

2018 Clear Creek Technical Team Annual Report for the Coordinated Long-Term Operations Biological Opinion

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Acronyms and Abbreviations

ACID	Anderson-Cottonwood Irrigation Diversion
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
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
DWR	Department of Water Resources
FWS	U.S. Fish & Wildlife Service
GMA	Graham Matthews and Associates
IFIM	Instream Flow Incremental Methodology
LCC	Lower Clear Creek
LCCFRP	Lower Clear Creek Floodway Restoration Project
NMFS	National Marine Fisheries Service
NPS	National Park Service
OBTCC	Oak Bottom Temperature Control Curtain
Reclamation	U.S. Bureau of Reclamation
RPA	Reasonable and Prudent Alternative
RWQCB	Regional Water Quality Control Board
SCTCC	Spring Creek Temperature Control Curtain
SWP	State Water Project
USFWS	U.S. Fish and Wildlife Service
WSRCD	Western Shasta Resource Conservation District

CHAPTER 1. BACKGROUND

1.1 Brief background on 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 spring-run Chinook Salmon (*Oncorhynchus tshawytscha*) and California Central Valley (CCV) steelhead (*O. mykiss*; Figure 1) within the Clear Creek watershed. The Clear Creek Technical Team (CCTT) has been working since 1996 to facilitate implementation of these CVPIA and CALFED restoration actions. Team attendance and participation have varied over the years depending on what topics are being covered in the meetings. The majority of the topics had involved physical habitat restoration. Since 2009, topics have included NOAA's National Marine Fisheries Service's (NMFS) Coordinated Long-Term Operations (CLTO) biological opinion (BO) Reasonable and Prudent Alternative (RPA) actions including flow and temperature management on Clear Creek.

Since being established, the Clear Creek Restoration Program (CCRP) 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 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:

- a near four-fold increase in escapement of fall-run Chinook Salmon to Clear Creek (population estimate average = 1,749 from 1967 to 1991, and 7,333 from 1992-2017);
- re-established use of Clear Creek by Federally listed Endangered Species Act (ESA) threatened CV 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; and
- increased the amount of salmonid spawning habitat.

1.2 Current Active Members

Jahnava Duryea, NMFS

Mike Berry, CDWR

Tricia Bratcher, CDFW

Laura Brodhead, BLM

Matt Brown, USFWS

Leslie Bryan, Redding Electric Utility

Charles Chamberlain, USFWS

Guy Chetelat, RWQCB

Eda Eggeman, CDFW

Sarah Gallagher, NMFS

Alicia Herrera, Point Blue

Matt Johnson, CDFW

Doug Killam, CDFW

Ross Perry, WSRCD

Derek Rupert, USBR

Russ Weatherbee, NPS

Paul Zedonis, USBR

Additional people from various agencies and entities participate on a less frequent basis.

