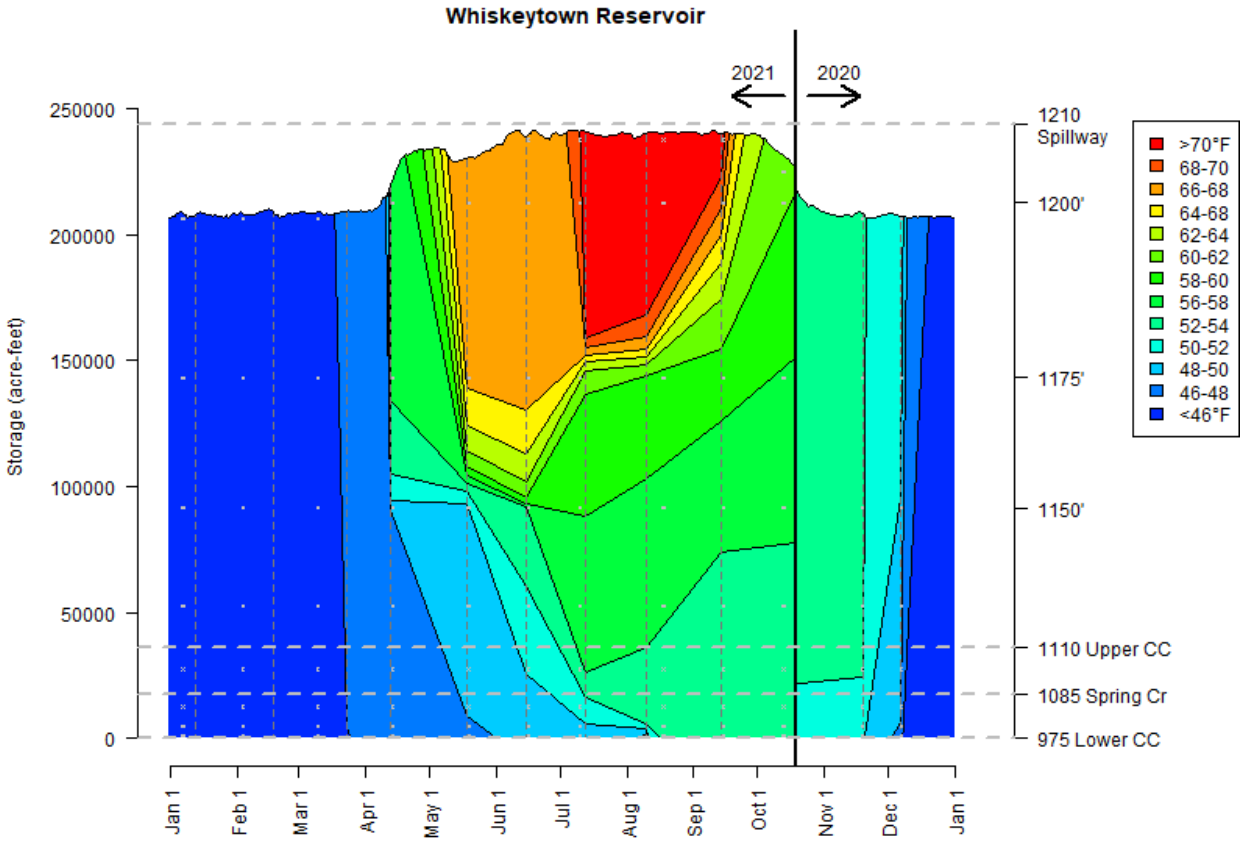

Figure 8. The isothermobath from Whiskeytown Reservoir in 2021 compared to 2020.

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 2021 for implementation of the ROD's flow requirements on Clear Cr. The CCTT deliberated on the timing and peak(s) of the pulse flow(s) actions. 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. These plans were implemented following final approval of Reclamation's CVO office. All pulse flow actions utilized a 25 cfs per hour or less down ramping rate.

Due to the lack of significant winter precipitation, WY 2021 was determined to be a Critically Dry. Therefore, the CCTT proposed a single spring pulse flow proposal just for Critically Dry water years (Figure 9) occurring May 7 through May 16, 2021, which had a 900 cfs peak (consistent with the Proposed Action and corresponding Biological Opinion). This peak was then adjusted to 840 cfs to accommodate the Clear Creek Community Service Districts infrastructure

limitations. This spring pulse was successfully implemented, and the fish response was monitored by the USFWS.

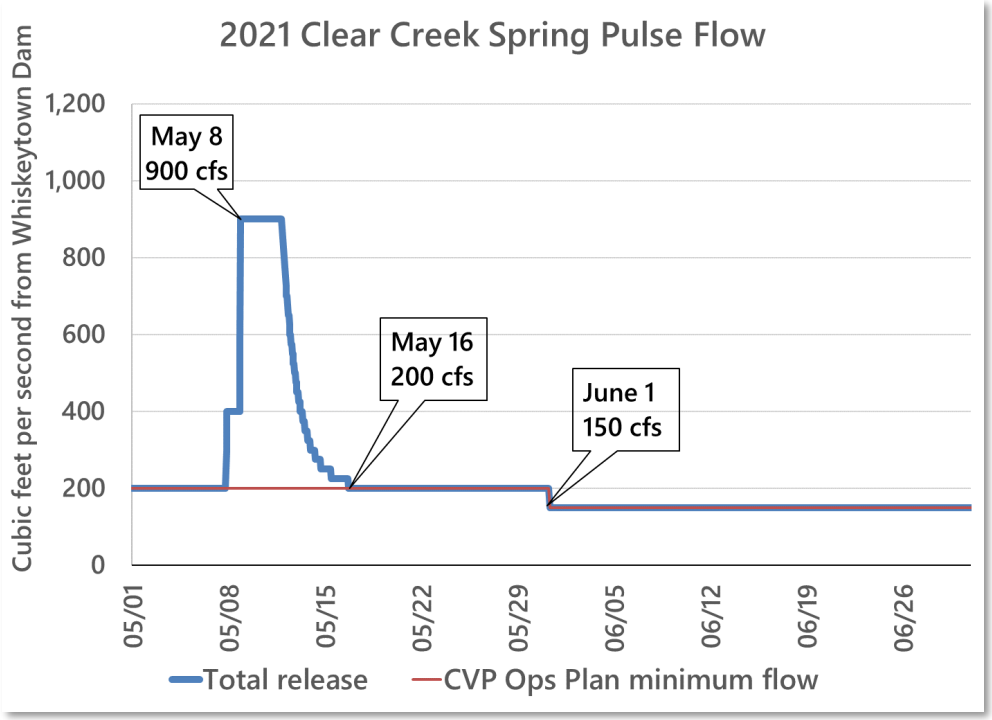

Figure 9. Proposed release schedule for 2021 spring pulse flow from Whiskeytown Dam.

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, Reclamation produced a news release that was published by their public affairs office. Finally, the CCTT has added a small flow bench (~300 cfs) to all the recent pulse flows 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.

Adult spring-run Chinook Salmon enter Clear Creek from late April through early July, with peak migration in May and June. In 2021, the single flow pulse provided from Whiskeytown Dam was chosen 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. Video monitoring results of previous years have suggested that spring-run Chinook Salmon passage into Clear Creek is greater in the earlier portion of prolonged pulse flows, and shorter duration pulses may provide the same attraction benefit and use less water.

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 (diver efficiencies are not determined), and spatial information on the distribution of adults within Clear Creek (Figure 10).

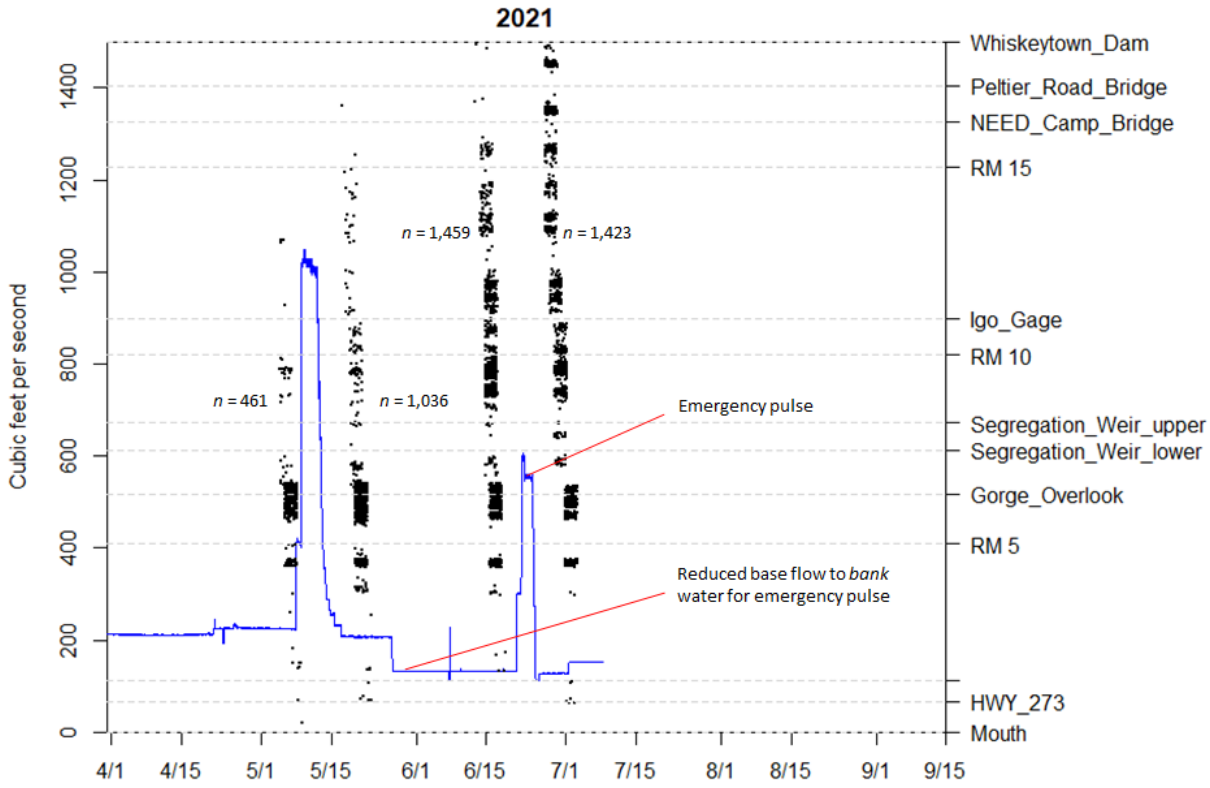

Figure 10. Distribution of spring-run Chinook Salmon before and after the spring pulse flow and emergency pulse-low flow action. USFWS Red Bluff unpublished data.

3.4 Emergency Pulse Flow and Low Flow Periods (A Water Neutral Action)

The spring attraction pulse flow occurred May 8–11, with an 840 cfs peak. The USFWS's data from May 17 (post-attraction flow) showed a large number of spring-run Chinook Salmon in the creek and a significant proportion of the fish downstream of the Clear Creek Gorge. Upon discovering that a record number of spring-run Chinook Salmon were occupying the lower reaches of Clear Creek following the single planned spring pulse flow, an ad hoc CCTT meeting was convened on May 24 to discuss the possibility of an emergency action. The CCTT discussed possible emergency actions and developed a tentative plan. On May 25, a proposal was distributed to the CCTT and sent to CVO (Figure 11). Further discussion occurred with CVO operators for concurrence and panning. The CCTT's proposed plan would not utilize additional water but would lower base flows below normal operations commensurate with the pulse flow volume (i.e., water neutral). This reduction in base flows is consistent with the PA, which states that flows may drop below 150 cfs in Critical water years. The proposed emergency pulse plan was initiated on May 27, with a base flow reduction. These reduced flows (125 cfs) occurred both before and after the emergency pulse (from May 27–June 20, and June 25–July 1). The emergency pulse occurred from June 20–24, with a 500 cfs peak.

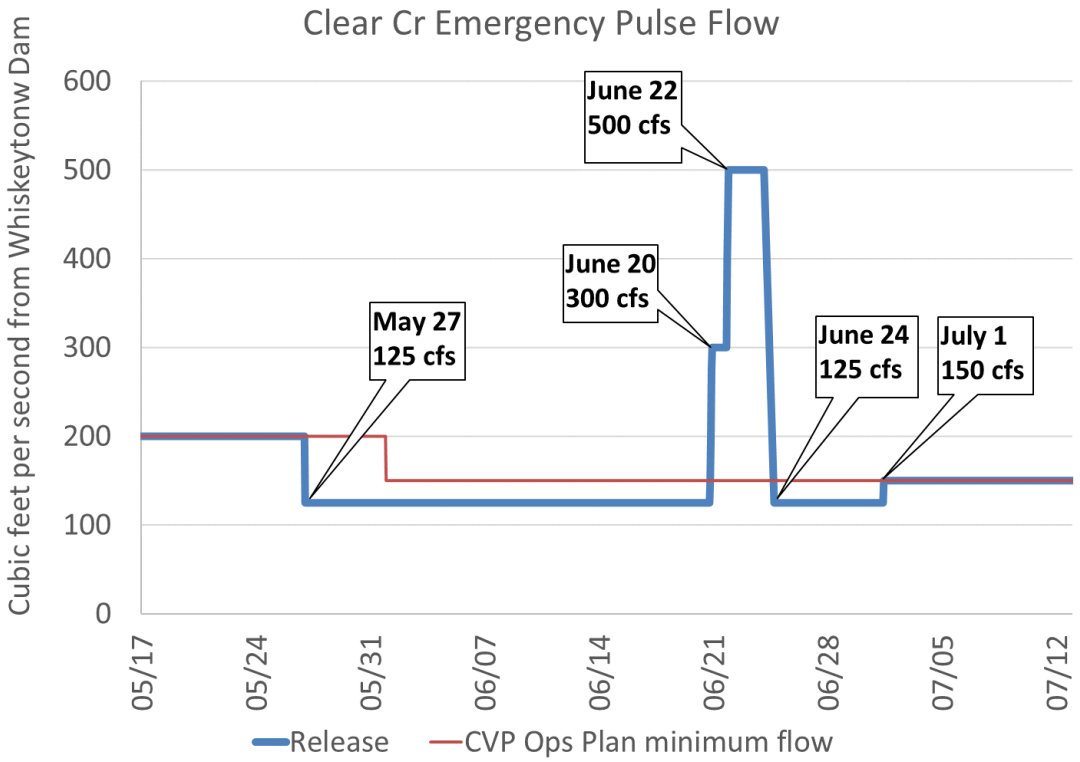

Figure 11. The CCTT proposed emergency pulse flow and corresponding reduced baseflow periods compared to the CVP operations plan minimum base flows. From CCTT's Emergency Flow Management Action for Clear Creek Spring-run Chinook Salmon proposal (CCTT 2020).