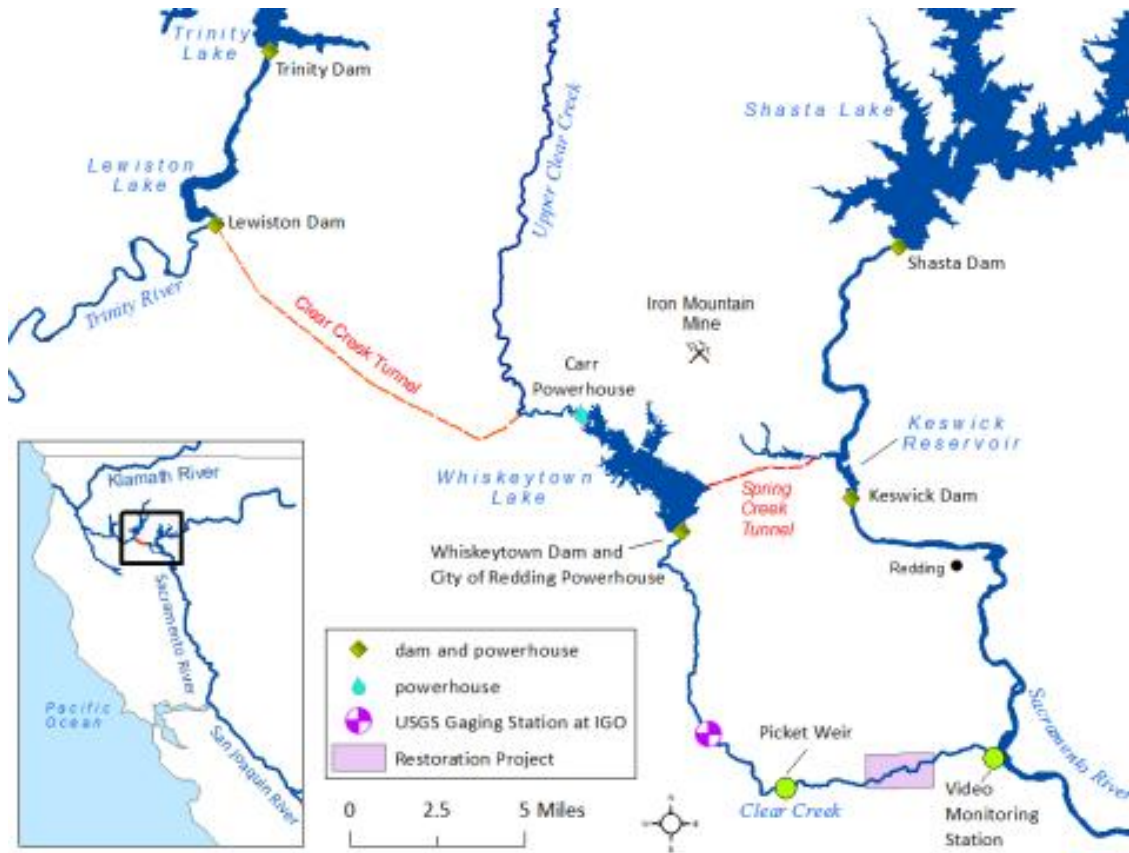


Figure 1. Location of Lower Clear Creek in Northern California, showing Trinity, Whiskeytown, and Shasta reservoirs and related CVP facilities.

1.3 List of Clear Creek Technical Team Discussions:

The following CCTT meetings (with general list of discussions) occurred since the 2017 Report:

December 7, 2017

- Gravel management plan for 2018
- Fisheries monitoring update
- Lower Clear Creek Floodway Restoration Project (LCCFRP) Phase 3C updates
- Spring pulse flow 2017 review
- Spring pulse flow 2018 planning
- Termination of the LCC Aquatic Habitat and Mercury Abatement Project
- Western Shasta RCD updates

March 15, 2018

- Phase 3B Completion Project
- Details on the Science Integration Team
- CVPIA Annual Work Plan 2019
- RPA reporting
- Fisheries monitoring updates
- Sarah Gallagher's new role with NMFS
- LCCFRP Phase 3C update
- Redding Rancheria participation
- Long-term gravel management
- Spring pulse flows in spring 2018
- Lamprey passage at Anderson-Cottonwood Irrigation District (ACID) diversion

June 21, 2018

- Extensive Phase 3C 60% design presentation
- Gravel augmentation update
- Presentation on the use of remote stream incubators
- Spring pulse flow update
- Snorkel survey update

September 20, 2018

- Further discussion on the Phase 3C design, permitting, and schedule
- Discussion on the Carr Fire's effects on Clear Creek, and the BAER Teams findings
- Discussion on the temperature management procedures and how to best operate Whiskeytown dam to meet RPA temp targets
- Review of the 2018 gravel augmentations and the work of the CCTT gravel sub-group
- Discussed the RPA reporting and draft reviews
- Discussed the Phase 3B Completion Charter and the history of the bond crisis and wetland balance
- General updates on fisheries

CHAPTER 2. SUMMARY OF CLEAR CREEK RPA ACTIONS

RPA Action Item	Progress in WY 2018
I.1.1. Spring Attraction Flows	Yes
I.1.2. Channel Maintenance Flows	No
I.1.3 Gravel Augmentations	Yes
I.1.4. Replace Temperature Curtain	Yes
I.1.5. Thermal Stress Reduction	Yes
I.1.6. Adaptively Manage to Habitat Suitability / IFIM Study Results	Yes
Other required monitoring and operations	Yes

Implementation of RPA Actions in WY 2018

2.1.1 Action I.1.1. Spring Attraction Flows

Objective: *Encourage spring-run movement to upstream Clear Creek habitat for spawning.*

Action: *“Reclamation shall annually conduct at least two pulse flows in Clear Creek in May and June of at least 600 cfs for at least three days for each pulse, to attract adult spring-run holding in the Sacramento River main stem. This may be done in conjunction with channel-maintenance flows (Action I.1.2)”.*

Results: Two pulse flows were provided from Whiskeytown Dam (Table 1). The timing was chosen to coincide with previously observed peak adult spring-run Chinook Salmon migration (Figure 2), and replicate the spring-run Chinook Salmon attraction success observed during past June pulse flows. Video monitoring results of previous years have suggested that spring-run 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.

Table 1. 2018 Clear Creek pulse flow timing, duration, and magnitude.

Date (includes ramping)	Peak
June 2 to 10	700 cfs
June 16 - 25	800 cfs

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 water 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 currently being evaluated by the Red Bluff U.S. Fish & Wildlife Office (RBFOW) to characterize spring-run Chinook Salmon passage through the entire emigration period, and to look for a detectable response to the spring pulse flows. Video and sonar reading are not yet complete at the time of this report. We anticipate 2018 to be a tough year to draw inferences about spring-run Chinook Salmon response due to extreme low run size into Clear Creek.