The proposed emergency pulse flow actions were intended to encourage spring-run Chinook Salmon upstream into the reaches of Clear Creek upstream of the Gorge. The Gorge is a steep cascade (RM 6.5) that is often difficult for migrating fish to pass, and it is an important division point between the lower and upper reaches of Clear Creek. Fish downstream of the Gorge are vulnerable to excessively warm water, increased poaching pressure, and possible impacts with fall-run Chinook Salmon (i.e., hybridization). The CCTT devised a proposal that utilized both a low flow period and pulse flow that was water-neutral (i.e., did not use additional water beyond normal operation). The period of reduced flows was anticipated to cause the water temperatures in the creek to warm and stimulate fish movement (i.e., they would seek cooler water upstream). The emergency pulse flow would cause a rapid drop in water temperature and increase turbidity, again stimulating fish migration. The objective was to have 100% of the adult spring-run Chinook Salmon to migrate upstream of the Gorge where they could hold in the safety of deep pools and cooler water.

The combination of reduced base flows and an additional pulse flow was successful in encouraging many spring-run Chinook Salmon to move upstream past the Gorge. The USFWS conducted several snorkel surveys in 2021 to count and determine the distribution of spring-run Chinook Salmon in Clear Creek. Each snorkel survey was conducted along the entire length the Lower Clear Creek. These data clearly showed that the distribution of spring-run Chinook Salmon continually moved upstream following each flow action (Figure 12). Early snorkel surveys (May 17) showed that 85% of the 1,035 spring-run Chinook Salmon were downstream of the Gorge. Following the reduced flow period and emergency pulse flow, snorkel surveys (June 28) revealed that only 31% of the 1,423 spring-run Chinook Salmon were downstream of the Gorge (Figure 12). Because of poor air quality indices, only reaches 1–5 (i.e. upstream of the Gorge) were snorkeled during the August Index survey.

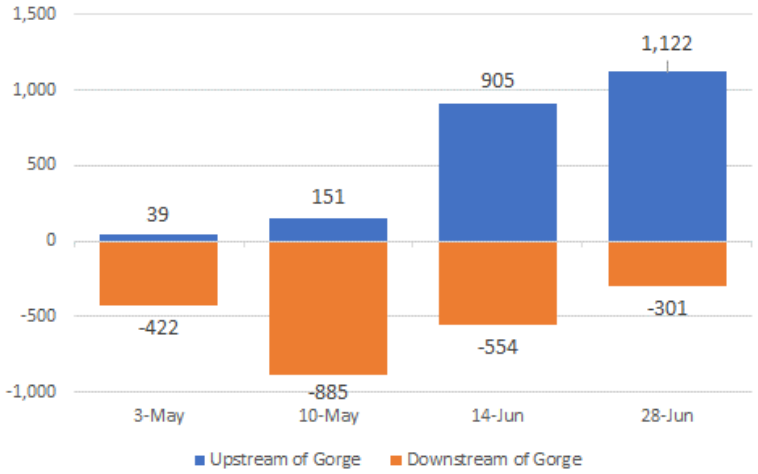

Figure 12. The distribution of spring-run Chinook Salmon in Clear Creek relative to the Gorge Overlook. From USFWS-Red Bluff unpublished data.

Water temperature data are collected continuously at the Igo gauging station. This information showed a response following the reduced flow periods (warmer water) and during the emergency pulse (cooler water; Figure 13). Even with the reduced base flows and a heat wave in June and early July (>115°F maximum daily air temperature), Clear Creek did not exceed the 60°F mean daily water temperature criterion.

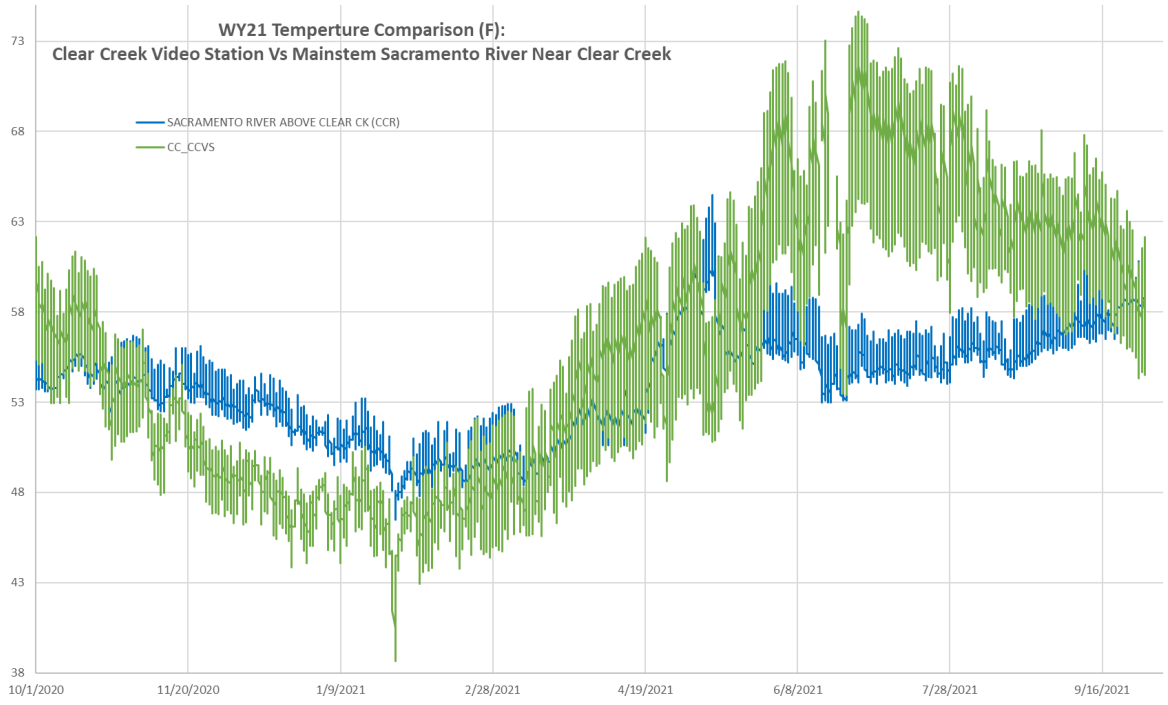

Figure 13. Hourly water temperature data from loggers on Clear Creek and in the Sacramento River. The green line represents the water temperatures at the Video Station Weir and the blue line represents the Sacramento River water temperatures just upstream of the confluence with Clear Creek. USFWS-Red Bluff unpublished data.

Some abnormal temperature management occurred on the Sacramento River in the spring of 2021, which may have influenced spring-run Chinook Salmon migration into Clear Creek. Operators released higher than normal water temperatures out of Shasta Dam to conserve cold

water pool for later in the year. Around April 21, the mean daily water temperatures in the Sacramento River (as measured just upstream of the confluence with Clear Creek) began to climb above those of Clear Creek (as measured just upstream of the Sacramento River confluence). This temperature discrepancy was more significant during May 8–12, when the Clear Creek spring attraction flows were released from Whiskeytown Dam, and water temperatures in Clear Creek further deviated (lower temperatures) from those in the Sacramento River. It is unclear how these water temperatures affected the movement of spring-run Chinook Salmon. Some have hypothesized that the higher water temperatures in the Sacramento River may have encouraged out of basin spring-run Chinook Salmon into Clear Creek. More information on this may come to light with the video monitoring weir data and further water temperature analysis. The CCTT should consider the temperatures and flow actions occurring on the Sacramento River when they propose future years' pulse flows.