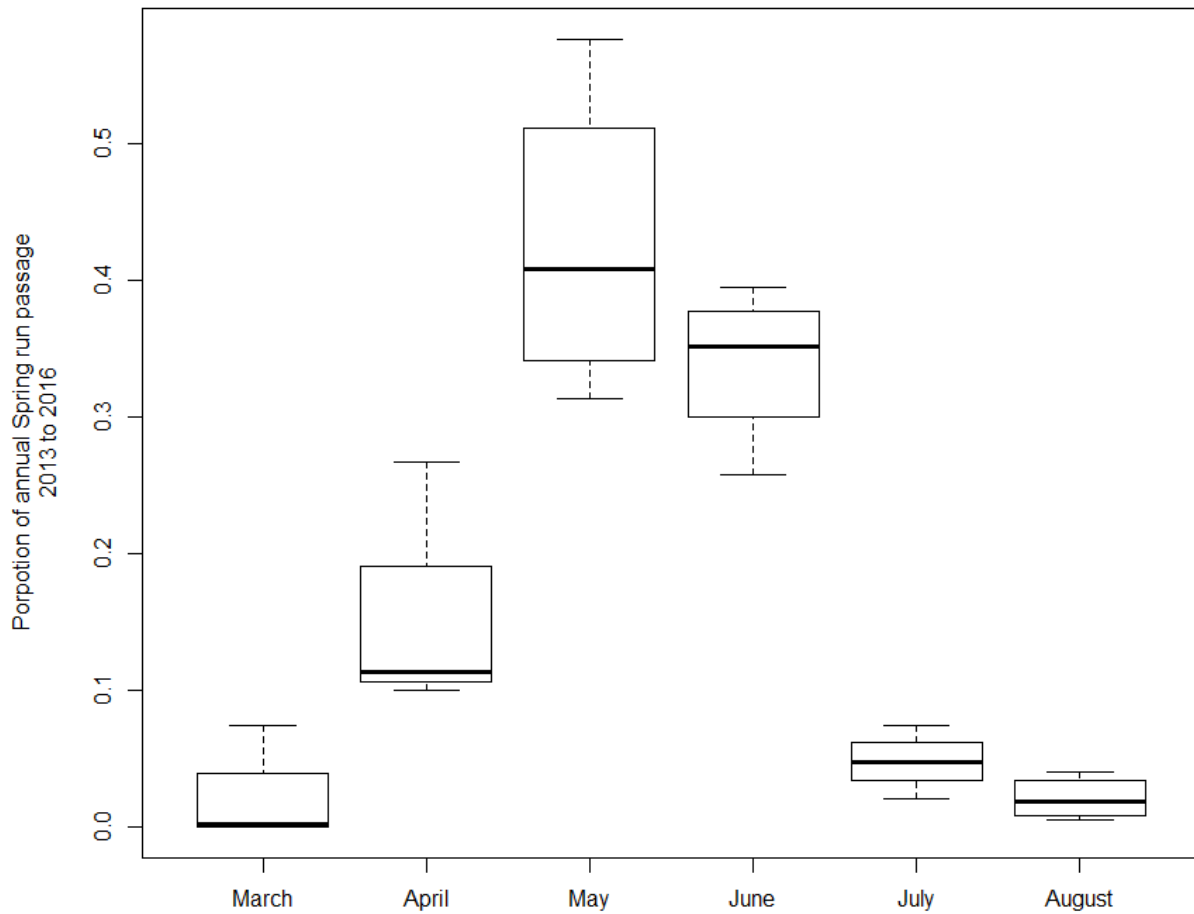


Figure 2. Proportion of annual spring-run Chinook Salmon passage by month at the Clear Creek Video Station (CCVS) from 2013 to 2016.

Snorkel surveys are conducted before and after each pulse flow to help determine the response of spring-run Chinook Salmon to the flow action. These surveys provide 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 3). Though few fish were observed on any survey this year, the number observed increased with each pulse flow (Table 2), and the distribution of observations shifted upstream (Figure 3).

Table 2. Clear Creek spring-run Chinook Salmon observed during 2018 snorkel surveys.