3.5 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: No Channel Maintenance Flows were released in 2021, as it was designated a "dry" water year type. There were no Gloryhole spills in WY2021.

The CCTT will be developing a plan for implementation of geomorphic flows in WY2022 if an appropriate water year materializes.

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 2022.

3.6 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: The gravel augmentation program on Clear Creek continues to enhance the spawning habitat available for spring- and fall-run Chinook Salmon and CCV steelhead. Augmentation of gravel supply helps restore and maintain the balance of sediment in Clear Creek, providing desirable river channel attributes like floodplain connectivity, channel migration, fish habitat formation (e.g., spawning habitat), and riparian community development. A total of 5,011 tons of coarse sediment (e.g., gravel) were injected at three sites on Clear Creek, including 6 boulders (Table 4). Permitting constraints inhibited the planned gravel augmentations at Reading Bar in 2021. The WY2021 augmentation increased the cumulative total amount of coarse sediment placed into Clear Creek to 196,605 tons (1996–2021).

The Above Phase 3A gravel augmentation site (RM 4.24) is located within the wide, alluvial valley that defines the lower reach of Clear Creek. Gravel augmentation was completed from July 7–9, with 2,022 tons placed (Figure 14). The Above Phase 3A site is important to the Lower Clear Creek Floodway Rehabilitation Project reach as it is the upstream most gravel augmentation site to feed directly into the 2.2-mile rehabilitation reach. This site has continually recruited gravel into the system with relatively low flows. The Above Phase 3A site has been utilized nine times since 2005 for gravel augmentations, receiving a cumulative total of 19,948 tons of gravel.

The Below Dog Gulch gravel augmentation site (RM 17.64) is located within the narrow, moderately confined valley that defines the upper reach of Lower Clear Creek. Gravel augmentations occurred between July 13 and July 16, with 1,976 tons placed, of which 351 tons was "large" material (Figure 15). There were 6 boulders (3-5 ft diameter) placed at the site, with 4 being placed as a single boulder cluster and 2 others placed individually. The riffle supplementation style augmentation implemented at Dog Gulch provides immediate spawning habitat for spring-run Chinook Salmon and CCV steelhead. The Dog Gulch site is the upstream most riffle supplementation site within Lower Clear Creek. The Dog Gulch site has been utilized 6 times since 2009 for gravel augmentation, receiving a cumulative total of 9,990 tons of gravel.

The Whiskeytown Dam gravel augmentation site (RM 18.24) is located within a narrow, confined valley only a few hundred yards below Whiskeytown Dam. Gravel augmentations were complete on July 20 and 21, with 1,013 tons of grave placed. The gravel is placed at this site as a talus cone, which will require high flow events (e.g., uncontrolled spill) from Whiskeytown to mobilize and transport the gravel downstream. It is possible the gravel placed at this site will stay in place for several years, as high flow events at this location are rare. This year's implementation marked the 11th time gravel augmentations occurred at Whiskeytown Dam since 1998, with a cumulative total of 29,780 tons placed at the site.

Table 4. Clear Creek materials augmented in 2021.

Location	Coarse Sediment (tons)	Boulders
Whiskeytown Dam (RM 18.24)	1,013	-
Below Dog Gulch (RM 17.64)	1,976	6
Above Phase 3A (RM 4.24)	2,022	-
Total	5,011	6

Figure 14. Construction of the lateral berm at the Above Phase 3A site. Photo credit: Derek Rupert, Bureau of Reclamation.

Figure 15. Implementation of the gravel augmentation project at the Below Dog Gulch site. Photo credit: Derek Rupert, Bureau of Reclamation.

3.7 Clear Creek Phase 3C Restoration Project

Objective: *Continue the Lower Clear Creek Floodway Restoration Project by constructing the Phase 3C project.*

Action: *"Reclamation and DWR propose to continue channel maintenance under the Clear Creek Restoration Program." (Section 4.10.2.6. of the PA)*

"… The Clear Creek Restoration Program is working on restoration of a 2-mile section of Clear Creek floodplain and stream channel degraded by aggregate and gold mining, dams and diversions, …" (Section 2.3.6.1. of the PA).

Results: In 2020, major construction was completed for the Lower Clear Creek Floodway Rehabilitation Project (LCCFRP) – Phase 3C. The Phase 3C project was funded through the CVPIA and was guided by technical input from CCTT and Reclamation's Technical Service Center. The Yurok Tribe helped develop the site's design and completed all the construction for the Phase 3C project. The project is on public lands administered by the BLM. In WY2021, the Yurok Tribe continued their efforts through the revegetation of areas disturbed during construction.

The revegetation design was described in the Lower Clear Creek Floodplain and Stream Channel Restoration Project – Phase 3C 90% Design document (Yurok Tribe Design Team, 2019). The revegetation at Phase 3C was initiated in late 2019 and continued through January 2021. A diversified revegetation strategy was implemented to improve the ecological function, habitat potential, and esthetics of the construction area (Figure 18). Willow clusters and trenches, container stock plants and trees, acorn dispersal, and seeding mulching were used throughout the site (Figure 17). In total, there were 13,784 willow pole cuttings used (representing 5 native species), approximately 70,000 container stock plants were planted (representing 13 native species), and more than 1,300 pounds of seed (representing 6 native species) was dispersed. Some deviations from the original revegetation design occurred, as there were less disturbed/bare areas created during construction than anticipated (Yurok Tribe Design Team, 2021).

In WY2021, planting and seeding were completed at Phase 3C (Figure 18). Irrigation of planted trees and plants continued through the summer of 2021. Additional irrigation will occur in 2022. Once irrigation ceases and the materials are removed, the Phase 3C project will be considered complete.

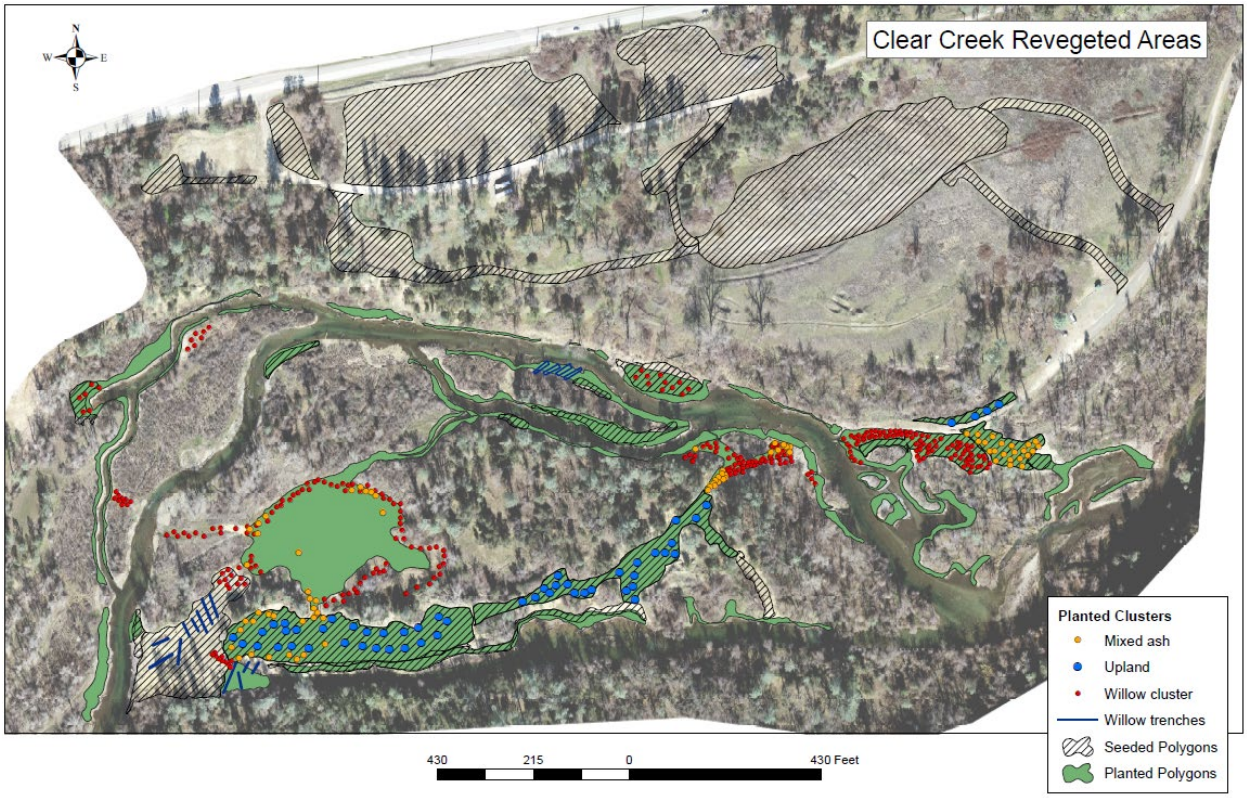

Figure 16. The revegetated areas and planting types completes at the Phase 3C project site. Adapted from the Lower Clear Creek Floodplain and Stream Channel Restoration Project, Phase 3C Revegetation As-Built Final Report (Yurok Tribe 2021).

Figure 17. Crates of containers stock plants ready for planting across the Phase 3C project area. Photo credit: Derek Rupert, Bureau of Reclamation.

Figure 18. Clear Creek flowing through the Phase 3C stream channel restoration project area. Spring (March 2021) plant growth reveals that the revegetation efforts were successes on the newly created river bars. Photo credit: Derek Rupert, Bureau of Reclamation.

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 2021, two traps were on the water from October 28, 2020, to June 30, 2021. Both traps were not fished on the weekends starting January 2, 2021, because of reduced staffing levels.

The juvenile fall-run Chinook Salmon passage index at LCC RST near China Garden was 4,877,452 fish (Figure 19). The *O. mykiss*/steelhead passage index at LCC RST was 39,316 fish (Figure 20). This passage is not adjusted for redds below LCC. Spring-run Chinook Salmon passage index at UCC near Clear Creek Road Bridge was 58,787 fish (Figure 21). This passage is not adjusted for redds between the separation weir and UCC. Spring-run Chinook Salmon passage estimate at LCC was 19,798. Note that the official reported index is from UCC, and the LCC passage index is calculated for comparison purposes. The Brood Year 2020 Juvenile Report is in progress.

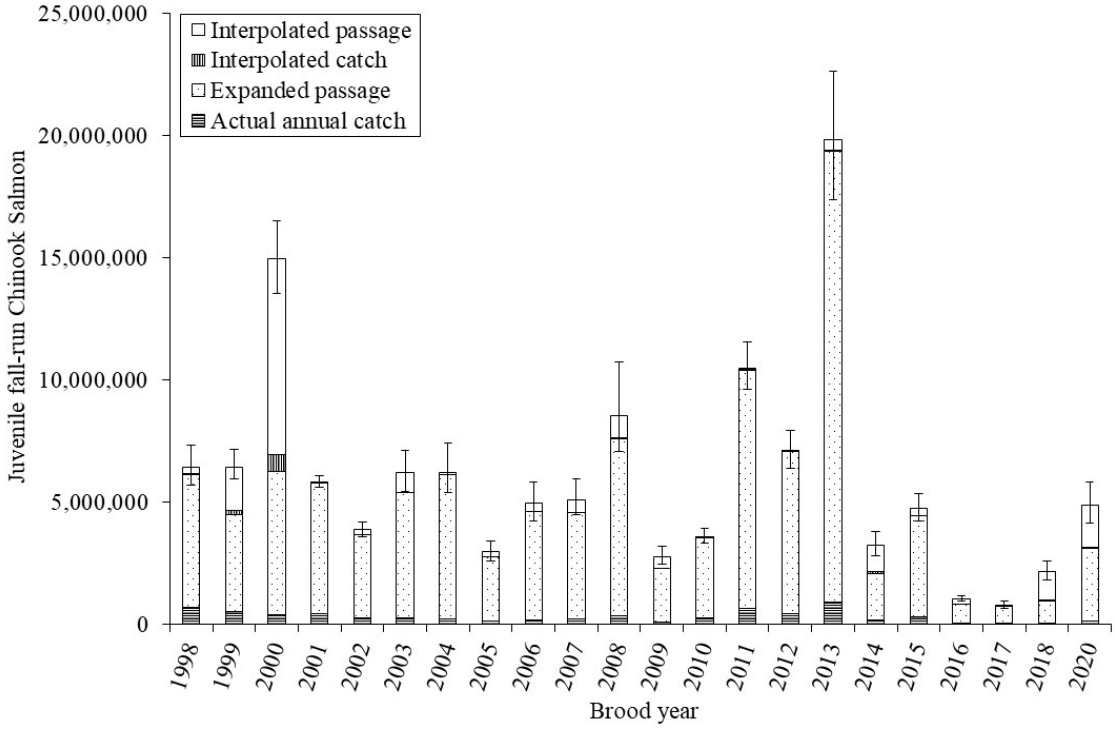

Figure 19. Annual passage indices of fall-run Chinook Salmon by brood year at the lower Clear Creek rotary screw trap from 1998 to 2020. Passage data from brood year 2019 are being summarized at the time of this report; delays in report development were due to COVID-19 related issues. USFWS-Red Bluff unpublished data.