Survey	Adult	Jack
Pre-pulse May 31 to June 1	6	3
Between pulse 1 and 2 June 11 to 14	9	1
After pulse 2 June 25 to 28	18	1
August index survey August 20 to 22	15	3

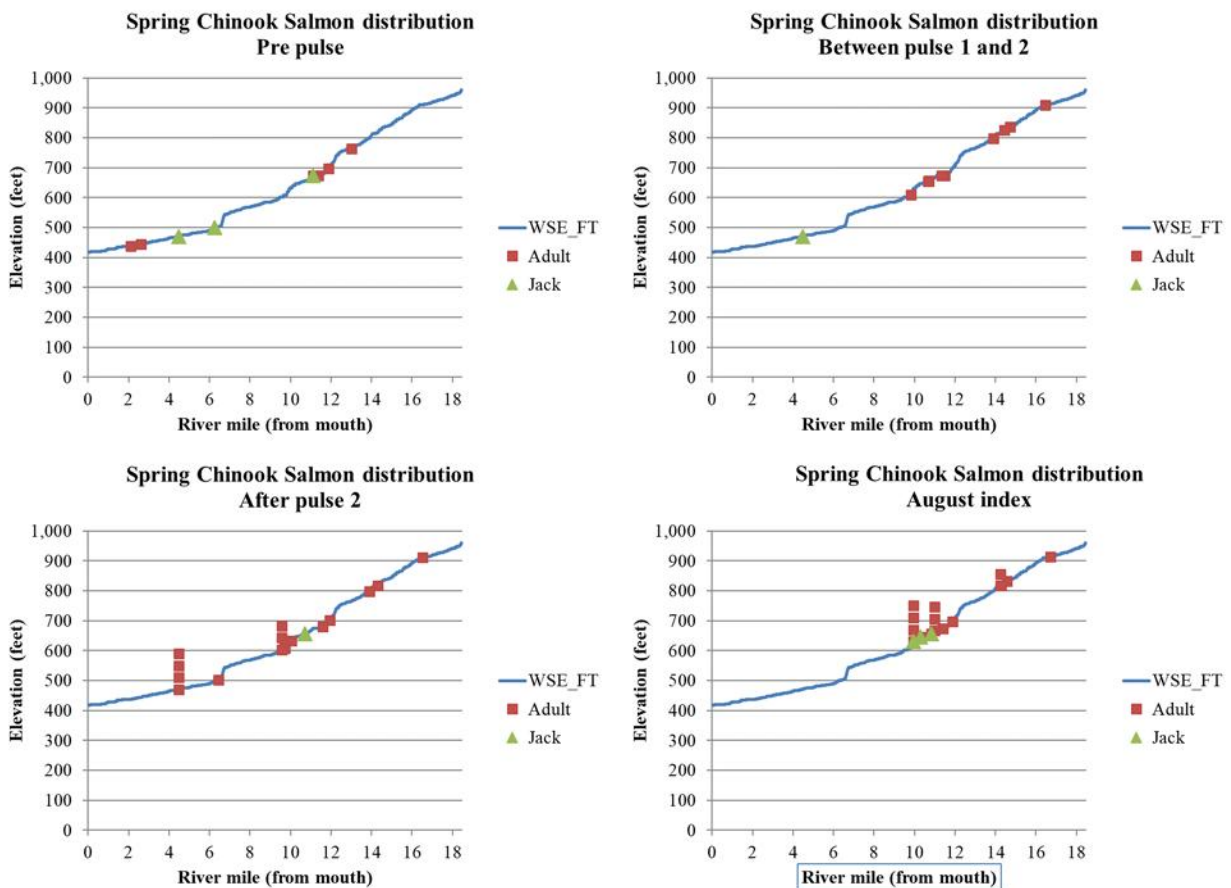


Figure 3. Distribution of adult spring-run Chinook Salmon observed during snorkel surveys 2018. Snorkel surveys were conducted before and after each pulse, and in August for the annual population index. WSE_FT equals the water surface elevation of Clear Creek.

The adult spring-run Chinook Salmon annual population index snorkel survey count occurs in late August just prior to spawning. In 2018, the spring-run Chinook Salmon population index was 18 (Figure 4). All were observed upstream of the location of the segregation weir - a weir that is installed in late August near Reading Bar that helps ensure segregation of adult spring- and fall-run Chinook Salmon to limit the potential for interbreeding and redd superimposition. The segregation weir location is at about river mile 8.2.

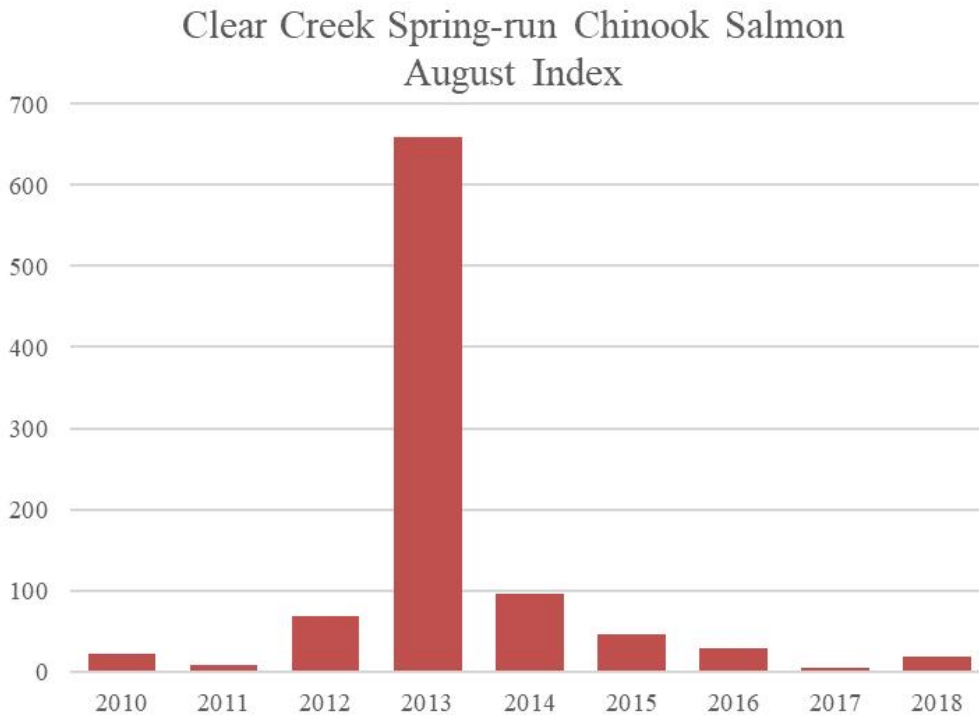


Figure 4. Clear Creek spring-run Chinook Salmon August Index 2010 to 2018.

2.1.2 RPA Action I.1.2. Channel Maintenance Flows

Objective: *Minimize project effects by enhancing and maintain previously degraded spawning habitat for spring-run Chinook Salmon and CV steelhead.*

Action: *“Reclamation shall re-operate Whiskeytown Glory Hole spills during the winter and spring to produce channel maintenance flows of a minimum of 3,250 cfs mean daily spill from Whiskeytown for one day, to occur seven times in a ten-year period, unless flood control operations provide similar releases. Re-operation of Whiskeytown Dam should be implemented with other project facilities described in the Environmental Water Program (EWP) Pilot Program”.*

Results: Progress on this RPA action through the Clear Creek Environmental Water Program (EWP) has been on hold for many years. While pre-project monitoring has continued under CVPIA funding, all other efforts to implement such flows ceased pending the Central Valley Operations (CVO) review of the technical memos.

A review by Reclamation’s Dam Safety Office (DSO) on the implementation of EWP flows was completed in 2018. Reclamation has determined that the safety risks inherent in EWP are too

great and that the EWP flows will not be implemented. An official memorandum from Reclamation was issued on Oct 30, 2018. This decision inhibits the ability of Whiskeytown Dam releases to produce channel maintenance flows, using glory hole uncontrolled spill.

2.1.3 RPA Action I.1.3. Spawning Gravel Augmentation

Objective: Enhance and maintain previously degraded spawning habitat for CV spring-run Chinook Salmon and CV steelhead.

Action: “Reclamation, in coordination with the Clear Creek Technical Team, shall continue spawning gravel augmentation efforts. By December 31 each year, Reclamation shall provide a report to NMFS on implementation and effectiveness of the gravel augmentation program”.

Results: The gravel augmentation program on Clear Creek is assessed empirically by identifying the habitat used by CV spring-run Chinook Salmon and CCV steelhead for spawning, and by annually surveying the amount of habitat available for spawning by these species. Over the last 15 years, the proportional use of injected gravels vs. native gravels has increased for both spring-run Chinook Salmon and steelhead (Figure 4).