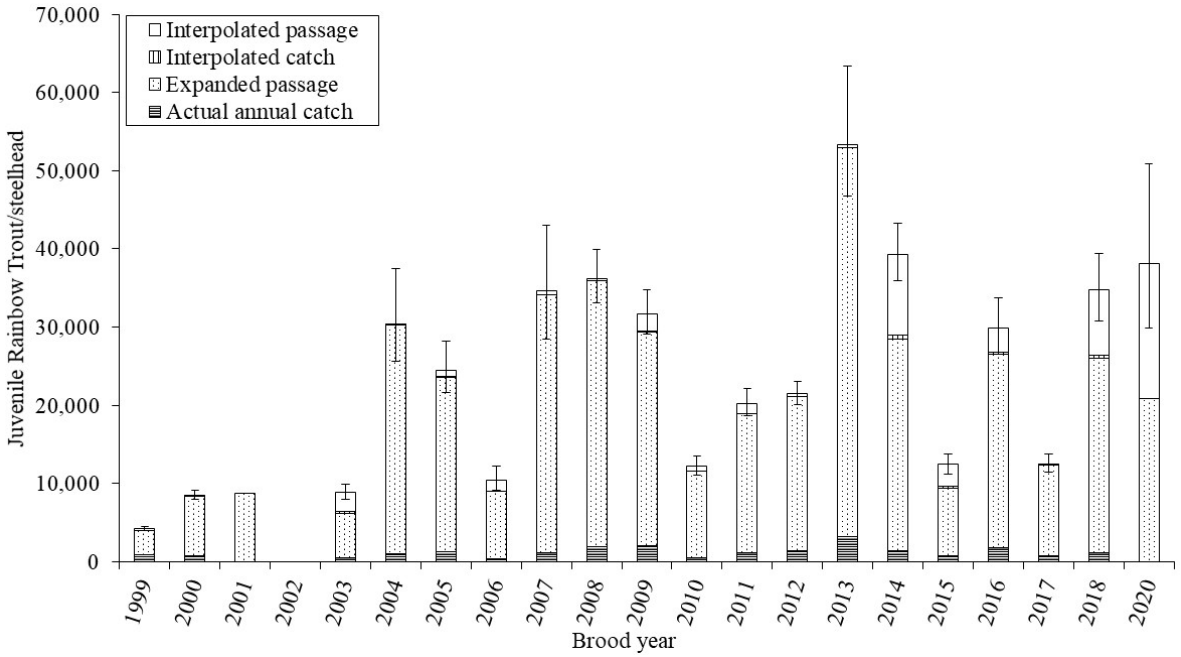

Figure 20. Annual passage of rainbow trout/steelhead by brood year at the Lower Clear Creek rotary screw trap from 1999 to 2020. There is no passage index for brood year 2019 because the trap was not fished during peak out-migration due to COVID-19 stay at home orders. USFWS-Red Bluff unpublished data.

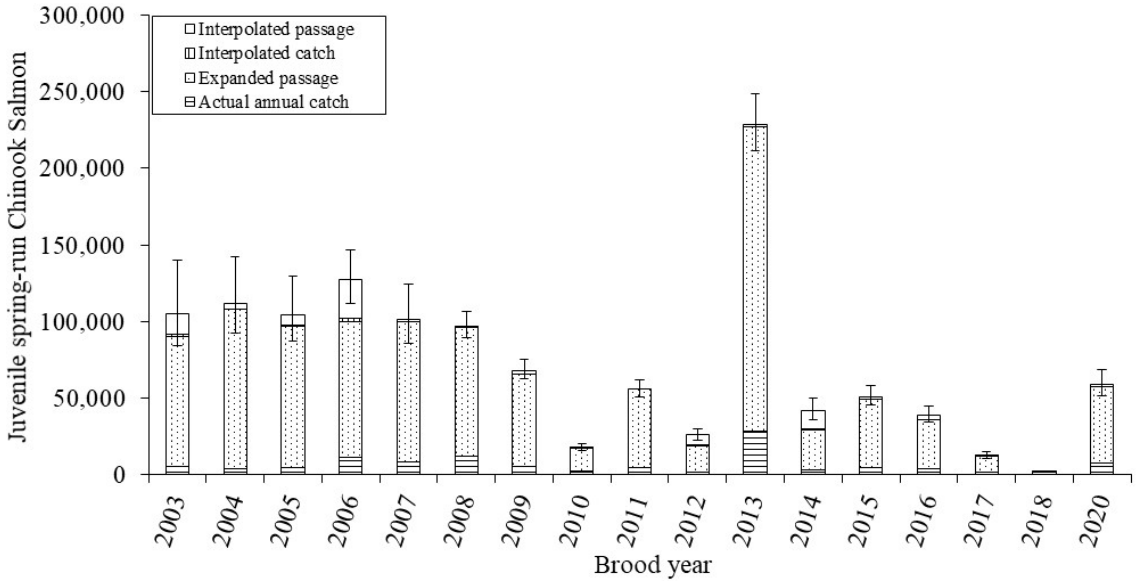

Figure 21. Annual passage of juvenile spring-run Chinook Salmon by brood year at the upper Clear Creek rotary screw trap from 2003 to 2020. Passage data from brood year 2019 are being summarized at the time of this report; delays in report development were due to COVID-19 related issues. USFWS-Red Bluff 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 water year 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. During high turbidity events when visibility on the underwater and overhead cameras is low to zero, ARIS sonar is used to record Chinook Salmon passage. Video and sonar 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 2020, revealed 172 adult spring-run Chinook Salmon passed upstream at the video weir near the mouth CI = [112, 217]. In 2020, 172 were reported to CDFWs GrandTab (Azat 2021). The video and sonar analyses for 2021 will be completed over the winter. Preliminary estimates indicate over 2,000 spring-run Chinook Salmon were recruited into Clear Creek in 2021. Final estimates will be communicated and published to the GrandTab.

The annual adult spring-run Chinook Salmon population index snorkel survey count occurs in late August, just prior to spawning. In 2021, air smoke from local fires made completing all sections of this survey impossible. Surveying was only completed above the Gorge Cascade. Despite only surveying part of the stream, 1,246 spring-run Chinook Salmon were observed (Figure 22). Both the preliminary video station estimate and partial August index snorkel count indicate that the BY 2021 spring-run Chinook Salmon is the largest on record (Figure 23).

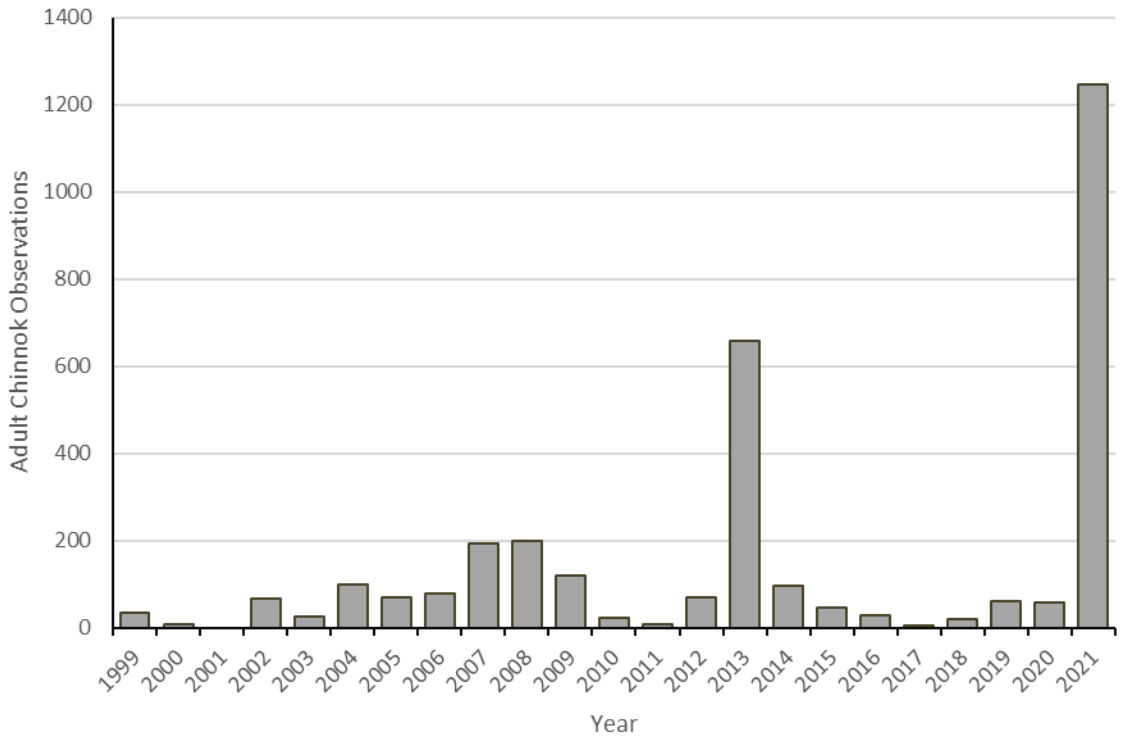

Figure 22. Clear Creek spring-run Chinook Salmon August Index 1999 to 2021. USFWS-Red Bluff unpublished data.

Figure 23. Spring-run Chinook Salmon in Clear Creek in a deep pool. Holding habitat for these fish improves as they migrate upstream. Note the decomposed granite coating the bottom of the pool. Photo credit: Derek Rupert, Bureau of Reclamation.

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 6,631 fall-run Chinook Salmon entered Clear Creek in 2020 (Azat 2021).

Late-fall run Chinook Salmon

The estimated late fall-run Chinook Salmon population was 130 adults. This number was calculated by applying an expansion factor of 2.75 on the 47 late-fall run Chinook Salmon redds that were observed during the survey season (December 28, 2020–April 2, 2021). 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 2021, the weir was installed on August 10th and closed to upstream fish passage on August 31st. As of October 10th, the weir has been "fish-tight" (i.e., adult Chinook salmon could not pass through it), and no schooling of fish have been observed downstream of the weir. A total of 101 Chinook Salmon carcasses have been collected and sampled from the upstream side of the weir between September 9, 2021, and October 12, 2021. Of the carcasses recovered to date, 93 have been unmarked (adipose fin present), 2 have been marked (adipose fin absent), and 6 were of unknown mark status. The heads of the marked and unknown mark status carcasses were recovered for possible coded wire tag retrieval. Absence of an adipose fin and/or the presence of a coded wire tag indicates that the fish is from a hatchery. Based on varying carcass condition and level of senescence, 96 were sampled for future genetic analysis.

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 2021 indicates a continuing "recovery" of spawning habitat area following the fine sediment inundation from the 2018 Carr Fire, with more spawning habitat mapped in 2021 (907,569 ft^2) when compared to 2019 (573,051 ft^2) and 2020 (Figure 24). Total suitable spawning area mapped in 2021 is still less than the average habitat mapped 2011–2018, primarily from reduction in habitat in "Renshaw Riffle" (RM 5–5.5), which is a key area for fall-run Chinook Salmon spawning.

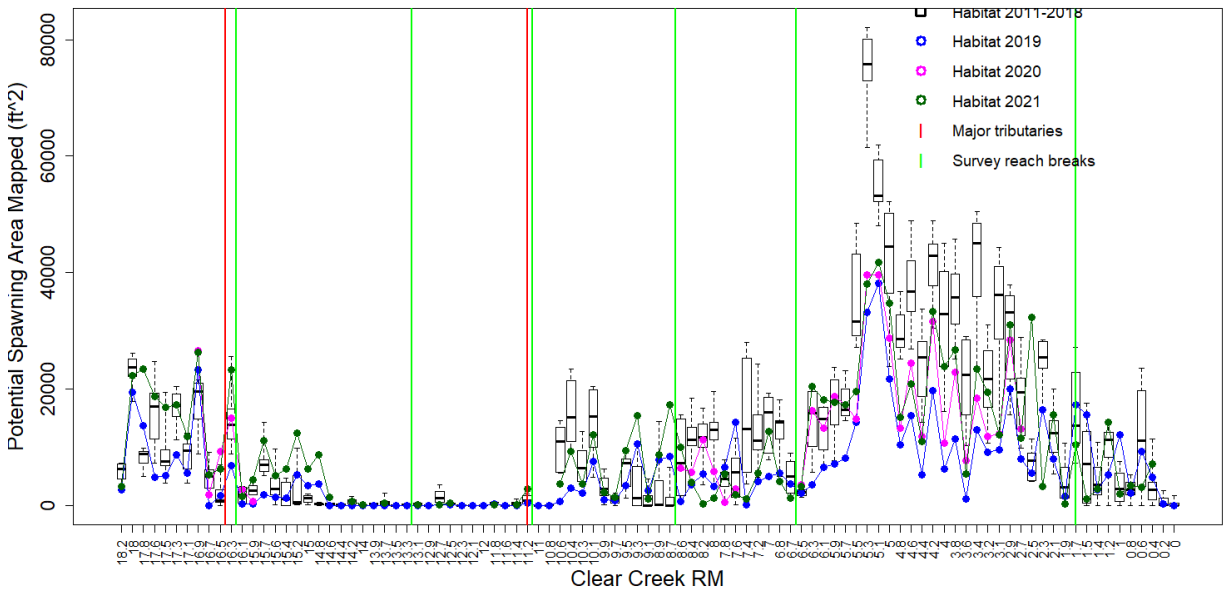

Figure 24. Anadromous fish spawning habitat mapped on Clear Creek 2011–2021. The X-axis indicates river mile breaks of roughly 1,000 ft. The Y-axis indicates the magnitude of habitat within each break. Years 2011–2018 are displayed by boxplot, 2019, 2020 and 2021 are presented as points. In 2020 only 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). There were 389,174 ft^2 of spawning area mapped for BY 2020 fall-run Chinook Salmon (Figure 25).

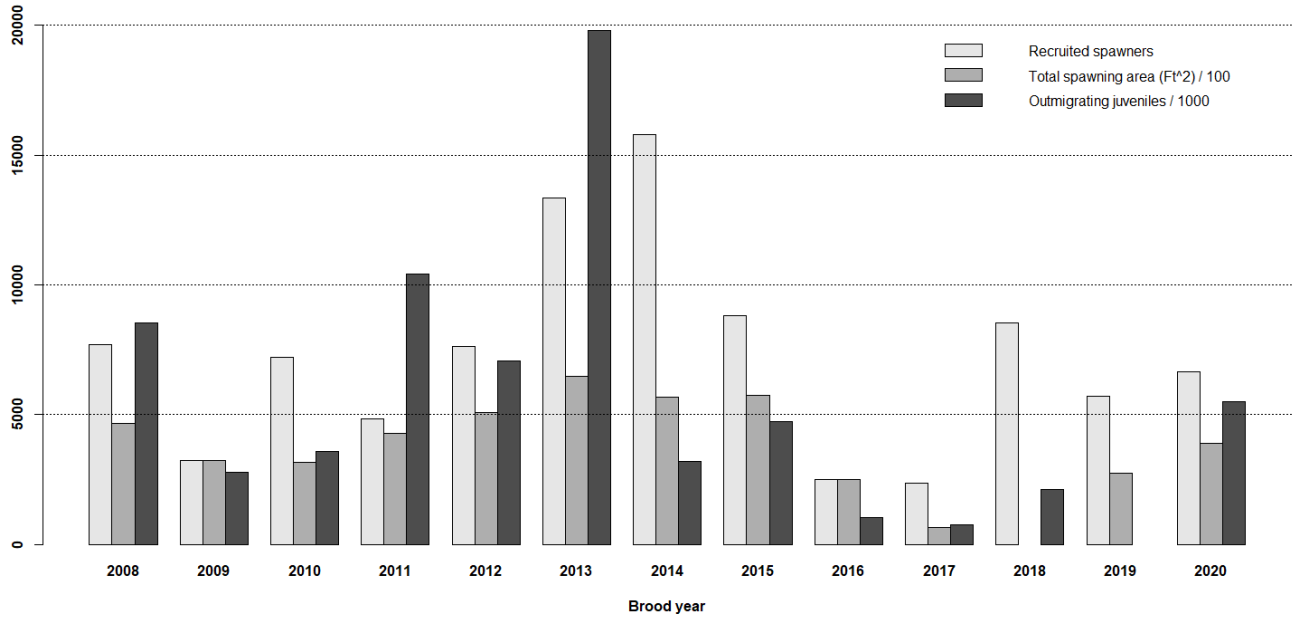

Figure 25. Area of spawning, adult escapement, and juvenile escapement fall-run Chinook Salmon 2008 to 2020. Total recruited spawners (light grey bar, Azat 2021). The combined total area of spawning disturbance, or spatial union of the October and December survey (ft^2) divided by 100 (dark grey bar). 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 26).