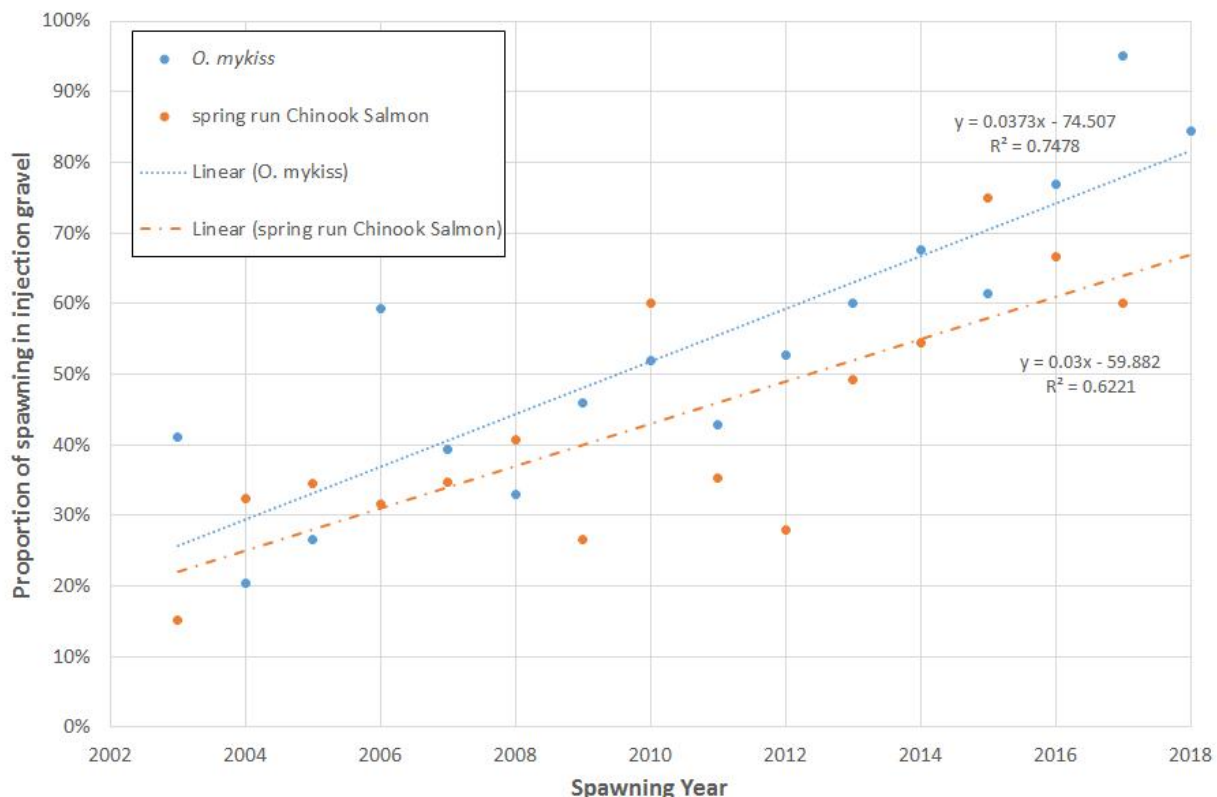


Figure 5. Annual proportion of spring-run Chinook Salmon and steelhead spawning in injection gravels, 2003-2017. Results limited to Clear Creek upstream of the spring and fall-run segregation weir.

The injection augmentation program on Clear Creek continues to enhance the spawning habitat available for CV fall and spring-run Chinook salmon and CCV steelhead. Ten thousand total tons of gravel were injected in July and August 2018 at five sites in Clear Creek (Table 2).

Table 3. Clear Creek gravel program quantities 2018.

Location	Amount (tons)
Below Dog Gulch	2,000
Paige Bar	0 (Redistribution only)
Guardian Rock	2,000
Placer Road Bridge	2,000
Clear Cr Road Bridge	2,500
Above Phase 3A	2,500
Total	10,000

2.1.4 RPA Action I.1.4. Spring Creek Temperature Control Curtain

Objective: *Reduce adverse impacts of project operations on water temperature for listed salmonids [Sacramento River winter-run Chinook Salmon, CV spring-run Chinook Salmon, CCV steelhead] in the Sacramento River.*

Action: *“Reclamation shall replace the Spring Creek Temperature Control Curtain in Whiskeytown Lake by 2011”.*

Results: Replacement of the broken Spring Creek Temperature Control Curtain (SCTCC) in 2011 was one component of a strategy intended to reduce the temperature of water diverted via the Spring Creek Tunnel to Keswick Reservoir that mixes with Shasta Dam released water before being discharged to the Sacramento River below Keswick Dam. This down-reservoir curtain was designed to allow the withdrawal of primarily the cold hypolimnetic waters from Whiskeytown Reservoir. The Oak Bottom Temperature Control Curtain (OBTCC; replacement installed in May 2016), which is located at the upper end of Whiskeytown Reservoir is intended to enhance coldwater transport from the upper end of the reservoir to the lower reservoir outlets including Spring Creek Tunnel and Whiskeytown Dam. Initial modeling results showed the functional OBTCC can exert even more influence on water temperatures than the SCTCC. The CCTT recognizes the importance of having the SCTCC and OBTCC functioning together in tandem to enhance coldwater availability to both outlets. A contemporary evaluation of the performance at both temperature curtains is being conducted by Reclamation’s Technical Service Center. Data collections are ongoing in 2018, with a final report expected in early 2019.

2.1.5 RPA Action I.1.5. Thermal Stress Reduction

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

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

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

Reclamation, in coordination with NMFS, will assess improvements to modeling water temperatures in Clear Creek and identify a schedule for making improvements.”

Results: In 2018, *Thermal Stress Reduction* water temperature criteria were met at Igo for all but one of the 106-day period for holding (maximum mean daily 60°F; Table 3 & Figure 5). In an attempt to move spring-run Chinook Salmon to upstream habitat, CVO was asked to manage flow and gate configurations at Whiskeytown Dam to warm water temperatures in the lower watershed, while still meeting holding criteria at IGO. CVO successfully managed water temperature close to the 60°F criteria, only exceeding criteria one day. Extenuating circumstances involving the Carr wild fire (and others) also affected water temperatures. Dense smoke reduced sun light intensity and Lower Clear Creek water temperatures for a time. However, the fire also interrupted water and powerhouse operations which reduced the volume of cold Trinity River water diverted to Whiskeytown Lake. The low spring-run Chinook Salmon run size inhibits evaluation of effectiveness of this approach as the sample size is very low. We look forward to continuing this approach and evaluating its effectiveness with larger future run sizes.

Spawning/incubation criteria (maximum mean daily 56°F) were met for all but 4 days for the spawning period (Table 3 & Figure 5). In 2018, like other years with warm dry fall seasons, CVO flow management has occasionally not been able to meet temperature targets as the reservoir begins to run out of cold water pool. Temperature targets at Igo are sometimes able to be addressed with additional release of cold water. By the end of the spawning/incubation criteria period this year however, the cold water pool of Whiskeytown Lake was exhausted.

Table 4. Proportion of days that water temperatures at Clear Creek IGO gage met targets.

Year	Holding temperature $\leq 60^{\circ}\text{F}$ June 1 to Sept 14	Spawning temperature $\leq 56^{\circ}\text{F}$ Sept 15 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%

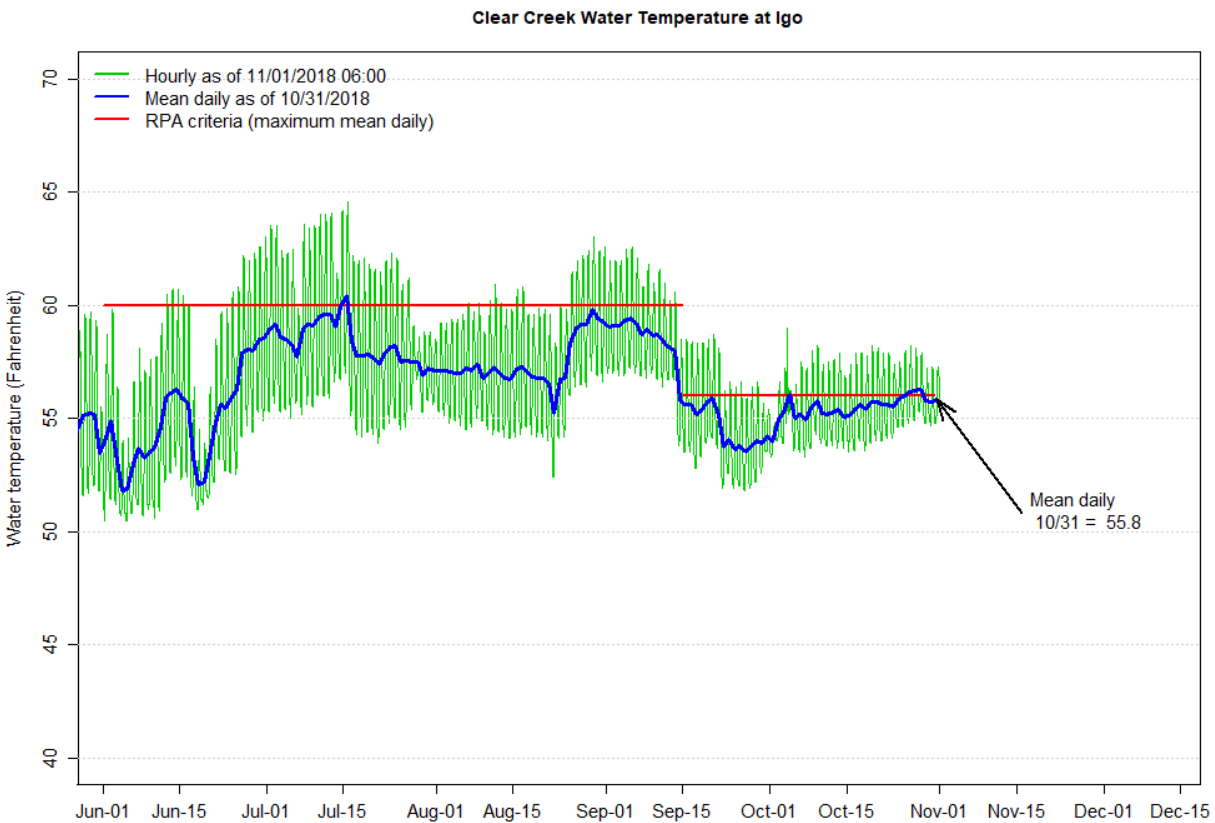


Figure 6. Water temperature at Igo in 2018 compared to the daily average RPA criteria for spring-run Chinook Salmon holding (60°F June 1 to September 15) and spawning and incubation (56°F September 15 to October 31).