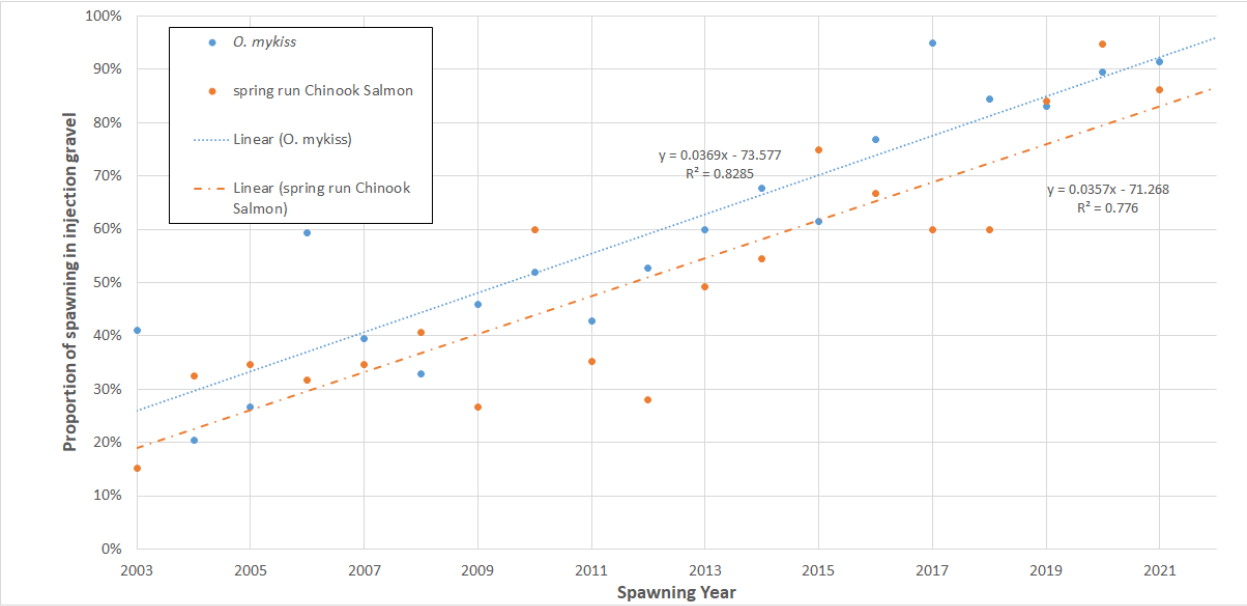

Figure 26. Annual proportion of spring-run Chinook Salmon and steelhead spawning in injection gravels, 2003–2021. Results limited to Clear Creek upstream of the spring- and fall-run Chinook Salmon separation weir. USFWS-Red Bluff unpublished data.

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" survey with the intent of quantifying spring-run Chinook Salmon spawning. In the 2020-2021 kayak season, five surveys were completed between late December 2020 and the first week in April 2021. The surveys observed 47 late-fall and 371 *O. mykiss* redds. Additionally, six late-fall Chinook Salmon carcasses were retrieved, four of which were marked (adipose absent). Coded wire tags revealed that all marked carcasses were late fall-run Chinook Salmon from Coleman National Fish Hatchery.

As of the writing of this report, two snorkel-based spawning ground surveys have been completed during the 2021 spring-run Chinook Salmon spawning season (in areas upstream of the separation weir. Surveyors have observed and mapped 486 redds upstream of the separation weir (Figure 27) where they are attributed to spring-run Chinook Salmon. Additionally, survey crews have sampled 92 Chinook Salmon carcasses for genetic analysis, only 6 of which were marked or 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.

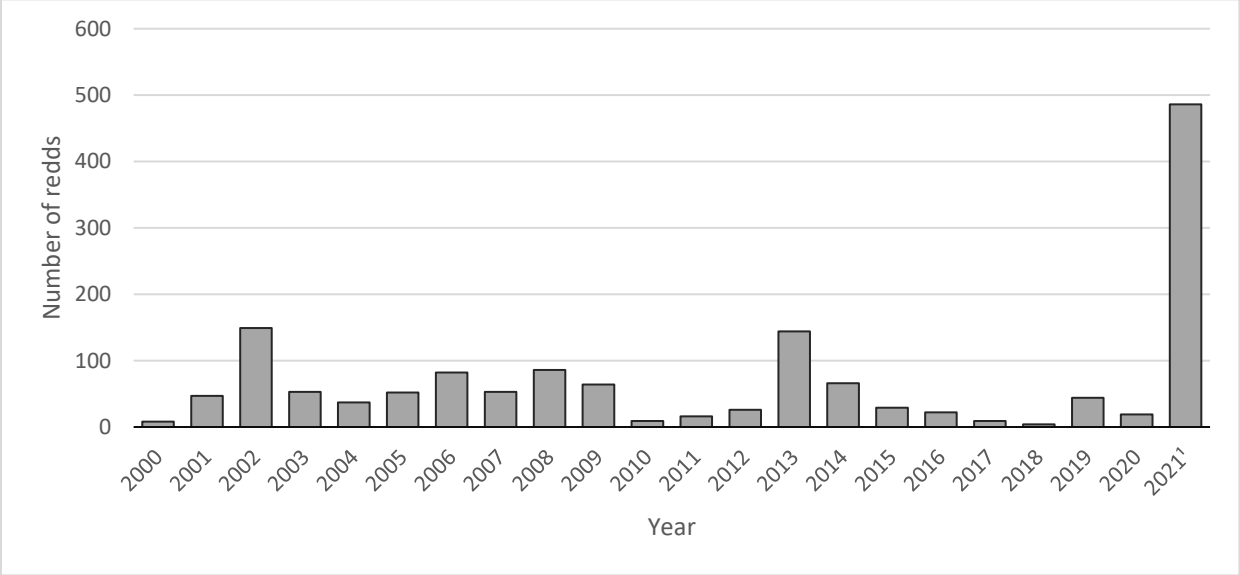

Figure 27. Number of spring-run Chinook Salmon redds observed above the segregation weir on USFWS spawning surveys from 2000- 2021. Note the 2021 redd count is not final and reflects surveying completed through 10/15/2021. USFWS-Red Bluff unpublished data.

Additional details on USFWS monitoring of Clear Creek can be found in published reports or by contacting Charlie Chamberlain, RBFWO.

CHAPTER 5. References

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.

Azat, J. 2021. California Central Valley Chinook Population Database Report. California Department of Fish and Wildlife. Updated on June 30, 2021 by Jason Azat, Fisheries Branch, Anadromous Resources Assessment. 25 pp. Available at: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=193361&inline=1.

National Marine Fisheries Service (NMFS). 2019. Biological Opinion on Long Term Operation of the Central Valley Project and State Water Project. WCRO-2016-00069.

Yurok Tribe Design Team. 2019. Lower Clear Creek Floodplain and Stream Channel Restoration Project, Phase 3C 90% Design. A report prepared for Bureau of Reclamation.

Yurok Tribe Design Team. 2021. Lower Clear Creek Floodplain and stream Channel Restoration Project, Phase 3C Revegetation As-Built Final Report. A report prepared for the Bureau of Reclamation.