Reclamation has not yet assessed improvements to modeling water temperatures in Clear Creek nor identified a schedule for making improvements. The 2011 amendment to the 2009 RPA, Section 11.2.1.2 (page 10) states that the “*Temperature monitoring and modeling identified in RPA Action I.1.5*” is one of the five “*specific research projects that have been identified as important to begin in the first year and complete as soon as possible*”.

In April 2011, NMFS wrote to Reclamation amending the 2009 BO. One of the purposes of the letter was to: “(4) *highlight the need... to explore options to avoid non-compliance with the RPA*”. This was specifically related to this action.

In 2011 the Independent Review Panel stated:

“The IRP believes that a model for management of Whiskeytown Reservoir would be valuable... The panel suggests that a more quantitative model-based program is needed to efficiently utilize the limited cold water resources in the Central Valley reservoirs... take real definitive actions to better coordinate the temperature control programs and commit real resources... includes alternative operations like seasonal shifts in Trinity River diversions to maintain cold water moving through the reservoir to the Sacramento River... measuring and reporting real-time water column temperatures in the reservoirs and possibly additional stations in the Sacramento River and tributaries that impact water temperature.”

In late 2016, Reclamation engaged with interested parties to work towards improving and refining computational tools for effective temperature management. Recent drought and associated impacts to fish species have increased attention on water temperature management and the challenges associated with limited water supply. Reclamation has partnered with stakeholders, stakeholder resources, and agencies, forming a collaborative model development process to enhance temperature modeling capabilities of the Upper Sacramento River. The first phase focuses on developing a model for Shasta and Keswick reservoirs. Future plans include expanding the model domain to capture the inter-connections of the Trinity-Sacramento river systems that will include Whiskeytown Reservoir.

2.1.6 RPA Action I.1.6. Adaptively Manage to Habitat Suitability/IFIM Study Results

Objective: *Decrease risk to Clear Creek spring-run and CV steelhead population through improved flow management designed to implement state-of-the-art scientific analysis on habitat suitability.*

Action: *“Reclamation shall operate Whiskeytown Reservoir as described in the Project Description with the modifications in Action I.1 until September 30, 2012, or until 6 months after current Clear Creek salmonids habitat suitability (e.g. IFIM [Instream Flow Incremental Methodology]) studies are completed, whichever occurs later.*

Reclamation will, in conjunction with the CCTWG, assess whether Clear Creek flows shall be further adapted to reduce adverse impacts on spring-run and CCV steelhead, and report their findings and proposed operational flows to NMFS within six months of completion of the studies. NMFS will review this report and determine whether the proposed operational flows are sufficient to avoid jeopardizing spring-run and CV steelhead or adversely modifying their critical habitats.

Reclamation shall implement the flows on receipt of NMFS' written concurrence. If NMFS does not concur, NMFS will provide notice of the insufficiencies and alternative flow recommendations. Within 30 days of receipt of non-concurrence by NMFS, Reclamation shall convene the CCTWG to address NMFS' concerns. Reclamation shall implement flows deemed sufficient by NMFS in the next calendar year."

Results: The FWS began an IFIM study on Clear Creek in 2004 looking at flow habitat relationships for salmon and steelhead. The results of the study are contained in four final reports. In addition, a fifth report known as the "Synthesis Report" takes the findings of the four IFIM studies and recommends flows based on flow habitat relationships. A final flow recommendation from Reclamation from these reports has not yet been proposed, but a conceptual process for developing annual flow needs for Clear Creek that considers more holistic needs of Clear Creek salmonid populations has been discussed with the CCTT.

The CCTT has proposed to include 5 types of flow in this approach, including flows to:

- meet habitat needs based on IFIM and habitat suitability study results;
- provide temperature control;
- move and maintain spawning gravels and create and maintain riparian vegetation;
- avoid fish and redd stranding / dewatering; and
- encourage anadromy of steelhead/Rainbow Trout through an adaptive management approach.

The CCTT (which includes a NMFS representative) intends this effort to address and meet the needs of both this RPA (Action I.1.6), *and* meet need of the CVPIA Clear Creek Restoration Program, which has a mandate under CVPIA to provide a long-term flow prescription to mitigate for the impacts of the CVP. Working with NMFS and the CCTT, Reclamation should continue to assess Clear Creek flows and determine if they should be further adapted to reduce adverse impacts on spring-run Chinook and steelhead and encourage the restoration of Clear Creek salmonids.